

## Annex G

### **Data Sources, Assumptions and Logic used to Model PSI's contribution to ARC in Eastern Myanmar**

PSI has modeled the interactions of numerous variables in order to estimate the scale, cost and impact of the proposed intervention. This annex sets out the logic of the model, showing how secondary variables are derived from primary data. It will reference the source data used in assigning a value to each primary variable, and describe the level of uncertainty in each by comparing alternative sources.

PSI has based key assumptions on data presented in the Draft Strategic Framework for Artemisinin Resistance Containment in Myanmar (MARC) 2011-2015 (14<sup>th</sup> January 2011.) Where possible, we have based other data on peer-reviewed literature. However, we recognize a significant level of uncertainty in many data. In order to mitigate the inherent risk, we have attempted to keep most assumptions conservative. We will also describe attempts to triangulate different information to reduce uncertainty.

PSI fully recognizes the lack of certainty inherent in this model. This is essentially an illustrative exercise, and only as the program rolls out will we be able to build confidence in our assumption. PSI is committed to gathering detailed baseline and monitoring data, following ACT Watch methodologies, in addition to routine programmatic monitoring. These data will be routinely shared with stakeholders and regular formal consultations will shape the program as it develops.

#### **Part 1 – Baseline**

##### **1) National Incidence**

The MARC uses an estimate of 4,559,000 cases of malaria in Myanmar in 2010. This figure is extrapolated from an estimate of 4,209,000 in 2006 based on an assumed 2% annual increase in incidence. The 4,209,000 is a median between reported formal treatments in 2006 and the World Health Organization's MERG Report<sup>1</sup> estimate of malaria incidence of 8,600,000 cases. Both values used to generate the median have a high degree of uncertainty.

##### **2) Target Area**

Reduced parasite clearance rates have been documented on both the Thai border east of Yangon<sup>2</sup> and far to the north on the Chinese border of Kachin State<sup>3</sup>. The latter is considered insufficiently robust

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<sup>1</sup>[https://www.who.int/malaria/publications/atoz/incidence\\_estimations2.pdf](https://www.who.int/malaria/publications/atoz/incidence_estimations2.pdf), (accessed August 2010.)

<sup>2</sup> See various references in "Draft Strategic Framework for Artemisinin Resistance Containment in Myanmar (MARC) 2011-2015", WHO, Version 14th January 2011

<sup>3</sup> Frank Smithuis, Moe Kyaw Kyaw, Ohn Phe, Thein Win, Pyay Phyoo Aung, Aung Pyay Phyoo Oo, Arkar Linn Naing, Mya Yee Nyo, Naing Zaw Htun Myint, Mallika Imwong, Elizabeth Ashley, Sue J Lee, Nicholas J. White. *An open randomized comparison of the effectiveness of five artemisinin combination regimens with or without primaquine in uncomplicated falciparum malaria*. The Lancet Infectious Diseases, Early Online Publication, 9 September 2010

for inclusion as a priority Zone 1 in the current draft MARC, but combined with other indicators<sup>4</sup>, is certainly cause for concern. For this program, PSI has defined a target area along the full eastern border of Myanmar, covering the majority of highly endemic townships and a population of 10,724,465 (see Annex E).

Evidence of malaria incidence in Myanmar is limited to studies in Rakhine state to the west, and amongst 'displaced' populations close to the Thai border in the East<sup>5</sup>. The latter reports an incidence of Pf of 232 cases per thousand per annum, declining to less than 100 cases following intensive control efforts. WHO's "Malaria Incidence Estimates at Country Level for the Year 2004"<sup>6</sup> gives a national incidence rate of 170 per 1,000 population per annum, significantly in excess of the current MARC estimates (equivalent to 73 per 1,000). In the absence of more evidence, PSI has used an estimate of 200 cases of malaria per 1,000 population per year in the (highly endemic) Target areas.

Multiplying incidence by target population gives an estimate of approximately 2 million (2,144,893) total malaria cases within the target townships per year, or a little under half (47%) of estimated national incidence.

### **3) Treatment seeking**

The MARC estimates that 42% of those tested for malaria test positive. This matches PSI data from our Sun Primary Health (SPH) Village Health Workers (VHWs), and is close to our Sun Quality Health (SQH) clinic data (44% positive.)

This proportion is used as a proxy for all treatment seeking; it is assumed that the proportion of patients seeking treatment from an informal drug seller who do actually have malaria will be similar to the proportion who seek treatment from a trained VHW. It is recognized that a more accessible informal provider may be the first port of call for malaria treatment, and therefore see a lower proportion of positives, but this is balanced against more effective geographical targeting. (VHWs data generally from low endemicity areas, where the proportion of fevers caused by malaria may be lower than in target areas.)

It is therefore estimated that, for approximately 2 million (2,144,893) malaria cases in the Target area, approximately 5 million (5,106,888) people will seek care.

### **4) Formal Treatment**

Testing and treatment using ACTs through trained providers is well documented, but makes up a fraction of total malaria treatment in Myanmar. VBDC reported 590,000 cases nationally in 2009<sup>7</sup>, to which NGOs (supported mainly by 3DF) add approximately 350,000 cases<sup>8</sup>.

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<sup>4</sup> Zhaoqing Yang et al, Multidrug-resistant genotypes of *Plasmodium falciparum*, Myanmar. *Emerging Infectious Diseases*, vol 17, No 3, March 2011.

<sup>5</sup> Cross-border malaria control for internally displaced persons: observational results from a pilot programme in eastern Burma/Myanmar Richards et al, *Tropical Medicine and International Health*, volume 14, no 5 pp 512–521 May 2009

<sup>6</sup> World Health Organisation, MERG Report, [www.who.int/malaria/publications/atoz/incidence\\_estimations2.pdf](http://www.who.int/malaria/publications/atoz/incidence_estimations2.pdf), (accessed August 2010)

<sup>7</sup> VBDC Program Annual data, quoted in Myanmar GFATM Round 9 proposal

<sup>8</sup> 3DF Annual Report 2009 gives 427,000 treatments, of which approximately 70,000 are managed through the public sector.

## 5) Treatment in the Private Sector

Private sector treatment, whilst probably the norm in most of Myanmar, is poorly documented. Its scale is hard to quantify.

PSI's rapid supply chain analysis on the Thai border (see Annex J) estimated that 70 – 80% of the private sector market for anti-malarials is held by AA Pharmacies' front line mono-therapy 'AA Artesunate.' A very similar pattern has since been found in a second analysis covering the northern Shan and Kachin States on the China border (Rapid Assessment 2, draft report 24<sup>th</sup> April 2011).

AA's own sales data give average sales of 75,000 strips of 12 tablets per month. AA also estimates that it supplies 70% of the private sector market, which would suggest total annual sales of all monotherapy are approximately 1.3 million strips (1,285,714.) This triangulates reasonably well with FDA import data (estimated 1.6 million strips), although the latter is unfortunately not easily converted into appropriate units<sup>9</sup>.

Interviews with front-line sellers of anti-malarials (Rapid Assessments 1 and 2<sup>10</sup>) support evidence from PSI's qualitative research in which patients suggest that these mono-therapies are typically sold in quantities of 2, 3 or 4 pills, often depending on ability to pay. A crude average of the data collected in Rapid Assessment 1 gives 3.35 treatments sold per strip of 12 tablets.

New evidence from Rapid Assessment 2 suggests that in the northern Shan / Kachin area, some malaria treatment is also dispensed in the form of a 'cocktail.' Drug 'cocktails' are a common approach to informal treatment in Myanmar in which a small plastic bag containing a variety of (often colorful) tablets is dispensed by an informal drug-seller based on a crude syndromic approach. In our survey, several cocktails sold for 'fever' in Kachin were found to contain 1 loose tablet of Artemether.

The average of 3.35 treatments per strip of 12 tablets does not take into account sales in more formal settings where a full course may be dispensed. It does not allow for patients who return (as apparently instructed) for more pills should fever not subside. Both these might result in an overestimate of the number of malaria suspects treated per strip. Conversely, the estimate does not allow for sales of 'cocktails' containing only one tablet of artemisinin monotherapy. For the purposes of this model, it is assumed that these are both relatively unusual, and that their effect balances.

Taking 3.35 treatments per strip suggests that artemisinin-containing tablets (mainly Artesunate) sufficient to treat approximately 4.6 million (4,605,542) malaria suspects are sold annually in Myanmar.

Of 4.6 million suspects seeking malaria treatment in the private sector, it is estimated that approximately 2.7 million (2,671,215) will have malaria (see Treatment Seeking, above.)

## 6) Treatment in the Target Area

Assuming an incidence of 200 cases per 1,000 population, in 2010 there were approximately 2.1 million (2,144,893) cases of all malaria in the target population of 10.7 million people. This represents 47% of national malaria incidence.

Two assumptions are necessary to apply this percentage to treatment in the Target area;

a) That the number of treatments dispensed is proportional to incidence ( and therefore if 47% of incidence is in the target area, we assume that 47% of treatment is in the target area)

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<sup>9</sup> Myanmar Survey Research "Medicine Import into Myanmar" 2007-2010

b) That the relative proportions of treatment through different channels is the same in the Target area as it is nationally.

These assumptions are unlikely to hold. In particular, accessibility issues would suggest that the private sector plays a relatively large role along the border, where few formal services exist. Nevertheless, there is currently no data from which to calculate this bias, and we have elected to maintain a conservative approach which likely overestimates the role of formal services.

Applying 47% of national treatment totals, therefore, in the Target area in 2010 approximately 400,000 (442,246, 21%) malaria cases were tested and treated formally through NGOs, franchised private clinics or the public sector. A further 900,000 (910,052, 42%) were treated with partial monotherapy in the informal private sector. And the remaining 800,000 cases (792,594, 37%) went without treatment.

## **Part 2 – Projections**

### **1) Incidence**

The MARC references the National Strategic Plan, which gives the “Estimated number of cases annually nationwide with intensified malaria control” declining by approximately 10% per annum from 2011. The NSP does not give specific conditions that need to be met to reach these targets, and we have not attempted to justify them in detail. However, the literature does contain examples of rapidly reduced incidence following intensified control efforts in the region<sup>11</sup>. We believe that these targets are reasonable (perhaps even conservative), providing the rapid replacement of partial monotherapy with complete ACT is successful. Complete ACT will reduce the risk of recrudescence, and combining ACT with a gametocidal dose of primaquine will reduce transmission directly.

This model therefore assumes that the reduction in incidence targeted in the NSP is achieved in the Target area.

### **2) Formal Treatment**

The GFATM Round 9 proposal plans to deliver an average of just under 1,000,000 treatments annually in the public sector (4,892,283 over 5 years) from 2011. A little under half of these treatments will be for non-Pf malaria with chloroquine (2,006,169 over 5 years.) A further 300,000 treatments per year are funded by GFATM through NGOs (1,457,308 over 5 years, of which 400,000 are chloroquine).

GFATM targets are national. GFATM insists on rapid access to all implementation sites, and so there may be a bias away from the Target populations, which are disproportionately difficult to access. However, it is assumed that this will be mitigated by increasing emphasis on resistance containment, and therefore that GFATM treatment numbers will be proportional to incidence (see assumptions under section 5 above.)

It is assumed that increases in treatment through GFATM to public sector programs will take place steadily over the next few years, reaching their 5 year average in the third year of the GFATM program.

The 3DF and 3MDG funds are expected to support approximately 190,000 treatments in 2011, rising to 300,000 treatments per annum from 2012. This additional treatment will take place in MARC targeted (Zone 1 and 2a) areas, and therefore within the Target Area for this proposal. Funding for 3DF is not currently committed, but there is a strong likelihood that it will be soon and 3DF has invited calls for proposals.

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<sup>11</sup> See, for example, “Prevalence of plasmodium falciparum in active conflict areas of eastern Burma: a summary of cross-sectional data” Richards et al, Conflict and Health 2007, 1:9, or evidence from the MSF(H) program in Rakhine published by Smithuis et al.

### 3) Private Sector Mono-therapy Replacement

Replacing AA mono-therapies with ACT will take place quickly. PSI routinely imports large quantities of commodities (including approximately 30 million condoms per year) and allows a lead time of between 6 and 8 months. This will be sufficient to import and over-package ACTs.

AA pharma typically holds no more than a three month buffer in stock. AA will prioritize the Target areas as they switch from monotherapy to ACT (ACT will go first to Target areas, buffer stocks will be used in non-target areas.)

According to PSI's rapid supply chain analysis, intermediary actors (wholesalers, formal pharmacies) carry relatively small stocks and replenish regularly, as do village outlets.

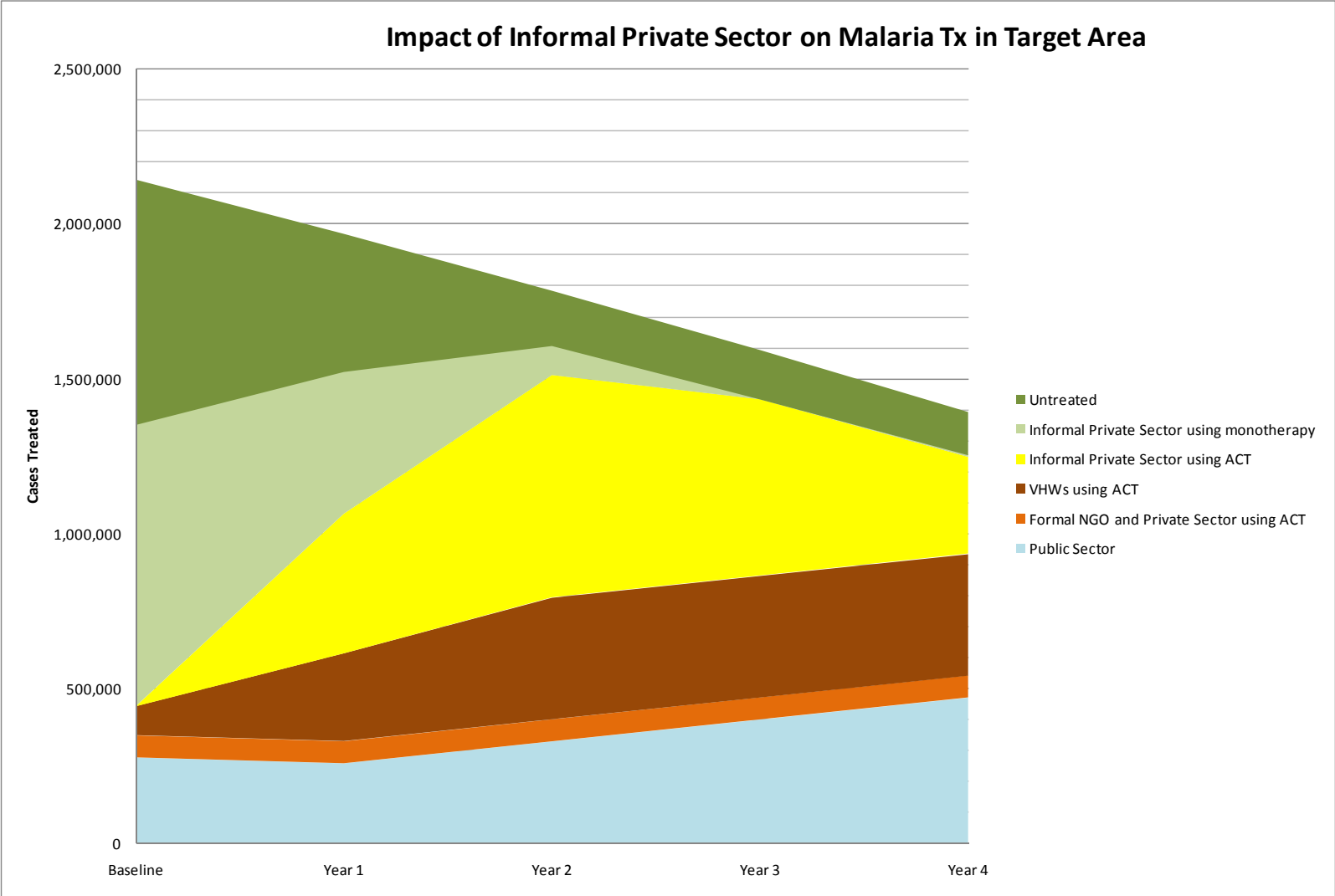
It is assumed, therefore, that branded ACTs through AA will be reaching the market within the first year of the project, and monotherapy will largely be replaced in year 2.

PSI expects, therefore, to sell 1.8 million (1,842,217) courses of ACT nationally in year 1, which will be used to treat approximately 450,000 malaria cases in the Target Area. This will increase rapidly in project year 2, doubling to more than 3.6 million (3,684,434) national sales treating more than 700,000 cases in the target area. As incidence comes down, and other interventions scale up, private sector sales will already be declining in year 3 (3,454,157 national sales, 568,672 malaria cases treated in the Target areas.)

### Summary Table

Malaria Cases in the Target Area;	Baseline	Year 1	Year 2	Year 3	Year 4
Untreated	792,595	446,148	178,615	159,445	139,428
<b>Treated by the Informal Private Sector using monotherapy</b>	<b>910,052</b>	<b>460,050</b>	<b>96,246</b>	<b>1,761</b>	<b>7,630</b>
<b>Treated by the Informal Private Sector using ACT</b>	<b>-</b>	<b>450,002</b>	<b>717,287</b>	<b>568,673</b>	<b>312,078</b>
Tested and Treated by the VHWs using ACT	94,095	284,095	394,095	394,095	394,095
Tested and Treated by the Formal NGO and Private Sector using ACT	70,571	70,571	70,571	70,571	70,571
Tested and Treated by Public Sector	277,580	188,190	235,237	282,285	329,332
Tested and Treated with Chloroquine by Public Sector	-	70,571	94,095	117,619	141,142
<b>Total</b>	<b>2,144,893</b>	<b>1,969,627</b>	<b>1,786,145</b>	<b>1,594,448</b>	<b>1,394,276</b>
Untreated	37%	23%	10%	10%	10%
<b>Treated by the Informal Private Sector using monotherapy</b>	<b>42%</b>	<b>23%</b>	<b>5%</b>	<b>0%</b>	<b>1%</b>
<b>Treated by the Informal Private Sector using ACT</b>	<b>0%</b>	<b>23%</b>	<b>40%</b>	<b>36%</b>	<b>22%</b>
Tested and Treated by the VHWs using ACT	4%	14%	22%	25%	28%
Tested and Treated by the Formal NGO and Private Sector using ACT	3%	4%	4%	4%	5%
Tested and Treated by Public Sector	13%	10%	13%	18%	24%
Tested and Treated with Chloroquine by Public Sector	0%	4%	5%	7%	10%
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

Part 3 - Putting it all together



**Baseline (year to June 2011).**

Public sector services complimented by some NGO VHWs, clinics and franchised clinics treat around 20% of cases in the Target area following national protocols of testing and full-course ACT. Double this number of cases are treated presumptively by the informal private sector with partial artemisinin containing monotherapy. Many cases remain untreated.

**Year 1 (year to June 2012)**

Scale up of NGO VHWs begins supported by 3DF, GFATM. By mid-year, subsidized ACTs begin quickly displacing mono-therapy in the informal private sector, reaching 40% cumulative sales by the end of year. Total private sector sales remain steady, but untreated cases begin to be squeezed out by increased availability of free treatment and extended NGO work.

**Year 2 (year to June 2013)**

Public sector scale up and continued NGO growth now treats 45% of all cases. Subsidized ACTs backed by behavioral change campaigns have almost completely displaced monotherapy from the informal private sector. Untreated cases reduced to 10% of the hardest to reach. Selection pressure for resistance controlled.

**Year 3 (year to June 2014)**

Public sector and NGO scale up continues, and this, together with declining incidence, begins squeezing out treatment without testing in the private sector. 10% of the hardest to reach remain untreated.

**Year 4 (year to June 2015)**

The private market for malaria treatment now reduced to approximately 20% of total cases treated, all providing full course ACT. People now seek treatment at formal services by default.