

# THE LANCET

## **Supplementary webappendix**

This webappendix formed part of the original submission and has been peer reviewed.  
We post it as supplied by the authors.

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# Supplementary webappendix

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## 1. Methods for the Analysis of Costing and Budgetary Data

### a. Cost inclusion criteria

To be included in this analysis, a cost or budget item must have been used to implement an intervention directly related to the malaria program. As a result all activities and expenditures related to the general operation of the health system or control of other specific infectious diseases were excluded. These include for example:

- Salaries and incentives for clinical staff;
- Construction or refurbishment of health facilities or other multipurpose buildings (e.g., medical stores);
- Activities related to the strengthening of the supply chain or other systems used for all health commodities;
- Commodities, staff and other costs used for the control of other vector borne diseases such as dengue fever.

In cases where cost items were partially applied to non-malaria activities, the program staff closest to the item in question estimated the proportion that was used for activities directly related to malaria.

### b. Intervention classification

To facilitate interpretation and analysis, all expenses within each country dataset were grouped into six intervention categories: prevention; treatment and prophylaxis; diagnosis; surveillance and response; information, education and communication (IEC); and program management. Budget/expenditure items were allocated to categories using the definitions and activity groupings shown below.

In cases where an item did not fit fully within a single category, relevant program staff estimated the appropriate division between categories based on the current and/or anticipated use of the item.

#### *Prevention*

Definition: Interventions intended to decrease malaria transmission by reducing contact between vectors and humans, including by reducing vector density and lifespan.

Activities: All expenses, including salaries, consumables, capital, and travel, that were intended to be used to implement the below activities:

- Distribution and re-treatment of insecticide-treated nets (ITNs)
- Indoor residual spraying (IRS)
- Anti-larval interventions, including use of biological or chemical larvicides and larvivorous fish
- Environmental management such as drainage projects directly intended to impact malaria transmission
- Insecticide fogging intended to reduce malaria transmission

#### *Treatment and Prophylaxis*

Definition: Interventions directly related to the provision of anti-malarial medicines to clear or suppress malaria parasitaemia

Activities: All expenses, including salaries, consumables, capital, and travel, that were intended to be used to implement the below activities:

- Procurement of anti-malarial medicines, including clearing, shipping, handling, and storage, for:
  - Treatment of clinical infections, either presumptively or on the basis of confirmed diagnosis;
  - Treatment of asymptomatic parasite carriers such as through mass drug administration;
  - Treatment of severe malaria;
  - Chemoprophylaxis of citizens and/or travelers;

- Intermittent preventive treatment for pregnant women (IPTp);
- Procurement of other commodities intended for use in the treatment of severe malaria, including saline solution and syringes
- Training of health workers in the administration of treatment, including for IPTp

### *Diagnosis*

**Definition:** Activities directly related to the confirmed detection of malaria parasites within symptomatic and asymptomatic individuals.

**Activities:** All expenses, including salaries, consumables, capital, and travel, that are intended to be used to implement the below activities:

- Procurement of diagnostic equipment for use in routine case management and/or screening;
- Training of health workers and/or other staff on diagnostic techniques;
- Establishment and operation of reference laboratories specifically for the diagnosis and analysis of malaria;
- Quality assurance and control systems for diagnosis, including lot testing of RDTs and external quality assurance of diagnosis usage in the field

### *Surveillance and Response*

**Definition:** Activities directly related to the regular identification, reporting and analysis of epidemiological and entomological data relevant to the management of a malaria program.

**Activities:** All expenses, including salaries, consumables, capital, and travel, that are intended to be used to implement the below activities:

- Screening - routine, ad hoc, or in response to a trigger – of individuals or groups for parasites
- Training of surveillance officers and/or health workers on collection, management and use of surveillance data
- Development of new systems for the recording and storage of surveillance data, including new equipment (e.g., computers), consultants, and training
- Analysis, synthesis, and dissemination of surveillance data at regional and central level
- Entomological surveillance
- Prediction of factors that can lead to changes in malaria risk, including meteorological monitoring and analysis
- Monitoring of insecticide resistance
- Monitoring of anti-malarial drug resistance
- Maintenance of additional commodities and capacity to respond to malaria epidemics

### *Information, Education, and Communication*

**Definition:** All activities intended to communicate messages related to the prevention and treatment of malaria to influence the knowledge and behavior of affected populations and other target audiences.

**Activities:** All expenses, including salaries, consumables, capital, and travel, that are intended to be used to implement the below activities:

- Mass media campaigns
- Decentralized communication methods such as cultural shows and mobile video units
- Community mobilization activities, including meetings and sensitization of local leaders
- Major events such as to recognize World Malaria Day
- Advocacy events and activities targeted at policymakers and funders
- Production and distribution of materials such as flyers and t-shirts
- Development and testing of messages and images

### *Program Management*

Definition: All expenditures related to malaria but not directly used for the implementation of programmatic interventions.

Activities: All expenses, including salaries, consumables, capital, and travel, that are intended to be used to implement the below activities that are not directly related to a specific programmatic intervention:

- Resource mobilization and donor reporting and relationship management;
- Monitoring and evaluation;
- Financial management, including audits;
- Coordination with other governmental and nongovernmental bodies;
- Planning and oversight, including meetings and vehicle expenses and travel;
- Supervisory visits intended to improve malaria-related practices of health workforce;
- Policy formation.

#### *c. Classifying expenditures*

Where possible, all costs were also classified into five expenditure categories: personnel, consumables, equipment, travel, and other. (See Table 1.1) Items were classified using guidelines shown below.

#### *Personnel*

- Salaries and benefits
- Training of malaria-specific staff and general health workforce on malaria-related issues
- Allowances and performance incentives

#### *Consumables*

- Health commodities, including drugs, diagnostics, and insecticides
- Procurement, handling, and storage costs for health commodities
- Communications materials such as flyers and posters
- Administrative materials

#### *Equipment and infrastructure*

- Health-related equipment such as microscopes and other laboratory machinery
- Vehicle purchase and maintenance
- Administrative equipment such as computers
- Construction and maintenance of malaria-related building such as an insectary

#### *Travel*

- Fuel
- Travel allowances such as for lodging and meals
- Other travel expenses such as airfare

#### *Other*

- Meetings to related to planning and implementation of malaria-related activities
- Technical assistance provided by local or international experts

In cases where the available data were not sufficiently granular to enable this classification, the aggregate costs were divided among these categories by applying the average proportions of the same intervention in the other countries in the analysis. The specific proportions used are detailed below.

	Supervision	Quality Assurance	IRS	ITNs	IEC Campaigns	Research/Surveys	Entomologic Monitoring	M&E
Personnel	35%	65%	30%	5%	35%	65%	30%	60%
Consumables	20%	30%	35%	85%	45%	10%	50%	15%
Equipment	0%	0%	0%	0%	0%	0%	0%	0%
Training/Meeting	35%	0%	25%	5%	5%	5%	10%	15%
Travel	10%	5%	10%	5%	15%	20%	10%	10%
Other	0%	0%	5%	0%	0%	0%	0%	0%

**Table 1.1: Assumed classification of expenditures by intervention type**

## 2. Sensitivity Analyses: Methods and Results

Given that considerable uncertainty exists around many of the inputs used in the analyses conducted in this investigation, it is vital to assess whether the use of different, but still realistic, assumptions would result in qualitative changes to conclusions.<sup>1</sup>

For example, if the combined costs of elimination and prevention of reintroduction (PoR) are more costly than controlled low-endemic malaria (CLM) when elimination is achieved in  $\geq 10$  years, but less costly if elimination is achieved in  $< 10$  years, it would be important to appropriately qualify any statement about these relative costs.

### a. Methods

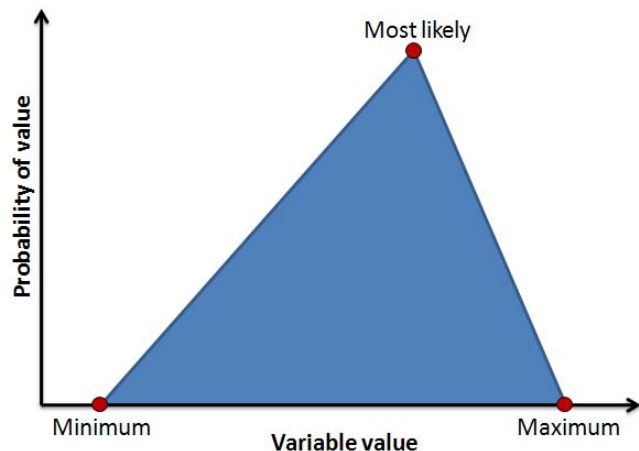
Variables for which uncertainty existed included:

- Annual cost of prevention activities for CLM, elimination, and PoR
- Annual cost of treatment and prophylaxis for CLM, elimination, and PoR
- Annual cost of diagnosis for CLM, elimination, and PoR
- Annual cost of surveillance for CLM, elimination, and PoR
- Annual cost of information, education, and communication (IEC) for CLM, elimination, and PoR
- Annual cost of program management for CLM, elimination, and PoR
- Year in which elimination ends and PoR begins
- Rate at which future costs are discounted

Not all variables around which uncertainty existed were included in the sensitivity analysis. For example, the population growth rate, the rate of importation of infections into the country, the effectiveness of prevention activities and treatment, human behavior, and socioeconomic development all contain varying degrees of uncertainty. Some of these factors – for example, the effectiveness of interventions – will be the same under CLM or under an elimination program and thus will have a

limited impact on conclusions. Others, such as the importation rate, could have a considerable effect on the conclusions but are beyond the scope of this analysis.

For each territory under consideration, a distribution was described for each of the selected variables. Each distribution was triangular, meaning that a minimum, maximum, and most likely value was selected. (Figure 2.1)



**Figure 2.1: Probability distribution example**

For cost categories corresponding to a program phase for which actual budgetary information was available, the most likely value was equal to the sum of the average annual budgeted costs for items falling within that expenditure category across all budgeted years. The minimum and maximum values were determined by summing the lowest and highest annual values, respectively, for every budget item in the given category across all budgeted years. Cost distributions for activity categories in program phases where no actual budgetary information was available were estimated as follows:

*China – Hainan and Jiangsu PoR:* Most likely values were estimated from average per capita at risk costs from three other Chinese provinces: Fujian, Hebei and Shanxi. Minimum values were taken to be the same as those in the province with lowest per capita at risk costs (Fujian) and maximum values from the highest (Shanxi).

*Mauritius CLM:* Values were based on the percentage difference in costs between control and elimination reported for 20 countries during approximately the same historical period by Kaser et al.<sup>2</sup> Because it was unclear what activities constituted “control” in this dataset, those spending less than \$0.11 per capita in adjusted dollars were deemed non-comparable and excluded. The most likely value then was calculated by assuming CLM would comprise a proportion of actual elimination costs equal to the median change of the remaining countries, while minimum and maximum values were calculated by assuming this change was equivalent to 1.5 times less and greater than the interquartile range around this median.

*Swaziland PoR:* Maximum annual PoR costs were assumed to be equal to the population-inflated costs of elimination in the final year of that phase. Most likely costs were assumed to be the same, but with no prevention activities. This assumption was based upon experience from other countries, including Mauritius and modeling from Zanzibar, demonstrating that many activities, including surveillance and management, will need to be maintained following elimination to diminish risk of resurgence in a receptive environment. Finally, minimum costs were assumed to be the same, but excluded prevention, treatment and prophylaxis, or IEC activities, and included a 50% reduction in management costs.

*Tanzania – Zanzibar PoR:* Costs of PoR were calculated from mathematical modeling of several potential scenarios.<sup>3</sup> In brief, the most likely costs were estimated from a scenario assuming that insecticide-treated nets (ITNs) would not be used during PoR but focal spraying with IRS would be maintained. The maximum costs were calculated assuming that both focal IRS spraying and universal coverage of ITNs would be maintained, while the minimum costs resulted from a scenario very similar to the most likely but with modest reductions in surveillance requirements.

It was assumed that the elimination phase would require ten years in all countries except Mauritius, where elimination was actually achieved in eight years. The minimum for this variable was assumed as six years and the maximum as 14.

Finally, it was assumed in all cases that future costs were discounted at a most likely rate of 3%. This same value was used for the minimum case, and 5% was estimated as a maximum. In a separate analysis, a discount rate of 0% was used to examine the impact of removing this factor altogether.

All sensitivity analyses were run in Excel 2007 by drawing values for each variable from its assigned distribution. First, the minimum and maximum possible values were calculated by assuming all variables simultaneously achieved their individual minimum or maximums. Due to the improbability of all variables simultaneously being at either extreme of their range, 50,000 Monte Carlo simulations were run for each territory using Oracle Crystal Ball. In each iteration, random values for each variable were drawn from the assigned distributions and the resulting outcome value recorded. The range of values in which 95% of outcomes occurred were then reported as most likely.

### ***b. Results***

Most likely values, minimums, maximums, and 95% probability ranges for key outcomes are depicted in Figures 1, 2, and 3 in the main text. Figure 1 depicts the relative annual cost of elimination and CLM, and it demonstrates that elimination is always expected to be more expensive in the most likely scenario, though the opposite may be true in certain cases in Mauritius and Zanzibar. In Mauritius, sensitivity analysis reveals that CLM may be more expensive than elimination, however, depending upon the values used for two variables: first, elimination activity costs and second, CLM costs as calculated as a percentage of elimination costs according to the data in Kaser. In Zanzibar, this relationship is determined almost entirely by the cost of prevention activities during elimination.

Figure 2 shows the actual (Mauritius) and assumed (other territories) average annual cost of preventing reintroduction compared to an equivalent period of CLM. This relationship is mixed across the five territories; in all cases, different combinations of assumptions can yield qualitatively different conclusions regarding which of these phases is more expensive. The core outcome from this analysis is the degree to which elimination is cumulatively cost saving (or is more expensive) across the entire time horizon. This outcome is depicted in Figure 3 in the main text. The relative influence of the different variables described here in affecting that relative change in costs was examined for both 25- and 50-year time horizons.

**Table 2.1: Top three influences on the magnitude of the annual difference in cost between elimination and CLM over 25 years**

Country	Variable	Contribution to variance
China – Hainan	Year in which elimination ends/PoR begins	7.8%
	Cost of diagnosis during CLM	6.8%
	PoR costs per capita at risk	5.9%
China – Jiangsu	Year in which elimination ends/PoR begins	63.8%
	PoR costs per capita at risk	29.2%
	Cost of management during elimination	1.2%



<b>Mauritius</b>	CLM costs as a percentage of elimination costs	80.8%
	Costs of elimination activities	18.2%
	Costs of PoR activities	0.5%
<b>Swaziland</b>	Cost of prevention activities during PoR	24.1%
	Cost of surveillance during elimination	11.2%
	Year in which elimination ends/PoR begins	11.2%
<b>Tanzania – Zanzibar</b>	Cost of prevention activities during elimination	60.4%
	Cost of prevention activities during PoR	22.4%
	Cost of surveillance during CLM	4.4%

**Table 2.2: Top three influences on the magnitude of the annual difference in cost between elimination and CLM over 50 years**

<b>Country</b>	<b>Variable</b>	<b>Contribution to variance</b>
<b>China – Hainan</b>	Year in which elimination ends/PoR begins	61.3%
	PoR costs per capita at risk	14.8%
	Cost of diagnosis during CLM	10.5%
<b>China – Jiangsu</b>	PoR costs per capita at risk	55.3%
	Year in which elimination ends/PoR begins	39.0%
	Cost of treatment during CLM	1.3%
<b>Mauritius</b>	CLM costs as a percentage of elimination costs	88.4%
	Costs of elimination activities	10.3%
	Costs of PoR activities	0.7%
<b>Swaziland</b>	Cost of prevention activities during PoR	33.5%
	Costs of prevention activities during CLM	23.4%
	Discount rate	11.0%
<b>Tanzania – Zanzibar</b>	Cost of prevention activities during PoR	48.3%
	Cost of prevention activities during elimination	36.8%
	Cost of surveillance during CLM	3.9%

As depicted in these tables, the most influential factors differed across territories. The length of the elimination period was an important determinant in 60% of the territories. In the case of Mauritius, the actual time to elimination was known, and thus

this factor was not varied. In Zanzibar, the importance of this factor was offset by the large magnitude of the variance within important cost categories; for example, the cost of prevention activities was assumed to be \$0, but in the maximum case could have been as high as \$1.5 million per year, an extremely large difference. More detailed information on the cost of PoR activities would help to narrow these ranges.

Discount rate did not greatly influence these results, in part because it was only varied through a narrow range of 3-5%. Allowing the discount rate to vary as low as 0% did increase the influence of this factor on model outputs. However, little qualitative change occurred in the conclusions. Over 25 years, for example, elimination remained more expensive than CLM for all territories, although the magnitude of the difference decreased without a discount rate.

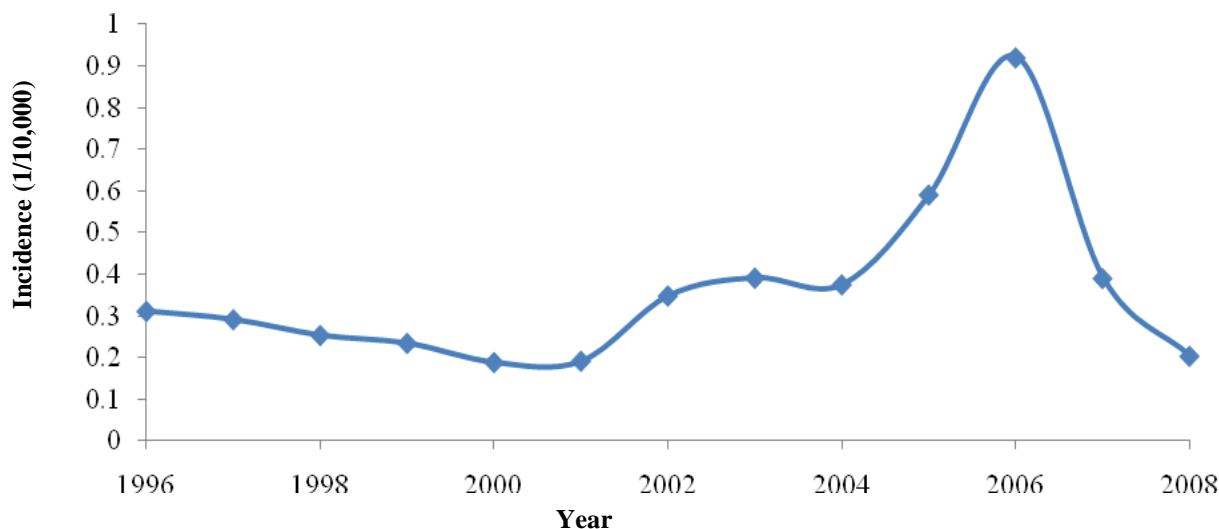
### **3. The Cost of Malaria Control and Elimination in China: Context and Methodology**

This supplemental document serves to provide a context for the Hainan and Jiangsu costing data presented in the main manuscript. We discuss the past and present malaria situation in China, and detail the country's strategy for transitioning from control to elimination. We then describe our methods for data collection of costing data from Hainan and Jiangsu provinces.

#### *a. Context – Malaria situation in China, past and present*

China has made measureable progress toward elimination. Prior to the launch of the national control programme in 1955, malaria was endemic in most of the country and there were at least 30 million malaria cases annually. In the middle part of the country, parasite prevalence was 5-10%; in the southern parts, parasite prevalence was 10-20%, the highest being 60%. Both *Plasmodium falciparum* and *Plasmodium vivax* were endemic, with *P. falciparum* accounting for 10-20% of cases in the middle part of the country, and 30% of cases in the south. After decades of improving coverage of microscopy, effective treatment, mass prophylaxis, and vector control, the parasite prevalence was reduced to less than 1% by 1998, and local *P. falciparum* transmission was confined to two southern provinces, Hainan and Yunnan.<sup>4,5</sup> In 2000, there were 29,039 confirmed cases reported in 2000, translating to an annual incidence of 0.22/10,000.<sup>6</sup>

Beginning in 2003, support from the Global Fund enabled a major escalation of control efforts in the higher endemic provinces of Hainan and Yunnan. The use of diagnostics, artemisinin combination therapy (ACTs), and insecticide-treated bed nets (ITNs) was scaled up, especially among poor, ethnic minority groups. The number of reported malaria cases in Hainan fell from 6,357 in 2003 to 1,844 in 2008 (incidence from 7.13/10,000 to 2.18/10,000) and 13,816 to 4,027 in Yunnan (incidence from 3.98/10,000 to 1.16/10,000).<sup>7,8</sup> However, from 2002 to 2006, there was a re-emergence of *P. vivax* malaria in the central provinces of Jiangsu, Anhui, Henan, and Hubei provinces, most likely due to weakened surveillance, climate changes, and increased mobility of people between these provinces.<sup>9,10</sup> In response, the country utilized domestic and Global Fund support to address the epidemic through targeted mass primaquine administration, active case finding, indoor residual spraying in outbreak communities, and heightened passive surveillance with an internet reporting system. By 2008, the epidemic was largely brought under control (Figure 3.1).



**Figure 3.1: National annual incidence (per 10,000) of *Plasmodium falciparum* and *Plasmodium vivax* malaria in China, from 1996 to 2008<sup>11</sup>**

A re-emergence of *P. vivax* in the central provinces accounted for the peak in 2006.

Lastly, Guizhou and Tibet are two provinces which have experienced focal outbreaks of *P. vivax* malaria since 2006. In 2008 there were 43 cases reported in Tibet, and 1,290 in Guizhou. As in the central provinces, poor surveillance and high mobility of populations have probably contributed to these outbreaks.

In 2008, 86% of reported cases were concentrated in the 8 provinces highlighted above, allowing for focused efforts in these provinces. In the rest of China, malaria is either non-endemic, has been eliminated, or is nearing elimination. The national annual incidence of malaria in 2008 was 0.21/10,000, far below the World Health Organization guidelines on when a country is ready to transition from control to elimination.<sup>8</sup> Given the country's success in malaria control and elimination, and recognizing that improving socioeconomic conditions will continue to facilitate elimination efforts, the Ministry of Health in 2009 set forth a revised malaria strategy focused on elimination.<sup>11</sup>

**b. National elimination strategy**

In March 2009, 26 malaria experts in China gathered with experts from WHO Western Pacific Region for a week-long meeting to develop a revised malaria strategy for China. The elimination strategies were based on WHO recommended strategies<sup>12,13</sup> as well as successful experiences within China, and in particular from provinces that have eliminated malaria in recent years at provincial and sub-provincial levels. After the draft strategy was developed, it underwent several months of revisions, based on comments received from experts through several subsequent meetings. It was identified by the Global Fund National Strategy Application (NSA) Technical Review Panel as a sound national strategy, and granted \$158 million USD over five years, to supplement the government's budget of \$778 million USD. The revised strategy was finalized by the Ministry of Health in March, 2010.

The revised strategy is based on stratification at the county level, the administrative unit below province and city, and above township and village. Counties are categorized into four types based on level of endemicity (Table 3.1). The distribution of counties among China's 31 provinces, municipalities, and autonomous regions is detailed in Table 3.2 and illustrated in Figure 3.2.<sup>14</sup>

**The goals of China's Revised National Malaria Strategy are to:**

**i. Overall goal**

By the end of 2015, all countries except those in the border areas of Yunnan province will achieve the goal of zero locally transmitted malaria cases; by the end of 2020, the whole country will achieve elimination.

**ii. Staged goals**

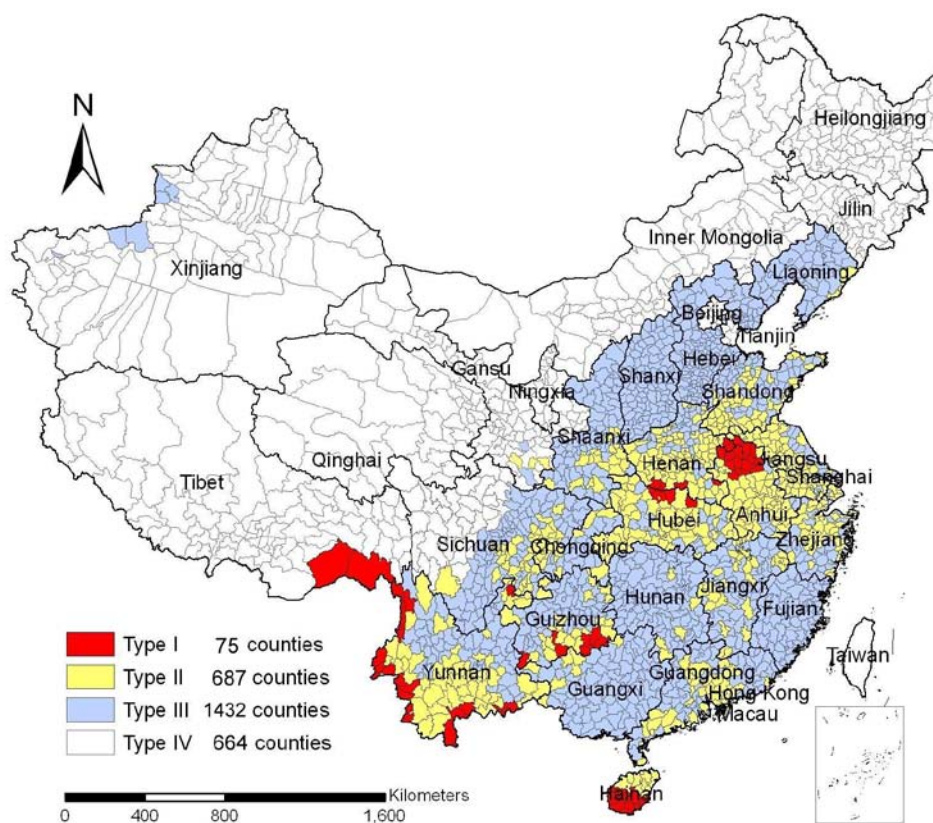
1. By the end of 2015, all Type 3 counties will achieve elimination.
2. By the end of 2015, all Type 2 and Type 1 counties except those in the border areas of Yunnan province will achieve the goal of zero locally transmitted malaria cases; by the end of 2018, these counties will achieve elimination.
3. By the end of 2015, Type 1 counties in the border areas of Yunnan province will achieve pre-elimination (incidence < 1/10,000); by the end of 2017, these counties will achieve the goal of zero locally transmitted malaria cases; and by the end of 2020, these counties will achieve elimination.

**In order to achieve the stated goals, the strategy will be implemented through six overall objectives:**

1. Access to early, accurate diagnosis, and prompt, effective, safe treatment through public and private sectors;
2. Full coverage of the population at risk with appropriate vector control measures;
3. Malaria health education, promotion, and community mobilization efforts to maximize utilization of malaria control and elimination services;
4. Comprehensive coverage of vulnerable, poor and marginalized populations at high risk of malaria with appropriate malaria interventions;
5. Strengthening the malaria surveillance system by improving case reporting, passive and active case detection, entomological and antimalarial resistance monitoring, and ensuring adequate outbreak response capability; and
6. Effective programme management, based on firm leadership commitment, to enable high quality implementation of strategies from malaria control to elimination.

**Table 3.1: Number of counties in each of the four categories**

County Type	Definition	No. of Counties	Target population (x10,000)
Type 1	Presence of local case(s) in the last 3 years, with all previous 3 years having an annual incidence $\geq 1/10,000$	75	3,965
Type 2	Presence of local case(s) in the last 3 years	687	44,880
Type 3	No local case for at least 3 years, only imported cases	1,432	62,337
Type 4	No history of any locally transmitted cases, only imported cases	664	18,737



**Figure 3.2: Geographical distribution of county types in China**

**Table 3.2: Number of county types within each province, municipality, or autonomous region**

Province, Municipality, or Autonomous region	No. of Type 1 counties	No. of Type 2 counties	No. of Type 3 counties	No. of Type 4 counties
Anhui	27	70	8	0
Guizhou	7	23	58	0
Hainan	10	8	0	0
Henan	6	84	69	0
Hubei	4	74	24	0
Tibet	2	0	0	71
Yunnan	19	55	55	0

Chongqing	0	13	27	0
Guangdong	0	47	74	0
Guangxi	0	7	102	0
Hunan	0	5	117	0
Jiangsu	0	82	24	0
Jiangxi	0	30	69	0
Liaoning	0	4	96	0
Shaanxi	0	27	80	0
Shandong	0	61	79	0
Shanghai	0	10	9	0
Sichuan	0	41	110	31
Zhejiang	0	43	47	0
Gansu	0	2	3	81
Fujian	0	0	85	0
Hebei	0	0	172	0
Shanxi	0	0	119	0
Xinjiang	0	0	6	92
Beijing	0	0	0	18
Heilongjiang	0	0	0	128
Jilin	0	0	0	60
Inner Mongolia	0	0	0	101
Ningxia	0	0	0	21
Qinghai	0	0	0	43
Tianjin	0	0	0	18
<b>Total</b>	<b>75</b>	<b>687</b>	<b>1432</b>	<b>664</b>

*c. Study Sites*

*1. Study site selection*

For the costing analysis in this study, we focused on provinces, rather than the entire country, as this enabled us to capture local expenditure and budgetary data, in addition to national and external funding contributions. We selected two provinces that would represent a spectrum of epidemiology and provide quality data. Hainan is a *P. falciparum* and *P. vivax* endemic province and Jiangsu is a province with only *P. vivax* malaria. Hainan and Jiangsu were also among the six provinces that had received Global Fund support in the past, and therefore were likely to have kept accurate and detailed sustained control expenditure data.

### ***Hainan – Background***

The forested island of Hainan was previously one of the poorest areas in China. In 1950s, *Plasmodium falciparum* was hyperendemic and annual incidence was >1,000/10,000.<sup>15</sup> After establishment of the malaria control program in 1955, incidence dropped to about 20/10,000 in the 1960s, 10/10,000 in the 1970s. Since the 1980s, there has been a steady decline due to scaling up of control measures and a growing economy from tourism (Figure 3.4). In 2008, there were 1,844 reported cases, or an incidence of 2.18/10,000 (population of 8.64 million). Prior to the 1970s, *P. falciparum* cases outnumbered *P. vivax* cases. However, as occurs when malaria comes under control<sup>16</sup>, the proportion of cases due to *P. vivax* increased. In 2008, *P. falciparum* occurred in 7.5% of slide-confirmed cases, with *P. vivax* comprising the rest. Malaria transmission mostly occurs among Li and Miao minority groups in the forest and forest fringe areas of the central and southern island (Figure 3.3). The main vectors include *Anopheles dirus* and *Anopheles minimus*. Whereas *An. minimus* usually bite and rest indoors, the forest vector *An. dirus* is usually outdoor biting and resting. *An. sinensis* and *An. anthropophagus* are also vectors in this area.<sup>17</sup> Imported malaria is not a problem as immigrants are mostly from non endemic areas of China; in 2008, there were 0 imported cases in Hainan.

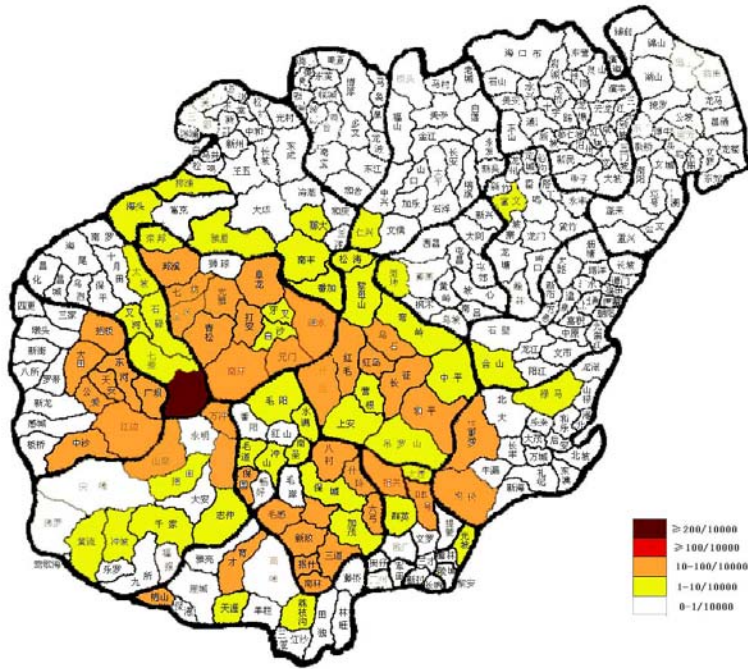
According to the new classification scheme, there are 10 Type 1 counties and 8 Type 2 counties. The entire province has endemic malaria and is considered to be at-risk. By 2017, Hainan aims to have reached elimination in the entire province.

### ***Jiangsu – Background***

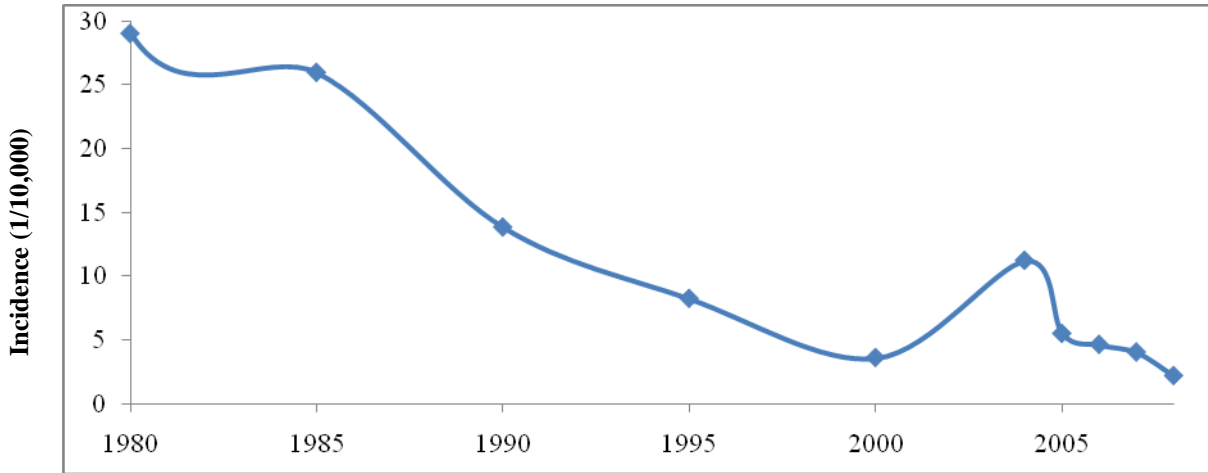
During the 1960s and 1970s, there were two large outbreaks in Jiangsu province and malaria burden was high. Incidence reached 2,500/10,000 in the 1960s and 1,700/10,000 in the 1970s. Most cases were due to *P. vivax*, but *P. falciparum* was also endemic, with about 0.5% cases due to *P. falciparum* in the early 1960s. Through improved case management, large scale use of IRS with DDT (dichlorodiphenyltrichloroethane) and ITNs with deltamethrin in the 1980s, *P. falciparum* was eliminated and *P. vivax* incidence dropped to near elimination levels.<sup>17</sup> However, beginning in the late 1990s, there was a resurgence of *P. vivax* due to weakened surveillance in combination with environmental and social factors. With domestic and Global Fund support, this epidemic was brought under control by improving diagnostic and treatment coverage, better surveillance with an internet reporting system, and focused mass treatment in outbreak communities (Figure 3.6).

In 2008, there were 668 reported cases in Jiangsu province, or an incidence of 0.086/10,000 (population 76.25 million). 609 cases were due to *P. vivax* and 59 due to *P. falciparum*. Because Jiangsu is a mainland province, imported cases, particularly from Anhui province have been a problem. Therefore, most cases occur on the northwest side of the province, near the border with Anhui (Figure 3.5). Also, because Chinese nationals are increasingly traveling to Africa for labor, imported malaria from abroad has also become a challenge. In 2008, 253 *P. vivax* cases were imported from Anhui and all 59 *P. falciparum* cases were imported from Africa.<sup>18</sup> The main vector is *An. sinensis*, an indoor and outdoor biting and resting mosquito.<sup>10</sup>

Jiangsu province has eliminated malaria in 24 previously endemic counties, maintaining interruption of local transmission in these counties for at least three years. The rest of Jiangsu's 82 counties are endemic for *P. vivax*, and this population of 58.12 million comprises the at-risk population. By 2017, Jiangsu aims to eliminate malaria in all Type 2 counties and prevent reintroduction of malaria in Type 3 counties.



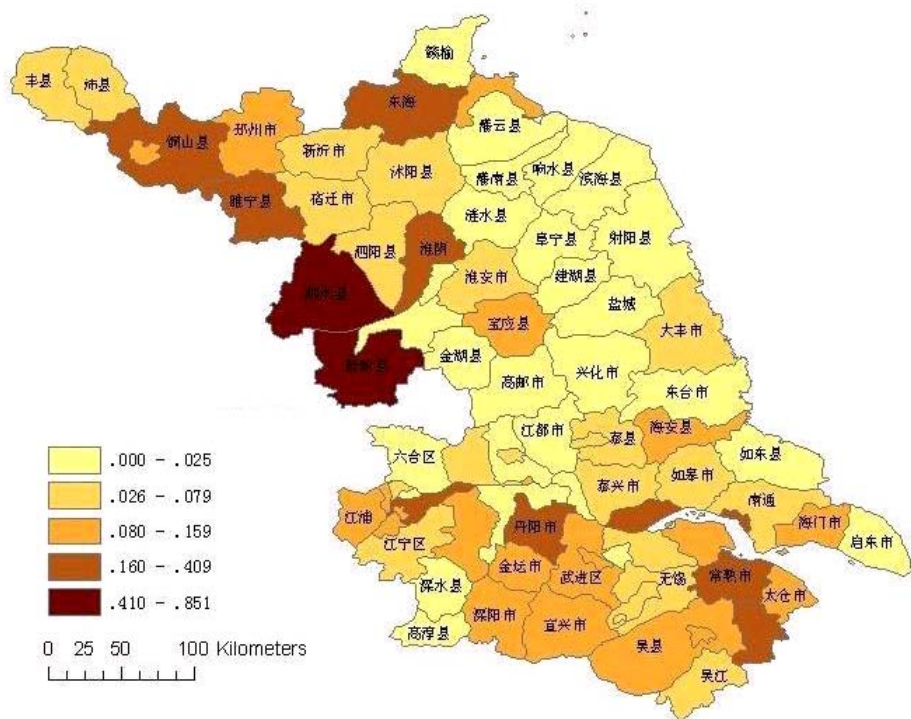
**Figure 3.3: Annual incidence of malaria in counties of Hainan, 2008**



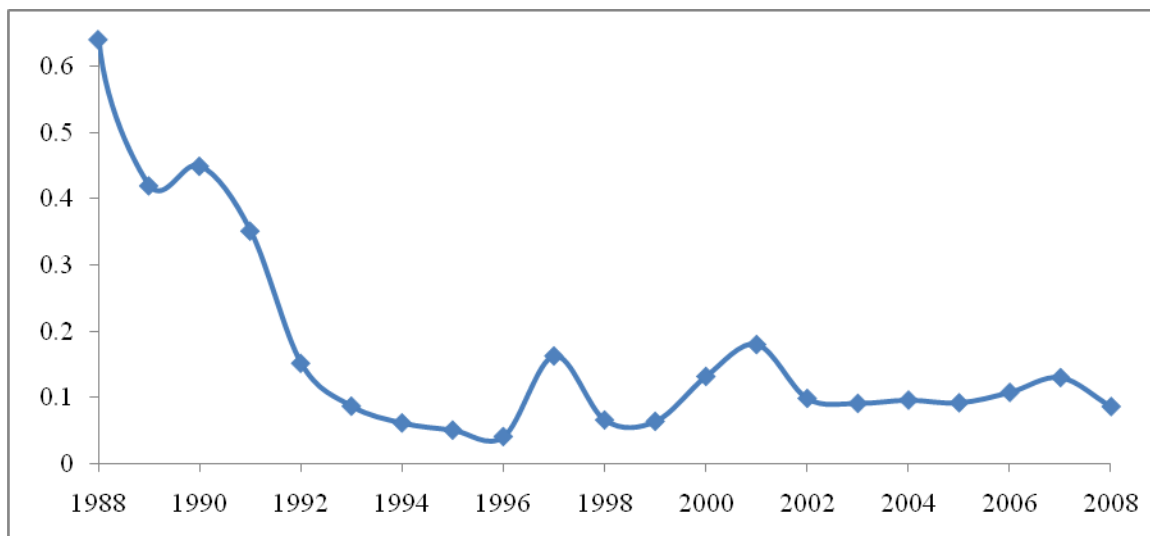
**Figure 3.4: Annual incidence (per 10,000 population) of malaria in Hainan, 1980 to 2008**

The peak in 2004 was due to improved surveillance compared to prior years.





**Figure 3.5: Annual incidence of malaria in counties of Jiangsu, 2008**



**Figure 3.6: Annual incidence (per 10,000 population) of malaria in Jiangsu, 1988 to 2008**

#### **d. Data Collection Methods**

##### ***Collection of CLM expenditures and projected elimination costs***

Costing data from 2007, 2008, and 2009 were gathered from expenditure records maintained at the Hainan and Jiangsu provincial offices and at the National Institute of Parasitic Diseases. Records were organized by funding source (Global Fund Round 5, national, provincial, or local) and costs per intervention category and activity (see supplemental data tables).

Based on the revised national malaria strategy, projected elimination costs were generated by financial and program managers at the Hainan and Jiangsu provincial offices and at the National Institute of Parasitic Diseases. The strategies were based on expert opinion from officers who have had experience with successful elimination efforts in recent years at provincial and sub-provincial levels. Budgetary data from years one to five following the transition from control to elimination were classified by funding source (Global Fund National Strategy Application (NSA), national, provincial, or local), intervention category and activity. Unlike the budgetary data that was previously used in a preliminary elimination costing analysis,<sup>19,20</sup> this data reflects China's revised national strategy.

For CLM and elimination data, where costs per intervention category or activity were not available (salary and some program management costs), interviews were conducted with program and financial staff to allocate costs appropriately (Table 3.4). Data was entered in Microsoft Excel spreadsheets (Microsoft Office, 2007). Costs per capita were calculated using the at-risk population as denominator. A summary of the CLM versus elimination strategies and interventions is as follows,

##### ***Hainan – CLM expenditure costs versus elimination budgetary costs***

*Prevention* - Current high risk areas (incidence  $\geq 1\%$ ) have 80% coverage of ITNs and the goal for elimination is 100% coverage with LLINs. Although the forest vector *An. dirus* is outdoor biting and resting, insecticide treated bed nets have been shown to provide protection from malaria, and are therefore a central component of the control and elimination strategy.

*Diagnosis* - Current control measures have achieved microscopy coverage at all township hospitals. The goal for elimination will be to also perform PCR confirmation of all positive cases, and make RDTs available in remote high risk areas.

*Treatment* - Effective therapies for *P. vivax* and *P. falciparum* are available at the village level, however the elimination strategy will require directly observed therapy for all cases. This new strategy will be particularly important for *P. vivax* treatment, for which there is poor compliance with primaquine due to the long treatment course.

*Surveillance and response* - Current control measures have achieved 60% coverage of township hospitals with passive surveillance (internet case reporting system). In addition, case investigations occur around new cases (with IRS to entire villages if the caseload reaches established thresholds). Also, active surveillance is performed in high endemic sites (village doctors screen villagers for fever every 10 days, and test fever cases for malaria). In the elimination phase, Hainan will aim for 100% coverage of township hospitals with the passive internet case reporting system. There will be expansion of the active surveillance program to all endemic sites. Also, to prevent potential imported malaria, all febrile passengers at ports of entry will be tested for malaria.

*IEC (information/education/communication)* - Current services involve IEC programs to health providers and school children. In the elimination phase, IEC will be provided to private health care providers, in addition to public providers. Programs targeted to school children will continue, however, the focus will be on elimination rather than control. Lastly, there will be mass media campaigns such as around World Malaria Day, and through collaboration with the Quarantine Bureau, travelers to endemic areas will receive information on how to protect themselves from contracting malaria.

*Program management* - In the elimination compared to control phase, staff and infrastructure needs will increase at township, county, and provincial levels, accounting for the increased program management costs.

#### ***Jiangsu – CLM expenditure costs versus elimination budgetary costs***

*Prevention* – These include media messages encouraging locals to take part in personal protection, specifically referring to use of bed nets (which may or may not contain insecticide) and use of insect repellents. ITNs or LLINs are not part of the strategy because transmission is extremely low and use of them would be neither economical, nor suitable, given that the local vector is not typically indoor biting and resting. In the elimination phase, there is no change in this strategy, though there will be increased media messaging to encourage use of personal protective measures (costs reflected in IEC budget). To the international malaria community, such a prevention strategy is unconventional. However, the experience with Jiangsu as well as from neighboring provinces with similar epidemiologies has shown this to be a cost-effective strategy.

*Diagnosis* - Current control measures have achieved microscopy coverage at 50% of township hospitals. The goal for elimination will be to increase coverage to 100% of township hospitals.

*Treatment* – In both the control and elimination phase, effective therapies are available at the township level. However, the elimination strategy will require directly observed therapy which again, is particularly important for *P. vivax* given poor compliance with primaquine.

*Surveillance and response* - Current control measures have achieved 50% coverage of township hospitals with passive surveillance (internet case reporting system). Case investigations occurs around new cases (with IRS to entire villages if the caseload reaches established thresholds) and active surveillance is performed by village doctors in high endemic sites. In the elimination phase, Jiangsu will aim for 100% coverage of township hospitals with the passive internet case reporting system. It will expand the active surveillance program to all endemic sites, and to prevent potential imported malaria, all febrile passengers at ports of entry will be tested for malaria.

*IEC* - Control and elimination measures are similar to those for Hainan except that in Jiangsu, the elimination phase will include special programs to educate migrant workers through peer groups.

*Program Management* – Staff and infrastructure needs will increase at township, county, and provincial levels during the transition from control to elimination, thus accounting for the increase in program management costs for elimination.

#### ***e. Projected prevention of reintroduction costs***

Budgets for the post-elimination period, or prevention of reintroduction phase, had not yet been calculated at the provincial or national levels. However, expenditure data was available from four provinces that have eliminated malaria in the last three to five years: Shanxi, Fujian, Hebei, and Xinjiang (Table 3.5). Therefore, unlike the modelled data that was previously used in a preliminary costing analysis,<sup>18</sup> we assumed that the prevention of reintroduction programs in Hainan and Jiangsu would be roughly equivalent to those in three of these four provinces (Hebei, Fujian, and Shanxi). As a province with few Type 3 historically endemic counties, it was felt that prevention of reintroduction expenditure data from Xinjiang would not accurately reflect the projected needs of Hainan and Jiangsu. Hebei, Fujian, and Shanxi are comprised entirely of Type 3 counties and thus the provincial population is considered to be at-risk for reintroduction of malaria. (Table 3.6)

National level malaria expenditures for the malaria-free provinces in 2009 were gathered from reports filed at the National Institute of Parasitic Diseases. Provincial, county, and township level expenditures for malaria specific activities in 2009 were collected through review of financial documents at these levels and through inquest with financial and program managers in the provinces and counties (Table 3.3). According to program and financial managers in these provinces, costs had been relatively stable compared to the prior two years. Expenditures were categorized according to the intervention categories as used for CLM and elimination costing. Where costs per intervention category or activity were not available (salary and some program management costs), interviews were conducted with program and financial staff to allocate costs appropriately (Table 3.4). A

summary of this data can found in the Supplemental Data Tables section. Costs per capita were calculated using the population at-risk as the denominator. The expenditures in these provinces reflect the following strategies and interventions:

*Prevention* – Encouraging use of personal protective measures, as described above.

*Diagnosis* – Microscopy for suspected malaria cases available at township and county levels.

*Treatment* – Treatment of imported cases. Maintaining stocks of drugs for *P. vivax* at the county level and drugs for *P. falciparum* at the prefecture or provincial level.

*Surveillance and Response* – Passive surveillance through the internet reporting system; investigation of all cases; IRS to villages with any malaria cases, vector surveillance at county and provincial levels.

*IEC* – Mass media messages on personal protective measures and seeking medical attention, especially when an imported case occurs.

*Program Management* – Management staff at township, county, and provincial levels spend an estimated 36-48% of time managing the above activities.

Unlike the budgetary data used for other prevention of reintroduction sites (e.g., modeled costs for Zanzibar, withdrawal of prevention costs for Swaziland), this budgetary data for Hainan and Jiangsu is based on actual expenditures from three other recently eliminated provinces, Hebei, Fujian, and Shanxi. The strength in using this data is it is based on actual experience from other Chinese provinces that have successfully eliminated. A comparison of the average GDP per capita and other socioeconomic indicators suggests that baseline economic situations are similar (see Table 3.6).

However, there are slight differences in baseline epidemiology, as the situation in Jiangsu is closer to that in Shanxi and Hebei (latitude ranging from 25 to above 33°N), and Hainan is more similar to Fujian (latitude at or below 25°N). The epidemiology of malaria in Chinese provinces reflects latitude. South of the 25° Nanling mountains, the weather is tropical and historically this area was hyper- or meso- endemic and *P. falciparum* was widely present. Between 25° and 33° (from the Nanling mountains to the Qinling mountains and Huaihe River), the weather is temperate and while *P. falciparum* was present in the past, today only *P. vivax* is endemic. North of 33° (north of the Qinling mountains and Huaihe River), malaria is of low endemicity and historically, only *P. vivax* has been endemic.<sup>5</sup> In addition, the revised malaria strategy includes some new prevention of reintroduction measures (e.g., screening of fevers in ports to prevent imported malaria) that have not yet been instituted in Hebei, Fujian, and Shanxi, and are therefore not reflected in their expenditures.

**Table 3.3: Data sources for costing data**

<b>Funding Source</b>	<b>Data Source</b>	<b>Informant</b>
<i>Controlled low endemic malaria (CLM), 2007-2009</i>		
<b>Global Fund Round 5</b>	Global Fund Round 5 Annual Expenditure Reports	Global Fund Round 5 Program Manager and Financial Officer, National Institute of Parasitic Diseases
<b>National</b>	Ministry of Health/National Institute of Parasitic Diseases Annual Expenditure Reports	National Malaria Control Program, Program Manager and Financial Officer, National Institute of Parasitic Diseases
<b>Provincial</b>	Jiangsu Institute of Parasitic Diseases and Hainan CDC Annual Expenditure Reports	Provincial Program Managers and Financial Officers
<b>Local (County and Township)</b>	County Malaria Program Financial Reports	County level program managers and financial officers

<i>Elimination, Years 1-5</i>		
<b>Global Fund Round National Strategy Application (NSA)</b>	Global Fund NSA Annual Budgets	Global Fund NSA Draft Team, National Institute of Parasitic Diseases
<b>National</b>	Ministry of Health/National Institute of Parasitic Diseases Annual Budgets	National Malaria Control Program, Program Manager and Financial Officer, National Institute of Parasitic Diseases
<b>Provincial</b>	Jiangsu Institute of Parasitic Diseases and Hainan CDC Annual Budgets	Provincial Program Managers and Financial Officers
<b>Local (County and Township)</b>	County Malaria Program Budgets	County level program managers and financial officers
<i>Prevention of Reintroduction (POR), 2007-2009</i>		
<b>National</b>	Ministry of Health/National Institute of Parasitic Diseases Annual Expenditure Reports	National Malaria Control Program, Program Manager and Financial Officer, National Institute of Parasitic Diseases
<b>Provincial</b>	Shanxi CDC, Hebei CDC, and Fujian CDC Annual Expenditure Reports	Provincial Program Managers and Financial Officers
<b>Local (County and Township)</b>	County Malaria Program Expenditure Reports	County level program managers and financial officers

**Table 3.4: Cost allocation assumptions for salaries**

	Staff Level	Vector Control Prevention	Treatment	Diagnosis	Surveillance and Response	IEC	Program Management
<i>Hainan – CLM</i>							
<b>2007</b>	Provincial	0-11	0-03	0-01	0-29	0-05	0-51
	County	0-16	0-14	0-03	0-16	0-08	0-43
	Township	0-18	0-29	0-11	0-05	0-08	0-29
<b>2008</b>	Provincial	0-11	0-02	0-01	0-30	0-06	0-50
	County	0-18	0-11	0-03	0-17	0-08	0-43
	Township	0-22	0-27	0-11	0-04	0-08	0-28
<b>2009</b>	Provincial	0-12	0-01	0-01	0-31	0-06	0-50
	County	0-22	0-08	0-03	0-17	0-08	0-42
	Township	0-24	0-24	0-12	0-03	0-08	0-29
<i>Hainan - Elimination</i>							
<b>Year 1</b>	Provincial	0-10	0-01	0-02	0-33	0-05	0-49
	County	0-12	0-03	0-04	0-33	0-07	0-42
	Township	0-20	0-11	0-12	0-20	0-06	0-32
<b>Year 2</b>	Provincial	0-10	0-01	0-02	0-35	0-05	0-48
	County	0-14	0-02	0-04	0-31	0-07	0-42
	Township	0-23	0-09	0-12	0-15	0-08	0-33
<b>Year 3</b>	Provincial	0-10	0-00	0-01	0-36	0-05	0-48
	County	0-16	0-00	0-03	0-32	0-07	0-42
	Township	0-25	0-06	0-14	0-14	0-08	0-33

<b>Year 4</b>	Provincial	0-10	0-00	0-01	0-36	0-06	0-48
	County	0-16	0-00	0-02	0-32	0-08	0-42
	Township	0-26	0-02	0-14	0-14	0-09	0-35
<b>Year 5</b>	Provincial	0-09	0-00	0-01	0-36	0-06	0-48
	County	0-17	0-00	0-01	0-33	0-08	0-41
	Township	0-28	0-01	0-10	0-15	0-10	0-36
<i>Jiangsu - CLM</i>							
<b>2007</b>	Provincial	n/a	0-01	0-01	0-37	0-08	0-53
	County	n/a	0-02	0-02	0-36	0-10	0-50
	Township	n/a	0-05	0-03	0-34	0-12	0-46
<b>2008</b>	Provincial	n/a	0-23	0-09	0-23	0-14	0-31
	County	n/a	0-01	0-01	0-37	0-09	0-52
	Township	n/a	0-02	0-02	0-36	0-12	0-48
<b>2009</b>	Provincial	n/a	0-04	0-03	0-36	0-15	0-43
	County	n/a	0-20	0-08	0-26	0-16	0-30
	Township	n/a	0-01	0-01	0-39	0-08	0-51
<i>Jiangsu – Elimination</i>							
<b>Year 1</b>	Provincial	n/a	0-01	0-01	0-41	0-08	0-49
	County	n/a	0-02	0-01	0-44	0-10	0-43
	Township	n/a	0-03	0-02	0-47	0-12	0-36
<b>Year 2</b>	Provincial	n/a	0-10	0-08	0-37	0-12	0-33
	County	n/a	0-01	0-01	0-44	0-06	0-48
	Township	n/a	0-01	0-01	0-50	0-05	0-43
<b>Year 3</b>	Provincial	n/a	0-02	0-02	0-48	0-08	0-40
	County	n/a	0-08	0-07	0-40	0-12	0-33
	Township	n/a	0-00	0-01	0-48	0-05	0-46
<b>Year 4</b>	Provincial	n/a	0-01	0-01	0-51	0-05	0-42
	County	n/a	0-01	0-02	0-48	0-09	0-40
	Township	n/a	0-03	0-06	0-43	0-14	0-34
<b>Year 5</b>	Provincial	n/a	0-00	0-01	0-52	0-05	0-42
	County	n/a	0-00	0-01	0-52	0-05	0-42
	Township	n/a	0-00	0-01	0-49	0-09	0-41
<i>Malaria-free provinces (Shanxi, Fujian, Hebei) – Prevention of Reintroduction</i>							
<b>2009</b>	Provincial	0-25	0-00	0-00	0-27	0-00	0-48
	County	0-27	0-01	0-01	0-24	0-06	0-41
	Township	0-44	0-03	0-08	0-00	0-09	0-36

**Table 3.5: Reported Cases (local and imported) from four Chinese provinces that have recently eliminated malaria**

Year	Shanxi		Fujian		Hebei		Xinjiang	
	Local Cases	Imported Cases	Local Cases	Imported Cases	Local Cases	Imported Cases	Local Cases	Imported Cases
2000	4	3	2	77	21	23	3	4
2001	2	4	0	85	22	19	2	7
2002	2	5	0	92	17	28	3	6
2003	4	1	2	111	15	24	1	8
2004	0	6	3	60	0	15	0	7
2005	0	4	3	41	0	21	0	3
2006	0	6	0	49	0	27	0	5
2007	0	3	0	44	0	23	0	12
2008	0	5	0	82	0	29	0	3

**Table 3.6: Epidemiological and economical factors in the study provinces versus the prevention of reintroduction provinces**

	Study Provinces			Prevention of Reintroduction Provinces		
	<i>Hainan</i>	<i>Jiangsu</i>	<i>Shanxi</i>	<i>Fujian</i>	<i>Hebei</i>	<i>Xinjiang</i>
Number of Type 1 counties	10	0	0	0	0	0
Number of Type 2 counties	8	82	27	0	0	0
Number of Type 3 counties	0	24	80	85	172	6
Number of Type 4 counties	0	0	0	0	0	92
Population (million) <sup>21</sup>	8.44	76.25	33.93	35.81	69.43	20.95
GDP per capita (in 2009 USD) <sup>22</sup>	\$2802	\$6467	\$2968	\$4404	\$3571	\$2908
Annual government health expenditure per capita (in 2009 USD)	\$53	\$123	\$44	\$37	\$35	\$63
Wage per capita (in 2009 USD)	\$884	\$1,406	\$826	\$1,264	\$903	-
Educational attainment						
<i>College educated</i>	1.81%	-	-	3.17%	2.25%	5.64%
<i>High school</i>	15.07%	-	-	11.27%	12.78%	13.27%
<i>Junior high school</i>	32.75%	-	-	35.87%	33.35%	30.22%
<i>Primary school</i>	50.37%	-	-	40.77%	51.63%	41.66%
Illiteracy rate	6.98%	6.31%	4.18%	7.20%	7.15%	-
Latitude	south of 25°	intersected by 33°	north of 33°	intersected by 25°	north of 33°	north of 33°

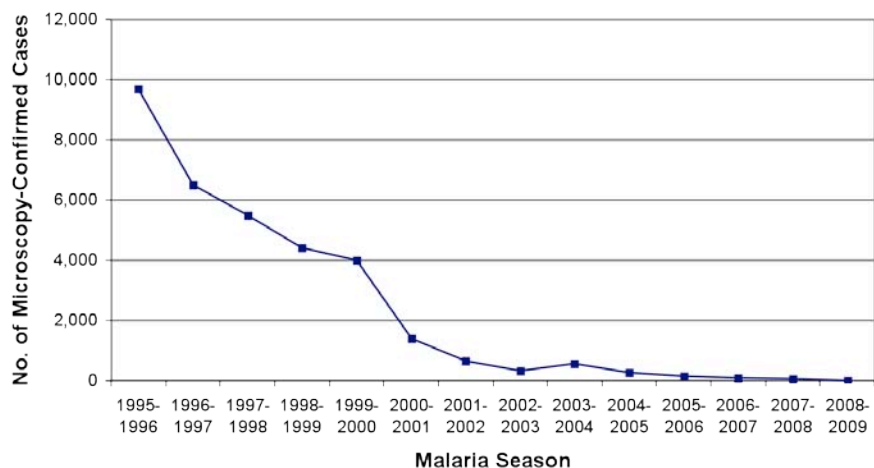
#### 4. The Cost of Malaria Control and Elimination in Swaziland: Context and Methodology

##### a. Context – Malaria situation in Swaziland, past and present

From 2000 to 2009, malaria incidence in Swaziland, as measured by the total number of patients presumptively treated for malaria at health facilities, has steadily declined. Clinical malaria cases decreased from 29 374 to 5 939 cases,<sup>23</sup> reducing the malaria burden from 80 to 16 cases per 1000 population at risk.<sup>24</sup> Laboratory-confirmed malaria cases also declined, from 4 005 cases during the 1999-2000 malaria season to 73 cases in 2008-2009 (Figure 4.1).<sup>25</sup> However, actual malaria incidence, as determined by parasitological diagnosis, remains unknown, as only a portion of the total suspected malaria cases were



confirmed by microscopy during this period. The Swaziland Ministry of Health only recently expanded malaria diagnostic capacity to all primary health facilities through the introduction of malaria rapid diagnostic tests (RDTs).



**Figure 4.1: Reported malaria cases, 1995-2009**

In Swaziland, approximately 228 000 people live in malaria-endemic areas. Transmission occurs mostly in the Lowveld and the Lubombo Plateau in the eastern part of the country near the Mozambican border. As a result of the porous border with Mozambique, there is frequent malaria importation by travelers. However, the introduction of spraying campaigns in the neighboring Mozambican province via the Lubombo Spatial Development Initiative (LSDI) has resulted in significant declines in malaria prevalence in the province, which has also contributed to decline of malaria in Swaziland.<sup>26</sup> Malaria transmission is most intense during the rainy season from October to May. In recent years, the country experienced severe drought in the malaria-endemic areas of eastern Lubombo, which has contributed to the decrease in malaria transmission and incidence.<sup>27</sup>

Although a large proportion of the Swazi population suffers from poverty and other endemic diseases, there is limited documentation to show that these factors have a significant impact on malaria outcomes. In a country where 69% of the population lives below the poverty line,<sup>28</sup> the malaria-endemic Lubombo region has the highest proportion of the population in the lowest wealth quintiles compared with the other regions.<sup>29</sup> However, the government provides free healthcare service to all socioeconomic strata, and 85% of the population lives within 8 km of a public health facility.<sup>30</sup> Swaziland has both the highest HIV prevalence<sup>31</sup> and the highest incidence of tuberculosis (TB) in the world.<sup>32</sup> As with pregnant women and children, immuno-suppressed individuals have a greater risk of developing life-threatening malaria. However, data has not been captured on whether those afflicted with HIV and/or TB in Swaziland are more at risk for malaria.

Prior to 2007, Swaziland malaria control goals were to “to effectively control malaria so that it ceases to be a major impediment to the socio economic development of the Swaziland population” with an aim to meet the Abuja targets to halve malaria morbidity and mortality.<sup>33</sup> To achieve this goal, the malaria control program focused on expanding coverage of interventions only within the communities in the malaria-endemic region. In addition to conducting an annual indoor residual spraying (IRS) campaign, the NMCP also established a weekly surveillance program at all health facilities in the region. Although chloroquine, the first-line treatment for uncomplicated malaria, was available at all health facilities, only those facilities in the malaria-endemic region collected microscopy slides, which are later sent to the NMCP laboratory for confirmation. Additionally, community outreach campaigns only targeted communities in the malaria-endemic regions.

In 2007, the African Union and the Southern African Development Community (SADC) selected Swaziland as a candidate for malaria elimination, establishing a target of 2015 for the achievement of the goal. The Swaziland government committed itself

to the goal and developed its elimination strategy in June 2008. The elimination program aims to expand malaria interventions, particularly those diagnosis, surveillance, and health promotion, to the total population.

**b. National Elimination Strategy**

Swaziland’s elimination strategy contains a major shift from its control program. The strategy includes the scale-up of vector control and information, education, communication (IEC) activities, the introduction of a comprehensive diagnostic and surveillance program, and the strengthening of program management and monitoring and evaluation (M&E). Table 4.1 outlines the major programmatic changes between Swaziland’s control and elimination programs.

**Table 4.1: Comparing Swaziland’s control and elimination programs**

Thematic Area	Control	Elimination
<b>Diagnosis</b>	<ul style="list-style-type: none"> <li>Confirmed diagnosis available at health facilities in the malaria-endemic areas</li> </ul>	<ul style="list-style-type: none"> <li>Confirmed diagnosis by RDT and/or microscopy at all health facilities</li> <li>Establishment of malaria diagnosis quality assurance program</li> </ul>
<b>Treatment and Prophylaxis</b>	<ul style="list-style-type: none"> <li>Use of chloroquine and SP as first-line treatment and prophylaxis</li> <li>Infrequent drug resistance testing</li> </ul>	<ul style="list-style-type: none"> <li>Use of artemisinin-based combination therapy (ACTs) as first-line treatment</li> <li>Ongoing drug resistance monitoring</li> </ul>
<b>Prevention</b>	<ul style="list-style-type: none"> <li>IRS for targeted communities in malaria-endemic area</li> <li>LLIN distribution for pregnant women and children under 5</li> </ul>	<ul style="list-style-type: none"> <li>IRS for all communities in malaria-endemic area</li> <li>LLIN distribution to all communities in the malaria-endemic area</li> <li>Larviciding in select communities</li> <li>Ongoing insecticide resistance monitoring</li> </ul>
<b>Surveillance</b>	<ul style="list-style-type: none"> <li>Weekly passive surveillance program established at health facilities in the malaria-endemic areas</li> <li>Establishment of epidemic preparedness and response (EPR) program</li> </ul>	<ul style="list-style-type: none"> <li>Weekly passive surveillance program established at all health facilities</li> <li>Active surveillance program to be established throughout the country; currently only in Lubombo Region</li> <li>6 surveillance sites to be established; currently only 2 are functional</li> <li>Continuous epidemic/outbreak monitoring and EPR program</li> </ul>
<b>Information, Education, Communication (IEC)</b>	<ul style="list-style-type: none"> <li>IEC for communities at risk</li> <li>Regular Knowledge, Attitudes, Practices (KAP) surveys</li> </ul>	<ul style="list-style-type: none"> <li>IEC for total population</li> <li>IEC for travelers</li> <li>Community outreach programs</li> <li>Regular KAP surveys</li> </ul>
<b>Program Management</b>	<ul style="list-style-type: none"> <li>4 malaria officers</li> <li>Limited Malaria Information System</li> </ul>	<ul style="list-style-type: none"> <li>12 malaria officers</li> <li>Comprehensive Malaria Surveillance Database</li> <li>Regular Malaria Indicator Surveys (MIS)</li> </ul>

Swaziland’s elimination program is based on the guidelines defined in the World Health Organization (WHO)’s *Malaria Elimination: Field manual for low to moderate endemic countries*. Although most WHO recommendations have been adopted by Swaziland’s elimination program, there are some minor deviations. First, no genotyping activities are currently planned. Second, the implementation of an immediate case notification is still impractical, given the relatively high levels of malaria in the country at the moment. However, it is hypothesized the caseload may reduce significantly after the introduction of RDTs, which may make immediate notification feasible. Third, collaboration with the private sector remains a challenge, although the Ministry of Health is planning to strengthen participation by the private sector in the elimination program. Finally, the current malaria program still focuses its interventions on the entire communities at risk rather than on targeted foci. However, as

malaria incidence and prevalence decreases, Swaziland’s elimination program will gradually transition to a foci-oriented approach of intervention coverage. Table 4.2 compares Swaziland’s elimination program to WHO guidance.

**Table 4.2: Comparing Swaziland’s elimination interventions against WHO recommendations**

Thematic Area	WHO Recommendation for Elimination*	Swaziland’s Elimination Program
<b>Case Management</b>	<ul style="list-style-type: none"> <li>• Implement new drug policy</li> <li>• Routine QA/QC expert microscopy</li> <li>• Active case detection</li> <li>• Monitoring antimalarial drug resistance</li> </ul>	<ul style="list-style-type: none"> <li>• New drug policy (ACTs) implemented</li> <li>• Introduced routine QA/QC expert microscopy</li> <li>• Conducting regular active case detection</li> <li>• Conducting ongoing monitoring of antimalarial drug resistance</li> </ul>
<b>Vector Control and Malaria Prevention</b>	<ul style="list-style-type: none"> <li>• Geographic reconnaissance</li> <li>• Vector control to reduce transmission in residual active and new active foci</li> <li>• Vector control to reduce receptivity in recent foci</li> <li>• Outbreak preparedness and response</li> <li>• Entomological surveillance</li> <li>• Prevention of malaria in travelers</li> </ul>	<ul style="list-style-type: none"> <li>• Introduced geographic reconnaissance</li> <li>• Conducting IRS, distributing LLINs, and introducing targeted larviciding to reduce transmission and receptivity</li> <li>• Outbreak preparedness and response measures established</li> <li>• Conducting ongoing entomological surveillance</li> <li>• Conduct health promotion campaigns on malaria prevention for travelers</li> </ul>
<b>Monitoring and Evaluation</b>	<ul style="list-style-type: none"> <li>• Case investigation and classification</li> <li>• Foci investigation and classification</li> <li>• Routine genotyping</li> <li>• Malaria surveys</li> <li>• Immediate notification of cases</li> <li>• Meteorological monitoring</li> </ul>	<ul style="list-style-type: none"> <li>• Conducting case investigation and classification</li> <li>• Preparing to introduce foci investigation and classification</li> <li>• No routine genotyping planned</li> <li>• Conducting regular malaria surveys</li> <li>• Immediate case notification program to be established once practically feasible</li> <li>• Conducting meteorological monitoring</li> </ul>
<b>Health Systems Issues</b>	<ul style="list-style-type: none"> <li>• Full cooperation of private sector</li> <li>• No OTC sale of antimalarial medicines</li> <li>• Free-of-charge diagnosis and treatment for all malaria cases</li> </ul>	<ul style="list-style-type: none"> <li>• Starting to coordinate with the private sector on case management, including sale of antimalarial drugs</li> <li>• Malaria diagnosis and treatment is free of charge at all public and some private health facilities</li> </ul>
<b>Programmatic Issues</b>	<ul style="list-style-type: none"> <li>• Implementation of updated drug policy, vector control, active detection of cases</li> <li>• Malaria elimination committee <ul style="list-style-type: none"> <li>○ Manage malaria elimination database</li> <li>○ Repository of information</li> <li>○ Periodic review</li> <li>○ Oversight</li> </ul> </li> <li>• Reorientation of health facility staff</li> </ul>	<ul style="list-style-type: none"> <li>• Continuous implementation of drug policy, vector control, and active detection of cases</li> <li>• Malaria elimination committee being established to regularly review implementation of malaria policies and interventions</li> <li>• Database and Geographic Information Systems (GIS) being established</li> <li>• Conducting ongoing training of health facility staff</li> </ul>

\* WHO recommendations are excerpted from WHO, *Malaria Elimination: Field manual for low to moderate endemic countries*, 2007.

Global Fund grants and the national Ministry of Health budget primarily fund Swaziland’s elimination program. The malaria program also occasionally receives pecuniary or in-kind support from local or international partners, such as UNICEF, corporate entities such as MTN, and the Clinton Health Access Initiative (CHAI). However, these provisions often fund one-time projects (e.g., a one-time operational research project) rather than ongoing programs.

*c. Data collection methods*

**Swaziland's sustained control program (mid-2003 to mid-2008) was funded by three main sources:**

- Swaziland's Global Fund Round 2 malaria grant actuals,<sup>34</sup> which contributed 26% of the average annual cost of the sustained control program
- Lubombo Spatial Development Initiative (LSDI) Global Fund Round 2 malaria grant budget,<sup>35</sup> which contributed 6% of the average annual cost of the sustained control program
- NMCP budget, which contributed 68% of the average annual cost of the sustained control program

**The elimination program (mid-2009 to mid-2014) is funded by the following sources:**

- Swaziland's Global Fund Round 8 malaria grant budget,<sup>36</sup> which contributes 69% of the average annual cost of the elimination program
- LSDI Global Fund Round 2 malaria grant budget, which contributes 1% of the average annual cost of the elimination program
- NMCP budget, which contributes 29.5% of the average annual cost of the elimination program
- National Clinical Laboratory Services budget (for the RDT procurement only), which contributes 0.5% of the average annual cost of the elimination program

The sustained control and elimination costing do not include health system expenditures that also contribute to positive malaria outcomes. If such costs were included, government contribution as a percentage of the overall malaria program costs would increase. Additionally, the costing does not account for occasional, variable, project-based support by partners (e.g., MTN support for Malaria Day), which may total up to US\$40,000 per annum. Rather, it only includes the costs for ongoing malaria interventions.

The Global Fund and NMCP budgets and actuals were obtained from the Principal Recipients for the two Global Fund malaria grants and the NMCP respectively. The following informants provided clarifications on amortization rates and unit costs as well as guidance on disambiguation of aggregate costs.

- A former malaria program officer at the NMCP and current manager of Global Fund resources
- The malaria grant manager for the Swaziland's Global Fund malaria grants at the National Emergency Response Council for HIV/AIDS (NERCHA), the Principal Recipient for Swaziland Global Fund malaria grants
- The manager of contracted activities under Swaziland's Global Fund malaria grant at the South Africa Medical Research Council (MRC); MRC performs activities under the Swaziland Global Fund Round 8 grant and manages the LSDI Global Fund Round 2 malaria grant

*d. Data sources*

Table 4.3 and 4.4 outlines the data sources, the relevant informant, and assumptions made in the disaggregation of lump sum costs, if any, for all data used in the costing exercise. Where assumptions were made for the disaggregation of lump sums, the informants estimated the amount of time personnel, vehicles, and communication materials were used for a particular intervention during the previous two months.

**Table 4.3: Data sources for sustained control costing (mid-2003 to mid-2008)**

Income Source	Data Source	Assumptions and Notes
Swaziland's Global Fund Round 2 malaria actuals	Grant Principal Recipient – NERCHA	<ul style="list-style-type: none"> <li>Disaggregated costs provided by NERCHA</li> </ul>
LSDI Global Fund Round 2 malaria budget	Grant Principal Recipient – MRC	<ul style="list-style-type: none"> <li>Disaggregated costs provided by MRC</li> </ul>
NMCP budget	NMCP	<ul style="list-style-type: none"> <li>Travel budget: 45% for case management training and supervision, 35% for the IRS campaign, 1% for surveillance, 1.9% for information, education, and communication (IEC), and 17.1% for program management</li> <li>Communication budget: 80% for passive surveillance, 2% or IEC, 18% for program management</li> <li>Personnel and allowances budget: 5% for case management training and supervision, 20% for the IRS campaign, 1% for active surveillance, 7.4% for IEC, and 66.6% for program management</li> </ul>

**Table 4.4: Data sources for elimination costing (mid-2009 to mid-2014)**

Income Source	Data Source	Assumptions and Notes
Swaziland's Global Fund Round 8 malaria budget	Grant Principal Recipient – NERCHA	<ul style="list-style-type: none"> <li>Disaggregated costs provided by NERCHA</li> </ul>
NMCP budget	NMCP	<ul style="list-style-type: none"> <li>Travel budget: 45% for case management training and supervision, 35% for the IRS campaign, 1% for surveillance, and 19% for program management</li> <li>Communication budget: 80% for passive surveillance, 20% for program management</li> <li>Personnel and allowances budget: 5% for case management training and supervision, 20% for the IRS campaign, 1% for active surveillance, and 74% for program management</li> </ul>
National Clinical Laboratory Services budget	National Clinical Laboratory Services	<ul style="list-style-type: none"> <li>RDT procurement budget based on 2009 RDT quantification</li> </ul>

## 5. Percentage of costs by expenditure category, program phase, and territory

	Phase	Personnel	Consumables	Equipment	Travel	Training	Other
China - Hainan	Controlled Low-endemic Malaria	61.6%	26.6%	0.5%	3.3%	5.4%	2.7%
	Elimination	35%	4%	7%	14%	9%	31%
	<b>% Change</b>	<b>-42.8%</b>	<b>-84.2%</b>	<b>1,305.8%</b>	<b>326.8%</b>	<b>67.0%</b>	<b>1,034.8%</b>
China - Jiangsu	Controlled Low-endemic Malaria	92.6%	2.9%	0.0%	0.4%	1.1%	3.0%
	Elimination	88.3%	2.0%	1.9%	4.1%	3.4%	0.4%
	<b>% Change</b>	<b>-4.7%</b>	<b>-32.0%</b>	<b>11,942.2%</b>	<b>833.2%</b>	<b>219.1%</b>	<b>-86.7%</b>
Mauritius	Elimination	87.6%	9.3%	2.5%	0.2%	0.5%	0%
	Prevention of Reintroduction	90.0%	6.3%	3.0%	0.2%	0.5%	0%
	<b>% Change</b>	<b>2.8%</b>	<b>-32.8%</b>	<b>22.8%</b>	<b>-6.5%</b>	<b>14.8%</b>	<b>-</b>
Swaziland	Controlled Low-endemic Malaria	39.8%	33.1%	5.6%	1.7%	16.4%	3.3%
	Elimination	25.8%	31.6%	15.6%	7.8%	8.6%	10.7%
	<b>% Change</b>	<b>-3.3%</b>	<b>-4.6%</b>	<b>176.4%</b>	<b>357.9%</b>	<b>-47.8%</b>	<b>222.8%</b>
Tanzania -Zanzibar	Controlled Low-endemic Malaria	20.6%	61.7%	4.2%	6.9%	5.1%	1.5%
	Elimination	N/A	N/A	N/A	N/A	N/A	N/A
	<b>% Change</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

Note: N/A – data not available

## 6. Intervention strategies and costs by program phase and territory

Territory	Phase	Prevention			Diagnosis			Treatment			Surveillance			Information, Education, Communication			Management		
		Major Interventions	Average Annual	Per capita at risk	Major Interventions	Average Annual Cost	Per capita at risk	Major Interventions	Average Annual	Per capita at risk	Major Interventions	Average Annual Cost	Per capita at risk	Major Interventions	Average Annual	Per capita at risk	Major Interventions	Average Annual Cost	Per capita at risk
China - Hainan	CLM	80% ITN coverage in high risk areas, 80% LLIN coverage in remote areas	\$481,911	\$0.06	Microscopy at all township hospitals; RDTs in remote areas	\$173,851	\$0.02	Standard treatment provision w/ ACT or CQ/PQ	\$210,051	\$0.02	60% coverage of passive internet reporting; active surveillance in high endemic sites; IRS response to outbreaks	\$181,523	\$0.02	Health education to providers and school children	\$144,308	\$0.02	266 - 528 management staff (.03 - .06 per capita at risk) at provincial, county, and township levels	\$439,929	\$0.05
	Elimination	100% LLIN coverage in high risk areas	\$1,538,054	\$0.18	Microscopy at all township hospitals with PCR validation; RDTs in remote areas	\$288,944	\$0.03	Directly-observed therapy w/ ACT or CQ/PQ	\$183,463	\$0.02	100% coverage of passive internet reporting; active case detection in all endemic sites; screening of febrile cases at borders, lower threshold for IRS response to outbreaks	\$616,795	\$0.07	Elimination-focused education including private providers and travelers; mass media messages	\$392,376	\$0.05	529 - 791 management staff (.06 - .09 per capita at risk) at provincial, county, and township levels	\$1,346,370	\$0.16
	% Change		219%		66%		-13%		240%		172%		200%						
China - Jiangsu	CLM	personal protection	\$0	\$0.00	Microscopy at 50% of township hospitals	\$517,721	\$0.01	CQ/PQ for P. vivax; ACT for P. falciparum	\$1,173,317	\$0.02	50% coverage of passive internet reporting; active surveillance in high endemic sites; IRS response to outbreaks	\$2,468,413	\$0.04	Health education to providers and school children	\$1,424,859	\$0.03	1,573 - 3,142 management staff (.03 - .05 per capita at risk) at provincial, county, and township levels	\$2,887,207	\$0.05
	Elimination	personal protection	\$0	\$0.00	Microscopy at all township hospitals with PCR confirmation	\$1,123,215	\$0.02	CQ/PQ for P. vivax; ACT for P. falciparum; Directly-observed therapy	\$693,717	\$0.01	100% coverage of passive internet reporting; active case detection in all endemic sites; screening of febrile cases at borders, lower threshold for IRS response to outbreaks	\$5,887,048	\$0.10	Elimination-focused education including private providers and travelers; mass media messages	\$2,243,808	\$0.04	3,143 - 4,712 management staff (.05 - .08 per capita at risk) at provincial, county, and township levels	\$6,653,236	\$0.11
	% Change		N/A		117%		-41%		138%		57%		130%						
Mauritius	Elimination	13% IRS coverage, island-wide larviciding	\$2,581,873	\$2.58	All suspected cases confirmed with microscopy	\$97,170	\$0.10	Directly-observed treatment; prophylaxis to travelers	\$178,336	\$0.18	Annual Blood Examination Rate (ABER) = 7.8%, through border screening and case follow-up	\$1,162,181	\$1.16	Health education via mass media, schools, and households near confirmed cases	\$141,385	\$0.14	1,032 unskilled labor/field staff; 306 skilled/managerial staff	\$195,113	\$0.19
	Prevention of Reintroduction	< 1% IRS coverage, island-wide larviciding	\$1,115,885	\$1.05	All suspected cases confirmed with microscopy	\$92,160	\$0.09	Directly-observed treatment; prophylaxis to travelers	\$116,466	\$0.11	ABER = 3.4%, almost all through border screening	\$966,401	\$0.91	Health education via schools, and for households near cases	\$57,761	\$0.05	266 unskilled labor/field staff; 260 skilled/managerial staff	\$422,703	\$0.40
	% Change		-57%		-5%		-37%		-47%		-59%		-117%						
Swaziland	CLM	5% ITN, 30% IRS coverage	\$376,382	\$1.63	0% cases confirmed	\$94,867	\$0.37	95% cases treated w/ CQ	\$46,277	\$0.20	Passive surveillance only	\$83,776	\$0.36	At-risk communities only	\$31,715	\$0.14	4 central staff	\$363,863	\$1.57
	Elimination	95% ITN, 95% IRS coverage	\$787,828	\$3.41	95% cases confirmed w/ RDT or microscopy	\$420,381	\$1.82	95% cases treated w/ ACT	\$65,445	\$0.28	Active surveillance around new cases	\$698,160	\$3.02	Total population	\$321,439	\$1.39	12 central staff	\$690,390	\$2.99
	% Change		109%		393%		41%		733%		914%		90%						
Tanzania - Zanzibar	CLM	100% LLIN coverage; 95% IRS coverage reduced to 10% after 2 years	\$2,031,798	\$1.61	All suspected cases tested w/ RDTs or microscopy in public facilities	\$491,259	\$0.39	All cases treated w/ ACTs; IPT for all pregnant women; presumptive treatment in private sector	\$173,318	\$0.14	Mobile technology reporting system in all public facilities	\$661,142	\$0.53	Mass media and community mobilization	\$201,688	\$0.16	19 core program staff	\$348,433	\$0.28
	Elimination	100% LLIN coverage; 95% IRS coverage reduced to 25% after 2 years and 10% after 4 years	\$2,161,620	\$1.72	All fever cases tested w/ RDTs in public and private facilities with PCR validation	\$746,164	\$0.59	All cases treated w/ ACTs; no IPT; treatment only in public sector	\$106,252	\$0.08	Reporting system extended to private sector; screening of households around all new cases	\$1,126,820	\$0.90	Mass media and community mobilization	\$201,688	\$0.16	85 core program staff	\$679,083	\$0.54
	% Change		6%		52%		-39%		70%		0%		95%						

## 7. Supplemental data tables

Tables present a summary of the actual datasets created for the analysis for each country and territory. Every year for which historical and/or prospective data were collected and deemed sufficiently robust is shown with costs classification by program phase, forms of intervention and expenditure, and source of financing.

**Table 1: China - Hainan**

Year	2007	2008	2009	2010	2011	2012	2013	2014	Average Annual Cost: CLM	Average Annual Cost: Elimination	Average Annual Cost: POR
<b>Classification (Phase)</b>	CLM	CLM	CLM	Elimination	Elimination	Elimination	Elimination	Elimination			
<b>Intervention</b>											
Prevention (% of total)	24%	29%	37%	35%	38%	35%	36%	33%	30%	35%	
Total	\$465,893	\$470,372	\$509,467	\$1,795,755	\$1,594,396	\$1,598,377	\$1,388,183	\$1,313,459	\$481,911	\$1,538,034	
Treatment and Prophylaxis (% of total)	13%	13%	12%	8%	5%	4%	2%	1%	13%	4%	
Total	\$254,713	\$204,868	\$170,573	\$410,277	\$191,715	\$180,259	\$79,052	\$56,014	\$210,051	\$183,463	
Diagnosis (% of total)	18%	8%	4%	8%	6%	8%	6%	5%	10%	7%	
Total	\$338,311	\$126,441	\$56,801	\$401,187	\$244,516	\$346,691	\$246,738	\$205,586	\$173,851	\$288,944	
Surveillance (% of total)	8%	13%	13%	15%	15%	12%	14%	14%	11%	14%	
Total	\$159,244	\$205,992	\$179,334	\$752,990	\$642,879	\$566,684	\$549,995	\$571,427	\$181,523	\$616,795	
IEC (% of total)	10%	12%	4%	7%	8%	9%	11%	11%	9%	9%	
Total	\$197,040	\$184,154	\$51,730	\$354,427	\$343,290	\$408,848	\$422,476	\$432,840	\$144,308	\$392,376	
Program Management (% of total)	27%	26%	29%	28%	29%	33%	31%	35%	27%	31%	
Total	\$510,523	\$408,069	\$401,196	\$1,436,736	\$1,202,632	\$1,505,871	\$1,185,633	\$1,400,979	\$439,929	\$1,346,370	
<b>Grand Total</b>	\$1,925,724	\$1,599,894	\$1,369,101	\$5,151,372	\$4,219,427	\$4,606,731	\$3,872,077	\$3,980,306	\$1,631,573	\$4,365,983	
<b>Grand Total per Capita</b>	\$0.23	\$0.19	\$0.16	\$0.59	\$0.48	\$0.52	\$0.44	\$0.45	\$0.19	\$0.50	
<b>Grand Total per Capita At Risk</b>	\$0.23	\$0.19	\$0.16	\$0.61	\$0.49	\$0.54	\$0.45	\$0.46	\$0.20	\$0.51	
<b>Expenditure Breakdown</b>											
Personnel (%)	54%	63%	70%	64%	72%	67%	76%	73%			
Consumables (%)	34%	26%	17%	18%	18%	16%	16%	18%			
Equipment (%)	0%	0%	1%	4%	2%	2%	2%	2%			
Travel (%)	4%	3%	3%	7%	2%	8%	2%	2%			
Training (%)	6%	5%	5%	6%	5%	6%	4%	5%			
Other (%)	1%	3%	4%	1%	1%	1%	0%	0%			
<b>Financing Source</b>											
Domestic	47%	55%	7%	60%	66%	62%	67%	67%			
External	53%	44%	93%	40%	34%	38%	33%	33%			
<b>Population</b>											
Estimated population	8,450,000	8,505,348	8,640,000	8,696,592	8,753,555	8,810,890	8,868,602	8,926,691			



**Table 2: China – Jiangsu**

Year	2007	2008	2009	2010	2011	2012	2013	2014	Average Annual Cost: CLM	Average Annual Cost: Elimination	Average Annual Cost: POR
<b>Classification (Phase)</b>	CLM	CLM	CLM	Elimination	Elimination	Elimination	Elimination	Elimination			
<b>Intervention</b>											
Prevention (% of total)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Treatment and Prophylaxis (% of total)	16%	14%	12%	8%	6%	4%	2%	1%	14%	4%	1%
Total	\$1,343,873	\$1,145,421	\$1,030,657	\$1,412,165	\$973,569	\$700,902	\$266,627	\$115,319	\$1,173,317	\$693,717	\$115,319
Diagnosis (% of total)	7%	6%	6%	9%	7%	8%	5%	5%	6%	7%	5%
Total	\$581,742	\$503,361	\$468,060	\$1,569,725	\$1,135,390	\$1,358,403	\$849,194	\$703,362	\$517,721	\$1,123,215	\$703,362
Surveillance (% of total)	27%	29%	31%	30%	36%	34%	37%	41%	29%	36%	41%
Total	\$2,373,310	\$2,381,030	\$2,650,898	\$5,180,798	\$6,011,670	\$6,079,856	\$5,816,536	\$6,346,381	\$2,468,413	\$5,887,048	\$6,346,381
IEC (% of total)	16%	17%	18%	13%	13%	13%	15%	13%	17%	14%	13%
Total	\$1,350,632	\$1,407,964	\$1,515,982	\$2,282,394	\$2,096,234	\$2,396,808	\$2,338,274	\$2,105,334	\$1,424,859	\$2,243,808	\$2,105,334
Program Management (% of total)	35%	35%	33%	40%	38%	41%	41%	41%	34%	40%	41%
Total	\$3,013,338	\$2,871,538	\$2,776,744	\$6,929,245	\$6,329,271	\$7,302,871	\$6,355,687	\$6,349,107	\$2,887,207	\$6,653,236	\$6,349,107
<b>Grand Total</b>	\$8,662,894	\$8,309,314	\$8,442,341	\$17,374,327	\$16,546,134	\$17,838,839	\$15,626,317	\$15,619,502	\$8,471,516	\$16,601,024	\$15,619,502
<b>Grand Total per Capita</b>	\$0.11	\$0.11	\$0.11	\$0.22	\$0.21	\$0.23	\$0.20	\$0.20	\$0.11	\$0.21	\$0.20
<b>Grand Total per Capita At Risk</b>	\$0.15	\$0.14	\$0.15	\$0.30	\$0.28	\$0.30	\$0.26	\$0.26	\$0.15	\$0.28	\$0.26
<b>Expenditure Breakdown</b>											
Personnel (%)	92%	93%	92%	85%	91%	84%	91%	91%			
Consumables (%)	3%	2%	3%	2%	2%	2%	2%	2%			
Equipment (%)	0%	0%	0%	1%	2%	2%	2%	2%			
Travel (%)	0%	0%	1%	8%	2%	8%	1%	1%			
Training (%)	1%	1%	1%	4%	3%	4%	3%	3%			
Other (%)	3%	3%	3%	0%	0%	1%	0%	0%			
<b>Financing Source</b>											
Domestic	97%	98%	97%	86%	88%	88%	90%	90%			
External	16%	11%	16%	14%	12%	12%	10%	10%			
<b>Population</b>											
Estimated population	76,250,000	76,700,000	77,245,000	77,750,955	78,260,224	78,772,828	79,288,790	79,808,132			
Estimated population at risk	57,371,351	57,747,133	58,120,000	58,500,686	58,883,865	59,269,555	59,657,770	60,048,529			

**Table 3: Mauritius**

	1983	1984	1985	1986	1987	1988	1990	2008	Average Annual Cost: CLM	Average Annual Cost: Elimination	Average Annual Cost: POR
<b>Year</b>											
<b>Classification (Phase)</b>	Elimination	Elimination	Elimination	Elimination	Elimination	Elimination	POR	POR			
<b>Intervention</b>											
Prevention (% of total)	<b>59%</b>	<b>60%</b>	<b>61%</b>	<b>60%</b>	<b>57%</b>	<b>57%</b>	<b>48%</b>	<b>31%</b>		<b>59%</b>	<b>40%</b>
Total	\$3,058,135	\$2,980,329	\$2,892,255	\$2,643,235	\$2,072,242	\$1,845,044	\$1,440,186	\$791,584	NA	\$2,581,873	\$1,115,885
Treatment and Prophylaxis (% of total)	<b>4%</b>	<b>4%</b>	<b>4%</b>	<b>4%</b>	<b>4%</b>	<b>4%</b>	<b>3%</b>	<b>5%</b>	NA	✓ \$178,336	\$116,466
Total	\$202,623	\$187,542	\$207,814	\$192,727	\$147,152	\$132,156	\$101,413	\$131,519	NA	✓ \$97,170	\$92,160
Diagnosis (% of total)	<b>3%</b>	<b>2%</b>	<b>2%</b>	<b>2%</b>	<b>2%</b>	<b>2%</b>	<b>2%</b>	<b>4%</b>	NA	✓ \$1,162,181	\$966,401
Total	\$153,409	\$102,903	\$95,188	\$84,618	\$77,394	\$69,507	\$70,779	\$113,541	NA	✓ \$141,385	\$57,761
Surveillance (% of total)	<b>27%</b>	<b>26%</b>	<b>25%</b>	<b>26%</b>	<b>28%</b>	<b>28%</b>	<b>29%</b>	<b>42%</b>	NA	✓ \$195,113	\$422,703
Total	\$1,383,048	\$1,303,859	\$1,214,161	\$1,122,067	\$1,027,319	\$922,630	\$854,115	\$1,078,687	NA	✓ \$4,356,058	\$2,771,375
IEC (% of total)	<b>3%</b>	<b>3%</b>	<b>3%</b>	<b>3%</b>	<b>3%</b>	<b>3%</b>	<b>3%</b>	<b>1%</b>	NA	✓ \$4.28	\$2.42
Total	\$171,230	\$158,486	\$146,603	\$135,960	\$124,353	\$111,681	\$96,268	\$19,254	NA	✓ \$4.28	\$2.42
Program Management (% of total)	<b>4%</b>	<b>4%</b>	<b>4%</b>	<b>4%</b>	<b>5%</b>	<b>5%</b>	<b>14%</b>	<b>17%</b>	NA	✓ \$4.28	\$2.42
Total	\$227,234	\$210,321	\$207,891	\$192,432	\$175,335	\$157,467	\$414,452	\$430,954	NA	✓ \$4.28	\$2.42
<b>Grand Total</b>	\$5,195,680	\$4,943,440	\$4,763,912	\$4,371,040	\$3,623,794	\$3,238,484	\$2,977,213	\$2,565,537	NA	✓ \$4,356,058	\$2,771,375
<b>Grand Total per Capita</b>	\$5.19	\$4.90	\$4.69	\$4.27	\$3.51	\$3.11	\$2.82	\$2.02	NA	✓ \$4.28	\$2.42
<b>Grand Total per Capita At Risk</b>	\$5.19	\$4.90	\$4.69	\$4.27	\$3.51	\$3.11	\$2.82	\$2.02	NA	✓ \$4.28	\$2.42
<b>Expenditure Breakdown</b>											
Personnel (%)	89%	88%	87%	85%	88%	88%	92%	88%			
Consumables (%)	10%	10%	10%	10%	8%	8%	5%	8%			
Equipment (%)	1%	2%	3%	3%	3%	3%	3%	3%			
Travel (%)	0%	0%	0%	1%	0%	0%	0%	0%			
Training (%)	0%	0%	0%	1%	0%	0%	0%	1%			
Other (%)	0%	0%	0%	0%	0%	0%	0%	0%			
<b>Financing Source</b>											
Domestic	100%	100%	97.9%	94.6%	98%	98%	98.3%	99.8%			
External	0%	0%	2.1%	5.4%	2%	2%	1.7%	0.2%			
<b>Population</b>											
Estimated population	1,000,804	1,009,233	1,016,000	1,024,680	1,032,760	1,040,841	1,057,000	1,268,835			
Estimated population at risk	1,000,804	1,009,233	1,016,000	1,024,680	1,032,760	1,040,841	1,057,000	1,268,835			

**Table 4: Swaziland**

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average Annual Cost: CLM	Average Annual Cost: Elimination	Average Annual Cost: POR
<b>Classification (Phase)</b>	CLM	CLM	CLM	CLM	CLM	Elimination	Elimination	Elimination	Elimination	Elimination			
<b>Intervention</b>													
Prevention (% of total)	45%	36%	37%	35%	37%	28%	26%	25%	26%	26%	38%	26%	
<i>Total</i>	\$454,698	\$306,103	\$381,065	\$334,394	\$405,651	\$789,969	\$789,969	\$779,263	\$789,969	\$789,969	\$376,382	\$787,828	
Treatment and Prophylaxis (% of total)	7%	3%	7%	3%	4%	2%	2%	2%	2%	2%	5%	2%	
<i>Total</i>	\$66,711	\$23,124	\$72,665	\$24,533	\$44,354	\$65,389	\$65,459	\$65,459	\$65,459	\$65,459	\$46,277	\$65,445	
Diagnosis (% of total)	8%	10%	8%	9%	8%	16%	13%	14%	13%	14%	9%	14%	
<i>Total</i>	\$79,774	\$82,437	\$85,125	\$87,561	\$89,439	\$434,260	\$397,063	\$436,760	\$397,063	\$436,760	\$84,867	\$420,381	
Surveillance (% of total)	6%	9%	7%	8%	12%	18%	26%	24%	25%	24%	8%	23%	
<i>Total</i>	\$56,388	\$76,869	\$77,041	\$77,000	\$131,583	\$494,901	\$768,153	\$739,152	\$751,556	\$737,035	\$83,776	\$698,160	
IEC (% of total)	3%	4%	3%	3%	3%	12%	10%	11%	10%	11%	3%	11%	
<i>Total</i>	\$29,812	\$30,807	\$31,811	\$32,721	\$33,423	\$326,472	\$312,931	\$331,531	\$306,131	\$330,131	\$31,715	\$321,439	
Program Management (% of total)	32%	39%	38%	41%	36%	24%	22%	23%	23%	23%	37%	23%	
<i>Total</i>	\$319,265	\$329,519	\$389,043	\$390,575	\$390,914	\$676,432	\$674,100	\$706,017	\$674,100	\$721,302	\$363,863	\$690,390	
<b>Grand Total</b>	\$1,006,648	\$848,857	\$1,036,752	\$946,783	\$1,095,364	\$2,787,424	\$3,007,676	\$3,058,184	\$2,984,279	\$3,080,658	\$986,881	\$2,983,644	
<b>Grand Total per Capita</b>	\$0.90	\$0.75	\$0.91	\$0.82	\$0.94	\$2.35	\$2.50	\$2.51	\$2.41	\$2.46	\$0.87	\$2.44	
<b>Grand Total per Capita At Risk</b>	\$4.70	\$3.93	\$4.74	\$4.28	\$4.88	\$12.23	\$13.01	\$13.04	\$12.55	\$12.77	\$4.50	\$12.72	
<b>Expenditure Breakdown</b>													
Personnel (%)	38%	43%	40%	43%	37%	26%	27%	25%	26%	25%			
Consumables (%)	37%	29%	34%	28%	36%	34%	31%	31%	31%	31%			
Equipment (%)	3%	5%	5%	7%	7%	9%	17%	17%	17%	17%			
Travel (%)	3%	1%	2%	1%	1%	9%	8%	8%	8%	7%			
Training (%)	15%	18%	16%	18%	16%	9%	8%	9%	8%	9%			
Other (%)	3%	4%	3%	4%	3%	13%	9%	11%	9%	11%			
<b>Financing Source</b>													
Domestic	63%	77%	65%	73%	65%	31%	28%	28%	29%	28%			
External	37%	23%	35%	27%	35%	69%	72%	72%	71%	72%			
<b>Population</b>													
Estimated population	1,115,005	1,124,410	1,136,712	1,151,399	1,167,834	1,186,000	1,202,841	1,219,922	1,237,244	1,254,813			
Estimated population at risk	214,352	216,160	218,525	221,348	224,508	228,000	231,238	234,521	237,851	241,229			

**Table 5: Tanzania – Zanzibar**

Zanzibar																	Average Annual Cost: CLM	Average Annual Cost: Elimination	Average Annual Cost: POR		
Year	2009	2010	2011	2012	2013	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019						
Classification (Phase)	CLM	CLM	CLM	CLM	CLM	Elimination	Elimination	Elimination	Elimination	Elimination	Elimination	Elimination	Elimination	Elimination	Elimination						
<b>Intervention</b>																					
Prevention (% of total)	53%	53%	49%	54%	51%	44%	44%	44%	46%	45%	45%	47%	47%	47%	49%						
Total	\$2,058,860	\$2,042,580	\$2,028,293	\$2,018,759	\$2,010,499	\$2,161,620	\$2,161,620	\$2,161,620	\$2,365,575	\$2,365,575	\$2,365,575	\$2,588,775	\$2,588,775	\$2,588,775	\$2,833,034						
Treatment and Prophylaxis (% of total)	4%	5%	4%	4%	5%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%						
Total	\$167,421	\$189,753	\$167,595	\$159,802	\$182,022	\$92,466	\$95,287	\$98,195	\$101,191	\$104,278	\$107,460	\$110,738	\$114,117	\$117,599	\$121,187						
Diagnosis (% of total)	14%	10%	12%	13%	14%	13%	14%	14%	14%	14%	14%	14%	15%	15%	15%						
Total	\$539,072	\$394,627	\$482,172	\$488,121	\$552,304	\$649,354	\$669,166	\$689,583	\$710,622	\$732,304	\$754,647	\$777,672	\$801,399	\$825,850	\$851,048						
Surveillance (% of total)	16%	17%	15%	15%	19%	23%	23%	23%	22%	22%	22%	21%	20%	20%	19%						
Total	\$635,273	\$651,195	\$715,567	\$552,238	\$751,436	\$1,126,820	\$1,126,820	\$1,126,820	\$1,126,820	\$1,126,820	\$1,126,820	\$1,126,820	\$1,126,820	\$1,126,820	\$1,126,820						
IEC (% of total)	5%	5%	5%	5%	5%	4%	4%	4%	4%	4%	4%	4%	4%	4%	3%						
Total	\$210,515	\$181,149	\$205,592	\$205,592	\$205,592	\$201,688	\$201,688	\$201,688	\$201,688	\$201,688	\$201,688	\$201,688	\$201,688	\$201,688	\$201,688						
Program Management (% of total)	6%	10%	13%	8%	7%	14%	14%	14%	13%	13%	13%	12%	12%	12%	12%						
Total	\$241,648	\$384,144	\$539,028	\$317,803	\$259,541	\$679,083	\$679,083	\$679,083	\$679,083	\$679,083	\$679,083	\$679,083	\$679,083	\$679,083	\$679,083						
<b>Grand Total</b>	<b>\$3,852,790</b>	<b>\$3,843,447</b>	<b>\$4,138,248</b>	<b>\$3,742,316</b>	<b>\$3,961,394</b>	<b>\$4,911,031</b>	<b>\$4,933,665</b>	<b>\$4,956,989</b>	<b>\$5,184,980</b>	<b>\$5,209,749</b>	<b>\$5,235,273</b>	<b>\$5,484,776</b>	<b>\$5,511,882</b>	<b>\$5,539,815</b>	<b>\$5,812,859</b>						
<b>Grand Total per Capita</b>	<b>\$3.15</b>	<b>\$3.05</b>	<b>\$3.19</b>	<b>\$2.80</b>	<b>\$2.88</b>	<b>\$3.90</b>	<b>\$3.80</b>	<b>\$3.71</b>	<b>\$3.76</b>	<b>\$3.67</b>	<b>\$3.58</b>	<b>\$3.64</b>	<b>\$3.55</b>	<b>\$3.46</b>	<b>\$3.52</b>						
<b>Grand Total per Capita At Risk</b>	<b>\$3.15</b>	<b>\$3.05</b>	<b>\$3.19</b>	<b>\$2.80</b>	<b>\$2.88</b>	<b>\$3.90</b>	<b>\$3.80</b>	<b>\$3.71</b>	<b>\$3.76</b>	<b>\$3.67</b>	<b>\$3.58</b>	<b>\$3.64</b>	<b>\$3.55</b>	<b>\$3.46</b>	<b>\$3.52</b>						
<b>Expenditure Breakdown</b>																					
Personnel (%)	20%	20%	22%	20%	21%	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*						
Consumables (%)	62%	62%	60%	64%	61%	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*						
Equipment (%)	4%	4%	4%	4%	4%	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*						
Travel (%)	7%	7%	6%	6%	7%	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*						
Training (%)	5%	5%	5%	5%	5%	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*						
Other (%)	2%	1%	2%	1%	1%	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*						
<b>Financing Source</b>																					
Domestic	2%	2%	2%	3%	2%	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*						
External	98%	98%	98%	97%	98%	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*						
<b>Population</b>																					
Estimated population	1,221,218	1,258,478	1,296,875	1,336,444	1,377,219	1,258,478	1,296,875	1,336,444	1,377,219	1,419,239	1,462,541	1,507,164	1,553,149	1,600,536	1,649,370						
Estimated population at risk	1,221,218	1,258,478	1,296,875	1,336,444	1,377,219	1,258,478	1,296,875	1,336,444	1,377,219	1,419,239	1,462,541	1,507,164	1,553,149	1,600,536	1,649,370						

NOTE: Estimated CLM costs derived from prospective national budgets for 2009-2014. Shaded area represents years during which elimination was assumed to have begun but were included in analysis of CLM costs. \*Relevant data to calculate these ratios was not generated by modeling exercise

**Table 6: China – Malaria-free Provinces (Fujian, Hebei, Shanxi)**

Year	Fujian		Hebei		Shanxi	
	2009*	Average Annual Cost: POR	2009*	Average Annual Cost: POR	2009*	Average Annual Cost: POR
<b>Classification (Phase)</b>	POR		POR		POR	
<b>Intervention</b>						
Prevention (% of total)	0%	0%	0%	0%	0%	0%
Total	\$0	\$0	\$0	\$0	\$0	\$0
Treatment and Prophylaxis (% of total)	12%	12%	13%	13%	13%	13%
Total	\$508,215	\$508,215	\$1,052,410	\$1,052,410	\$692,950	\$692,950
Diagnosis (% of total)	4%	4%	4%	4%	4%	4%
Total	\$179,560	\$179,560	\$362,080	\$362,080	\$228,120	\$228,120
Surveillance (% of total)	35%	35%	34%	34%	35%	35%
Total	\$1,486,040	\$1,486,040	\$2,716,680	\$2,716,680	\$1,891,700	\$1,891,700
IEC (% of total)	10%	10%	10%	10%	10%	10%
Total	\$414,210	\$414,210	\$825,480	\$825,480	\$530,820	\$530,820
Program Management (% of total)	38%	38%	39%	39%	38%	38%
Total	\$1,600,370	\$1,600,370	\$3,150,380	\$3,150,380	\$2,068,080	\$2,068,080
<b>Grand Total</b>	\$4,188,395	\$4,188,395	\$8,107,030	\$8,107,030	\$5,411,670	\$5,411,670
<b>Grand Total per Capita</b>	\$0.09	\$0.09	\$0.12	\$0.12	\$0.16	\$0.16
<b>Grand Total per Capita At Risk</b>	\$0.09	\$0.09	\$0.12	\$0.12	\$0.16	\$0.16
<b>Expenditure Breakdown</b>						
Personnel (%)	73%		75%		72%	
Consumables (%)	0%		0%		0%	
Equipment (%)	8%		6%		8%	
Travel (%)	14%		14%		15%	
Training (%)	5%		5%		5%	
Other (%)	0%		0%		0%	
<b>Financing Source</b>						
Domestic	100%		100%		100%	
External	0%		0%		0%	
<b>Population</b>						
Estimated population	44,096,500		69,890,000		34,110,000	
Estimated population at risk	44,096,500		69,890,000		34,110,000	

\* Costs are consistent with 2007 and 2008

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