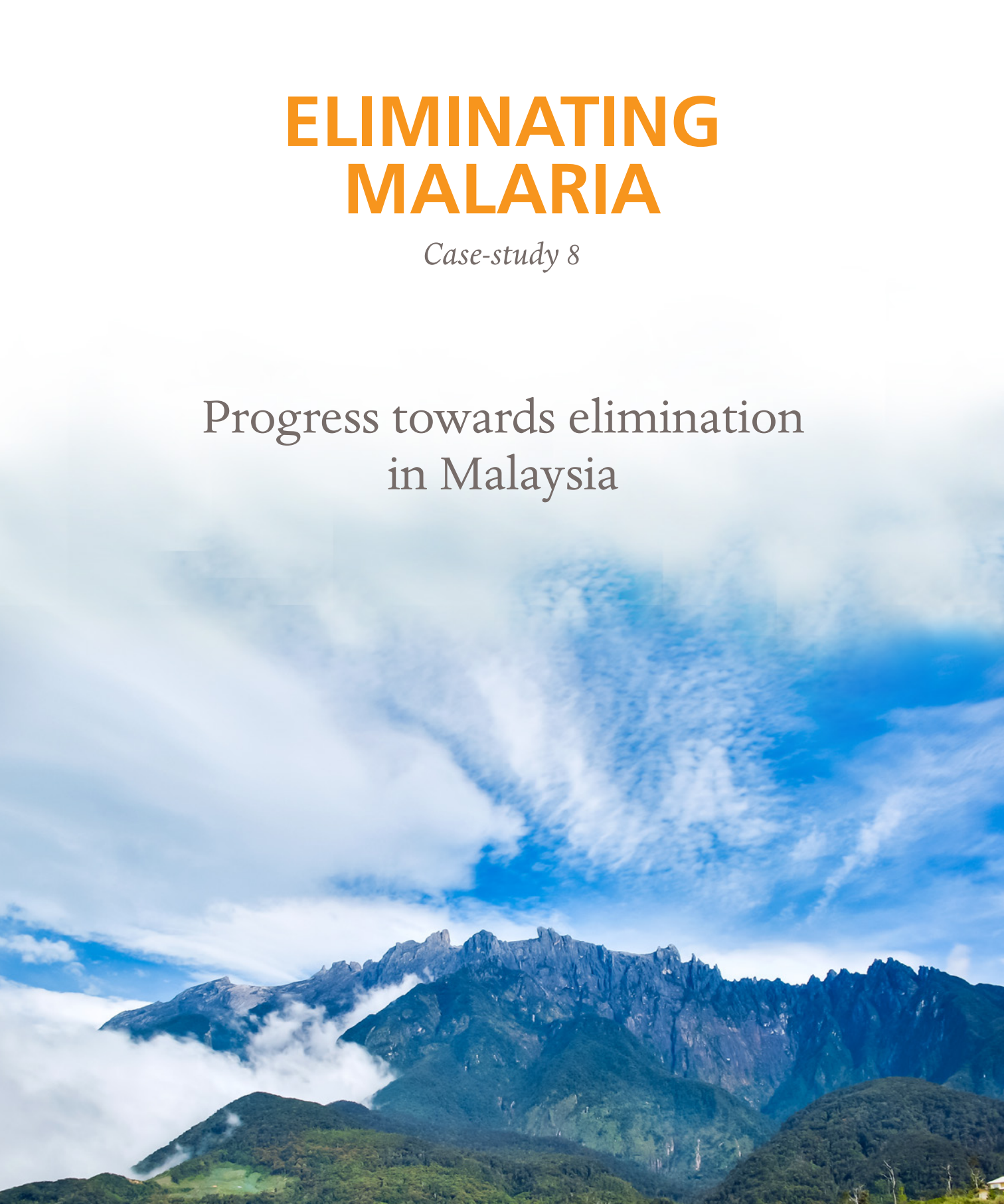


ELIMINATING MALARIA

Case-study 8

Progress towards elimination
in Malaysia



UCSF GLOBAL HEALTH SCIENCES

THE GLOBAL HEALTH GROUP

From evidence to action



**World Health
Organization**

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The authors remain responsible for any errors and omissions.

ACRONYMS AND ABBREVIATIONS

ABER	annual blood examination rate
ACD	active case detection
ACT	artemisinin-based combination therapy
API	annual parasite index
APMEN	Asia Pacific Malaria Elimination Network
ASEAN	Association of Southeast Asian Nations
DALY	disability-adjusted life year
DHO	district health office
DDT	dichloro-diphenyl-trichloroethane
EPI	Expanded Programme on Immunization
GDP	gross domestic product
GPS	geographic positioning system
GIS	geographic information system
GMEP	Global Malaria Eradication Programme
HDI	Human Development Index
IRS	indoor residual spraying
IMR	infant mortality rate
ITN	insecticide-treated net
IVM	integrated vector management
LLIN	long-lasting insecticidal net
MBS	mass blood survey
MDG	Millennium Development Goals
MEP	Malaria Elimination Program
MOH	Ministry of Health
NEM	New Economic Model
NSP	national strategic plan
PCD	passive case detection
PCR	polymerase chain reaction
PHCV	primary health care volunteer
PPP	purchasing power parity
SPR	slide positivity rate
VBDCP	Vector-Borne Diseases Control Programme
WHO	World Health Organization

GLOSSARY

The terms listed in this glossary are defined according to their use in this publication. They may have different meanings in other contexts.

Active case detection

The detection by health workers of malaria infections at community and household level in population groups that are considered to be at high risk. Active case detection can be conducted as fever screening followed by parasitological examination of all febrile patients or as parasitological examination of the target population without prior fever screening.

Annual blood examination rate

The number of examinations of blood slides for malaria by microscopy per 1 000 population per year.

Annual parasite index

The number of reported malaria cases per 1 000 population per year.

Case-based surveillance

Every case is reported and investigated immediately (and also included in the weekly reporting system).

Case definition (control programmes)

confirmed malaria

Suspected malaria case in which malaria parasites have been demonstrated in a patient's blood by microscopy or a rapid diagnostic test.

presumed malaria

Suspected malaria case with no diagnostic test to confirm malaria but nevertheless treated presumptively as malaria.

suspected malaria

Patient illness suspected by a health worker to be due to malaria. Fever is usually one of the criteria.

Case definition (elimination programmes)

autochthonous

A case locally acquired by mosquito-borne transmission, i.e. an indigenous or introduced case (also called "locally transmitted").

imported

A case the origin of which can be traced to a known malarious area outside the country in which it was diagnosed.

indigenous

Any case contracted locally (i.e. within national boundaries), without strong evidence of a direct link to an imported case. Indigenous cases include delayed first attacks of *Plasmodium vivax* malaria due to locally acquired parasites with a long incubation period.

induced

A case the origin of which can be traced to a blood transfusion or other form of parenteral inoculation but not to normal transmission by a mosquito.

introduced

A case contracted locally, with strong epidemiological evidence linking it directly to a known imported case (first generation from an imported case, i.e. the mosquito was infected from a case classified as imported).

locally transmitted

A case locally acquired by mosquito-borne transmission, i.e. an indigenous or introduced case (also called "autochthonous").

malaria

Any case in which, regardless of the presence or absence of clinical symptoms, malaria parasites have been confirmed by quality-controlled laboratory diagnosis.

Case investigation

Collection of information to allow classification of a malaria case by origin of infection, i.e. imported, introduced, indigenous or induced. Case investigation includes administration of a standardized questionnaire to a person in whom a malaria infection is diagnosed.

Case management

Diagnosis, treatment, clinical care and follow-up of malaria cases.

Case notification

Compulsory reporting of detected cases of malaria by all medical units and medical practitioners, to the health department (as laid down by law or regulation).

Certification of malaria-free status

Certification granted by WHO after it has been proved beyond reasonable doubt that the chain of local human malaria transmission by *Anopheles* mosquitoes has been fully interrupted in an entire country for at least three consecutive years.

Elimination

Reduction to zero of the incidence of infection 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.

Endemic

Applied to malaria when there is an ongoing, measurable incidence of cases and mosquito-borne transmission in an area over a succession of years.

Epidemic

Occurrence of cases in excess of the number expected in a given place and time.

Eradication

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.

Evaluation

Attempts to determine as systematically and objectively as possible the relevance, effectiveness and impact of activities in relation to their objectives.

Focus

A defined, circumscribed locality situated in a currently or former malarious area containing the continuous or intermittent epidemiological factors necessary for malaria transmission. Foci can be classified as endemic, residual active, residual non-active, cleared up, new potential, new active or pseudo.

Gametocyte

The sexual reproductive stage of the malaria parasite present in the host's red blood cells.

Hypnozoite

The dormant stage of the malaria parasite present in the host's liver cells (limited to infections with *P. vivax* and *P. ovale*).

Incubation period

The time between infection (by inoculation or otherwise) and the first appearance of clinical signs.

Intervention (public health)

Activity undertaken to prevent or reduce the occurrence of a health condition in a population. Examples of interventions for malaria control include the distribution of insecticide-treated mosquito nets, indoor residual spraying with insecticides, and the provision of effective antimalarial therapy for prevention or curative treatment of clinical malaria.

Local mosquito-borne malaria transmission

Occurrence of human malaria cases acquired in a given area through the bite of infected *Anopheles* mosquitoes.

Malaria-free

An area in which there is no continuing local mosquito-borne malaria transmission and the risk for acquiring malaria is limited to introduced cases only.

Malaria incidence

The number of newly diagnosed malaria cases during a specified time in a specified population.

Malaria prevalence

The number of malaria cases at any given time in a specified population, measured as positive laboratory test results.

Mass blood survey

Also known as mass blood examination. Examining of the blood of all persons in a unit of the population, which may be repeated at certain intervals. Blood specimens are commonly obtained during house-to-house visits.

Monitoring (of programmes)

Periodic review of the implementation of an activity, seeking to ensure that inputs, deliveries, work schedules, targeted outputs and other required actions are proceeding according to plan.

Outbreak

Two or more local cases occurring in a medium or low-risk locality (village, housing area, or a section of a plantation) within the incubation period of approximately two weeks (in Malaysia). In a high-risk area, an outbreak occurs when the number of reported cases is higher than the monthly median in a locality from the previous five years.

Parasite prevalence

Proportion of the population in whom *Plasmodium* infection is detected at a particular time by means of a diagnostic test (usually microscopy or a rapid diagnostic test).

Passive case detection

Detection of malaria cases among patients who, on their own initiative, go to a health post for treatment, usually for febrile disease.

Population at risk

Population living in a geographical area in which locally acquired malaria cases occurred in the current year and/or previous years.

Rapid diagnostic test

An antigen-based stick, cassette or card test for malaria in which a coloured line indicates that plasmodial antigens have been detected.

Rapid diagnostic test positivity rate

Proportion of positive results among all the rapid diagnostic tests performed.

Receptivity

Relative abundance of anopheline vectors and existence of other ecological and climatic factors favouring malaria transmission.

Re-establishment of transmission

Renewed presence of a constant measurable incidence of cases and mosquito-borne transmission in an area over a succession of years. An indication of the possible re-establishment of transmission would be the occurrence of three or more introduced and/or indigenous malaria infections in the same geographical focus, for two consecutive years for *P. falciparum* and for three consecutive years for *P. vivax*.

Relapse (clinical)

Renewed manifestation of an infection after temporary latency, arising from activation of hypnozoites (and therefore limited to infections with *P. vivax* and *P. ovale*).

Sensitivity (of a test)

Proportion of people with malaria infection (true positives) who have a positive test result.

Slide positivity rate

Proportion of microscopy slides found to be positive among the slides examined.

Specificity (of a test)

Proportion of people without malaria infection (true negatives) who have a negative test result.

Spleen rate

The prevalence of splenomegaly.

Surveillance (control programmes)

Ongoing, systematic collection, analysis and interpretation of disease-specific data for use in planning, implementing and evaluating public health practice.

Surveillance (elimination programmes)

That part of the programme designed for the identification, investigation and elimination of continuing transmission, the prevention and cure of infections, and the final substantiation of claimed elimination.

Transmission intensity

Rate at which people in a given area are inoculated with malaria parasites by mosquitoes. This is often expressed as the “annual entomological inoculation rate”, which is the number of inoculations with malaria parasites received by one person in one year.

Transmission season

Period of the year during which mosquito-borne transmission of malaria infection usually takes place.

Vector control

Measures of any kind against malaria-transmitting mosquitoes intended to limit their ability to transmit the disease.

Vector efficiency

Ability of a mosquito species, in comparison with another species in a similar climatic environment, to transmit malaria in nature.

Vectorial capacity

Number of new infections that the population of a given vector would induce per case per day at a given place and time, assuming conditions of non-immunity. Factors affecting vectorial capacity include: the density of female anophelines relative to humans; their longevity, frequency of feeding and propensity to bite humans; and the length of the extrinsic cycle of the parasite.

Vigilance

A function of the public health service during a programme for prevention of reintroduction of transmission, consisting of watchfulness for any occurrence of malaria in an area in which it had not existed, or from which it had been eliminated, and application of the necessary measures against it.

Vulnerability

Either proximity to a malarious area or the frequency of influx of infected individuals or groups and/or infective anophelines.

SUMMARY

This case study examines the strategies and policies of the Malaysian National Malaria Control Programme (NMCP) and outlines the dramatic decline in malaria cases nationally since 1991. It documents the history of malaria in the country and malaria control interventions that have been successfully implemented. The case study also highlights current strategies to reach the country's national target of eliminating malaria by 2020. Lessons for countries that are embarking upon elimination are distilled.

History of malaria and malaria control

Malaysia is an upper-middle income country with an estimated population of about 29 000 000 people. Malaysia has battled endemic malaria for most of its recent history, but has seen remarkable progress in decreasing malaria cases since 1991. Most of the country is highly receptive and vulnerable to malaria transmission from nearby endemic areas both within and outside Malaysia, with a perennial transmission season in most areas. In 2011, the majority of cases nationwide were *Plasmodium vivax* (2 422 cases, 45.6%) and *P. falciparum* (973 cases, 18.3%), closely followed by *P. malariae* (903 cases, 17.0%), *P. knowlesi* (854 cases, 16.1%), and mixed cases (153 cases, 3%) also contributing cases annually.

Malaysia has a one hundred year old malaria control programme. Shortly after the discovery of malaria's transmission route in the early 1900s, scientific and operational research projects on malaria and its control began in the Federated States of Malaya (West Malaysia), and the British colonial government began conducting

malaria control projects on rubber and coffee plantations. As a participant in the World Health Organization's Global Malaria Eradication Programme in the 1970s, Malaysia managed to substantially decrease cases, and continued to do so even after reorienting to control in 1982.

Throughout the 1990s, the programme focused on building a strong surveillance system, increasing coverage of indoor residual spraying and insecticide treated nets, and early detection of and response to cases. A general improvement in infrastructure, education and economic development in the country was also a likely contributor to declines in malaria incidence. The most dramatic decrease occurred between 1994 and 2011, and has been largely attributed to increased malaria control activities in the Sabah State on the island of Borneo, an area that historically has contributed a large number of cases to national incidence.

Malaysia declared its intent to eliminate malaria in 2011, with a phased goal of achieving zero local transmission in West Malaysia by 2015, and in Sabah and Sarawak by 2020. The National Malaria Elimination Plan, 2011–2015, described how this policy was to be implemented. Today, rapid reporting of cases by public and private sector health centres through an online system allows the National Malaria Control Programme to respond quickly through case investigation and management of outbreaks. In addition, investigations to determine origin (imported or local) are conducted for all reported cases. Coordinated campaigns of indoor residual spraying (IRS) and distribution of insecticide treated nets (ITN), in conjunction with mass blood screenings, are conducted every six months in high-risk areas. These activities have contributed to the decline in malaria incidence over the decades.

Lessons learned

The Ministry of Health in Malaysia has strong national political support for malaria elimination, and the government has committed human and financial resources to reach its elimination target of 2020. Due to the fact that Malaysia does not rely on outside aid, the NMCP has the flexibility to address challenges quickly. While the country continues to use evidence-based control activities as part of its strategy for elimination, the NMCP supports innovative approaches to malaria control, such as local level partnerships with private companies, through district level projects guided by local knowledge at the state and district level. In addition, a strong focus on local level input from district and state level malaria control officers has undoubtedly contributed to Malaysia's progress.

District level entomologists and malaria control officers (also called assistant environmental health officers and formerly known as Health Inspectors) are responsible for understanding vulnerability and receptivity in their localities, and are expected to provide feedback during strategic planning and workshops hosted by state and national offices. The programme has maintained a focus on entomological surveillance, and employs entomologists in every state and in high-risk districts to monitor changes in vector behavior and breeding habits. A strong surveillance system allows most cases to be quickly diagnosed, and coverage of vector control and surveillance, particularly in at-risk areas, continues to increase. The program continues to search for ways to identify cases in rural, remote areas—particularly amongst undocumented workers.

Historically, poor access to geographically remote areas of Sabah and Sarawak has been a major challenge. A malaria sector office has been set up in every district in Sabah. In malarious areas, the development of malaria 'subsector' offices in these areas, staffed with control officers, has increased access to prompt detection, diagnosis and treatment of cases, as well as subsequent reactive case detection and vector control activities. Additionally, the development of intersectoral partnerships with the private sector, most notably in the Sabah State, is a key strategy for elimination. In districts with a large

plantation sector, partnering with plantation management to support vector control and surveillance activities has helped the NMCP to reach at-risk populations that might otherwise be inaccessible.

Outlook for the future

With elimination targets of 2015 for West Malaysia and 2020 for Sabah and Sarawak, Malaysia continues to move closer to reaching its national goal of zero local transmission. A strong focus on parasitological and entomological surveillance, early detection and investigation of cases, and increased vector control coverage in remote risk areas will be critical to achieving this goal.

As the country pushes towards elimination, the control programme will continue to search for effective, innovative ways to face operational challenges around *Plasmodium vivax* control, importation of cases by migrants and tourists, and access to remote or mobile populations. Many areas of the country continue to face the threat of ongoing importation of malaria from nearby endemic countries, and as such, states with a large plantation sector supported by migrant workers will need to be closely monitored. Maximizing intersectoral collaboration with the private sector, international partners, and other government departments is critical. Currently, the NMCP collaborates with endemic countries such as Indonesia and Thailand on a formal level through joint Ministry of Health meetings planned annually, and on an ad-hoc basis with the NMCP and local health offices in the Philippines. The NMCP plans to foster stronger relationships with nearby endemic countries, particularly Indonesia, the Philippines and Myanmar, and will continue to engage in regional collaboration with groups such as the Asia Pacific Malaria Elimination Network (APMEN).

Recent progress has bolstered political support for malaria elimination, and as cases continue to decline country-wide, the NMCP will require continued political and financial support. Adequate funding must be ensured to prevent reintroduction of malaria in states that have reached zero local transmission and to eliminate the disease in those with ongoing transmission.

INTRODUCTION

The malaria elimination case-study series

The Global Malaria Programme of the World Health Organization (WHO/GMP) and the Global Health Group of the University of California, San Francisco—in close collaboration with national malaria control programmes and other partners and stakeholders—are jointly conducting a series of case-studies on elimination of malaria and prevention of reintroduction. The objective of this work is to build an evidence base to support intensification of malaria elimination as an important step in achieving international malaria targets. Many countries are embarking upon or considering a malaria elimination goal. In order for countries to make well-informed decisions on whether or how to pursue malaria elimination, reviewing historical and current country experience of malaria elimination and prevention of reintroduction—particularly of those countries in similar eco-epidemiological settings—is critical.

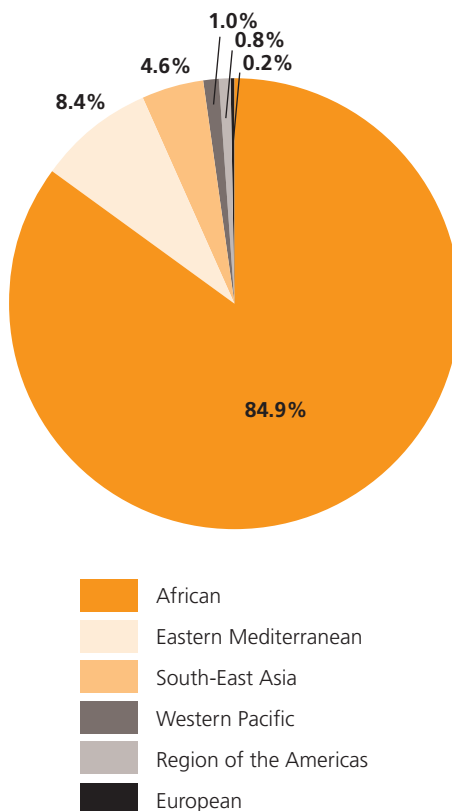
Ten case-studies are being prepared, which, taken together will provide insights into, and lessons to be learnt from, a wide range of elimination approaches and geographical settings.

The University of California, San Francisco Global Health Group collaborated with APMEN and the National Vector-Borne Disease Control Programme of Malaysia on this malaria elimination case study. Malaysia was chosen because of its extensive history of malaria control and its recent progress towards eliminating malaria. The main authors collaborated in the data collection process and write-up, focusing efforts on malaria control efforts since 1991. The methods used for data collection and analysis for the case study of Malaysia are summarized in [Annex 1](#).

Malaria in South-East Asia and the Western Pacific

The South-East Asia and Western Pacific regions have made immense strides in decreasing malaria incidence and mortality over the past ten years (1). The following countries have seen the most marked declines: Bhutan, the Democratic People’s Republic of Korea, Thailand, Sri Lanka and Malaysia (1). Despite these gains, malaria continues to cause major morbidity in the regions, contributing upwards of 5.6% to the total number of malaria cases worldwide (see [Figure 1](#)) (2).

Figure 1. Proportion of worldwide malaria cases by region in 2012



Source: reference 2

In 2008, the WHO also estimated that 1.34 million disability-adjusted life years (DALYs), are lost due to malaria in South-East Asia alone, with substantial impact on economic productivity, health systems and overall health (3). Both South-East Asia and the Western Pacific regions host numerous malaria parasite species, with *Plasmodium falciparum* and *Plasmodium vivax* contributing the highest number of cases annually.

Malaria in Malaysia

Malaysia has one of the oldest malaria control programmes in the world. Under British colonial rule in the early 1900s, Dr. Malcolm Watson, an eminent British malariologist, began his revolutionary work on environmental modification for malaria control in West Malaysia (4). Although the British typically focused their malaria efforts on rubber estates, and not on local villages and communities, their early pioneering work formed the foundation for the current government malaria control programme (5). Today, environmental management is not used as prominently. The country focuses on seven key strategies: (i) building strong surveillance systems; (ii) vector control using the Integrated Vector Management (IVM) approach; (iii) early detection of infection and prompt treatment; (iv) preparedness and outbreak response; (v) communication and social mobilization; (vi) capacity building; and (vii) operational research.

Malaysia has battled malaria for most of its recent history (4). Post World War II reports show upwards of 300 000 cases treated annually (inpatient and outpatient) in West Malaysia alone (6). Rates remained high through the 1950s and 1960s, with more than 200 000 reported cases in 1961 (7). At the same time as the country gained independence and the Federated States of Malaya (current West Malaysia) joined with Singapore, Sabah and Sarawak in 1963, the concept of “malaria eradication” was gaining traction around the world, and Malaysia began strategizing about the feasibility of elimination in the country (5, 8). The World Health Organization’s Global Malaria Eradication Programme (GMEP) spurred the development of a national eradication plan in Malaysia in 1967. Despite the country’s failure to actually eradicate malaria, cases decreased to a low of 50 000 by

1994 (9). Since 1991, the Vector-Borne Disease Control Programme has continued to see declines, with cases dropping to around 5 000 annually (10).

Malaria epidemiology has historically been varied across the country, with the lowest number of cases in West Malaysia and the Sarawak State, and higher number of cases in the Sabah State. West Malaysia, a conglomerate of 11 states, which at one time made up the Federated States of Malaya, showed dramatic declines in malaria incidence during the GMEP (5). Since the GMEP, West Malaysia has seen continued declines in incidence, with malaria cases dropping from more than 100 000 annually to just 1 500 today. The state of Sarawak has stabilized at between 1 000 and 3 000 cases annually since the early 1990s. While some decreases have occurred in both West Malaysia and Sarawak since 1991, the Sabah State on Borneo has shown the most dramatic decrease in incidence, from 49 192 cases in 1994 to 2 032 cases in 2011.

In light of the differing logistical and technical challenges in each region of the country, Malaysia has a phased malaria elimination plan that began in 2010 for Sabah and 2011 for West Malaysia and Sarawak. Malaria elimination is defined as “the reduction to zero of the incidence of infection by human malaria parasites in a defined geographical area as a result of deliberate efforts (11).” The country has a goal of zero local transmission for West Malaysia by 2015 and by 2020 for Sabah and Sarawak. Malaysia is also a founding country partner of APMEN, a group of 14 countries with national or subnational elimination goals that works collaboratively to address challenges specific to malaria elimination in the Asia Pacific region.

Malaria in Sabah

The Sabah State is a major focus of this case study, as declines from 1991 to 2011 largely represent the substantial decreases seen nationally. [Figure 2](#) depicts the State of Sabah with district boundaries delineated (12).

Figure 2. Map of the Sabah State



Source: reference 12

Since 1994, the national level Vector-Borne Disease Control Programme, which finances all malaria control work in the country, has increased financial and human resources for malaria work in Sabah, acknowledging the logistical and geographic challenges faced by those engaged in work on the ground. Lack of infrastructure, rough terrain, and isolated communities make control work challenging. Much of the state is mountainous and covered by dense forest or plantations, and shares a large remote border region with the Kalimantan State of Indonesia. Due to a burgeoning palm oil and rubber plantation sector, Sabah also employs a large number of foreign workers from Indonesia and the Philippines, two nearby

endemic countries. Documented workers typically go through a series of screening procedures for communicable diseases, including malaria, but porous sea and land borders allow for considerable undocumented migration. Importation of malaria by undocumented migrant workers, a challenging group to access and trace, is a challenge for the programme. However, even with these challenges, distribution of bed nets, increased coverage of indoor residual spraying (IRS), a focus on early detection through large-scale screening, and a drought in the mid-1990s started a dramatic downward trend in malaria incidence that continues today.

COUNTRY BACKGROUND

Geography, population and economy

Malaysia is a tropical, equatorial country located in the Western Pacific that has land borders with Thailand, Brunei and Indonesia. There are annual monsoons in the southwest from April to October, and in the north-east from October to February (13). The country has considerable natural resources, including iron ore, bauxite, natural gas, copper, timber, tin, and petroleum (13). Administratively, Malaysia has three general territories: West Malaysia, which is located on a peninsula below Thailand and is comprised of 11 states; Sabah and

Sarawak States, located on the island of Borneo; and three federal territories -Labuan, Kuala Lumpur and Putra Jaya (see Figure 3). The country is 329 847 square kilometers, and consists mostly of coastal plains that rise to hills and mountains (13). See Figure 3 for an administrative map of Malaysia (14).

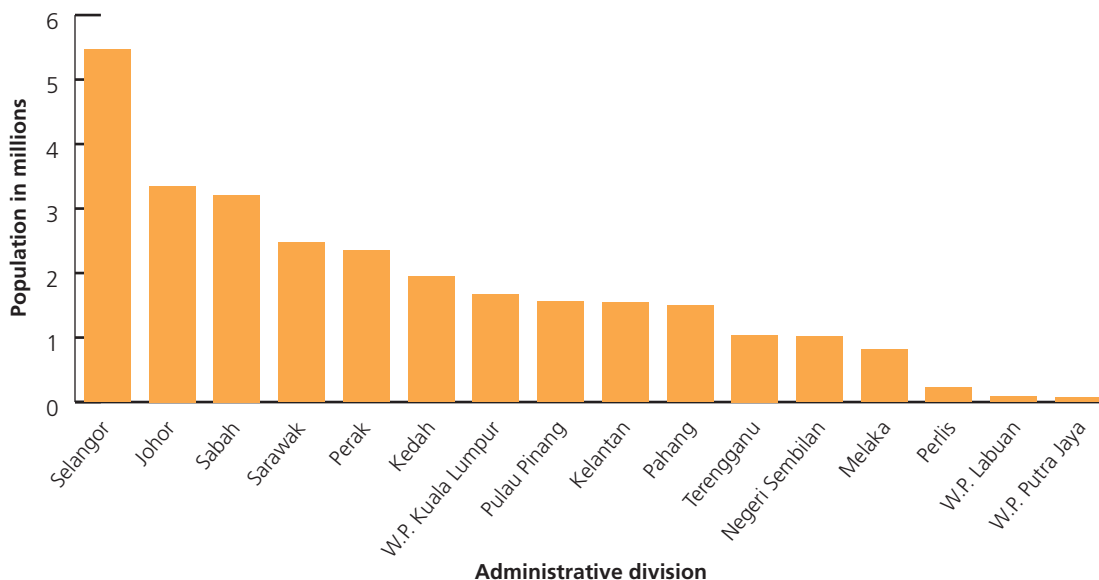
The country had an estimated population of 28 859 154 people in 2011 (15). Much of the population is heavily concentrated in the West Malaysian state of Selangor; Figure 4 shows population breakdown by administrative division in 2010 (16).

Figure 3. Map of administrative divisions of Malaysia



Source: reference 14

Figure 4. Population of Malaysia by state in 2010



Source: reference 16

Malaysia is an upper-middle income country which had a GDP per capita (PPP) of 16 900 (\$ USD) in 2012 and a 4.4% real growth rate in the same year (13). Kuala Lumpur is the trade, political and administrative capital, and is located on peninsular Malaysia.

Life expectancy is 71.7 years for men and 76.6 years for women, with a crude birth rate of 18.8 infants per 1 000 population (17). The country is comprised of several ethnic groups, the majority of which are Malay (50.4%), Chinese (23.7%), indigenous peoples (11.0%), Indian (7.1%), and other or unspecified ethnicities (7.8%) (13). The national religion is Islam, and Bahasa Malaysia and English are the official languages (13).

West Malaysia was colonized during several periods of its history, first by the British in the 18th and 19th centuries and then by the Japanese during World War II from 1942–1945 (18). After Japanese occupation, the region was recolonized by the British, but achieved independence in 1957. Malaysia was formed in 1963 when the territories of Sabah and Sarawak, as well as Singapore, joined the Federation. After the creation of the Malaysian Federation, the country faced a communist insurgency, a war with Indonesia, a confrontation with the Philippines

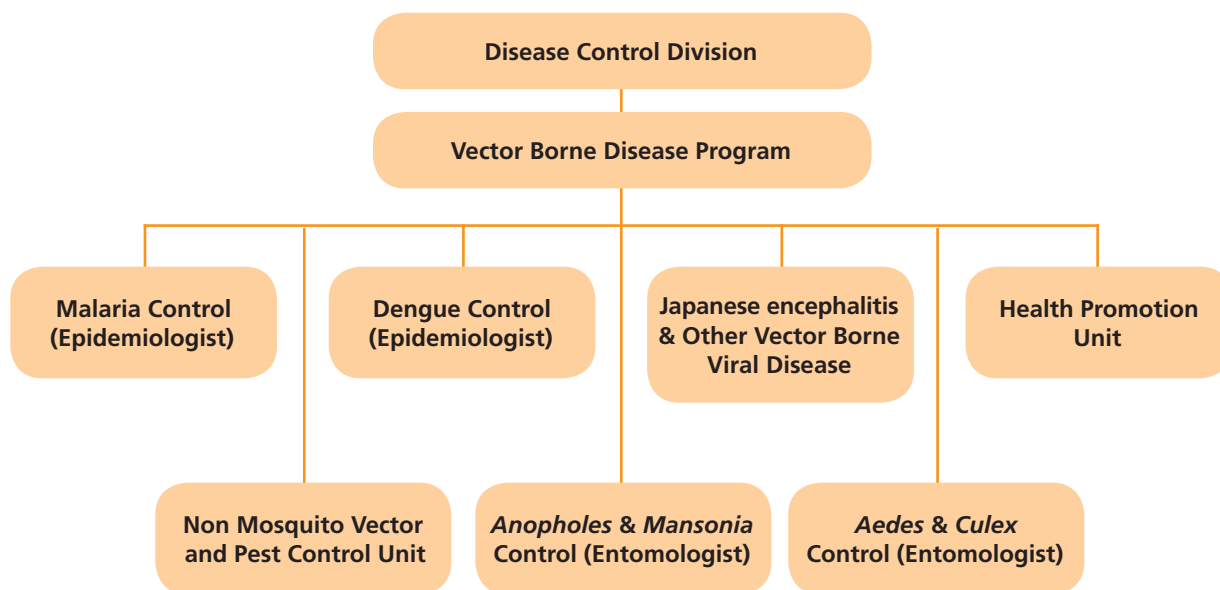
over ownership of Sabah, and the secession of Singapore from the Federation (18). The country is now a stable parliamentary democracy and a constitutional monarchy (13).

Malaysia has a strong multi-sector economy. The country is aiming for high-income status by 2020 under the New Economic Model (NEM). It is working to attract biotechnology and high technology companies, as well as investments from foreign companies (19, 20). Malaysia is also a large exporter of oil and gasoline, and supports a large plantation sector, with considerable investment in rubber, palm oil, acacia and logging (19).

Health system and population health profile

Malaysia has a universal health system that provides health care free of charge, and supports a robust private sector and health tourism industry. The Malaysian Ministry of Health guides health policy and runs central health programmes. The Malaria Control Programme, which was initially a vertical programme, was integrated into the Vector-Borne Disease Control Program (VBDCP) in the mid-1980s. The national level Malaria Control Programme, housed within the VBDCP (Figure 5),

Figure 5: Organizational structure of the Malaysian Disease Control Division



develops policy and provides technical expertise for state and district-level malaria programmes. The VBDCP, which consists of entomologists and support staff, coordinates policy development and supervision of vector control activities. Each state and district has its own VBDCP, with allotment of staff time based on local incidence of each disease.

Primary health care is provided at the district and sub-district level, with secondary and specialty care delivered in state hospitals. Malaria control work is fully funded and implemented by the government, and health programmes do not receive outside funding from multi or bilateral organizations. Table 1 lists selected health service provision indicators for 2010 (17). The country had 131 public hospitals with 33 211 available beds in that year, and there were 1.17 physicians and 2.45 nurses per 1 000 population.

The health status of Malaysia’s population has shown dramatic improvements since the 1980s. The country is currently following the typical epidemiological shift of middle and upper income countries, moving from a high communicable disease burden to a larger non-communicable disease burden (21). Prevalence of diabetes,

Table 1: Health Sector Indicators, Malaysia, 2010

Indicator	Number
Number of general public hospitals	131
Number of public hospital beds	33 211
Number of physicians per 1 000	1.17
Number of nurses per 1 000	2.45
Per Capita Total Expenditure on Health (US \$)	368.0
Percentage of GDP spent on Health	4.39%
Private Expenditure on Health as Percentage of Total Expenditure on Health	44.5%

Source: reference 17

hypertension and obesity has risen steadily, and in 2012 the Ministry of Health placed renewed focus on these non-communicable diseases.

The most common notifiable diseases in 2010 were dengue fever, tuberculosis, hand foot and mouth disease, food poisoning and HIV (20). Malaria has been a notifiable disease since the Global Malaria Eradication Programme in 1967. Notification of all infectious diseases by the public and private sector was made mandatory

in the Prevention and Control of Infectious Disease Act of 1988; failure to notify is punishable by law. Leading causes of mortality in 2010 were heart disease, septicaemia, pneumonia, malignant neoplasms and cerebrovascular diseases (22). For a list of health related Millennium Development Goal indicators, please see [Annex 2](#).

The crude birth rate was 18.8 per 1 000 in 2010, and there was a fertility rate of 2.4 amongst women 15–49 years. Malaysia had an infant mortality rate (IMR) of six

deaths per 1 000 live births in 2011, considerably lower than the East Asia and the Pacific Region as a whole, where the IMR was 42 deaths per 1 000 live births (2011) (23). The Expanded Programme on Immunization (EPI) vaccination coverage is between 95% and 98%, a strong indication that the country's universal health care delivery services are effective (24). Malaysia is ranked 61st in the International Human Development Indicator (HDI) list (25)

HISTORY OF MALARIA AND MALARIA CONTROL

Parasites and vectors

In 2011, *Plasmodium vivax* (2 422 cases, 45.6%) and *P. falciparum* (973 cases, 18.3%) were responsible for the majority of malaria cases in Malaysia, closely followed by *P. malariae* (903 cases, 17.0%) and *P. knowlesi* (854 cases, 16.1%), which together represent a substantial proportion of cases in Sabah and Sarawak. This is in contrast to parasitological trends in 1992, at which time *P. falciparum* made up 65.1% of reported cases, while *P. vivax* contributed 31.6%. Trends show a decline in *P. falciparum* cases from 1997 to 2011 (Figure 6), both in number and in proportion. This trend follows that of many other pre-elimination and elimination countries. *P. vivax* infections

are often more challenging to detect in a population than *P. falciparum* cases, due to lower parasite load, frequent subclinical infections, and the biology of the *vivax* species, including the parasite's ability to lay dormant in a hypnozoitic liver phase (26).

P. malariae cases have ranged from 285 to 905 since 1991. These relatively high numbers are not well understood, and the NMCP continues to explore potential reasons for this increase. *P. knowlesi* cases have been reported since 2008, in high proportion to total cases. It is unclear if this is due to improved diagnostic techniques, or if in fact cases are rising due to increasing encroachment on simian territory.

Figure 6. Malaria cases by species nationally, 1997–2011 (*P. knowlesi* cases were reported starting in 2008)

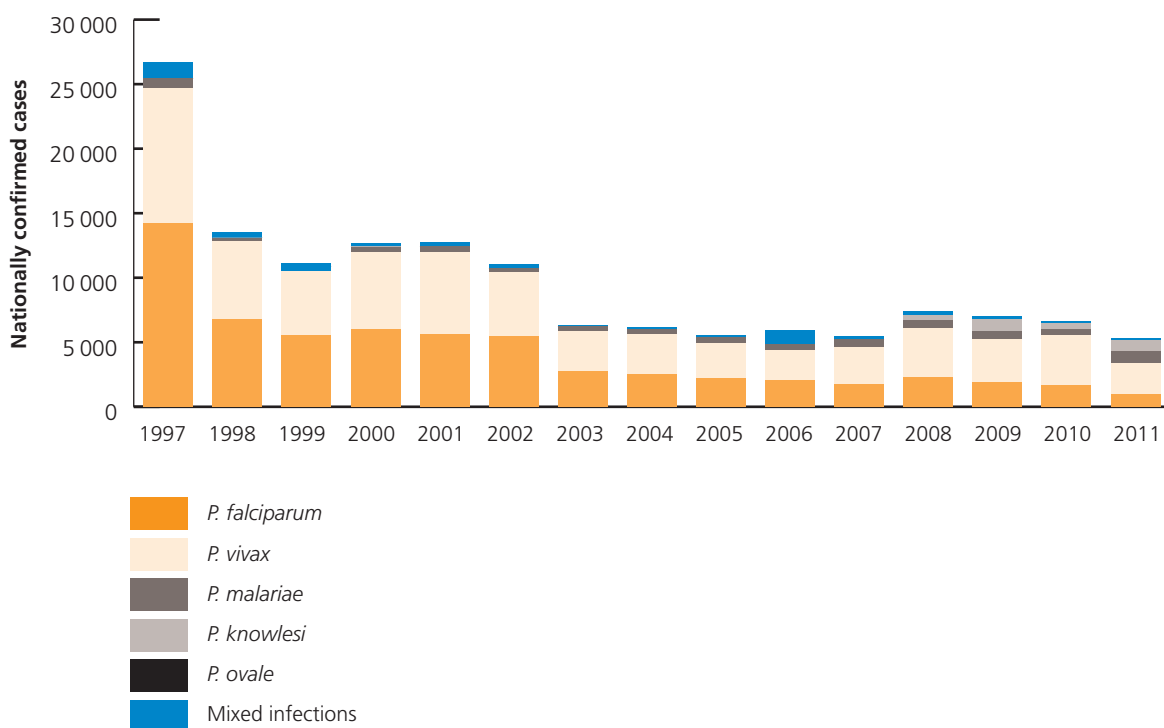
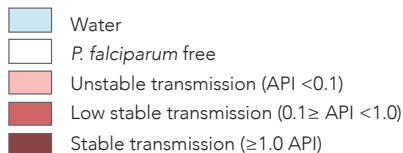
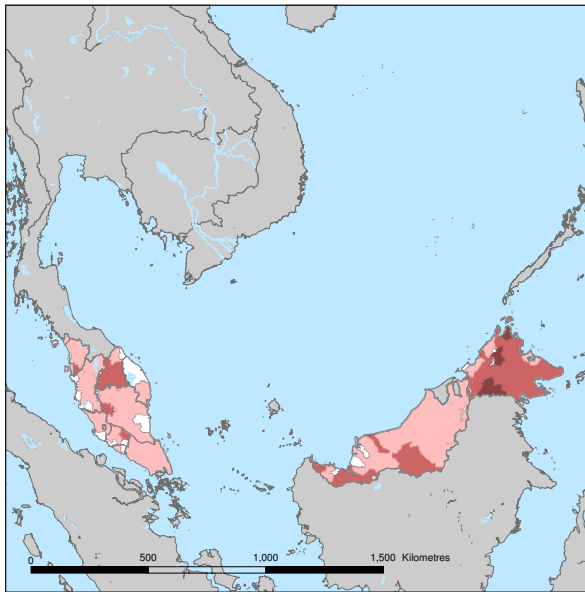
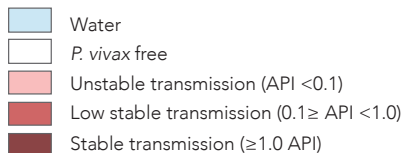
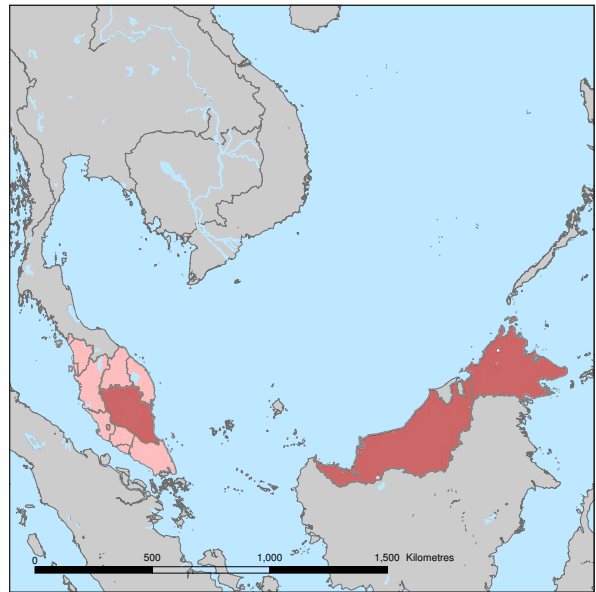


Figure 7. *Plasmodium falciparum* and *Plasmodium vivax* transmission limits in Malaysia

Plasmodium falciparum



Plasmodium vivax



P. falciparum/*P. vivax* malaria risk is classified into no risk, unstable risk of <0.1 case per 1,000 population (API), low stable risk of ≥0.1 to <1.0 case per 1,000 population (API), and stable risk of ≥1.0 case per 1,000 population (API). Risk was defined using health management information system data and the transmission limits were further refined using temperature and aridity data. Data from the international travel and health guidelines (ITHG) were used to identify zero risk in certain cities, islands and other administrative areas.

Source: references 27, 28

Imported cases (between 1 and 18 cases annually since 1999) of *P. ovale* have also been reported. Mixed infections rates have remained stable between 2% and 4% since 1999, with one major increase to 17.4% in 2006. **Figure 7** illustrates geographic transmission limits of *P. falciparum* and *P. vivax* in Malaysia in 2010 (27, 28).

Malaysia has an abundance of malaria-transmitting vector species. Dominant vectors in West Malaysia are *Anopheles maculatus*, *epiroticus*, *campestris*, *letifer*, *dirus* and *cracens*. The malaria vectors in Sabah are *An. balabacensis*, *sundaicus* and *flavivirostris*, while *An. latens*, *donaldi* and *sundaicus* are found in Sarawak (29, 30).

The principle vector in West Malaysia, *An. maculatus*, breeds in slow moving streams and springs in hilly or mountainous areas (31). The species is mostly exophagic, or outdoor-feeding, and although it prefers cattle (*zoophily*), it has been reported to feed on humans (*anthropophily*) between 21:00h and 24:00h (32). It is considered to be both exo and endophyllic, resting on the inside of houses as well as on outdoor surfaces (5). Sabah's main vector is *An. balabacensis*, which typically breeds in small pools of muddy water, and is found in forest fringe areas (31). The vector is zoophilic and exophagic (32). In Sarawak, *An. latens* and *An. donaldi* are the major contributors to transmission (29). *An. latens* is considered to be simio-anthropagic, feeding preferentially on humans and several breeds of monkey (32). It is frequently implicated in *P.*

knowlesi infections, or simian malaria, which typically infects long-tailed macaques, but can be transmitted to humans. *An. donaldi* is also zoophilic, exophagic and exophilic. Similar to *An. latens*, *An. donaldi* prefers stagnant pools at the edge of forests (29).

Pre-malaria control and early control efforts: 1805–1967

The first cases of malaria were reported in the British colony in 1805 on the island of Penang, which is located near Thailand on the east coast of the West Malaysian peninsula (33). Although likely present in Malaysia before 1805, epidemics on Penang were the first to be officially recorded (34). The disease crippled the colony; 20 of the 34 civil servants stationed on Penang between 1805 and 1825 died from the disease (33). Throughout the 1800s, malaria impacted local populations, colonial administrators and imported migrant labour, typically from China, Nepal and India. As new land was cleared for plantation crops, estate and mine owners often saw their work forces devastated by the disease (33, 35). With the growing plantation sector, imported cases were frequent, and contributed to the increased incidence among both migrants and local people (5).

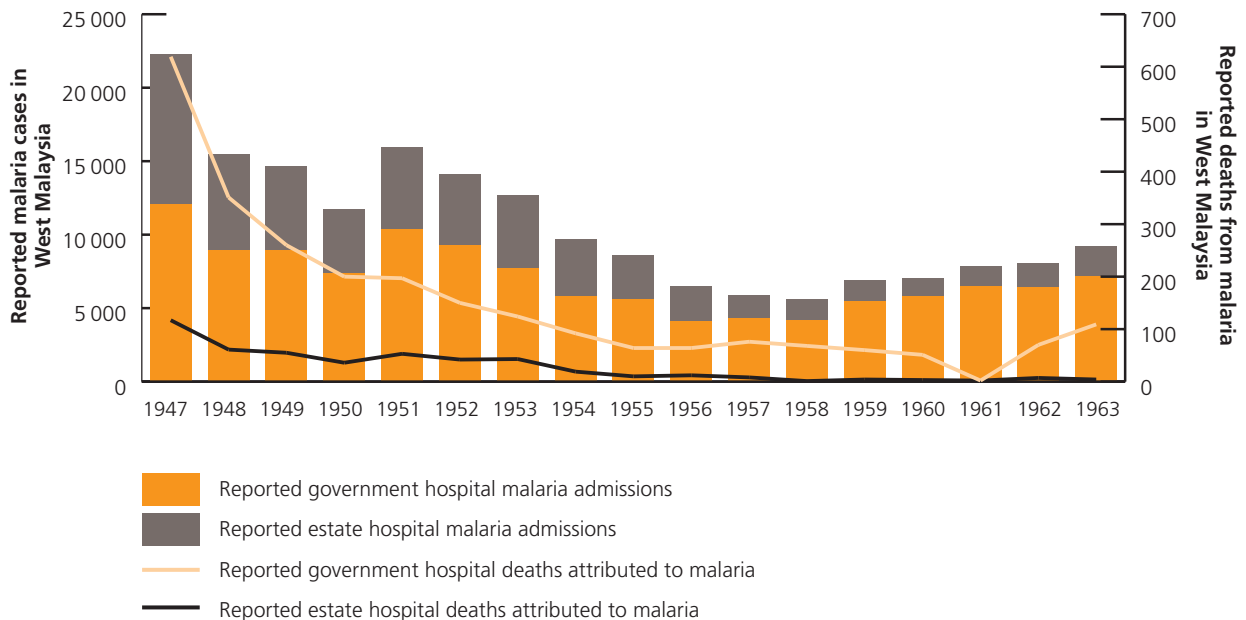
The earliest malaria programme in Malaysia was started in 1901 in the Federated States of Malaya (West Malaysia) by the British colonial administration. It was one of the first to apply new information coming from early malaria research to develop its preventative malaria programmes (5, 33). Anti-larval projects focused on the reduction of breeding sites through environmental modification techniques such as draining and oiling of pools of water (35, 36). Larval control was the basis for malaria control for over fifty years in Malaysia, until the introduction of DDT in the late 1950s. As the rubber plantation sector continued to grow, new agricultural policies, such as government-mandated draining and clearing of vegetation, prevented major malaria epidemics by reducing the number of vector breeding sites (5).

The Institute for Medical Research was created in 1899 with the aim of conducting health research in West Malaysia, and became an important player in providing research capacity and programme support to the British colonial government (34). A Malaria Advisory Board was created in 1911 for the purpose of guiding the government on control strategies and implementing malaria control projects (37). Members of the board included government administrators and health officers, estate health officials, community members and engineers. This board acted as the malaria control programme, monitoring changes in malaria epidemiology and conducting control activities (5). The Malaria Advisory Board reported 312 323 cases in West Malaysia in 1947, and 159 755 in 1963 (38). These cases included inpatient and outpatient malaria cases, and were generally not confirmed by microscopy. Reported numbers were probably lower than actual cases, since case detection capacity from the 1940s to the 1960s was limited, and malaria was not a notifiable disease during that period. Figure 8 depicts reported estate and government hospital reports of malaria admissions and deaths in West Malaysia from 1947 to 1963 (6). Statistics do not reflect cases detected and treated in the field or at clinics, and it is unlikely that all hospitals in West Malaysia reported cases to the Malaria Advisory Board during this time. Estimates for total cases in the region range from 100 000 to 300 000 annually during this period (6).

Malaria control and research in Sabah, guided by the malaria officers employed by the British North Borneo Company, focused heavily on entomological surveys and vector control activities similar to those in use in West Malaysia (39).

The Institute for Medical Research in West Malaysia continued to conduct operational and scientific malaria research into the 1940s, until Japanese occupation halted all malaria control work (39). During the immediate post-war era, the malaria programme saw substantial progress, particularly in the management of malaria on estates and plantations.

Figure 8. Reported state and government hospital malaria admissions and deaths attributed to malaria in West Malaysia, 1947–1963; statistics represent a mix of confirmed and unconfirmed cases, which were not disaggregated in original reports



Source: reference 6

The Global Malaria Eradication Programme: 1967–1981

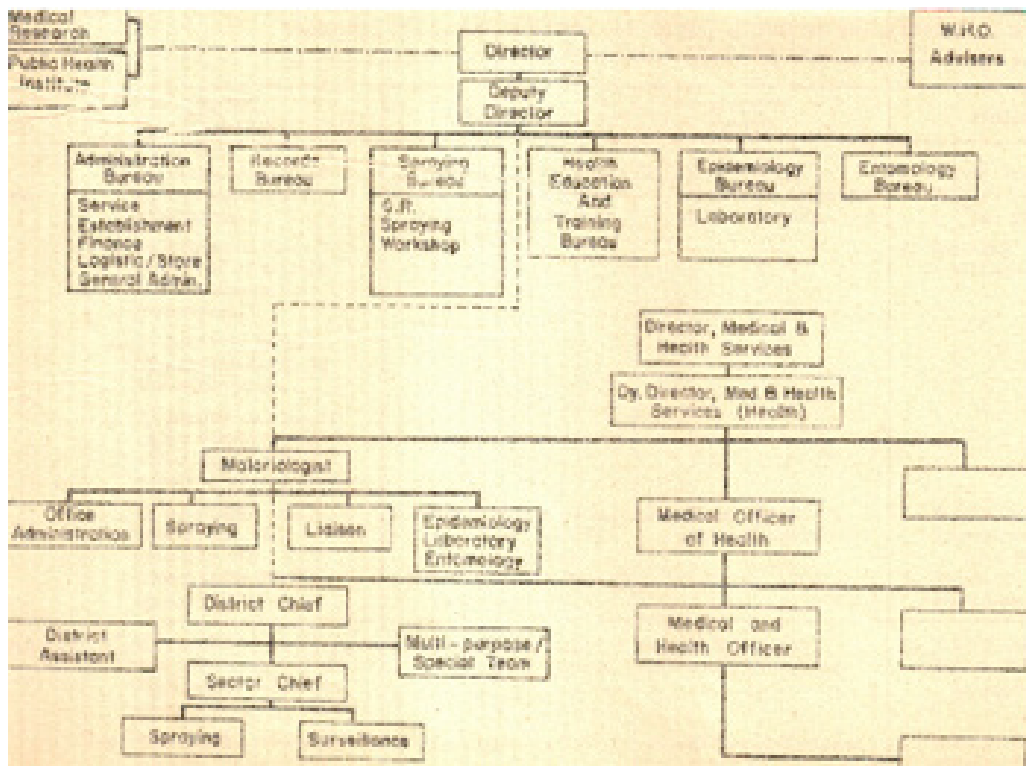
Malaysia embarked on a campaign to eliminate malaria in 1967, twelve years after the Global Malaria Eradication Programme (GMEP) was launched by the World Health Organization (8). The organizational structure of the Malaysian Malaria Eradication Programme is depicted in Figure 9 (40).

This late implementation was due, in part, to ongoing internal political conflict and to concerns around the potential for an eradication campaign within the Malaysian context to succeed (5). In addition, during this period Singapore, the Federated States of Malaya (West Malaysia), Sarawak and Sabah were declaring independence and joining together to become one country, Malaysia, in 1963, which made development of a comprehensive programme challenging. Furthermore, Malaysian malarialogists believed Malaysia’s perennial transmission, fueled by continual clearing of jungle for plantations and

estates, increasing vector breeding, a multitude of vectors with varying breeding and biting habits, and the decreasing effectiveness of DDT against outdoor biting vectors, might prevent success (41).

Although delayed, West Malaysia joined the Global Malaria Eradication Programme (GMEP) in 1967 with a goal of eliminating malaria by 1982 (34). During this time, the programme experienced substantial declines. In 1966, the country had an estimated 300 000 cases of malaria (42). By 1977 there were an estimated 44 910 cases countrywide. Increased IRS coverage with DDT and improvements in passive case detection and management are believed to have brought about this decrease (42). Sabah and Sarawak participated in separate eradication programmes during this time. In the years leading up to the implementation of the Malaysian Malaria Eradication Programme, the Institute for Medical Research in Kuala Lumpur conducted a series of feasibility pilot projects and field trials of anti-malarial drugs and insecticides (34).

Figure 9. Malaysia Malaria Eradication Programme, Organizational Structure, 1967



Source: reference 40

Additionally, a Malaria Eradication Pilot Project and Pre-Eradication Survey was conducted in West Malaysia from 1965–1966 in partnership with the WHO (42). At the time, the government cited several reasons for pursuing elimination, including reducing the negative impact of malaria on educational performance, increasing funding for malaria offices in rural areas, and social responsibility to rural poor populations (34). Vector control activities during this time focused on IRS with DDT, on larval control, and on geographic reconnaissance to identify sprayable structures—activities in line with the GMEP strategy. Increased coverage with surveillance activities through case investigation, active case detection, passive case detection, mass blood surveys, and developing case registries, were also prioritized.

From 1967 to 1975, the Malaysian Malaria Eradication Programme spent 50 million US dollars (unadjusted), and incidence was reported as dropping in West Malaysia (34). By 1969, the GMEP was discontinued globally. Overreliance on IRS as the main control strategy, a lack of flexibility in programming for different countries and cultures, insecticide and chloroquine resistance, and decreases in funding have been blamed for the failure of both the global and Malaysian programmes (8). Malaysia continued its eradication programme until 1982, at which time it reoriented towards malaria control, as many of the countries in the GMEP had done (30).

Although the Malaysian Malaria Eradication Programme did not succeed in eliminating malaria from the country, it did contribute to a substantial decline in cases in West Malaysia and Sarawak, as seen in Table 2 (43). Sabah, at the time, did not have a robust program with elimination goals.

Table 2. Reported cases by administrative area, 1972–1979 (*estimate)

Year	Reported cases in West Malaysia	Reported cases in Sarawak	Reported cases in Sabah	Reported total cases
1972	32 141	2 432	19 000*	34 573
1973	17 655	2 154	24 913	44 722
1974	16 640	2 044	26 417	45 101
1975	12 689	1 667	26 496	40 852
1976	14 931	1 402	46 232	62 565
1977	13 808	1 133	22 627	37 568
1978	10 365	1 548	43 027	54 940
1979	10 500	1 086	33 324	44 910

Source: reference 43

Vector borne disease integration and re-establishment of malaria control: 1982–2004

Throughout the 1980s, with the programme refocused on malaria control, activities mainly consisted of IRS and environmental management. Incidence ranged between 2.2 and 3.3 per 1 000 population from 1985 to 1990 (Table 3).

By 1988, 73% of nationally reported cases were from Sabah, 25% from Peninsular Malaysia and 2% from Sarawak. The country developed national incidence targets of 1.0 per 1 000 population, yet the target was not met

Table 3. National malaria indicators, 1985–1990

Year	Reported cases	Incidence	Reported deaths	Case fatality rate
1985	49 526	3.3	106	0.21
1986	44 145	2.8	67	0.15
1987	36 657	2.2	75	0.2
1988	50 721	3	72	0.14
1989	65 283	2.8	62	0.09
1990	49 266	2.7	56	0.11

for another decade. During this time, the West Malaysian states of Pahang (incidence of 3.3 per 1 000 population) and Kelantan (3.0 per 1 000 population) were particularly problematic. Reports indicate that from 1986 to 1988 there was a dramatic increase in cases occurring among migrants and land scheme workers and settlers, particularly in the West Malaysian states of Pahang, Kelantan, Johor, Terengganu and Perak.

Epidemiology differed by region. In West Malaysia, cases began declining slowly from 1991 to 2004, dropping from 9 879 to 1 310 cases respectively. In Sarawak cases fluctuated from 2 132 in 1991 to 2 089 in 2004, and a 20 000 case increase occurred in Sabah in 1994 (Table 4). Throughout this time, national level incidence was highly reflective of the serious malaria problem in Sabah, which consistently claimed the highest number of cases in the country. The high incidence of malaria in Sabah has been attributed to the state’s large and isolated geographic areas and to large plantation and timber extraction activities that use substantial numbers of migrant workers in highly receptive forested areas. Additional information on malaria epidemiology in Sabah is provided in the “Contribution of Sabah State to National Trends” section below.

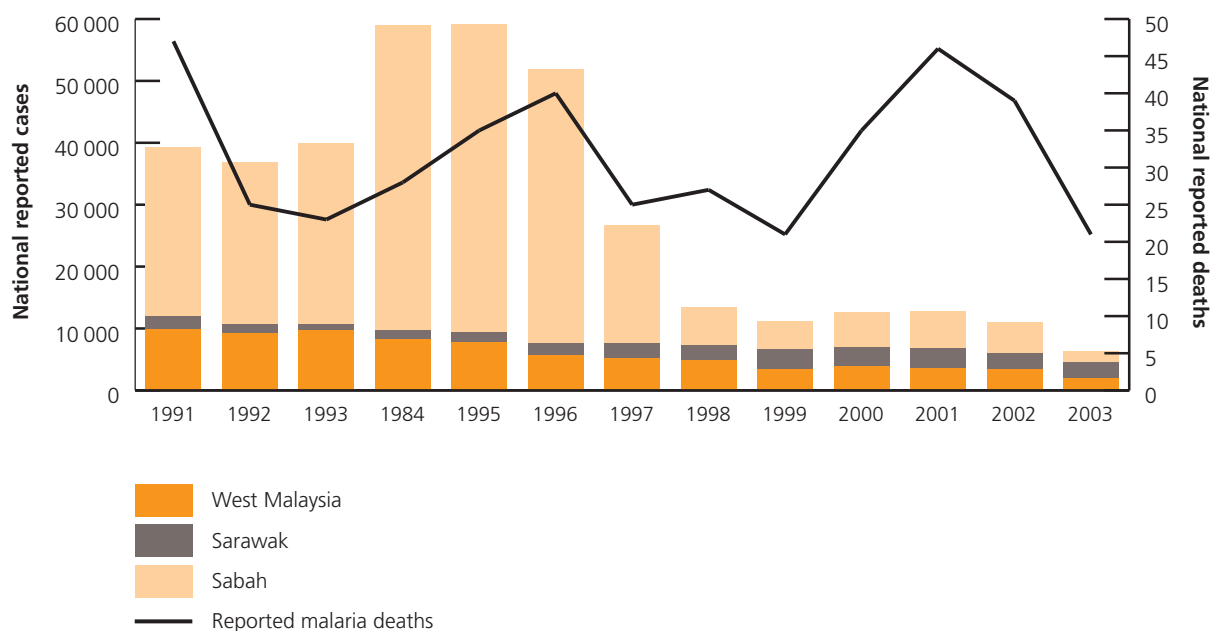
Starting in 1995, more aggressive vector control activities, specifically nationwide distribution of ITNs, were implemented in many areas, and confirmed cases decreased by almost 84% from 1995 to 2004 (Figure 10). Incidence in the country decreased from 4.3 per 1 000 population in 1981 to 0.2 per 1 000 population in 2004, mostly due to reductions in cases in Sabah State (Table 4).

Mortality attributed to malaria remained relatively stable, with between 20 to 40 deaths per year from 1991 to 2004, peaking at 46 deaths in 2001. The reason for this increase in deaths is unclear. The proportion of cases attributable to *P. falciparum* dropped from 63.8% (n = 25 023/39 189) of reported cases in 1991 to 40.6% (n = 2 496/6 154) in 2004, while the proportion due to *P. vivax* grew from 34.0% (n = 13 325/39 189) to 51.5% (n = 3 167/6 154) in the same period (Figure 6).

Table 4. Malaria indicators, 1991–2004

	Total Cases	West Malaysia	Sarawak	Sabah	Labuan	Incidence (per 1 000)	Total Deaths	Annual Blood Examination Rate (ABER)	Slide Positivity Rate (SPR)	Total Slides Collected
1991	39 189	9 879	2 132	27 178	NA	2.1	47	8.2	1.9	2 076 270
1992	36 853	9 330	1 429	26 094	NA	2.0	25	8.3	1.8	2 101 803
1993	39 890	9 701	1 059	29 130	NA	2.1	23	7.8	1.9	2 147 816
1994	58 958	8 245	1 521	49 192	0	3.0	28	7.7	2.5	2 343 957
1995	59 208	7 752	1 591	49 865	0	3.0	35	7.3	2.7	2 158 206
1996	51 921	5 745	1 900	44 276	0	2.5	40	6.8	2.4	2 192 804
1997	26 649	5 141	2 510	18 998	0	1.2	25	9.9	1.2	2 143 923
1998	13 491	4 835	2 557	6 099	0	0.7	27	8.0	0.8	1 783 720
1999	11 106	3 493	3 155	4 458	0	0.5	21	7.7	0.6	1 755 023
2000	12 705	3 918	3 011	5 776	0	0.5	35	7.9	0.8	1 648 041
2001	12 780	3 585	3 145	6 050	0	0.5	46	7.6	0.7	1 808 759
2002	11 019	3 427	2 496	5 096	0	0.5	39	7.2	0.6	1 761 721
2003	6 338	1 946	2 615	1 770	7	0.3	21	6.5	0.4	1 632 024
2004	6 154	1 310	2 089	2 741	14	0.2	36	6.2	0.4	1 577 387

Figure 10. Total Cases in West Malaysia, Sarawak and Sabah and number of nationally reported deaths, 1991–2004



CONTRIBUTION OF SABAH STATE TO NATIONAL TRENDS

Throughout the 1970s, Sabah greatly contributed to trends in national incidence. Although data is unavailable for the 1980s, anecdotal evidence indicates that Sabah continued to see an increase in cases during this time, particularly as the programme reoriented to control.

In 1994, Sabah was responsible for 83.4% of the total national malaria burden, declining to 27.9% by 2003. Incidence likewise declined dramatically from 187.0 per 1 000 population (44 276 cases) in 1996, to 76.0 per 1 000 population (18 998 cases) in 1997, and down to 16.0 (4458 cases) by 1999 (Table 5). From 1996, cases dropped to a low of 2 202, and an incidence of 6.2 per

1 000 population. SPR also decreased dramatically, from 9.1 in 1995 to 1.3 by 1998. Deaths attributed to malaria fluctuated from 1991 to 2004, with 42 deaths in 1996 and 6 deaths in 1998. This number has stabilized at between 6 and 18 deaths annually thereafter.

These trends largely reflect the Sabah Malaria Control-Programme's prioritization of vector control and surveillance interventions. Through aggressive vector control (IRS and ITN distribution), increased case detection capability and surveillance, in addition to other external factors such as a drought, the number of cases in Sabah began to decrease from 1997 onwards.

Table 5. Sabah malaria indicators, 1995–2004

Year	Total cases	Incidence	Total deaths	Annual blood examination rate (ABER)	SPR	Total slides collected
1995	49 857	223	29	21.7	9.1	714 850
1996	44 276	187	42	20.8	7.9	802 668
1997	18 998	76	10	16.8	3.5	777 306
1998	6 099	23	6	23.5	1.3	621 404
1999	4 458	16	7	20.4	1.1	568 012
2000	5 776	23	17	22.5	1.4	569 355
2001	6 050	23	12	19.5	1.2	511 663
2002	5 096	18.6	18	21.4	0.9	585 271
2003	2 202	6.2	8	15.3	0.3	537 459
2004	2 741	9.6	17	13.1	0.6	438 676

Moving toward malaria elimination: 2005–present

From 2005, the national programme was successful in maintaining low levels of malaria through a multi-pronged approach to elimination (vector control, case management, and entomological and parasitological surveillance). The West Malaysian states of Perlis and Malacca, and the Federal Territory of Kuala Lumpur (Figure 3), maintained zero local transmission throughout this time. In light of the dramatic declines in incidence experienced throughout the 1990s and early 2000s, the malaria control programme began discussing the possibility of declaring an elimination goal in 2005 (Table 4). In 2011, the programme officially declared an elimination target of 2015 for West Malaysia and of 2020 for Sabah and Sarawak.

By 2005, cases in Malaysia had declined to 5 569 from 59 208 cases in 1995 (Tables 5 and 6). Cases fluctuated between 5 294 and 7 390 cases annually between 2005 and

2010. In 2010, 0.4% of the population was reported to be at risk nationwide, with 19.7% in Sarawak, and 24.5% at risk in Sabah.

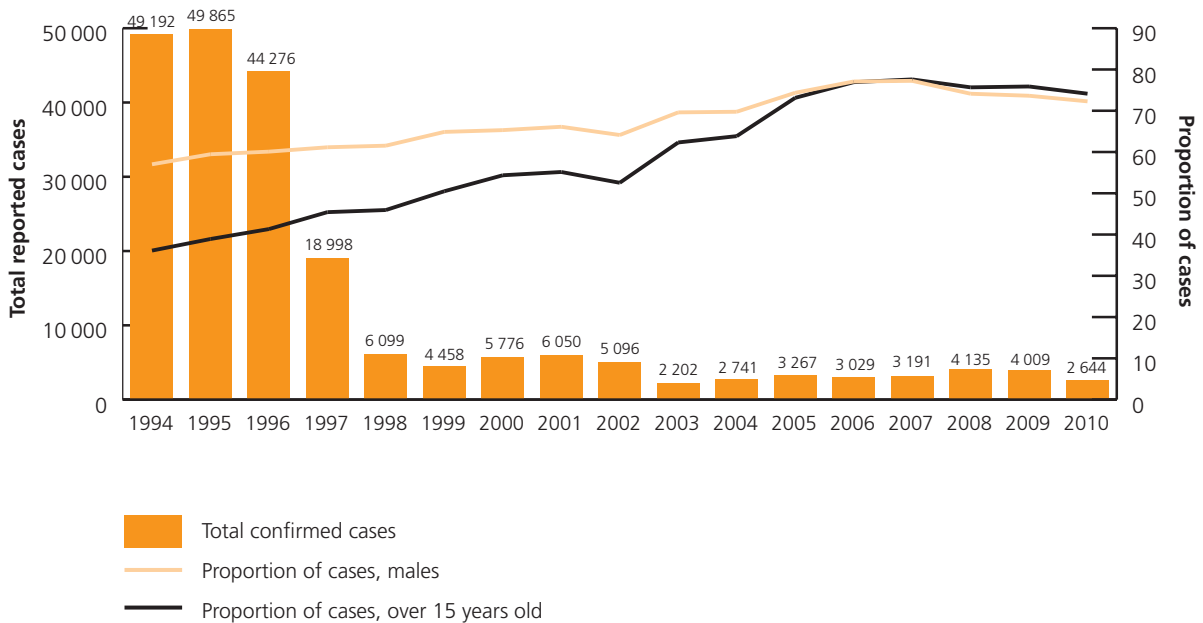
In 2005, 10.5% of national cases were imported, with most cases coming from Indonesia, Papua New Guinea and sub-Saharan Africa. By 2011, 1 142 cases, or 21.5% of total cases, were imported, most frequently from nearby Indonesia. That same year, imported cases were 51.6% (n=780/1 512) of confirmed cases in West Malaysia, 13.6% (n=234/1 761) in Sarawak, and 6.2% (n=127/2 032) in Sabah.

The risk profile of those with malaria had also changed; males and adults over the age of fifteen have become increasingly more likely to be infected. By 2010, 72.2% (n=1 911/2 644) of cases in Malaysia were in males, while 74.1% were older than 15 years of age (n=1 960/2 644). Figure 11 shows the shift in case demographics towards older adults and males from 1994 to 2010.

Table 6. National malaria indicators, 2005–2010

	Total Cases	West Malaysia	Sarawak	Sabah	Labuan	Incidence	Total Deaths	Annual Blood Examination Rate (ABER)	Slide Positivity Rate (SPR)	Total Slides Collected
2005	5 569	757	1 545	3 267	0	0.2	33	5.45	0.4	1 425 997
2006	5 294	852	1 413	3 029	0	0.2	14	8.04	0.2	2 142 694
2007	5 456	1 106	1 157	3 191	2	0.2	18	5.76	0.3	1 565 033
2008	7 390	1 342	1 909	4 135	4	0.3	30	5.13	0.5	1 562 148
2009	7 010	1 175	1 823	4 009	3	0.2	26	5.52	0.4	1 562 675
2010	6 650	1 204	2 802	2 644	0	0.2	33	5.73	0.4	1 659 629

Figure 11. Evolution of risk population in Sabah compared with total confirmed cases, 1994–2010



CONTRIBUTION OF SABAH STATE TO NATIONAL TRENDS

As Sabah has developed throughout the 1990s and 2000s, malaria cases have become more confined to the rural population living in less accessible, hilly, forested hinterland, and to areas with inadequate transportation and communication facilities. In 2011, the state reached its lowest level of malaria, with an incidence of only 6.0. [Table 7](#) shows malaria indicators in Sabah between 2005 and 2011.

In 2010, the Sabah malaria control programme reported that nearly half of malaria cases in Sabah each year were identified in foreigners living and working in plantations and logging areas. Approximately 60% of cases were among people with occupations considered to carry a higher risk of contracting malaria, particularly in the forestry, plantation and agriculture sectors. Incidence increased between 2007 and 2008, and although cases increased slightly in almost every district, major contributions to caseload could be attributed to outbreaks in the districts of Ranau, Kota Marudu and Kinabatangan ([Figure 2](#)). Outbreaks are defined as two or more local cases occurring in a medium or low risk locality—village,

housing area, or a section of a plantation—within the incubation period of approximately two weeks; in a high risk area an outbreak is when the number of reported cases is higher than the monthly median from the previous five years. Although Sabah has a considerable number of migrant workers (statistics unavailable) arriving from endemic countries each year, imported cases were only between 20.0% and 36.4% of its total caseload from 2005 to 2010, indicating that there is an ongoing need to devote resources to interrupting local transmission. From 2005 to 2009, the state continued vector control activities at similar levels to those implemented between 2000 and 2005.

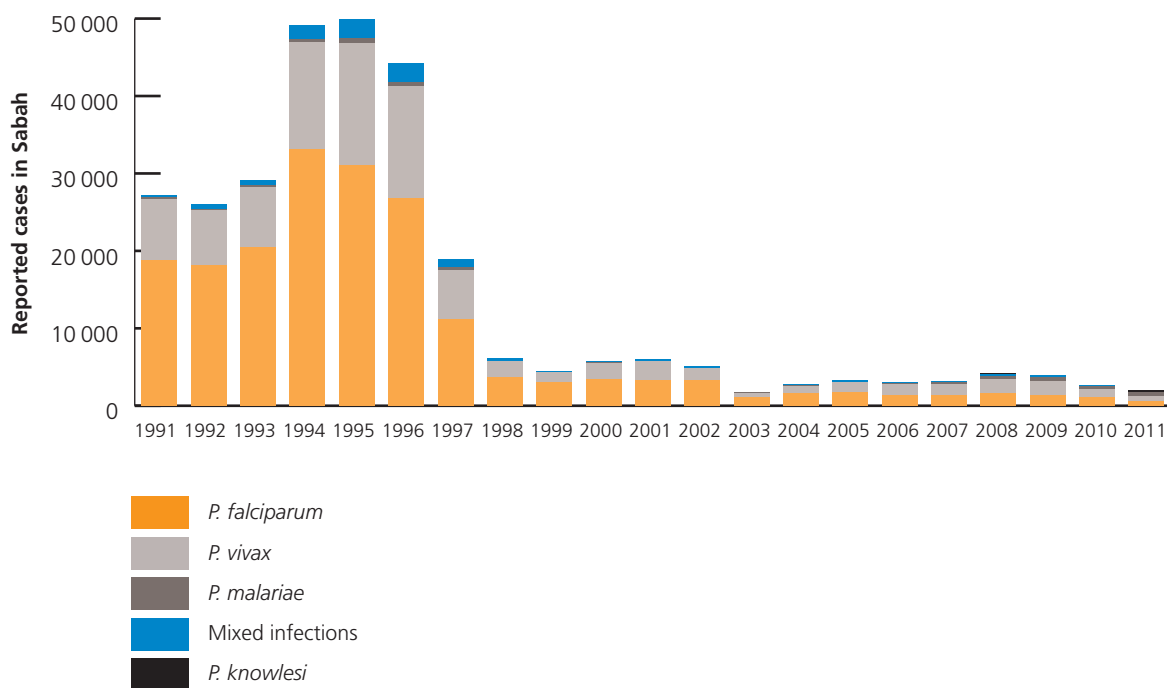
From 2005, *P. malariae* infections began increasing, possibly due to better diagnosis and testing by polymerase chain reaction (PCR) of cases confirmed by microscopy ([Figure 12](#)).

Recent research suggests that *P. knowlesi* cases may also be on the rise, probably due to an increased number of people engaged in high risk occupations in the forest, where they come in contact with simian parasite reservoirs (44). As a zoonotic form of malaria, Malaysia does not currently consider *P. knowlesi* as part of its elimination campaign, but continues to closely monitor the situation.

Table 7. Sabah malaria indicators, 2005–2011

Year	Total cases	Incidence	Total deaths	Annual blood examination rate (ABER)	SPR	Total slides collected
2005	3 267	10.9	19	13.3	0.9	391 125
2006	3 029	9.7	9	14.5	1.1	412 988
2007	3 191	9.9	9	11.1	1.2	466 541
2008	4 135	12.3	12	13.2	1.5	445 721
2009	4 009	11.7	13	12.3	1.5	422 720
2010	2 644	8.2	7	11.4	0.9	402 733
2011	2 032	6	7	12.5	0.5	379 107

Figure 12. Reported cases in Sabah by species, 1991–2011



FACTORS CONTRIBUTING TO THE CHANGING MALARIA SITUATION: 1982–2011

Why does malaria persist in Malaysia?

Malaria transmission depends upon the existence of the Plasmodium parasite, the presence of an *Anopheles* vector, and a human population, or, in the case of *P. knowlesi*, a simian population. In all countries aiming for malaria elimination, including Malaysia, the feasibility of interrupting malaria transmission is influenced by many factors, of which receptivity and vulnerability are particularly important. Vulnerability, otherwise known as importation risk, is “the probability of malaria reintroduction based on an area’s proximity to other malarious areas and the movement of infected humans or infected *Anopheles* mosquitoes (45).” Receptivity refers to the risk of resurgence and is defined as “a measure of the potential of an area or focus to allow transmission to occur (45).”

RECEPTIVITY

Malaysia’s ecology, geography and climate enables vector breeding and ongoing malaria transmission. In most areas of Malaysia, transmission is year-round. There is typically high vector receptivity in areas with significant internal migration, which generally exist within highly forested and remote areas, or those covered with palm oil or rubber plantations

Because of ongoing receptivity, the Malaria Control Programme maintains vector control in receptive areas throughout the year. Most of Sabah and Sarawak have stable parasite transmission year round, particularly in forested areas with large vector populations. As in much of the Asia Pacific region, vector populations are diverse, with great variation in breeding habitat and in biting and resting behaviors. This variation requires a high degree of vigilance and robust entomological surveillance by the

Malaria Control Programme. District level entomologists monitor local vector populations and identify new or potential breeding sites. In much of West Malaysia, *An. maculatus*, the main vector, breeds in water pools in hilly or mountainous areas, which often form after reforestation or development for agriculture. This vector typically feeds outdoors (29) and although *An. maculatus* prefers cattle to humans, it will bite inside and outside earlier than many other subspecies (18:00 to 21:00) (46). As such, it is possible that ITNs do not have a substantial impact in these areas. Plantation and agricultural workers are at risk, as are those who engage in hunting and fishing during peak biting times.

Sabah’s main vector, *An. balabacensis*, breeds in animal footprints, streams, rice paddies, and containers, as well as at the edges of swamps along the fringes of forests. Outside of urban areas, much of Sabah is forested, putting local village populations at risk. In particular, migrants and locals working on plantations and those hunting or fishing in forest areas during outdoor peak biting times from 19:00–20:00h are at higher risk (46). *An. latens* is the main vector in Sarawak, and has similar breeding behavior to *An. balabacensis*, feeding from 22:00–24:00h. It is abundant in forest fringe areas, and mobile individuals who do not use ITNs are highly susceptible to infection (46).

VULNERABILITY

Malaysia is highly vulnerable to malaria importation. Migration from Indonesia and the Philippines into the Sabah and Sarawak States occurs on a daily basis, with migrant workers often seeking positions in the growing plantation and logging sectors. Migrants also enter West Malaysia from Nepal, Myanmar, Thailand and Indonesia for plantation and factory work. This population movement presents operational challenges to malaria elimination. The country has stringent disease screening

requirements, including for malaria, whereby all documented migrant workers are tested upon arrival in the country by a pre-approved physician, who reports the migrant's health status to authorities. However, after this initial screening, migrants re-entering Malaysia from visits abroad are not subjected to screenings, increasing importation risk. Malaysian nationals working on oil platforms or plantations in Africa, in addition to those who travel to endemic areas without prophylaxis, further increase vulnerability.

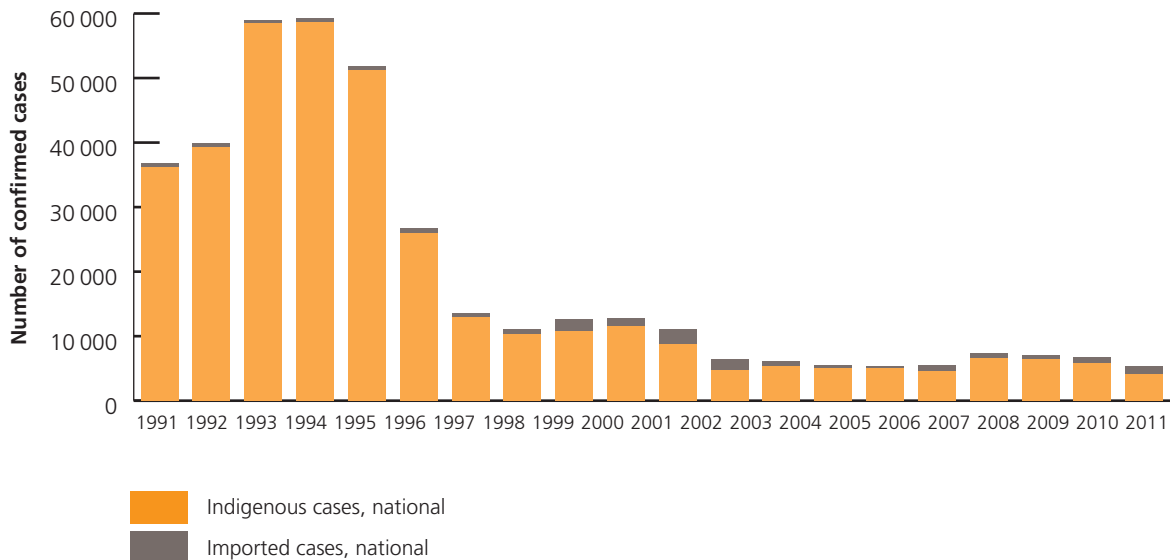
Importation of cases by migrants is a critical challenge to achieving elimination. According to programme staff, strict labour laws and recent government policies have reduced or kept stable the number of documented foreign workers from endemic countries. However, workers often move from plantation to plantation, seeking the best pay and benefits, which creates challenges for diagnosis, treatment and case follow-up. Official statistics on the number of migrant workers living in Malaysia are unavailable, but sources report that during the mid-2000s there were upwards of 1.9 million foreign workers in the

country (47). Annual national local and imported cases by year are illustrated in Figure 13.

Internal migration in Sabah, particularly amongst plantation workers, is also a major challenge for the Malaria Control Programme. Plantation workers tend to move between plantations and engage in high-risk activities, such as hunting and fishing in forested areas, to supplement their livelihoods. This group is challenging to access with health services, and cases may not present to health facilities or be available for treatment follow-up.

Logistical and Technical Challenges: Geographic inaccessibility to risk populations in Sabah and Sarawak challenges malaria control efforts, particularly for vector control activities and prompt and early diagnosis. Additionally, continual transfer of trained staff within the Ministry of Health, typically between Vector-Borne Disease Control Programme units, or to other environmental health units, can be particularly challenging for retention of institutional malaria control programme knowledge and quality of interventions.

Figure 13. Annual imported and indigenous cases for Malaysia, 1991–2011



How did Malaysia control malaria from 1982 to 2004?

With one hundred years of malaria control programming, Malaysia has benefited from a rich history of malaria control. From 1982 to 2004, the programme focused on several key strategies, including vector control, scale up of early detection of cases and active case detection, geographic reconnaissance, surveillance, and robust monitoring and evaluation systems. The programme also continued entomological work, including surveillance of receptive areas with breeding habitats.

(48). Sixty to 70% of all confirmed cases were detected through passive case detection in health facilities in the 1990s and early 2000s. One to two million slides have been collected each year since 1991 through ACD, PCD and other surveys (Table 6). Table 8 reflects the number of cases detected through passive and case detection, in addition to cases detected through other investigations, such as mass blood surveys or epidemiologic surveys.

The annual blood examination rate (ABER) fluctuated from 6.2% to 9.9% from 1991 to 2004, while SPR decreased from a high of 2.7 in 1995 to 0.4 in 2004

Table 8. Slides collected through passive case detection, 1992–2008

	1992	1994	1996	1998	2000	2002	2004	2006	2008
Cases detected through ACD	2 879	1 740	2 325	526	751	1 139	352	267	693
Cases detected through PCD	22 865	43 335	40 829	8 406	8 257	6 792	4 217	4 094	5 598
Cases detected through other means (MBS, other surveys)	11 109	13 883	8 767	4 559	3 697	3 088	1 585	933	1 099
Total cases	36 853	58 958	51 921	13 491	12 705	11 019	6 154	5 294	7 390

By 1981 it was clear that elimination was not feasible in Malaysia, and malaria control services around the country were integrated, becoming the Vector-Borne Disease Control Programme. Sabah and Sarawak were integrated by 1986. Throughout the 1990s, official programme objectives centered around reducing mortality and morbidity of vector borne diseases and preventing their resurgence in low endemic areas (34). Malaria control activities continued to be fully funded by the Malaysian government.

The programme adopted a Primary Health Care Approach to malaria control in 1990, whereby diagnosis occurred at the clinics and hospitals rather than solely relying on staff from the malaria control programme

(Figure 14 and Table 4). SPR reached a high of 2.7 in 1995. During this year, Sabah experienced an increase of 20 000 cases; SPR rose from 5.9 in 1993 to 9.6 and 9.1 in 1994 and 1995 respectively, contributing to the national trends depicted below.

Surveillance was key to better targeting malaria control measures from the 1990s to date: reactive and proactive screenings were employed, typically through mass blood surveys. Increased mass blood survey coverage and other investigations (epidemiologic surveys and reactive case detection activities) contributed to the success in decreasing incidence, with approximately 600 000 to 850 000 thousand slides collected and 5 000 to 20 000 cases detected annually through those activities (Figure 15).

Figure 14. Slides collected nationally and slide positivity rate (SPR), 1991–2009

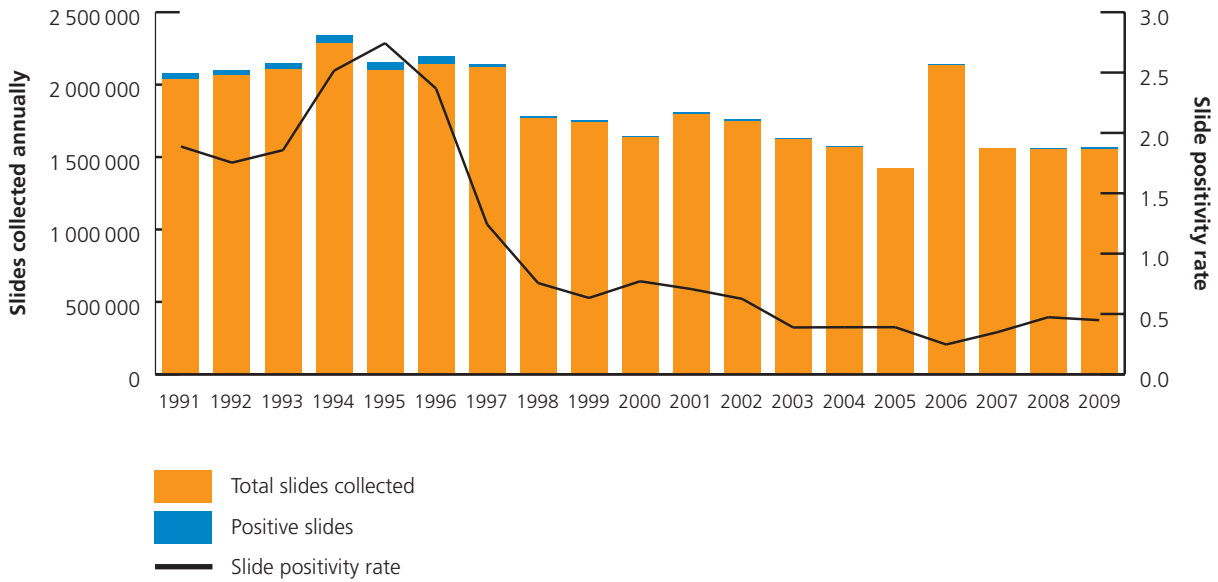
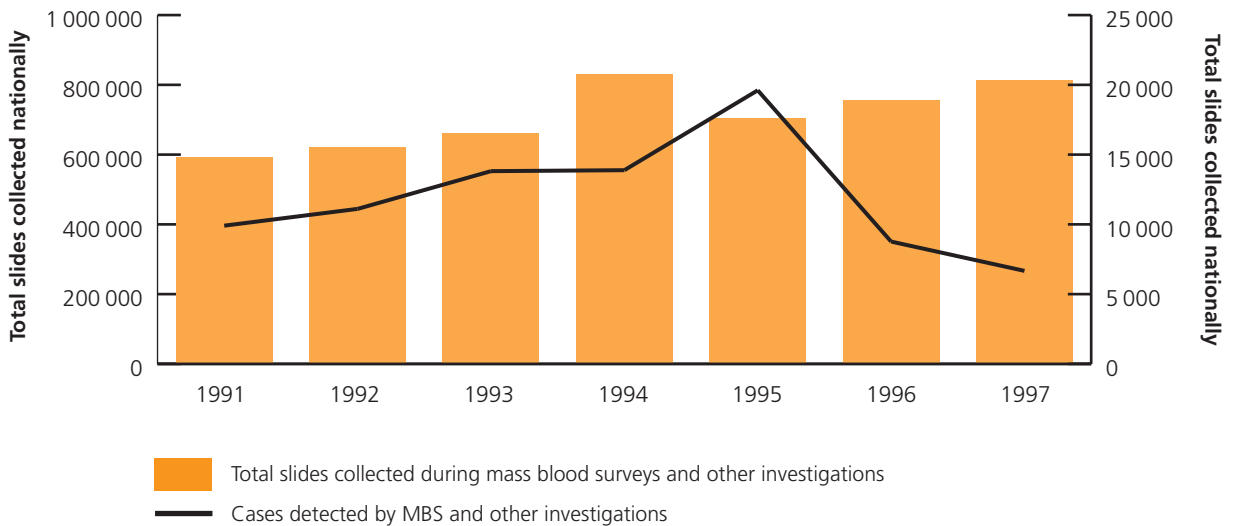


Figure 15. Slides collected through Mass Blood Survey and other investigations and cases detected through these activities, 1991–1997



IRS continued to be the primary vector control intervention across the country until the implementation of ITNs in 1995. In 1998, the programme transitioned from DDT, which had been a mainstay for over 40 years, to pyrethroid insecticides for IRS. In addition to conducting IRS in high-risk areas, the programme began to carry out focal spraying at village level in receptive non-malarious or malaria-prone areas. This took place every six months through the 1990s (34). Reports show that from 1997 to 2000 the programme covered between 31 000 and 70 000 houses with regular IRS, and between 50 000 and 200 000 people during six monthly spraying rounds (data is not disaggregated by round I and II conducted every six months, number reflects two spraying rounds per year). From 2001 to 2005, the programme covered between 200 000 and 400 000 people with IRS. Focal spraying in vulnerable and receptive areas, or those with outbreaks, was also implemented during this time. In 2002, 20 591 houses and 89 653 people were covered with focal spraying, while in 2004, 12 287 houses and 71 756 people were covered.

ITN distribution with retreatment every six months, which began in 1995, appears to have been critical to controlling malaria during this period. Additionally, the NMCP began to identify sprayable structures through geographical reconnaissance by hand mapping cases, in addition to surveying and mapping community water sources. Through this mapping, district level malaria

control officers were able to track and monitor cases and vector breeding spots. Certain risk groups were targeted for ITN distribution, including mobile populations and those living in highly endemic areas across the country. Some areas of West Malaysia, the island of Penang in particular, continued to employ some environmental management techniques, specifically through the use of subsoil drains. Entomological surveillance was also maintained throughout the country during this period. District and state officers devoted staff time to evaluating the entomological situation at the district level through local entomological surveys, which were conducted to assess the presence of breeding spots or to determine the efficacy of larviciding activities.

Educating the general public about malaria and its prevention was also initiated during this period of time, and was conducted through door-to-door visits during IRS/ITN activities. Officers were tasked with imparting knowledge on the signs and symptoms of malaria. Malaria posters, pamphlets and exhibitions were distributed by the Health Promotion Unit, which conducts separate health education campaigns that include other diseases.

In 2000, an online surveillance system, eVekpro, was developed specific for malaria for the purposes of monitoring and evaluation. eVekpro contains data regarding cases, as well as information from case investigations and vector control activities (Figure 16) (49).

Figure 16. A reproduction of a spreadsheet in the eVekpro monitoring system with case demographic information

Senarai Daftar Malaria Tahun 2012									
Terdapat 4 722 rekod di dalam database									
Bil (#)	Nama (Name)	Umar (Age)	Janrina (Sex)	Epid (Week)	Daerah (Area)	Negiri (State)	Pekerjaan (Job)	Tarik Laporan (Report Date)	Tarik Key In (Date of Key In)
1	XXXXX	41	Female	1	Marudi	Sarawak	Petani	2012-01-02	2012-01-03
2	XXXXX	56	Male	1	Raub	Pahang	Pembantu Hal Ehwal Islam	2012-01-01	2012-01-01
3	XXXXX	25	Male	1	Kapit	Sarawak	Penoreh Getah	2012-01-06	2012-01-06
4	XXXXX	14	Female	1	Kapit	Sarawak	Tiada	2012-01-06	2012-01-08
5	XXXXX	44	Male	1	Guamusang	Kelantan	Penyelia kilang	2012-01-08	2012-01-08
6	XXXXX	38	Male	1	Raub	Pahang	Petani	2012-01-09	2012-01-09

Source: reference 49

In addition, the eNotifikasi online notification system for health providers was introduced in 2000, allowing private and public health facilities to rapidly report all notifiable infectious diseases, including malaria cases. The two online systems help district, state and national offices to track: data collected on index cases; information from case investigations; and information on malaria control activities, such as IRS and ITN distribution. This has allowed the national and state Malaria Control Programmes to conduct more sophisticated analysis on the epidemiologic situation at the village (foci), district, state and national level.

Finally, in order to prevent the introduction of drug resistant malaria from the nearby Mekong region, the National Anti-malarial Drug Response Surveillance programme was started in 2003 to monitor drug efficacy. The programme consisted of 18 sentinel sites in highly endemic areas within seven states (49). To date, resistance to artemisinin has not been reported.

FOCUS ON SABAH STATE

Most of the major declines in incidence during this time occurred in Sabah (Table 5). Changing conditions in the state contributed to this decrease, in particular the economic development of the early 1990s, which led to an increase in health care access for rural populations. Economic development also led to land use changes, with receptivity decreasing in urban areas and in some established agricultural areas. A drought in 1995 may also have contributed to the decline in cases.

However, economic development also brought its challenges. Documented and undocumented migration continued to increase, and presented a considerable risk of malaria importation (47). Areas of virgin forest became highly endemic as migrant workers, involved in timber extraction and plantation work, created reservoirs of malaria parasites. In response to these challenges, Sabah began ITN distribution in 1993, with statewide implementation in 1995, and increased IRS coverage with pyrethroids in 1995. Several insecticide susceptibility and vector behavior studies were also conducted to inform the Sabah Malaria Control Programme on the choice of

vector control activities (with NMCP input) (50, 51). A baseline survey showed low coverage of both IRS (5%) and ITN (9%) in malarious districts. The programme responded by increasing financial and human resources for vector control. Coverage of IRS, conducted twice per year, was increased in all vulnerable areas with pyrethroid insecticides, and coverage also improved for ITNs (Table 9). The programme continued to face challenges around access to remote villages and adequate staff to cover large rural areas.

Table 9. ITNs distributed and retreated; number of houses sprayed during bi-annual IRS, 1993–2011

Year	Total ITNs distributed	Total number of nets retreated	Number of houses sprayed during Round 1 IRS	Number of houses sprayed during Round 2 IRS
1993	4 135	4 282	34 324	25 722
1994	21 674	28 976	8 744	8744
1995	88 759	104 044	10 339	19 706
1996	78 579	183 977	20 758	31 384
1997	53 741	254 122	34 189	42 955
1998	36 221	256 825	14 402	18 276
1999	20 473	265 520	22 709	25 272
2000	21133	218 346	23 322	22 311
2001	22 224	179 481	15 196	6 810
2002	41 318	163 645	14 999	12 464
2003	35 013	197 803	12 954	9 642
2004	36 721	178 540	8 824	7 361
2005	35 077	213 082	8 387	7 957
2006	26 904	216 437	11 184	14 483
2007	70 925	169 278	11 137	10 208
2008	37 160	220 261	8 519	8 256
2009	55 619	208 821	9 919	19 605
2010	76 532	307 985	46 126	82 853
2011	79 424	300 349	46 096	64 500

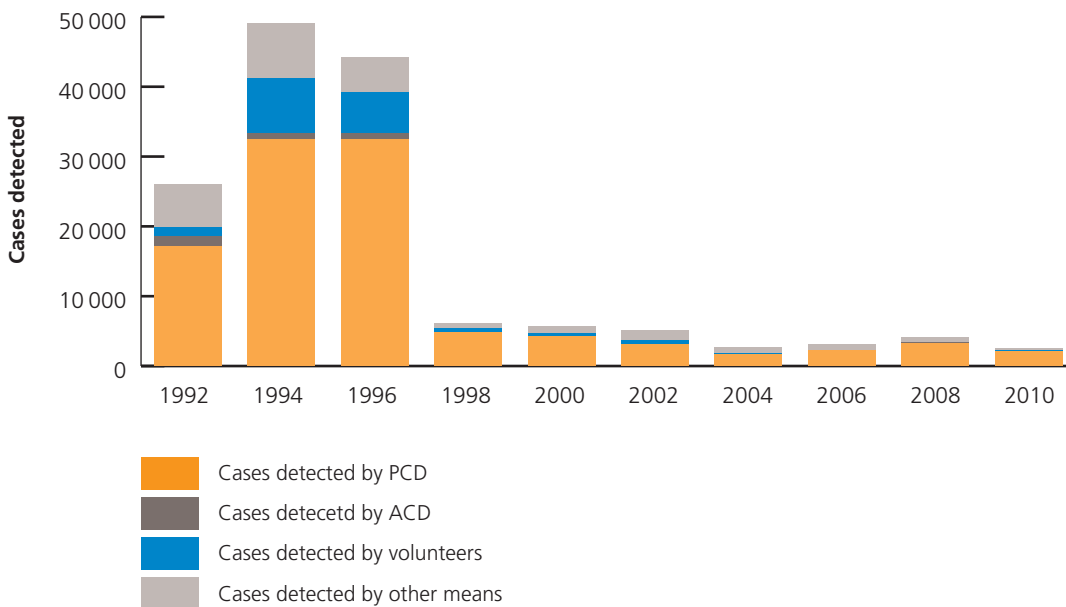
State and district entomologists closely monitored vector behaviour, conducted entomological surveys, and supervised ITN and IRS activities to ensure efficacy. Although many countries have transitioned from ITNs to long-lasting insecticide treated nets (LLINs), the Malaysian NMCP has decided against implementation of LLINs until pilot studies have been conducted. The NCMP indicated that the current system of bi-annual spraying in conjunction with ITN retreatment has worked successfully to date, and allows NMCP officers to easily identify houses in the community without nets and to check net quality at the same time. Currently the program is discussing strategies for implementation of LLINs.

Surveillance activities were increased, with mass blood surveys conducted proactively, or as a means to search for cases in the community without the trigger of an index case, or reactively, in response to an index case. Mass blood surveys were conducted proactively every six months in conjunction with IRS and ITN coverage in high-risk areas, and reactively to search for asymptomatic cases, or additional fever cases, in the community.

The annual blood examination rate (ABER) in Sabah, which represents the number of blood slides collected out of the total state population, fluctuated over this period, with a high of 23.5% in 1998 and a low of 13.1% in 2004. During this time, between 500 000 and 800 000 slides were collected each year in Sabah, mostly through passive case detection, mass blood surveys and by volunteers who aided in the collection of slides (Figure 17). Malaria control in the Sabah State is discussed in greater detail below, given its important contribution to the national malaria burden and continuing receptivity and vulnerability to malaria transmission.

In 1995, Sabah launched a Five-Year Action Plan for malaria control, which was presented to the national level to justify the need for increased funding and resource allocation. The Sabah programme urgently needed health inspectors and public health assistants, also called malaria control officers: only 243 malaria-specific posts existed in 1994, compared to 300 in 1984, a 20% reduction in staff. There were particularly acute shortages of malaria officers in the field, with only about 53% of malaria positions filled. The action plan, developed in 1994, noted the need: (1) major increases in vector control activity

Figure 17. Case detection in Sabah, 1992–2010



coverage; (2) the development of subsector outpost offices in remote areas; (3) more community involvement; and (4) the implementation of case follow up and investigation procedures. It stipulated that each malaria officer in the field needed to collect at least 60 slides per week for early detection of cases.

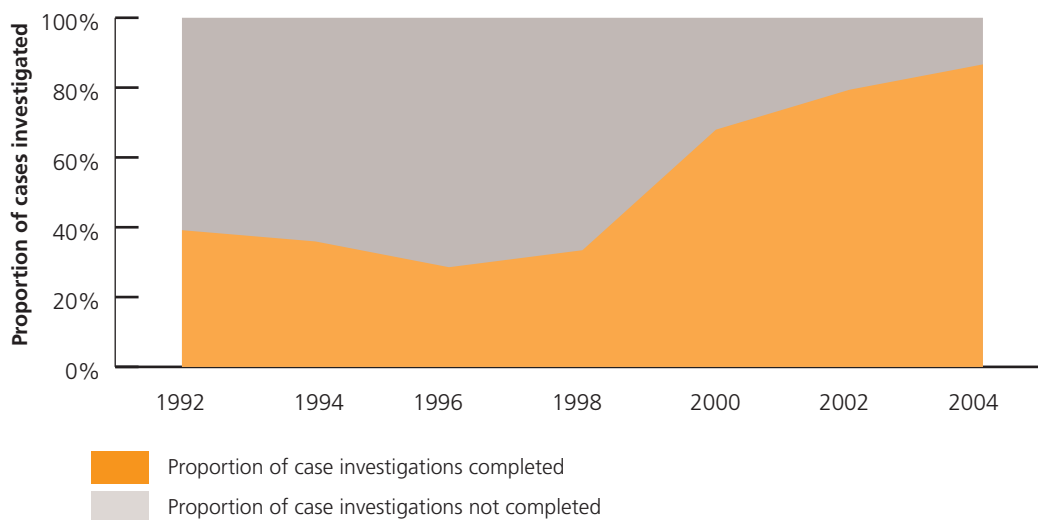
The programme was successful in obtaining an increase in human resources—100 additional positions—from the national government for the Malaria Control Programme in Sabah. The increase in funding and successful implementation of these activities contributed to the decline in malaria cases. It became possible for officers to investigate more index cases. By 2004, the proportion of cases investigated rose to 86.6% from 39.1% in 1992. **Figure 18** shows the rising proportion of cases being investigated from 1992 to 2004.

From 1995–2000, there were two critical innovations that helped the Sabah Malaria Control Programme achieve such success. First, the development of malaria offices in remote localities, or subsector offices, was critical to the state’s success in reducing transmission. This has allowed the malaria control programme to have greater reach

by housing officers within endemic communities that are difficult to access. The offices are typically staffed by public health assistants, who implement IRS, ITN distribution, mass blood surveys, and health education. Most subsector offices provide microscopy services. All offices conduct vector control and health education activities in their respective areas and are well integrated into the communities they serve. Current and retired programme officers report that the placement of malaria control officers in subsector offices has had a substantial impact on malaria morbidity in these areas.

In conjunction with the subsector offices, primary health care volunteers (PHCVs) played an important role and continue to do so. A corps of health volunteers was formed to conduct malaria specific activities in remote or inaccessible areas to fill the gaps in access to diagnosis, treatment and prevention. PHCVs were trained to provide early diagnosis and treatment, provide education about malaria and malaria control, promote ITN use, and help malaria officers with IRS activities. In 1995, Sabah PHCVs collected an estimated 14% of all blood slides for malaria parasites taken in the state, allowing government officers to allocate their time to prevention activities.

Figure 18. Proportion of case investigations, Malaysia, 1992–2004



How did Malaysia reach and maintain pre-elimination status through 2011?

In 2005, malaria cases stood at 5 569, of which almost 600 were imported, and the national Vector Borne Disease Control Programme began considering an elimination target. Throughout the following years, a number of workshops were conducted at district level by state programmes, and several national technical meetings were convened, with consultation from public health specialists, primary health care providers, and laboratory specialists.

The World Health Organization suggests that countries can use a slide positivity rate of less than 5% as a milestone at which to consider reorienting from the control phase to the pre-elimination phase (52). Nationally, SPR in Malaysia had remained relatively stable between 0.2% and 0.5% since 2003, well below the recommended 5%. In addition, national policy already required: that all febrile cases seeking treatment at all health facilities be tested for malaria; 100% confirmation of cases by microscopy; and mandatory notification of malaria cases. The strategic plan for elimination received high-level approval at the end of 2010.

Throughout this time, the success of the NMCP can be attributed to several key priority areas: targeting of high risk groups with control activities; building surveillance capacity; an ongoing focus on health systems strengthening by the Ministry of Health; increasing vector control coverage; developing a quality assurance programme for microscopy; and building political and financial commitment to elimination.

A focus on targeting risk groups was implemented during this time. The Orang Asli (indigenous) population in West Malaysia (who typically inhabit remote forest and forest fringe areas) had historically contributed a significant number of cases. In 1995, 6 141 reported infections occurred in the Orang Asli population. Starting in 2003, these communities were targeted with increased coverage of control activities by the Malaria Control Programme, and by 2005 only 172 cases were reported.

Mobile populations in Sarawak were also targeted (data unavailable), as were remote populations in Sabah. Since 2010, migrant populations have been targeted, typically through mass blood surveys on plantations and manufacturing plants. Although data is not available for these activities, the Malaria Control Programme has continued to prioritize targeted interventions within this group.

Surveillance has remained a priority. The programme's two online notification and monitoring systems, eVekpro (Figure 13) and eNotifikasi were redeveloped to collect more robust data. These changes reflected the need for a more detailed system that could track data collected during case investigations as well as vector control activities. In addition to the eVekpro system, the eNotifikasi online system, which tracks cases reported to the disease control programme by clinics and hospitals, allows for a comparison of data inputs between the two systems, and for the programme to work with hospitals, clinics and private providers that may not be notifying cases. They also allow the Malaria Control Programme to track trends in areas with ongoing transmission and to quickly identify outbreaks. ACD, mass blood surveys and other epidemiological surveys continued to be prioritized during this time, with over 1 000 cases detected through these methods annually between 2005 and 2008. Passive case detection continues to identify a majority of cases, but ACD, or fever screening, and mass blood surveys are also responsible for detecting a percentage of cases (Table 10).

Success in maintaining low cases in recent years can be partly attributed to strong passive case detection due to the strength of the health system, and to available infrastructure, a priority for the Ministry of Health. An increased number of rural health centres, as well as general advances in infrastructure that have increased access to health care for villagers, such as mobile health clinics, have likely contributed to progress. The capacity of the health system to quickly detect and treat cases has also been crucial, and in 2010, a policy was put in place requiring all slides in clinics and hospitals to be read within 24 hours. This has not only ensured that most cases are confirmed before treatment but that patients are treated promptly and with the correct anti-malarial drugs.

Table 10. Cases detected through ACD, PCD, Mass Blood Surveys, Investigations and other means

	Cases detected by passive case detection (PCD)	Percent of cases detected by passive case detection (PCD)	Cases detected by active case detection (ACD)	Percent of cases detected by active case detection (ACD)	Cases detected by mass blood surveys	Percent of cases detected by mass blood surveys	Cases detected by other investigations	Percent of cases detected by other investigations	Cases detected by other means
2009	5 571	79%	490	7%	475	7%	288	4%	186
2010	4 787	72%	811	12%	644	10%	374	6%	34
2011	4 320	81%	293	6%	395	7%	122	2%	176

Entomologic surveillance remains a key strategy for malaria reduction in Malaysia. The NMCP also added entomological staff in district malaria control offices in Sabah and Sarawak to better monitor the vector situation (Figure 19). Entomologists continue to be responsible for monitoring the vector situation within their districts. In Sabah and Sarawak, district level entomologists are monitored by a team of entomologists at the state level, who provide technical expertise and supervision. Entomologists from the Institute for Medical Research have also continued to partner with the NMCP, researching breeding habitats and vector behavior (53–55).

Figure 19. An entomologist inspects a water body after an outbreak on Pulau Gaya off the coast of Sabah.



As cases decreased and investigation of every case became more feasible, the NMCP increased its focus on actively detecting cases through mass blood surveys in outbreak areas.

The NMCP has continued to rely on IRS and ITNs as primary vector control interventions, and aimed to increase targeted coverage of foci starting in 2012. In 2008, the NMCP restratified districts by risk. In turn, coverage rates increased, as the programme began using the ‘at-risk population’ as the denominator rather than total national population. By 2010, regular IRS was conducted in the five Malaysian states with ongoing transmission and with highest case incidence (Sabah, Sarawak, Kelantan, Pahang and Perak). In the first six months of this strategy, 78 088 houses were sprayed, with 64 789 houses sprayed in the second half of 2010. Focal spraying continued to be conducted in districts with malaria prone and malaria free areas that were considered vulnerable to the spread of disease, often areas with large numbers of migrant workers or indigenous settlements. In 2010, focal spraying was conducted in all states except the federal territory of Labuan. A total of 18 616 residential structures were sprayed in the first six months; 14 736 houses were sprayed in the second half of the year.

Integrated Vector Management (IVM) is currently being introduced as a management tool as part of the NMCP’s elimination strategy. IVM in Malaysia includes intersectoral collaboration with other government units and the

private sector, community engagement in vector control, and entomological surveillance, to ensure adequate and appropriate vector control implementation, including ITN distribution, IRS, and larviciding. The programme also conducts regular larviciding in receptive and outbreak areas, and bioassays of IRS and ITNs to monitor effectiveness and potential resistance at sentinel sites around the country.

As incidence declined, the NMCP identified quality assurance of microscopy as crucial for reaching elimination. Individual state Malaria Control Programmes began developing quality assurance standard operating procedures, with the aim of maintaining a high quality of diagnosis. All positives and 10% of negative slides from all facilities with microscopy services are sent to the main public health laboratory in each state every month for rechecking. Each state has individually tailored plans, depending on incidence and laboratory capacity. Targets include: microscopy false positive rate not to exceed 1%, with false negatives at 0%. As annual cases continue to decrease in pre-elimination settings, there is concern that microscopists may lose skills and misidentify parasites. Despite this, programme officers report that laboratory microscopy error rates have continued to decrease nationally, although the 0% false negative indicator has not yet been reached, but remains under 0.1% and 0.07% in Sabah. The national Public Health Laboratory supervises laboratory microscopists and provides retraining for those with frequent diagnostic mistakes.

Upon implementation of the national malaria elimination plan, the Malaysian government increased its commitments to malaria control activities and human resources. From 2008 to 2010, the Ministry of Health allocated around \$USD 23 800 000 annually to malaria control; in 2011 this increased to \$USD 37 844 710 (1, 56). This dramatic increase reflected the cost of the additional staff and material resources necessary to achieve elimination targets, particularly in areas of ongoing transmission in Sabah and Sarawak.

FOCUS ON SABAH STATE

As discussions began on a national level about the feasibility of elimination, Sabah conducted a series of district-level workshops to gather input from officers on the resources needed to eliminate malaria. Malaysia, and Sabah in particular, has a strong focus on utilizing local level inputs from district malaria control staff to inform strategic planning.

Continuing prioritization of vector control through IRS and ITN, increased human resources, ongoing implementation of policy around microscopic confirmation before treatment, quality assurance of microscopy, and collaboration with private industry, contributed to state trends. Sabah State operationalized its elimination strategy in 2010, a year earlier than the rest of the country, due to ongoing challenges with migration and access to remote populations.

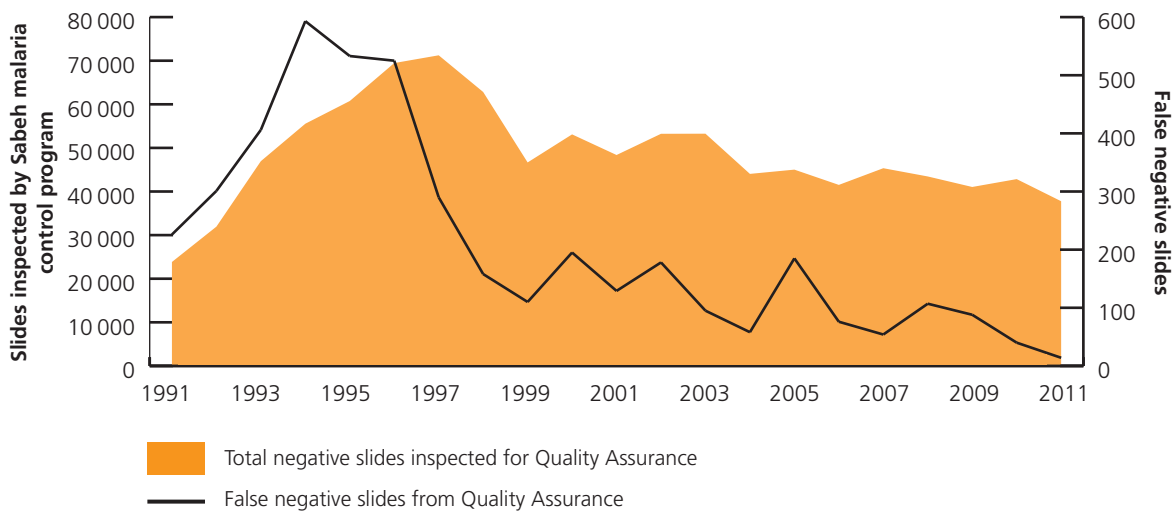
Vector control continued to be a key strategy. In 2009, only 55% of high-risk areas were covered by ITNs, with the lowest coverage in the Tawau district (15%), largely due to its size, its substantial number of plantations, and to its large migrant population and remote geography. Two districts, Ranau and Keningau, did not conduct regular IRS. When Sabah officially declared its intention to eliminate malaria, the Sabah Malaria Control Programme increased IRS and ITN retreatment activities. In 2009, the programme covered 9 919 houses during the first round of spraying and 19 605 houses in the second round. Comparatively, in 2010, 46 126 houses were covered in the first round and 82 853 houses in the second round. ITN distribution also increased from 55 619 distributed nets in 2009 to 79 424 in 2011, and the programme retreated over 100 000 more ITNs in 2011 than in 2009.

In 2010, in addition to the 148 temporary, part-time malaria staff employed by the state, the Sabah Malaria Control Programme requested and received from the national level new vehicles, microscopes, global positioning system (GPS) units to map houses and breeding sites, and other funding.

Microscopy continued to be the primary diagnostic tool, but PCR for quality assurance was introduced to national and state laboratories in 2007. Also beginning in 2007, positive slides for *P. knowlesi* and *P. malariae*, and slides from malaria fatalities, were sent to the state public health laboratory for PCR confirmation. In line with national policy, Sabah continues to emphasize the role of prompt and correct diagnosis through microscopy, and re-examines 10% of all negative slides and all positive slides. Due to a strong focus on adequate and regular training for microscopists, including annual workshops at the state and national level for laboratory workers to be retrained, Sabah has experienced a decrease in the number of false negative slides (Figure 20).

Rural villages without access to static health centres continue to exist, so presumptive treatment is still used in very remote areas when microscopy results cannot be immediately obtained. Blood slides are taken at the same time as treatment is given, and are later examined at health facilities. Treatment is then altered if necessary upon confirmation of species. In 2006, the programme provided 12 955 presumptive treatment courses; that number declined dramatically over the next six years after the implementation of policies requiring confirmation before treatment, with only 264 presumptive treatments given before microscopic confirmation in 2011.

Figure 20. Slides examined by Sabah malaria control program for quality assurance



Another addition to malaria control activities in the state was the development of a number of informal partnerships with private sector plantations. Although some of these began in the early 2000s, much of the impact has been seen since 2005. Plantations have long been an epicenter of malaria: in fact Malaysia pioneered most of its environmental modification techniques on plantation estates in West Malaysia in the 1900s. Borneo has a large number of palm oil and rubber plantations, with corresponding high levels of cases. In the 1990s, upwards of 400 cases each month occurred on some plantations. The combination of remote location and migrant workers makes plantations highly susceptible to outbreaks and ongoing local transmission.

In most cases, state and district level offices initiated these plantation collaborations in response to plantation outbreaks (data unavailable). Some plantations maintain

a communicative and cooperative relationship with the control programme and others commit resources, including financial or logistical support, to malaria control. Several plantations have clinics with microscopy and treatment provided by trained technicians on site. Others have built subsector buildings that are staffed by government malaria officers, and yet others provide transportation and logistical support for the indoor residual spraying (IRS) and ITN distribution teams. The most extensive contributions are those plantations that subcontract IRS and buy ITNs for their workers, in addition to providing medical and/or logistical support. There have been decreases in incidence and a declining number of outbreaks since the start of these collaborations. The programme is actively seeking new plantations for partnership.

CURRENT PROGRAMMATIC STRATEGIES TO REACH MALARIA ELIMINATION

Malaysia has a goal of malaria elimination nationwide by 2020, with zero local transmission by 2015 in West Malaysia and 2020 in Sabah and Sarawak. The NMCP has developed a comprehensive Malaria Elimination Strategic Plan, implemented in 2010 in Sabah and 2011 in West Malaysia and Sarawak. The following sections describe the current programmatic strategies for elimination outlined in the 2010 National Malaria Elimination Strategic Plan.

Organization/support

The Disease Control Division of the Ministry of Health has seven units, one of which is the Vector Section. This section has malaria and dengue programmes in addition to units dedicated to filariasis, Chikungunya, rickettsia, and scrub typhus. Entomological surveillance work is integrated into the malaria and dengue units (See [Figure 5](#) for organizational structure of the Ministry of Health). The NMCP controls financing, programme activities, and development of strategies and guidelines for malaria, with input from states. These are then implemented at state and district level. In addition, the NMCP monitors and analyzes data on malaria trends across the country.

The state level provides technical expertise, state programming and guidelines, and supervision at district level. Districts are responsible for implementation of surveillance (including entomological surveillance), vector control, monitoring of risk groups, and all other elimination activities, based on guidelines and policies.

Human resources: Each year, district and state offices determine their human resource needs and lodge requests with the NMCP. All final decisions on staffing are made at national level. Public health specialists (physicians) hold positions in top management, and malaria control officers, also called Assistant Environmental

Health Officers, manage and conduct malaria control work, including vector control, surveillance, health education and some entomological surveillance around the country. Additional staffing includes administrative workers, drivers, and permanent and temporary spraymen. Health professionals such as physicians, assistant medical officers, nurses and laboratory technicians are staff positions under the Family Health Development Division but also work with malaria teams. In Sabah, newly hired spraymen and drivers are often recruited from the Primary Health Care Volunteer programme.

Sabah and Sarawak have multiple entomologists who focus on dengue, malaria, or both. District-level entomologists work on both diseases, with allotment of their time dependent on disease trends.

Policy/legislation

Currently, national level policy strongly recommends diagnosis before treatment, except in remote areas where microscopy is not immediately available. The Destruction of Disease Bearing Insects Act (DDBIA) 1975 (amended in 2000) gives Ministry officials the power to enforce environmental clean-up and gives the Vector-Borne Disease Control Programme authority to engage in IRS and in ITN distribution on private property (57). The Prevention and Control of Infectious Diseases (PCID) Act 1988 sets parameters for the government to engage in communicable disease control (57). Sabah and Sarawak have additional public health ordinances that allow the conduct of malaria control activities. The Occupational Safety and Health Act of 1994 protects domestic and migrant worker rights, and provides a legal foundation for worker welfare (58). The NMCP uses the Occupational Safety and Health Act, OSHA, in addition to the PCID Act, to ensure that the government can access private land for

IRS, ITN distribution and surveillance. Malaysian policy requires all foreign workers to be screened for a number of communicable diseases before receiving a work permit, and upon arrival in Malaysia. In 2008, several states began denying migrant workers visas if they presented with symptoms of a communicable disease, and would deport them post-diagnosis.

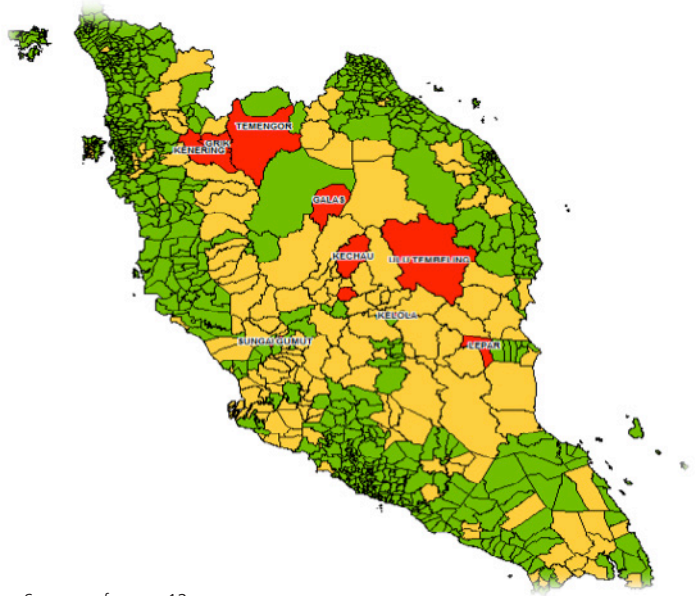
Stratification system

Malaria control priorities are based on a stratification system, which takes into account incidence for the previous three years, vector receptivity and access to the health system (Figure 21). Although Malaysia has had a district stratification system for many years, it previously defined districts as malarious, malaria prone or non-malarious. This system shifted in 2008 to the following categories, still taking into account the previous three years of incidence history: districts with an incidence of one or more cases per 1 000 population (red), with less than one case per 1 000 population (yellow), and with zero incidence (green) (Figures 21–24) (12). Stratification serves to guide vector control activities, and to inform entomological surveillance. Since 2008, 0.4% of the population in West Malaysia was deemed to be at risk of malaria, while 24.5% of the population in Sabah and 19.7% of the population in Sarawak was considered at risk. The programme will re-stratify in 2013.

Figure 21. Stratification criteria for malaria elimination, as of 2008

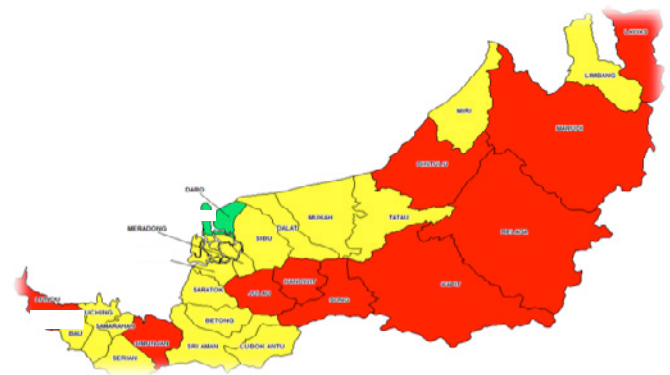
Area	Criteria
Red	Incidence \geq 1/population
Yellow	Incidence $<$ 1/1 000 population
Green	No indigenous/local transmission

Figure 22. Stratification by locality in West Malaysia in 2008



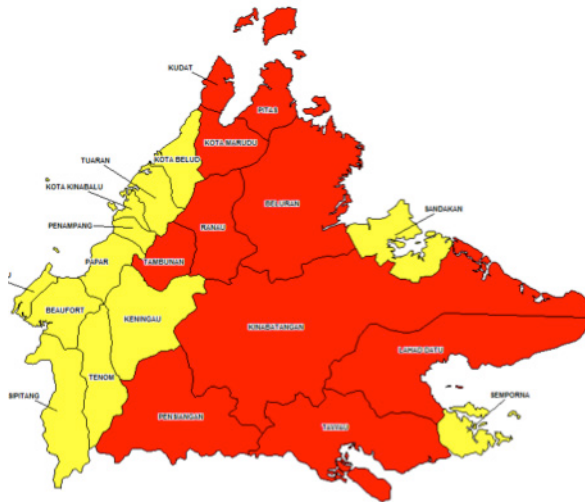
Source: reference 12

Figure 23. Stratification by locality in Sarawak in 2008



Source: reference 12

Figure 24. Stratification by locality in Sabah in 2008



Source: reference 12

Case management

Diagnosis: Microscopy is available countrywide and Rapid Diagnostic Tests are not used. PCR is used for quality assurance purposes at state and national level laboratories, typically for cases resulting in mortality or *P. malariae* and *P. knowlesi* cases. Slides from cases that present to a clinic or are detected through mass blood surveys or ACD are to be read within twenty-four hours, although in Sabah State, slides from outside facilities were most often done within 48 hours because of the terrain. This protocol is challenging in Sabah and Sarawak, where the caseload is still relatively high. Additionally, *Plasmodium vivax* patients may not be able to commit two weeks (treatment length) to a hospital stay. In any of these special cases, medical officers may release patients to malaria officers, who follow up cases daily on treatment adherence and to monitor for relapse.

Treatment Recommendations: Treatment (see Annex 3) is free for Malaysian nationals with a nominal fee for foreign nationals, which is seen as increasing access to diagnosis and treatment for all. The NMCP is currently revising its treatment recommendations with consultation from infectious disease physicians and public health specialists. Treatment guidelines are issued in

the Malaysia National Antibiotic Guidelines 2008 (see Annex 3). Recommended first-line treatment for *Plasmodium falciparum* is combination artesunate/mefloquine or artemether/lumefantrine. Addition of single dose primaquine is recommended if gametocytes are present. Outside of hospitals, earlier treatment guidelines are still applied. For example, in some areas of Malaysia, particularly in Sabah and Sarawak, combination sulfadoxine/pyrimethamine is still used to treat uncomplicated *P. falciparum*. Because of concerns about resistance, both states are moving towards ACT treatment for all cases. When possible, all confirmed cases regardless of species, should be admitted to a hospital for the duration of treatment, and until the patient has had three negative blood slides.

First line treatment for *P. vivax* cases consists of three days of chloroquine and fourteen days of primaquine. G6PD testing is recommended for all patients prescribed primaquine, but is not conducted by all physicians. In Malaysia, all newborns delivered in government health facilities are tested for G6PD deficiency. In 2011, 363 754 newborns were tested for G6PD, and 376 760 cases in 2012. *P. knowlesi* cases are treated with chloroquine and severe cases are treated as for *P. falciparum*. Mixed infections are also treated similarly to *P. falciparum*. Severe malaria is treated with intravenous artesunate.

Chemoprophylaxis: Government-recommended prophylaxis, issued free of charge, consists of combination fansidar/chloroquine, proguanil/chloroquine, or doxycycline. These drugs are recommended for Malaysian travelers visiting endemic countries and high-risk areas in Sabah and Sarawak, and for those working in forested areas, such as those employed in surveying, rubber tapping and forest clearing. Military and police personnel are provided with prophylaxis when engaged in field training or when posted to endemic areas.

Drug procurement: All antimalarial drugs, as requested by individual hospitals, are procured from one MOH-approved Malaysian company. Currently the Director General of the Ministry of Health must approve procurement of intravenous artesunate drugs, although this policy is under review. In West Malaysian states with low

endemicity, antimalarial drugs (typically only enough for one patient) are kept at state referral hospitals. Malaria patients in these areas are referred to the nearest state hospital.

Mortality Investigation: Malaria mortality is a national indicator, with a target of zero deaths. A review is conducted on every malaria death at district level and state level. At national level, a technical meeting, led by the Director of the Disease Control Division, is held every three months to discuss malaria deaths, identify shortcomings in quality of care, and order remedial measures when necessary.

Surveillance

Case Detection: The majority of cases in Malaysia are found through passive case detection. Early detection of cases is a key strategy of the programme, with particular emphasis placed on the more endemic areas of Sabah and Sarawak. According to national elimination guidelines, all fever cases must be screened upon presentation to a clinic or hospital. In areas with risk groups, documented and undocumented workers, or outbreaks, medical officers, nurses and physicians screen whether or not high-risk individuals have symptoms. Patients with a history of travel to highly endemic countries and all pregnant women living in high-risk areas should be screened on their first clinic visit. In low- or medium-risk areas, all outpatients (regardless of citizenship) with a fever or malaria symptoms, or who participate in high-risk activities (plantation/logging sector work, forest gathering, river or stream fishing in forested areas) should be tested. In addition, febrile and/or anemic pregnant women, and all workers or visitors from endemic countries who present at a facility should be tested for malaria.

Active case detection in Malaysia consists of screening risk groups for febrile individuals only. It is rarely employed—only during outbreaks or within high-risk groups. High-risk groups consist of the military (particularly those stationed in Sabah and Sarawak), indigenous peoples (Orang Asli) in West Malaysia (59), mobile ethnic groups in Sarawak, and communities in Sabah that are isolated and forest-dwelling. Additionally foreign travelers

and migrant workers, typically from the Philippines, Indonesia, Nepal, Vietnam and Bangladesh, are considered to be at high risk. Students returning to school hostels from holiday visits to their rural home villages are also screened.

Mass blood surveys are considered to be separate from ACD, and are intended to test at least 80% of the community. Mass blood surveys are conducted proactively every six months in high-risk areas in conjunction with IRS and retreatment of nets. Policy requires officers to test at least 80% of populations who receive ITN and IRS. Mass blood surveys are also done reactively during outbreaks, when officers are required to test everyone in the outbreak area. Additionally, and as described above, all documented foreign workers undergo compulsory disease screening by microscopy within one month of arrival in Malaysia.

When a local case is detected, the programme conducts reactive case detection. Mass blood surveys are conducted within the village or housing area of the index case. IRS and ITN distribution is sometimes considered part of a reactive case detection campaign and is conducted in low- and medium-risk areas immediately, and in high-risk areas where spraying operations were conducted four or more months before.

Case follow up: District level malaria officers conduct specific case follow-up procedures. In addition to case investigation procedures (see below), officers are required to collect slides and check symptoms in patients each week for one month after discharge. *P. falciparum* cases are followed up weekly for twenty-eight days. *P. vivax* and *P. ovale* cases are followed weekly for one month, and then monthly for eleven additional months. This procedure is effective for Malaysian nationals with stable housing, but is challenging for officers attempting to follow up migrant workers, who are often highly mobile and frequently change their place of work. *P. malariae* and *P. knowlesi* cases are followed once weekly for a month, and then monthly for an additional five months.

Case investigation: All malaria cases are supposed to be investigated. However, the programme has not yet reached 100% coverage due to logistics problems. After the NMCP receives notification of a case, an officer visits the patient in hospital or clinic, discusses patient history (including current residence, travel history), checks and rechecks slides, and visits the case's community to conduct contact tracing, mass blood surveys (if indicated), health education, IRS/ITN distribution (if indicated). The officer may also conduct entomological surveys or larviciding. See [Annex 4](#) for a Case Investigation Form.

Entomological surveillance: State and district-level entomologists conduct vector surveys on a regular basis. Sites are selected based on data and requests from districts. The new IVM system calls for increased vector surveillance, with an emphasis on areas with high-risk groups, and includes at least one sentinel station in each state of Sabah, Sarawak and West Malaysia.

Geographic reconnaissance: Cases are mapped spatially by hand by district and subsector offices. GPS coordinates are used in some states and districts to help direct officials, but this is not standard throughout the country. GIS, using GPS coordinates and mapping software, is currently in use in Sarawak, and will be implemented in Sabah in the future.

Monitoring systems and case notification

Drug resistance monitoring: Chloroquine resistance to *P. falciparum* was reported in 26.3% of the patient population in Malaysia as early as 1963 (60). The government developed the National Anti-Malaria Drug Response Surveillance System in 2003, which consists of eight sentinel sites across Malaysia. The sentinel sites report on treatment failure and success based on the standard WHO 28-day efficacy study for *P. falciparum* malaria.

Insecticide resistance monitoring: There are sentinel sites in West Malaysia, Sabah and Sarawak for monitoring insecticide resistance. National and state entomologists have been trained by WHO and follow WHO insecticide resistance monitoring standards. In 2012, The National Public Health Laboratory set up an insectory to enable

monitoring of insecticide resistance in both *Anopheles* and *Aedes* mosquitoes.

Notification and tracking of cases: Notification of malaria cases to the nearest District Health Office has been mandatory since 1988 under Section 10(2) Act 342 of the Prevention and Control of Infectious Diseases Act of 1988 (57). All private and public sector practitioners are required to notify district offices within seven days. However, in the Malaria Elimination Programme, this period has been shortened to 24 hours in West Malaysia and three days for Sabah and Sarawak due to inadequate communication networks. Failures to notify are punishable by law.

Outbreak monitoring and response

There is a national standard operating procedure for outbreak control and monitoring, and a Crisis Preparedness and Risk Communication Centre exists at both national and state levels. District officers respond to malaria outbreaks and report to state level, where the activities are assessed and a report forwarded to national level. Early outbreak detection and prompt response is a critical component of Malaysia's malaria strategy: elimination policy calls for outbreaks to be controlled within six weeks, though this goal is not yet met in every case. The monitoring of new plantations and logging areas, as well as migrant communities, is also encouraged by the NMCP.

Vector control

All states in Malaysia are currently transitioning to IVM, which calls for increased coverage of IRS and ITNs, the future use of LLINs, increased vector surveillance, larviciding and enhanced multi-agency collaboration (Figure 25). Vector management will be integrated throughout the decentralized health system with close collaboration of clinics, laboratories, private sector (local government, agricultural, plantation and timber companies) and officers from other health units, to tackle vector management issues. Insecticides are chosen based on WHO technical recommendations.

Figure 25. IRS spraymen conducting outdoor and indoor spraying of a household



IRS with pyrethroid insecticides is a primary vector control activity, conducted every six months in high-risk areas. Current elimination policy calls for 100% of permanent structures to be sprayed every six months in highly receptive and vulnerable low- and medium-risk areas for at least one year, and for semi-permanent structures to be sprayed every three months for at least one year, or until staff has determined the area is no longer vulnerable. Focal spraying is conducted in response to outbreaks. In Sabah, private sector plantations and manufacturers are encouraged to pay for or provide logistical or technical support to the programme for IRS on site or in nearby communities.

ITNs have been distributed since the 1990s, and are currently retreated with synthetic pyrethroids. ITNs are retreated (Figure 26) or replaced on the same six monthly cycle as IRS and are provided free of charge for all Malaysians and to migrants in outbreak situations. Although WHO currently recommends the use of LLINs, Malaysia has a well-coordinated system of ITN distribution and retreatment, a system which is also used as an opportunity to conduct health education and mass blood surveys. The NMCP plans to assess LLIN implementation through a series of pilot projects in high-risk areas in 2013.

Figure 26. Retreatment of ITNs by malaria staff



Larviciding is conducted whenever vector breeding is found in low-risk areas, and it is recommended in outbreak areas in conjunction with entomologic surveys. In high-risk areas, larviciding is conducted regularly with Abate 500. *Bacillus thuringiensis israelensis* (BTI) is also used effectively in some districts, particularly in West Malaysia.

Health promotions

The MOH has a dedicated Health Promotion Division that conducts health education on all diseases. This group works at both the district and state level and conducts community programmes that include education on malaria and its symptoms. Sometimes health promotion activities are conducted separately from the control programme but are closely coordinated. Information, Education and Communication materials focusing on malaria signs and symptoms are distributed at health clinics and hospitals, and there is a strong emphasis on community participation via integrated health promotions campaigns with the NMCP and the Health Promotions Unit.

Comprehensive malaria education is conducted by malaria officers during ITN distribution and retreatment, during IRS, or during mass blood surveys. Malaria officers also conduct malaria education during exhibitions in villages, factories or on plantations.

Laboratory support (EQA/EQC)

All laboratories in Malaysia are monitored by the National Public Health Laboratory, housed in the national Ministry of Health. The NMCP works closely with national, state and district laboratories to ensure quality of microscopy, and the National Public Health Laboratory provides regular training courses for clinic and hospital microscopists.

Quality assurance of microscopy is an important component of the programme, guiding performance based on false positive and negative indicator rates. All positive slides and 10% of negative slides are cross-checked by state labs. PCR is also used to re-check slides for fatal malaria cases, and for *P. malariae* and *P. knowlesi* slides.

Government commitment and financing

The NMCP receives 100% of its funding from the Malaysian government. Since discussions around elimination began within the Vector-Borne Disease Control Programme in 2005, the Ministry of Health has fully supported the national Malaria Unit in its push for zero local transmission and has committed to increased funding and resources.

External support and collaboration

Malaysia does not receive financial support from any multi or bilateral agencies for malaria work. The Asian Collaborative Training Network for Malaria (ACTMalaria) Training Centre for the Transfer of Training Technology is located in Malaysia and conducts human resource development training courses on malaria. Malaysia is also a founding country partner of the Asia Pacific Malaria Elimination Network (APMEN).

As the medical research arm of the Malaysian government, the Institute for Medical Research conducts malaria research that is often applicable to NMCP work. From its inception in 1900, the Institute for Medical Research has worked closely with field officers and administrators, and conducted entomological and parasitological research in Malaysia. Other local universities, the Public Health Institute, and the National Public Health Laboratory, work closely with the NMCP on training and capacity building. The World Health Organization and other United Nations agencies do not have a strong presence in Malaysia due to the country's strong health system and high GDP, but continue to partner on health and development issues and provide technical assistance and guidance when requested.

Sabah and Sarawak collaborate with Indonesia through SOSEK MALINDO (Sosial Ekonomi Malaysia Indonesia), a group of government agencies from both sides of the border that meets every year. In addition, Malaysia collaborates with countries through Brunei Darussalam-Indonesia-Malaysia-Singapore-Thailand (BIMST), a regional information-sharing network for health that holds annual public health conferences. Malaysia is also a member of the Association of Southeast Asian Nations (ASEAN) and engages in working groups that are occasionally related to malaria control in the region.

Malaysia does not currently have any non-governmental organizations devoted to anti-malaria work. Some district offices work closely with industry, particularly construction, logging and plantations companies. Sabah interacts frequently with private companies, specifically through extensive collaboration with plantations. The state expects to continue developing new partnerships with plantations, particularly those located in areas with ongoing transmission.

Volunteers

Community health worker campaigns were implemented as pilots in several areas of Sabah in the late 1980s (61). Since that time, the Sabah Vector-Borne Disease Control Programme has used volunteers most successfully, creating a formal Primary Health Care Volunteer (PHCVs)

campaign in 1995, which has played a substantial role in malaria reduction in Sabah. Although volunteers were used throughout the GMEP, continuing high endemicity in Sabah has made community support and participation critical over the years. While decreases in incidence have resulted in a reduction in the number of PHCVs, the programme continues to train and develop volunteers in many communities. The Sabah State Malaria Control Programme plans to continue using PHCVs throughout its elimination campaign, but is currently re-strategizing around the best way to utilize volunteers as a resource for case detection. Ensuring high motivation can be challenging with few cases, and the control programme is working to develop incentives to promote participation in the PHCV program.

PHCVs have extensive training: three or more days in a district office, one-on-one training with a malaria officer, and update training when possible. They work under the direct supervision of a malaria officer, and are trained to conduct active and passive case detection through slide collection. They also help malaria staff monitor drug adherence of patients who have been released from a hospital or clinic but are still being treated. They continue to help malaria staff with IRS and ITN treatment, and are asked to help provide health education to their communities when necessary.

LESSONS LEARNED AND DRIVERS OF CHANGE

Malaysia benefits from a long history of malaria control, with past experiences guiding current strategy. In particular, the failure of the Malaysian Malaria Eradication Program helped illustrate the need for a multi-pronged approach to control and elimination. The country continues to use evidence-based control activities as part of its strategy to decrease incidence, but also supports innovation at the state and district level. A strong focus on local knowledge and programming has also bolstered Malaysia's success. District level entomologists and malaria control officers are responsible for understanding vulnerability and receptivity within their local context, and are expected to help guide strategy.

Government commitment

With the advent of the malaria elimination program (MEP) in 2011, the NMCP committed itself to reaching elimination by 2015 in West Malaysia, and by 2020 in Sabah and Sarawak. Developing the elimination program required careful planning, with feedback provided by several years of district and state-based feasibility workshops. This planning process determined needs across the country's diverse contexts. Since declaring an elimination goal, the government has increased human resources devoted to malaria work. The strong commitment of the Ministry of Health to malaria elimination, including the continued allocation of resources despite declining incidence, has been a critical driver of progress.

Malaria control activities: vector control, surveillance

Continued financial and human resource commitments from the Malaysian government, and a reliance on local level knowledge to guide national, state and district level programming have also been key. Active case detection through mass blood surveys every six months, in

conjunction with IRS/ITN operations, have helped the control programme to identify and treat asymptomatic cases in the community. Surveillance will continue to play a central role in reaching elimination targets. Key interventions that have led to declines in malaria in Malaysia include increased IRS and ITN coverage in malarious areas, and the technical strength of the entomological staff and their consistent evaluation of vector populations at the state and district level.

Health system: diagnosis and case management

Malaysia has a strong health system that has developed in conjunction with increased economic prosperity. Prompt diagnosis and effective treatment is available through a strong passive case detection system—most areas in the country have access to a hospital or local clinic. The programme has identified poor access to health care and geographic isolation of residents in remote areas of Sabah and Sarawak as major challenges, and continues to search for innovative ways to provide care to these populations. In Sabah, the creation of subsector malaria offices has increased early detection by the programme and provided increased vector control coverage.

Private-public partnerships

Formal and informal partnerships with the private sector, particularly in Sabah, have been crucial in supporting malaria control in recent years. In areas with a large plantation sector, engaging plantations in malaria control has helped to increase vector control and surveillance coverage in areas that might be too challenging to access otherwise. The NMCP at the state and district level continues to work with private sector partners to identify areas for collaboration.

Challenges: *P. vivax*, resistance, imported cases, access

Similar to other countries in the region, Malaysia has seen an increase in the proportion of *P. vivax* cases as overall cases have declined (26). This is likely due to operational challenges in early detection of asymptomatic and subclinical *P. vivax* cases. Malaria infections with lower parasite density, such as *P. vivax* and *P. malariae*, are harder to detect, and the hypnozoitic liver phase of *P. vivax* leads to spontaneous relapse if treated incorrectly or incompletely (62, 63). The programme will continue to search for asymptomatic carriers in high-risk areas through proactive case detection with mass blood surveys every six months (conducted at the same time as IRS and ITN retreatment), and through rapid identification and response to confirmed *P. vivax* cases.

The presence of artemisinin resistant malaria in the Mekong region poses a potential threat to elimination in Malaysia. Although no cases of resistant malaria have been detected in the country to date, the number of migrant workers and visitors coming to Malaysia from neighboring countries will require vigilance and innovative planning to ensure that resistant Plasmodium strains are not being introduced into the local population.

West Malaysia, which has traditionally had the lowest number of indigenous cases, continues to request additional support to prevent reintroduction, particularly in areas with a large number of imported cases, typically in the migrant worker population. Importation will continue to be a significant challenge, particularly in areas with a large plantation sector. Access to remote areas and mobile populations also presents a real challenge to the malaria control program, particularly in Sabah and Sarawak, which both have a large populations living in rural areas. The programme continues to search for innovative ways to access and monitor these groups.

Finally, Malaysia has committed to becoming an international education hub and provides scholarship funding to thousands of African students to study in Malaysian universities, often from Nigeria (64). This group will continue to present importation risk, particularly upon re-entry from visits to endemic home countries. International tourism also continues to be a risk factor, with the annual tourism rate increasing steadily since 1998. Malaysia hosts upwards of 24 million tourists each year; many come from endemic countries in Africa, the Middle East and South-East Asia (13).

FUTURE OUTLOOK

Malaysia is quickly approaching its elimination targets of 2015 for West Malaysia and 2020 for Sabah and Sarawak. As the country pushes towards elimination, it must continue to: search for effective, innovative ways to detect cases early; deal with the challenges associated with preventing transmission from imported cases (45); harmonize control measures across endemic districts; and maintain monitoring of the parasitological and entomological situation at a local level. Adequate funding must be ensured to prevent reintroduction in zero transmission states and to eliminate in high incidence states. The programme should continue to evaluate and adjust its strategies based on local level input.

Malaysia plans to continue its resource commitments to prevent reintroduction in future zero transmission states and to eliminate in high incidence states. The NMCP is also prioritizing foci-oriented vector control with IRS and ITNs and routine surveillance as key strategies to reach elimination targets. The programme will devote increased resources to better coverage in areas with continued local transmission, particularly among high-risk groups, such as migrants, in West Malaysia, and in receptive and vulnerable areas in Sabah and Sarawak.

While cases continue to decrease, the country faces challenges around migration of workers from neighboring endemic countries, the threat of multi-drug resistance in the region, and a lack of consistent access to malaria control by remote populations on Borneo. As the national economy has continued to grow, Malaysia attracts thousands of documented and undocumented workers from endemic areas around the South-East Asia region who are high risk for malaria (65, 66). In an effort to address these issues, the government has implemented stringent screening programs, and will continue these efforts. Finally, the programme plans to more closely monitor and screen migrants, and will continue working with the private sector to identify incoming workers for screening.

As Malaysia moves toward elimination, it aims to continue fostering strong relationships with nearby countries' NMCPs, particularly Indonesia, the Philippines and Myanmar, and build cross-border collaborations and initiatives. Learning from other country's elimination experiences, like those of Sri Lanka, which is nearing elimination, and participating in networks like the Asia Pacific Malaria Elimination Network (APMEN) and the Asian Collaborative Training Network for Malaria, will help Malaysia in its push to eliminate malaria (26).

CONCLUSIONS

This case study on the Malaysian malaria control programme experience, progress and challenges will add to the growing body of literature on malaria elimination in the Asia Pacific region. As an economic leader in the South-East Asia region, Malaysia's experiences in reaching the pre-elimination stage, and the lessons learned over the past century, are important to share with the international malaria community. Many of the challenges faced by Malaysia, particularly: *Plasmodium vivax* control; the risk of importation because of continual in-migration; the numbers of workers engaged in high risk occupations; and the diversity of microclimates and vectors, are similar to those faced by other countries in the region (66, 67). As cases decline and the proportion of *P. vivax* infections rises in Malaysia and much of the Asia Pacific, and drug resistant strains of *P. falciparum* pose a

risk of spreading, countries will need to share experiences in dealing with these challenges. Strategizing around best practices for controlling or eliminating *P. knowlesi* will also continue to be important.

Malaysia has maintained a strong malaria control programme since the discovery of the malaria parasite in the late 1800s, and will continue to implement evidence-based strategies to eliminate malaria and to support innovative strategies at the local level, led by well-trained and seasoned district officers. With a growing economy, robust health system, and strong government commitment to elimination, Malaysia has made great strides in decreasing incidence and will continue to strengthen its malaria control programme as it approaches and achieves malaria elimination.

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ANNEX 1: DATA METHODS AND ANALYSIS

Data collection and literature review

Published and unpublished literature was reviewed on the history of malaria epidemiology, control and pre-elimination in Malaysia. Relevant searches were conducted on Bing, Google, Google Scholar, Pubmed, the World Bank data bank (1), the WHO data bank (2) and the WHO South-East Asia and Western Pacific Regional Office (3, 4). Relevant references were also found in the bibliographies of publications. The review included grey literature from the Vector-Borne Disease Control Programme offices at national, state and district levels during field data collection, such as annual reports, administrative reports and plans, and grant reports. Data on cases, incidence, diagnosis, testing and control activities were taken from routine surveillance records of national and state offices.

Interviews

Interviews were conducted in the public and private sector. Thirty-six semi-structured interviews with sixty interviewees were conducted at: the national Vector-Borne Disease Control Programme office; Sabah, Sarawak, Malacca and Negeri Sembilan State Vector-Borne Disease Control Programme offices; and Keningau, Kunak, Lahad Datu, Sipitang, and Tawau district Vector-Borne Disease Control Programme offices. Eleven managers at six private rubber, acacia and palm oil plantations across Sabah were also interviewed.

Four interviews with managers, data specialists and entomologists were conducted at the national level Vector-Borne Disease Control Programme office. Forty-five participants were interviewed at the state and district Vector-Borne Disease Control Programme offices across Malaysia with directors, programme managers,

entomologists, environmental health officers, data specialists, IRS spraymen and support staff. Interview subjects were identified through purposeful sampling, with managers at each level identifying knowledgeable staff who could provide insight on the subject areas under investigation.

Informed written consent from subjects was obtained for each interview.

Analysis

The quantitative and qualitative data were reviewed to identify factors that had contributed to the decreased incidence of malaria in Malaysia. Information from the literature found in the desk review before commencement of fieldwork was used to formulate the tools for collecting quantitative and qualitative data, such as the interview guide and Excel spreadsheets for surveillance data. These documents and grey literature, accessed during and after data collection, were used to identify the main changes in malaria control strategies and interventions. These preliminary findings were compared with the qualitative and quantitative data collected in the field. In later stages of analysis, these documents were used to fill gaps in data or to confirm or question conclusions derived from the interviews and quantitative data.

Annual data on malaria incidence, surveillance and vector control activities by district were plotted in Microsoft Excel. Major malaria indicators and coverage estimates were calculated, and trends over time were derived. All trends were then compared through data triangulation, defined as the review, synthesis and interpretation of data from multiple sources. If there was any difference among data sources in the case study, the interviews were considered the primary source of information.

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ANNEX 2: DEMOGRAPHIC DATA, ADMINISTRATIVE DIVISIONS, POLITICAL ORGANIZATION AND SOCIAL AND ECONOMIC DEVELOPMENT

Table 11. Demographic data according to the World Bank (1)

Variable	Year/Period	Value
Population (thousands)	2011	28 859 154
Population sex ratio (male per female)	2011	1.0
Percentage aged 0–14	2011	29.9
Percentage aged 15–64	2011	65.2
Percentage aged 65 and above	2011	4.9
Population growth rate (annual %)	2011	1.6
Crude birth rate (live births per 1 000 population)	2010	20.3
Crude death rate (deaths per 1 000 population)	2010	4.7
Infant mortality rate (infant deaths per 1 000 live births)	2010	5.4
Life expectancy at birth, males/females (years)	2010	71.9/76.3

Table 12. Main indicators on health economics according to the World Bank and World Health Organization, 2010 (1, 2)

Indicator	Year	Value
External resources for health as percentage of total expenditure on health	2010	0.007
General government expenditure on health as percentage of total expenditure on health	2010	55.5
General government expenditure on health as percentage of total government expenditure	2010	9.2
Total expenditure on health as percentage of GDP	2010	4.4
Out-of-pocket expenditure as percentage of private expenditure on health	2010	76.8
Per capita government expenditure on health at average exchange rate (US\$)	2010	204*
Per capita total expenditure on health at average exchange rate (current US\$)	2010	367.9
Private expenditure on health as percentage of total expenditure on health	2010	44.5*
Social security expenditure on health as percentage of general government expenditure on health	2010	0.7*

*World Health Organization Statistics

Table 13. Health indicators according to the World Health Organization, 2009 and 2010 (2)

Indicator	Sex	Figure	Year
Adult mortality rate (per 1 000 adults 15–59 years)	Both sexes	137	2009
Under 5 mortality rate (per 1 000 live births, both sexes)	Both sexes	6	2010
Maternal mortality ratio (per 100 000 live births)	Both sexes	29 (12–64)	2010

Table 14. Distribution of years of life lost by cause in Malaysia according to the World Health Organization, 2008; percentage reflects proportion of total years of life lost (3)

Indicator	Year	%
Communicable diseases	2008	26%
Noncommunicable diseases	2008	58%
Injuries	2008	16%

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ANNEX 3: MALARIA TREATMENT PROFILE

Species	Drug	Figure
First line <i>Plasmodium falciparum</i> treatment	Preferred: 1–3: Artesunate 4mg/kg PO q24h D1–3: Mefloquine 25mg/kg PO over 2 days OR 8.3mg/kg PO q24h Dosage according to body weight <10kg: Artesunate 25mg q24h for 3 days Mefloquine 125mg single dose 10–20kg: Artesunate 50mg q24h for 3 days Mefloquine 125mg q24h for 3 days 20–40kg: Artesunate: 100mg q24h for 3 days Mefloquine 250mg q24h for 3 days (Artequine® 300/750) OR Artemether/Lumefantrin	If using primaquine, MOH recommends always checking for G6PD. Add Primaquine 0.75mg/kg single dose q24h if gametocyte is present at any time during treatment Currently Artesunate, although the preferred treatment, is not generally available to all physicians. ID physicians must receive pre-approval from the Director General to procure the drugs. This policy is currently under revision.
	Alternative: D1–7: Quinine 10mg salt/kg PO q8h PLUS Doxycycline 3.5mg/kg PO q24h OR Clindamycin 10mg/kg PO q12h (Either drug to be given for 7 days)	
	In the field: Chloroquine/Sulfadoxine-Pyrimethamine/Chloroquine+Sulfadoxine (day 3) +/- Primaquine (3 days)	
Complicated <i>Plasmodium falciparum</i> treatment	Preferred: D1: Artesunate 2.4mg/kg IV on admission, then repeat again at 12h D2–7: Artesunate 1.2mg/kg IV q24h	Dilute Quinine in 250ml of D5% over 4 hours. Change to oral if able to tolerate. Quinine: maximum 600mg.
	Alternative: Loading 20mg/kg IV over 4 hours then IV 10mg/kg IV q8h D2–7: Quinine 10mg/kg IV q8h PLUS Doxycycline 3.5mg/kg PO q24h OR Clindamycin 10mg/kg/dose q12h (Both drugs to be given for 7 days)	
First line <i>Plasmodium vivax</i> treatment	Preferred: Total Chloroquine 25mg base/kg divided over 3 days as below: D1: 10mg base/kg stat then 5mg base/kg 6 hours later D2: 5mg base/kg q24h D3: 5mg base/kg q24h PLUS Primaquine 0.25mg base/kg PO q24h for 14 days	Check G6PD status before giving Primaquine Primaquine 0.75mg base/kg once a week for 8 weeks
	Alternative (relapse): Repeat Chloroquine and Primaquine	
<i>Plasmodium knowlesi</i>	Preferred: Total Chloroquine 25mg base/kg divided over 3 days, as below: D1: 10mg base/kg PO stat then 5mg base/kg 6 hours later D2: 5mg base/kg PO q24 D3: 5mg base/kg PO q24h	
	Alternative: Treat as <i>Pf</i>	
Mixed Infections	Treat as <i>Pf</i>	

Reference

1. Ministry of Health Malaysia. *National Antibiotic Guideline*, 2008: Putra Jaya, Malaysia.

ANNEX 4. CASE INVESTIGATION FORM

**MINISTRY OF HEALTH MALAYSIA
VECTOR-BORNE DISEASE CONTROL PROGRAMME (RKPBV)**

CASE INVESTIGATION FORM FOR MALARIA CASES

MALARIA CASE REGISTRY				Malaria Parasite Type
District Code	Sub-Urban Code	Village Code	Case Number	

Case Summary and Conclusions:

1. Case Detection: _____ (PCD/ACD/Routine/SS)
2. Blood Slide Date Taken: _____
3. Blood Slide Date Examined: _____
4. Place of Detection: _____
5. Cause of Infection: _____ (Indigenous, Introduced, Relapse, Induced, Imported, Unclassified)
6. Infection Date: _____
7. Route of Infection: _____
8. Suspected Site of Infection: _____
9. Possibility of Spreading Disease: _____
10. Operational Area/Locality/Residence: _____
11. Other Important Information: _____

1. Patient Information:

- a. Patient Name: _____
- b. Gender: _____ c. Age: _____ d. Race: _____
- e. Current Residential Address: _____
- f. Occupation: _____

2. Clinical Patient Information :

- a. Date of First Fever: _____
- b. Patient Clinical Signs: _____
 - i. Pale
 - ii. Fever
 - iii. Chill/rigor
 - iv. Headaches
 - v. Malnourished
 - vi. Other (specify)
 - vii. No signs
- c. Previous history of malaria infection _____
 - i. How many times patient has been infected? _____
 - ii. Last time patient was infected? _____
- d. History : _____
 - i. Has the patient been given a blood transfusion? _____
 - ii. How many blood transfusions: _____
 - iii. Last date of blood transfusion: _____
 - iv. Place of last blood transfusion: _____
 - v. Reason for blood transfusion: _____
 - vi. Most recent blood donor information: _____

- e. Was the patient taking malaria medication prior to treatment or diagnosis of malaria?
- i. Date taken: _____
 - ii. Name of the drug _____
 - iii. Date of presumptive treatment: _____
 - iv. Date preventative/prophylactic medication taken: _____

3. Patient Contacts:

- a. Number of contacts: _____
- b. List of contacts examined and treated: _____

No.	Contact Name	Age	Relationship	Address	Blood Slide	Rx.
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						

4. Risk Groups for Malaria

Yes/No

- a. Military/Jungle Police Patrol? _____
- b. Land Settlers? _____
- c. Undocumented migrants? _____
- d. Timber workers? _____
- e. Forest gatherers? _____
- f. Hunters? _____
- g. People staying overnight outside (farms, jungle, orchards)? _____

5. Patient movement within the past two months

No.	Date of Visit		Places Visited	
	From	To	Village Name	District/State

6. Visitors to the patient in the last two months

No.	Date of Visit		Origin		Number of Visitors	Visitor Purpose
	Beginning	To	Village	District		

7. Patient records of radical treatment

	No. of tablets given according to the treatment/regime and dates:													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Day														
Date of Treatment														
Type														
Number														
Chloroquine														
Fansidar														
Primaquine														

Treatment given by:

a. Hospital: _____ days

b. Patient Self-treated: _____ days

c. Malaria Programme Staff: _____ days

8. Locality referring to patient's village:

Issues	Items
1. Number of houses	
2. Population	
3. Village Type (City, Village, Settlements, estate and squatters)	
4. Malaria control activities carried out	
a. ACD:	
b. IRS:	
c. MBS/MDA:	
d. Other:	

9. Comments by Sector Head

a. Total malaria cases in the locality in the last six months:

 i. Number of cases: _____

 ii. SPR rate for Pf: _____

 iii. Incidence per 10 000 population: _____

b. Malaria control activities that need to be undertaken: _____

c. Result of malaria control activities that have been conducted: _____

10. Review of Health Officer (Area/District): _____

Date: _____ Name: _____

Position: _____

11 Case Investigation done by: _____

a. Name: _____

b. Position: _____

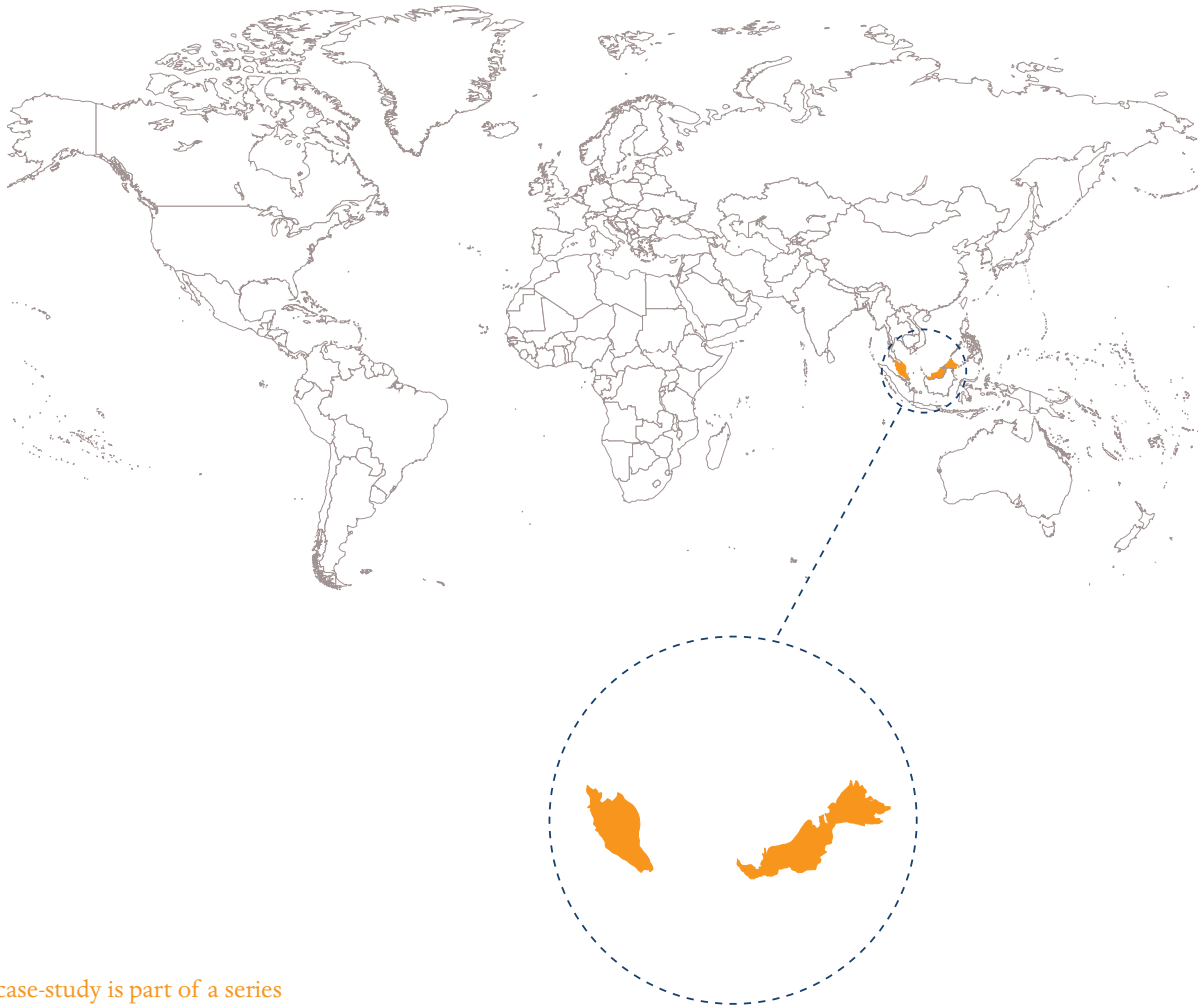
c. Date of case investigation: _____

d. Date of case notification: _____

e. Case registration date: _____

Reference

1. Ministry of Health Malaysia. *National Case Investigation Form*. 2014: Putra Jaya, Malaysia.



This case-study is part of a series of malaria elimination case-studies conducted by the World Health Organization (WHO) Global Malaria Programme and the University of California, San Francisco (UCSF), Global Health Group. The case-studies series documents the experience gained in eliminating malaria in a range of geographical and transmission settings with the aim of drawing lessons for countries that are embarking upon elimination.

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