Malaria Elimination Task Force

Interim Report
February 2016

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All photos credit : *SMRU*
Font cover picture : *METF worker on her way to visit villagers in a remote area of Karen state.*
Back cover picture : *The Moei River in Karen state.*

Foreword

Malaria has plagued South East Asia for centuries and it remains an obstacle to development for the populations in rural Myanmar/Burma.

Progresses to control malaria have been made in recent years, with the support of many organisations and institutions but they are now under threat because of drug resistance and much remains to be done to free our people from this burden.

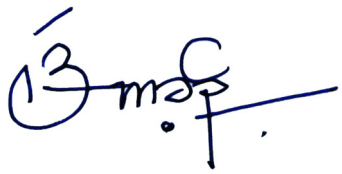
The Malaria Elimination Task Force was set up to respond to this challenge, with the ambitious goal to eliminate malaria in a large area of Karen state. It is a collaborative effort of Karen Community-Based Organisations (Karen Department of Health and Welfare, Mae Tao Clinic, Back Pack Health Workers Team, Burma Medical Association, Karen Border Guard Force, Karen Peace Council, Klohtoobaw Karen Organisation) and the Shoklo Malaria Research Unit as part of the Mahidol Oxford University Research Unit.

As Chairman of the Executive Committee of the Malaria Elimination Task Force, I am proud to present you this Interim Report describing the activities and the preliminary results of this very important programme.

The results presented here are very encouraging. They show that we are on the right tracks: our Karen people are strongly supportive and the health workers very dedicated. As a result the number of cases of malaria have plummeted.

We are grateful to the Global Fund, the Bill & Melinda Gates Foundation and the Wellcome Trust for their support.

As 2016 is starting, our country is entering a new chapter in its history and we are committed to contribute to a brighter future by eliminating malaria rapidly and definitively.



Saw Diamond Khin
Chairman
Malaria Elimination Task Force Executive Committee

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EXECUTIVE SUMMARY

The Malaria Elimination Task Force (METF) main objective is to develop and implement methods to eliminate malaria rapidly in Eastern Myanmar. The initial target is the elimination of artemisinin resistant falciparum malaria. METF started activities in May 2014 in four townships in eastern Myanmar (Karen/Kayin state). It is supported by the Global Fund Regional Artemisinin Initiative – Inter Country Component (GF-RAI-ICC) and the Bill & Melinda Gates Foundation (BMGF). METF operates under the governance of an Executive Committee (EC) representing all the health-related organisations in the area. EC members elect the Chairperson, and a Secretary calls meetings, liaises among the partners and keeps records. Other organisations involved in malaria elimination activities in other parts of Karen state are invited as observers to METF EC meetings.

The strategy of METF rests on seven pillars:

Mapping and geographic information system (page 13)

Knowing the terrain is essential so detailed and reliable mapping of villages is the first priority. Global Positioning System (GPS)-fed maps are the first layer of a comprehensive geographic information system (GIS) that also includes village names in all relevant languages (Burmese, Karen and English), the presence and nature of communication means, health facilities and basic demographic information. Maps are then used for the planning and monitoring of all subsequent activities.

Community engagement (page 14)

Disease elimination is not possible without the participation of the population. This malaria elimination programme requires a minimum understanding of the disease as well as support of the population for the proposed activities. Trust is at the heart of Community Engagement (CE), a complex and difficult process. METF has benefited from the help of social scientists but the activities are carried-out mainly by people from the affected communities who organise meetings first with the leaders then with the entire population.

Malaria posts (page 17)

The functioning and effective malaria post (MP) is key to *P. falciparum* elimination: the MP is a simple structure that provides free and uninterrupted access to reliable diagnosis and effective treatment for any fever cases from the community within 24-48 hours of onset. This implies that the MP is operated by a worker (MPW) from the village who is trained and supported continuously, and uses rapid diagnostic tests (RDTs) and administers treatment i.e. an artemisinin based combination therapy (ACT) correctly.

Picture 1: Malaria Post Worker at work.

Real-time data collection and reporting (page 18)

No battle can be fought without intelligence gathering and analysis. To achieve prompt elimination of *P. falciparum* malaria, intelligence in real-time is crucial to adapt and respond effectively to a rapidly changing front-line. Weekly data are needed to assess MP activities, responsiveness, supplies and impact. Regular mapping updates identify coverage gaps and changes in the communication networks. Extensive use of electronic communication makes this real-time data collection and sharing possible.

Submicroscopic malaria prevalence surveys (page 20)

There is now robust evidence that a substantial proportion of the population in endemic areas harbour malaria parasites without apparent illness. Identifying and treating these reservoirs is essential for the rapid elimination of *P. falciparum*. At present there is no indicator as to where these reservoirs may be, so villages are selected randomly and a small sample of adult villagers are asked to give a blood sample after consent has been obtained. These samples are processed in a central laboratory using a highly sensitive quantitative polymerase chain reaction (qPCR) assay. Villages with more than 40% positive samples (and 20% of the positives are *P. falciparum*) are called "hotspots". The main difficulties with these surveys are: the need of a venous sample, the time limit (48h) before processing and the cost (25 USD) per sample.

Mass drug administration (page 21)

Once a "hotspot" is identified, the most effective approach for elimination is mass drug administration (MDA). MDA has two objectives: to eliminate the reservoir of parasites rapidly and to provide protection against new infections for at least a month after each round of MDA. Studies conducted before the start of this programme have shown that the first objective can be achieved if ≥ 80% of the population receives one treatment course. Three-month protection is expected for individuals who receive 3 rounds of treatment at 1-month intervals. This level of participation can only be obtained if the MDA campaign is preceded by comprehensive and effective CE activities.

Picture 2: Villager taking a course of malaria drug during MDA

Entomology (page 21)

A good understanding of the vector population and its behaviour is important for malaria elimination. Detailed entomological studies were conducted prior to the start of the METF programme. They demonstrated that in this area low infectivity rates are compensated by a large number of mosquito vectors and that over 60% of infective bites are not preventable by impregnated nets. The studies have also revealed that the prevalence of submicroscopic infections closely correlates with infectivity of the mosquito vectors. As part of the METF programme, mosquito catching is conducted in "hotspot" villages before and after the MDA campaign. These surveys will guide vector control measures and confirm parasite elimination.

Mapping and geographic information system (page 23)

The current maps contain data from over 1,200 villages (circa 330,000 inhabitants) spanning a geographic range of 16,719 km^2 divided into 3 areas (from north to south: Area 1 = 6,747 km^2; Area 2 = 6,241 km^2; Area 3 = 3,731 km^2). There are important differences between the areas in terms of population density, communication infrastructure and occupations. The original geographic survey indicated that only 14% of villages in the project area had functioning MPs. This percentage has increased to >50 % of mapped villages (Figure 1).

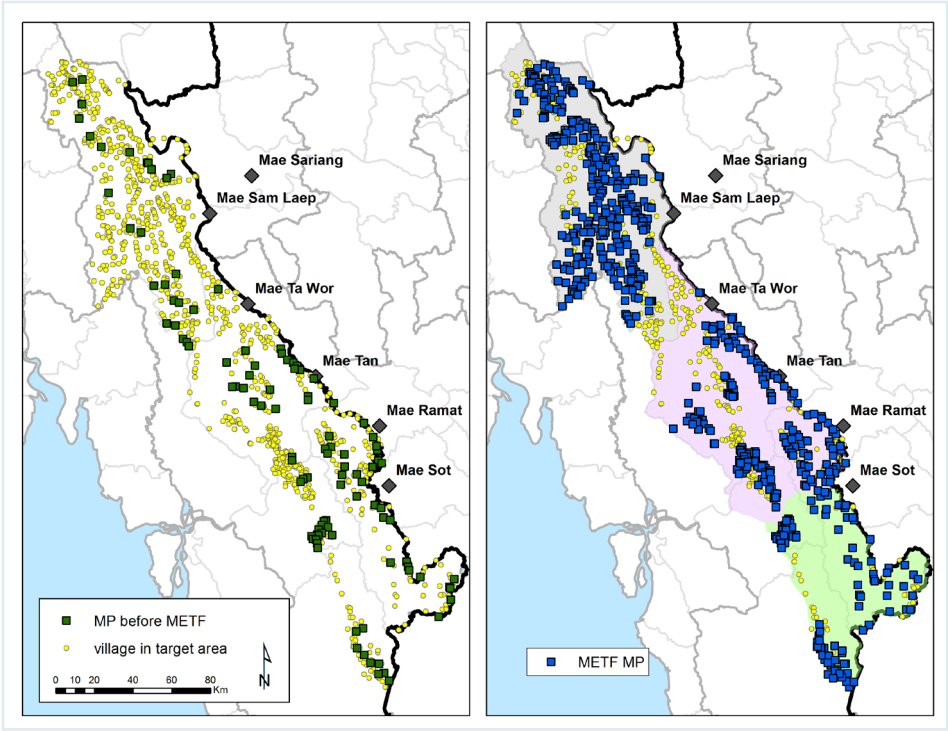


Figure 1: Map of functioning malaria posts before the METF project began (left panel) and current METF MPs (right panel). The baseline geographic survey indicated that only 14% of villages in the programme area had functioning malaria posts. This has now increased to over 50%.

Community engagement (page 24)

The CE team organised a large number of meetings and workshops. Activities were concentrated particularly in the villages selected for the submicroscopic prevalence surveys and in the "hotspot" villages treated with MDA. The most important determinant of the effectiveness of the elimination effort is probably the level of participation to MDA campaigns. Overall over 80% of village inhabitants received at least one round of MDA (i.e. one treatment course necessary for reservoir elimination). The proportion of participants who received the full 3 courses (needed for protection) was 63%. Other "softer" indicators of the positive impact of CE are: i) requests by some villages to be equipped with an MP, ii) demands to address *P. vivax* as well as *P. falciparum*, iii) an overall positive feedback from community leaders regarding the programme.

Malaria posts (page 25)

METF trained 983 MPWs, 86 MP supervisors, 36 Zone coordinators and opened 700 MPs. A total of 100,320 fever cases were seen by the MPWs and 101,767 RDTs were used. Overall RDT-positivity for malaria was 14.5%, and 14,589 malaria cases were treated (5,433 *P. falciparum* and 9,156 *P. vivax*). Four deaths related to malaria and 37 severe malaria cases were reported. The estimated incidence of *P. falciparum* declined by 78% in Area 1, 99% in Area 2 and 68% in Area 3. Similar declines were not seen for *P. vivax* and this resulted in significant changes in the PF/PV ratios that correlate with the time the MP has operated (Fighure 2). Preliminary results indicate that the incidence of *P. falciparum* has declined faster in the "hotspot" villages treated with MDA than in non-hotspot/non-treated villages.

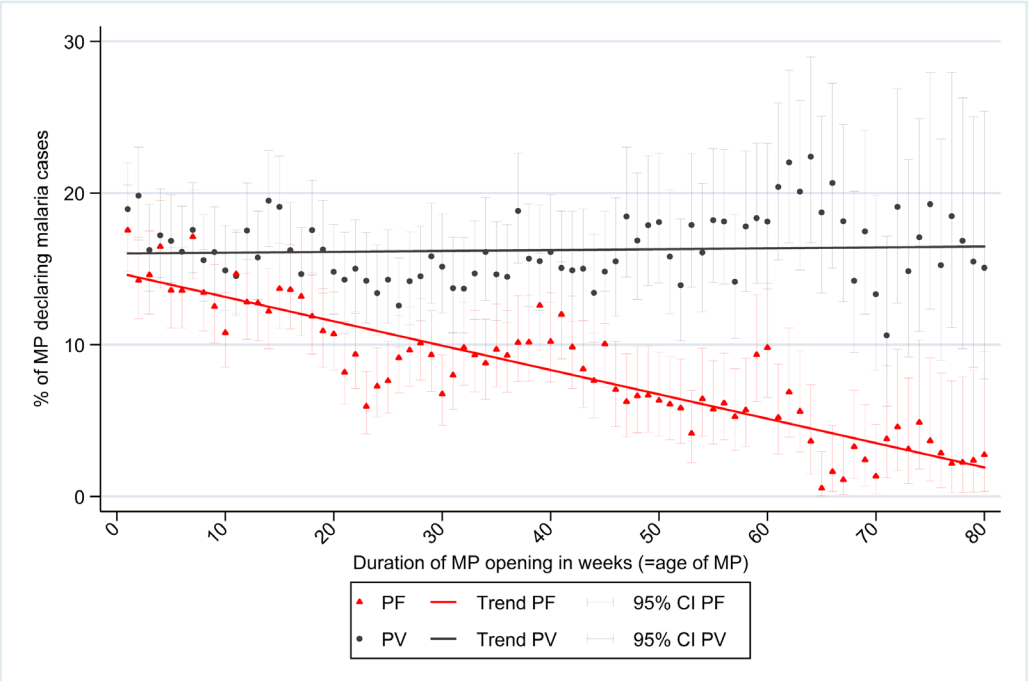


Figure 2: Probability of reporting malaria cases (vertical axis) by number of weeks since MP opening (horizontal axis). The crude trend was estimated by simple linear regression. The graph illustrates the differential impact on P. falciparum and P. vivax.

Real-time data collection and reporting (page 27)

Of the 700 MPs, 467 (67%) presented no gap in their data reporting while 171 (24%) had one or several one-week gaps. Only 62 MPs (9%) had reporting gaps of more than one week. Many of these delays resulted from transmission or entry errors. Across all data available the median (IQR) delay in data reporting was 8 (3-10) days but there was variation by method (i.e. paper versus electronic). Gradual introduction of smartphones resulted in a rapid reduction in delays: data transmitted by SMS were available after a median of 2 days (IQR=2-4 days), while data relying on porters (Area 1) were available after a median of 9 days (IQR=7-10). All data generated by MPs are available on a secured portal accessible to all stakeholders: National Malaria Programme, METF partners and donors.

Submicroscopic malaria prevalence surveys (page 27)

During the reporting period 190 surveys were completed and the results are available for 145 surveys. The prevalence of asymptomatic malaria was highly variable: from 0% to 35% for *P. falciparum* and 0% to 64% for *P. vivax*. Out of these 145 surveys, 30 villages meeting "hotspot" criteria were identified. Most of these villages were located in Area 1. Submicroscopic malaria "hotspots" tend to cluster spatially. The vast majority of malaria "hotspot" villages occur within 5 km of one-another and this pattern remains when examining *P. falciparum* or *P. vivax* independently

Mass drug administration (page 29)

MDA was conducted in 30 communities corresponding to the 30 "hotspots" detected during the surveys. The median proportion of villagers that received at least one round (i.e. a 3-day curative course of dihydroartemisinin/piperaquine (DP)) was high: 92% (IQR=89-94%). The corresponding figure for the 3 rounds of MDA (complete coverage) was 63% (IQR=58-72). The difference between these proportions is explained by the population stability, estimated by the proportion of the population present in the village during the 3 months of the MDA campaign. This stability was lower in Area 2 and 3 (median 68%) compared to Area 1 (median 85%). Most importantly no severe adverse events were recorded following MDA. The main reasons for not participating were refusal (55% of non-participants), being away (27% of non-participants) and not meeting inclusion criteria (10%).

Conclusion

The METF programme provides a comprehensive and effective approach to malaria elimination and is the largest implemented so far. The METF is embedded in the affected community. It is evidence based, reactive, adaptable and responsive. After 18 months of operation it now covers 700 villages in hard-to-reach areas of the eastern Karen state mostly under the control of non-state actors. The success of the programme derives from a deep knowledge of the population and robust evidence gathered over 30 years of malaria research in the area. The impact on *P. falciparum* has been spectacular with a sharp reduction in the number of new clinical cases of falciparum malaria. This is attributed to the deployment and continued support of effective MPs and the rapid elimination of sub-microscopic infections by MDA. Continued success will depend on completing coverage of all villages in the area and the sustained efficacy of the drugs used. The objective for the next 6 months is to achieve complete coverage and then assess the impact during the 2016 rainy season. Later, elimination of *P. vivax* malaria will provide substantial additional health benefits and critically will sustain the surveillance necessary to maintain elimination of *P. falciparum*. This project is designed to generate crucial information on the feasibility of *P. falciparum* and later *P. vivax* elimination to be used by the National Malaria Programmes, health agencies, and supporting institutions in Myanmar and beyond.

Picture 3: Mother taking her children to MDA.

The Malaria Elimination Task Force (METF) was set up in 2014 to conduct a large-scale pilot project for *P. falciparum* elimination in 4 townships (Kawkareik, Myawaddy, Hlaingbwe, and Hpapun) of Eastern Myanmar (Karen/Kayin state). It is governed by a committee composed of one representative of local NGOs/CBOs (KDHW, MTC, BPHWT, BMA, KBGF, KPC, KKO, SMRU)[1]. Other organisations also involved in malaria elimination in Myanmar (MAM, CPI)[2] are invited as observers to the Executive Committee (EC). The structure of METF has been developed by the EC to facilitate communications, logistics, reporting, supervision and management (Figure 3) .

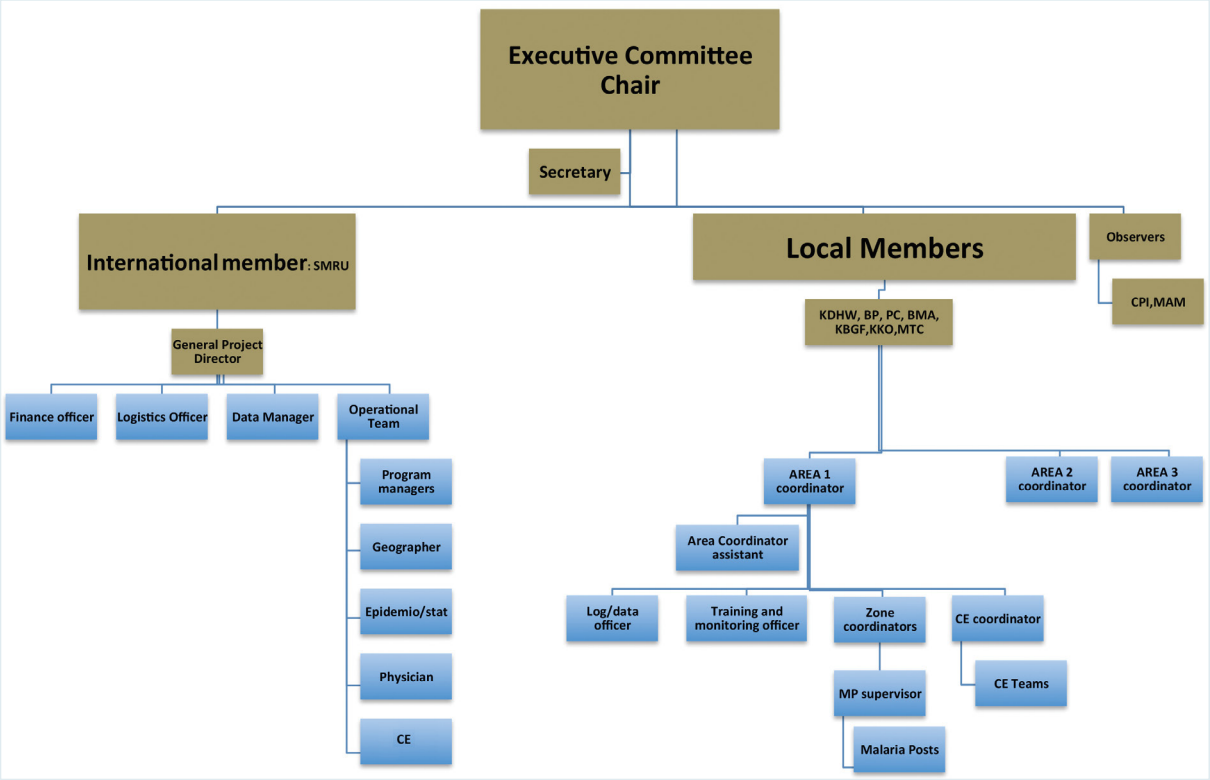


Figure 3: The METF organisational chart

- The project area is large and divided into 3 'Areas' under the responsibility of an area programme manager and a coordinator seconded by a technical team for CE, training & monitoring, data collection and administration.
- Each area is divided into zones, where health services are administered by one of the local NGOs/CBOs.
- Each zone has a number of MPs (depending on the landscape and demographic concentration). A MP supervisor is responsible for 10 to 15 MPs.
- The central coordination team is composed of the area programme managers/ coordinators, one epidemiologist/biostatistician, one geographer/anthropologist and a medical referent. It is headed by a programme director and based at SMRU.
- SMRU provides support for logistics, data management, finances and grant management as well as laboratory.

[1] KDHW: Karen Department of Health and Welfare; MTC: Mae Tao Clinic; BPHWT: Back Pack Health Workers Team; BMA: Burma Medical Association; KBGF: Karen Border Guard Force; KPC: Karen Peace Council; KKO: Klohtoobaw Karen Organisation; SMRU: Shoklo Malaria Research Unit.

[2] MAM; Medical Action Myanmar; CPI: Community Partners International

METF is supported by the Global Fund Regional Artemisinin Initiative–Inter Country Component (GF-RAI-ICC), the Bill & Melinda Gates Foundation (BMGF) and The Wellcome Trust of Great Britain. The aim of this project is to assess the feasibility of eliminating *P. falciparum* rapidly in the context of increasing artemisinin resistance. As such it can be seen as a study or pilot project and is endorsed by the Ministry of Health of Myanmar and the Karen Department of Health and Welfare (KDHW). It is approved by the Ethics Committee of the Department of Medical Research (Lower- Myanmar). This interim report presents in detail the components of the elimination strategy and the results after 18 months of operation.

BACKGROUND

Malaria is endemic in Myanmar and a major cause of mortality and morbidity. The main plasmodial species involved are *P. falciparum* and *P. vivax*. Transmission is low and seasonal and caused by multiple anopheles vectors. Along the border with Thailand, *P. falciparum* has become resistant to almost all available antimalarials including the artemisinin derivatives. This represents a major threat to the region and the rest of the world. Given the paucity of new drugs, the only alternative is to attempt elimination before the rebound of malaria that inevitably follows the spread of high-level drug resistant parasites. Between 2012 and 2014 a pilot Targeted Chemo-Elimination study (TCE) was conducted in 4 villages on the Thai-Myanmar border. These villages were selected because a high proportion of the population was infected with malaria parasites but without symptoms. In each village, malaria posts with RDTs and ACTs were set-up and long lasting insecticide-treated nets (LLINs) distributed. Community engagement (CE) activities were conducted and mass drug administration (MDA) was offered to the population in this controlled environment. The safety and acceptability of this intervention were carefully evaluated. The impact was measured by detailed surveys using an ultra-sensitive and validated qPCR assay. Detailed entomological evaluations were conducted throughout the 24 months of the TCE study. The results show that the strategy is safe and effective in rapidly eliminating the sub-microscopic reservoir of malaria parasites, in reducing the transmission to mosquito vectors and is well accepted by the population. It also indicates that new vector control methods are needed because the majority of infections were not preventable by LLINs. These encouraging results motivated the METF project to attempt *P. falciparum* elimination on a larger scale using the same approach.

Picture 4: Preparing all paperwork (consent forms, population lists, logbooks) the day before MDA starts in a village.

A. Mapping and geographic information system (GIS)

As the Karen State has been in civil conflict for over half a century, there is no accurate census or map for most of the target area. This information is essential for all further steps in the project. The data generated from mapping are linked to all other data (survey dates and results, logistics, financial matters, malaria cases at malaria posts, etc.), so all programme data are spatially referenced in a geographic information system (GIS), the underlying structure on which all other activities are built.

Mapping strategy:

- The entire area must be mapped at the smallest geographic unit possible (preferably at least one point per village). Mapping relies on "ground-truth" data as opposed to assuming that existing maps are accurate or only using satellite imagery.
- During mapping, basic attributes of a village are recorded (population estimate, existing health facility capabilities, cell phone service).
- The area is frequently re-mapped, both as a form of quality control and to capture changes in the geography and demography of the region.
- Identification codes are assigned to the geographic points (villages) and used in all other parts of the program.
- From a logistic and administrative standpoint it is then useful to create aggregate units (e.g. "zones" and "areas") from geographic points.

Mapping logistics:

The mapping team is composed of community members familiar with the region, a geographer and several trained staff. The training on global positioning system (GPS) and survey forms takes place in a central location. The initial mapping focus on whether or not malaria services exist, whether or not they are properly staffed and stocked, the names of villages and the number of houses in a village. Field mappers immediately begin mapping their areas after a training session. Maps are useful only if they are accurate, complete and rapidly acquired.

Picture 5: Mapping training

Technical aspects of mapping:

The data from the forms are entered into a Microsoft Excel spread sheet that is merged with the geographic data downloaded from each GPS unit. These data form the basic architecture for METF's geographic information system (GIS). R statistical software(https://cran.r-project.org/) and Python programming language(https://www.python.org/) are used for data tabulations and merging; mapping of the data has primarily been done using ArcGIS(http://www.esri.com/software/arcgis), especially ArcMap; QGIS(http://www.qgis.org/) is used for creating and manipulating some spatial shape files. Each mapped village is assigned an arbitrary identification code including both English letters and Arabic numerals. All information relating to a village (blood surveys, weekly malaria post reports, financial reports, etc.) is labelled using this identification code. Such data come in on a continuous basis and are merged to the core data set which can be viewed as a spread sheet in a wide variety of easy to use computer environments (Excel, LibreOffice, etc.). Python is used to pull new data from various sources, to update the base spread sheet, and then to print updated maps each week. The resulting maps and updated data spread sheet are placed on a secure server.

B. Community engagement (CE)

Community engagement (CE) is a process by which a dedicated CE team (usually consisting of 5 – 15 people from the programme team and the community) works to build relation and trust to facilitate community ownership and understanding of the malaria elimination project. The entire programme relies on widespread participation and cooperation within and between villages in the area. The success (or potential failure) of the project is therefore heavily dependent on the ability to properly interact with the population, making CE a cornerstone of the malaria elimination programme.

The malaria-focused CE work started with four pilot villages as part of the TCE study in 2013. Through the experiences gained and lessons learned a guiding set of key themes was established including principles and methods that could be applied across a wide geographic range in the scale-up programme (i.e. METF). Three major themes emerged from this preliminary work: human behaviour, geography and social structures.

Picture 6: Karen farmer in her rice-field

Human behaviour: CE workers and other malaria elimination team members must work toward understanding community members worldviews, the ways that they allocate their time and the motivations and desires that drive their decisions and decision-making processes. For example, CE and other malaria programme tasks must not conflict with the workload of the people. Most rural villages in the METF area follow a basic calendar revolving around rice paddy farming and several other crops (Figure 4). Harvest seasons (September to December) are typically labour-intensive and require some farmers to spend up to several weeks away to protect the crops and harvest them.

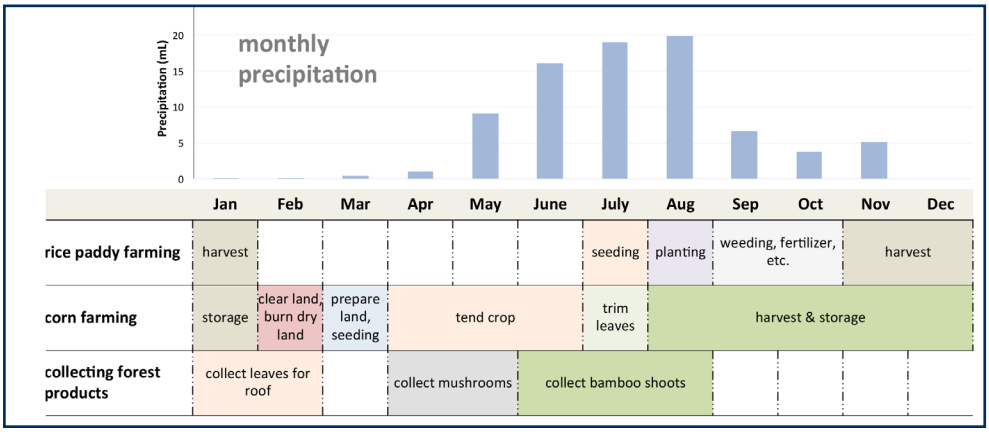


Figure 4: Agricultural calendar for rural Karen communities in the METF area. The above calendar gives general schedules for: a one-season rice paddy system, a corn (maize) farming system and commonly-collected forest products. Most rural villages in the METF area follow this basic calendar, though many schedules are more complex, including more major and minor crops.

Geography: The physical and social geographic attributes of a community have important correlates with regard to CE, public health and ultimately malaria elimination. The relative physical and/or social isolation can have a major impact on the knowledge and understanding of community members as well as on health-related work. People in remote locations are often poor and have little understanding of malaria or other public health threats.

Social structures: It is crucial that CE team members understand and utilise some of the existing social, political and economic power structures in place. Such systems include local village heads, township health officers, important religious and other political and military actors. Socio-political dynamics can dictate appropriate means of engaging with community members and rolling out health-focused projects. Karen state has many different political actors, some operating simultaneously in the same areas. This political complexity can make implementation of health programmes very challenging. The malaria elimination project has been able to work in communities despite these potential obstacles through the incorporation and help of important key contacts. It is often possible to directly go to upper level health officials and obtain permission to set up a malaria programme in an area. Without community acceptance, however, implementation at the ground level may flounder.

Picture 7: Karen village in a remote area. Villagers in the middle of forest and hills with no access to communication appreciate the METF programme : "We don't have to risk our lives to take the boat or to go on foot for hours during raining season to go to the nearest clinic...."

CE training for MPs: Malaria posts are typically established in batches. Prior to MPW training, the CE team asks for a meeting with local health workers, village headmen, and other leaders. During this initial meeting the programme, MP function and CE are explained to local leaders. CE training also takes place with the MPW during training workshops. MPWs are taught about malaria biology and ecology, how to prevent malaria and what to do in case of malaria symptoms. This training is valuable for the MPWs who will also convey this knowledge to community members. The MPW effectively becomes an important extension of the CE team, as he/she is already part of the local community.

Malaria prevalence surveys: Before embarking on a survey, the project team meets to discuss the detailed planning. Township-level health care leaders and village headmen are then invited to attend a meeting at a central location so that the plan can be proposed and the CE team asks for permission to conduct the surveys. Survey planning relies heavily on village headmen, who notify and gather the participants on the specific day and time(s). The concept of submicroscopic malaria is quite complex and difficult to explain. Several workshops are organised to train local leaders (health care workers and village headmen) who are already trusted by local villagers and can therefore aid in the dispersal of knowledge and information.

MDA preparation: Once a village is identified for MDA, plans begin for CE exercises aimed at community preparedness. The Area and Zone coordinators inform the village headmen. The CE team arrives 2 days prior to the beginning of MDA in order to organise and set up new meetings with leaders and villagers to explain the medication, the potential side effects and the regimen that will be followed. The MDA team stays in a village for 7 days per visit to document any side effects, to address any concerns and to treat other minor illnesses. In villages with MPs already in place feedback from villagers after the 7-day period will come via MPW through MP supervisors, Zone coordinators and Area coordinators.

Picture 8: A CE meeting attended by religious, administrative and military leaders

CE as an iterative process:

CE is not a short-lived process with successes or failures that can easily be measured. The trust and understanding are based on dynamic relations with the community. Part of this relationship includes providing feedback about the project and reacting to new developments including rumours that can be detrimental.

Tools and activities used for CE:

- Workshops, trainings, and group discussions (focus groups).
- Demonstrations and hands-on activities-learning materials including handouts, manuals and posters.
- Capacity building activities aimed at youth, including children's songs and poems, drawing, school activities aimed at teaching scientific methods.
- Participation in monthly village meetings, celebrations, and community work activities (such as farming).
- Household visits.
- Village incentives (water supplies or systems, buildings for community activities, solar panels, some training opportunities for health workers, boosting existing medical capabilities, providing basic out-patient care while the team is in the field).

Picture 9: METF team explaining the submicroscopic parasite carriage during CE.

MPs are set up in all villages to provide early malaria diagnosis and treatment for every fever case occurring in the community. MP tasks include:

- *Testing all fevers or suspected malaria cases in the village using RDT within 24 to 48 hours of symptoms.*
- *Administering quality-assured anti-malaria treatment to all confirmed malaria cases: ACT+primaquine for P. falciparum and chloroquine for P. vivax.*

This activity not only provides treatment for malaria-infected patients but also helps to limit the on-going transmission of *P. falciparum* since early treatment of symptomatic cases prevents the emergence of gametocytes. The use of quality-assured antimalarials contributes to fighting drug resistance that may emerge through the use of low quality or substandard drugs.

MP worker (MPW) selection and training:

MPWs are selected by the village headman and the community. They must have basic literacy skills, interest in health-related activities and should live in the village. After selection, the MPW undergoes a 3-day training covering malaria case management, referral and reporting systems, CE, followed by an examination. The practical training includes the use of RDTs and dosing-tables, the recording of patients in logbooks and the weekly reporting of cases on a standard form. MPWs are provided with a MPW manual in Karen language as a reference for their daily activities.

Picture 10: A MPW in the house of a feverish man who became paralysed following a tractor accident a month before.

Choice of antimalarial treatment for uncomplicated malaria:

Treatment algorithms (Figure 5 page 33) follow the Myanmar National Malaria Programme, the World Health Organisation (WHO) treatment guidelines and the SMRU malaria handbook. For *P. falciparum* infections the total target dose is 5 to 24mg/kg of artemether and 29-144mg/kg of lumefantrine (AL). AL doses are administered twice a day for 3 days with food. Pregnant women are treated with quinine 10mg/kg TID along with clindamycin 5mg/kg TID for 7 days in the 1st trimester and AL for the 2nd and 3rd trimesters. A single low dose of primaquine (0.25 mg/kg) is given to prevent further transmission except in pregnancy, children younger than 6 months and lactating mothers. For *P. vivax* chloroquine (25mg base/kg) is given over 3 days. The doses administered are determined by the patient body weight.

Refresher training and evaluation of MPWs performance:

Refresher trainings are given annually on malaria biology and treatment protocols. Programmatic revisions, feedback about technical problems or difficulties encountered in the field are also discussed. Pre- and post-testing are conducted to ensure the satisfactory performance of the MPWs.

ACT resistance monitoring

Malaria positive RDTs are shipped back to the main METF office and stored in a dry, cool location. The RDTs are sorted by MP code and sent to the laboratory for extraction of parasite DNA to monitor any major changes in the distribution of important drug resistance markers (e.g. K13 alleles/PfMDR1 copy number) in parasite populations across the area.

D. Real-time data collection and reporting

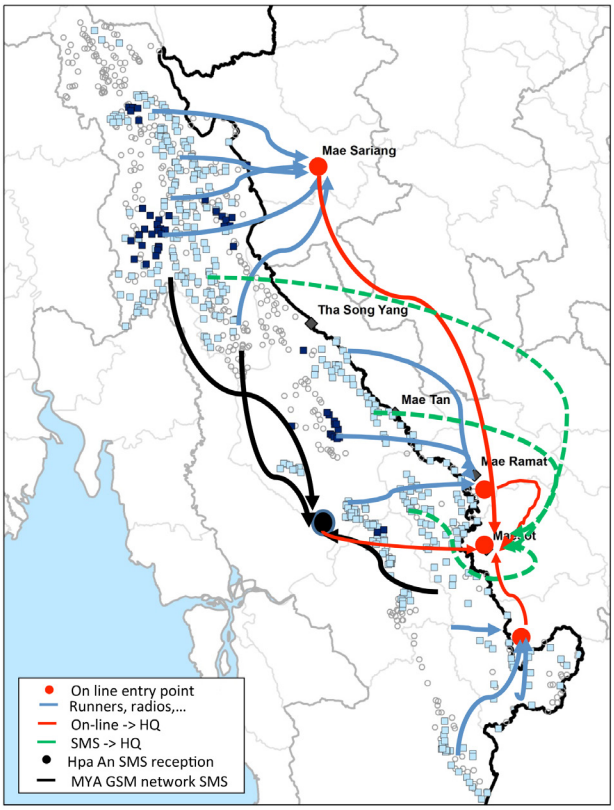
Timely information is essential for the coordination and the monitoring of the programme. The geographical spread and the difficulty to access some areas (sometimes for security reasons) are the greatest challenges. The two main requirements for this system are that data reports must be sent weekly and accessible to the management team in near-real time. A one-page form has been developed (Figure 6 page 34) and includes:

- All cases of fever by age groups (0-4y, 5-14y and ≥ 15y)
- All RDT results (*P. falciparum* / *P. vivax*/ Negative / Invalid by gender and age groups
- The number of severe malaria cases referred and the number of pregnant women with malaria and the number of deaths attributable to malaria
- Remaining stocks of ACTs and RDTs

The hierarchical organisation of the programme allows data to be crosschecked and validated by MP supervisors during transfer from the site to the data centre.

All weekly forms are transmitted from the MPWs to the MP supervisor and then to the nearest data entry point. Data entry mode depends on location and access to a GSM (global system for mobile communications) network.

MPs are grouped by types of data transmission:



Paper transmission is used in zones where no GSM network is available. Data collection relies on 'runners' who collect the forms and bring them to the nearest data-entry point. The online data-entry points are 3 SMRU clinics on the border and one office in Mae Sariang, equipped with computer and a high-speed internet connection. The online entry form and database were developed using VooZaNoo® an open-source formgenerator developed by EpiConcept[1]. Access to this application is secured and all operations on the database are traceable. After data entry the paper forms are filed for future reference.

Figure 7: Organisation of the weekly data transmission from MPs to the data centre.

[1] http://voozanoo.net

An SMS-based application was developed to capture data on a smartphone. All SMS generated (1 per week / MP) arrive in the main data centre on a dedicated phone number where they are merged into an Excel file imported into the VooZaNoo database. Cheap (< $ 100) smartphones (Asus Zenfone 4®) are used because they are robust and reliable in field conditions. Some remote areas have no phone signal but are able to link to the network using relays providing Edge signal (voice / SMS). The data entry form has been developed from DroidDB, an android-based freeware[1]. Freeware is also used to merge the SMS into a single file[2]. Paper forms are collected by MP supervisors, transmitted to Zone coordinators and then to the data centre to be filed for future reference.

All sites covered by a Myanmar phone operator (Telenor, Ooredoo, etc.) are progressively equipped with smartphones. In order to keep operational cost low and avoid international roaming expenses, SMS are received at a concentrator located in the METF office in Hpa An, where the operator merges the SMS twice a week and sends the file to the data centre in Mae Sot via e-mail.

MP weekly data reports are consolidated twice weekly into a central database and reports are produced on MP function, data quality and malaria indicators. The reports allow the MP to be monitored and to feedback information to field teams for programme management and malaria surveillance. One of the main challenges is data completeness. Regular cleaning of the database in search of duplicates and missing values is performed using paper records stored centrally or other source data as necessary. All MP weekly data are made available to partners and stakeholders on a secured Internet portal and a monthly report is generated and communicated to partners.

Picture 11: A zone coordinator is checking weekly data received from Malaria Posts before sending them by SMS.

[1] www.droiddb.com

[2] Sms2file, available on Google apps store

E. Submicroscopic malaria prevalence surveys

Surveys are conducted in randomly selected villages to estimate the prevalence of P. falciparum and P. vivax malaria infections using an ultrasensitive high-volume qPCR and to identify places with a large asymptomatic reservoir.

Sample size and randomization:

To ensure that the selected villages are representative of the area a grid (with 20km wide by 30km long cells) is superimposed on the map and each cell of the grid is assigned a number of surveys (25% of the villages). Villages are then randomly selected within each cell. The sample size is calculated taking into account feasibility and the precision estimates. The feasibility constraints involve: village size and accessibility, time and conservation of samples (cold chain and processing in Mae Sot within 48h of collection) and security of the teams (in conflict areas). In order to estimate the prevalence of malaria infection at 40% with ±10% precision and 90% confidence, the sample size required is between 41 samples for a village with 20 households (~100 inhabitants) and 65 for the largest communities (above 500 households, ~2500 inhabitants).

Survey and analysis:

The survey takes place after CE has been conducted to invite adult villagers to participate. After giving informed consent randomly selected individuals aresampled by venous puncture. Samples (2 mL) are collected on EDTA tubes, stored on ice and brought back to SMRU laboratory within 48h. At the laboratory, samples are centrifuged to collect packed red blood cells. DNA is extracted and analysed using an ultra-sensitive qPCR assay[1] to detect malaria parasites.

Picture 12: METF worker taking a venous blood sample during a survey.

Hotspot definition criteria:

Villages are classified as "hotspots" when the 90% CI upper limit of the prevalence estimate is ≥ 40% and the proportion of *P. falciparum* in the positive samples is ≥20%. This is an arbitrary definition and it will be reviewed periodically using the data collected. Surveys where an insufficient number of samples are collected are excluded from analysis.

[1] Imwong, M., et al. (2014). "High-throughput ultrasensitive molecular techniques for quantifying low-density malaria parasitemias." J Clin Microbiol 52(9): 3303-3309. http://jcm.asm.org/content/52/9/3303.full.pdf

F. Mass drug administration

MDA is not the most critical component of the elimination strategy but it is the most effective to achieve rapid elimination. It is justified by the presence of large reservoirs of sub-microscopic and asymptomatic infections and because the spread of artemisinin resistance threatens to derail any attempt to control malaria.

Choice of drugs for mass administration:

In order to limit drug pressure MDA uses an ACT different to that used by MPs (AL). The regimen used in MDA consists of dihydro-artemisinin (7mg/kg) plus piperaquine (55 mg/kg) given over 3 days (DP) with a single low dose of primaquine (0.25mg/kg). DP remains highly efficacious against *P. falciparum* parasites in this area and is associated with a post-treatment prophylactic effect of around 30 days after one complete course. One treatment course (3 days) is sufficient to eliminate the sub-microscopic reservoir while three consecutive rounds of DP (one month apart) are necessary to maximise the impact on transmission by preventing reinfection from infected mosquitoes.

MDA exclusion criteria :

Women who are in the 1st trimester of pregnancy, children under 1 year of age, individuals with previous drug allergies and villagers who refuse to participate are not included in MDA. Women of unknown pregnancy status are screened with a urinary HCG test kit.

Treatment administration:

After obtaining informed consent each participant medical history is briefly reviewed and a clinical examination conducted. Those who meet the inclusion criteria are provided a 3-day course of DP with a single low dose of primaquine on the first day and this is repeated over 3 consecutive months. Treatment is administered under supervision by the METF team to ensure participant adherence. Primaquine is not given in the 2nd and 3rd trimester of pregnancy. All adverse events (AE) reported by participants within a week of the MDA are carefully recorded and treated when necessary.

Picture 13: A boy and his younger brother voluntarily took part in the MDA. They were guided by their father who accompanied them in on their way to school.

G. Entomology

In “hotspot” villages mosquito collections are conducted using human landing catch (HLC) and cow bait collection (CBC). In each site, mosquito collections are carried out in six points from 06.00 pm to 06.00 am for five consecutive nights. Five sites under a supervisor are used for HLC (outdoor and indoor) and one for CBC. Each night the team of collectors rotates according to a Latin square design. Every morning the supervisors collect the cups containing the mosquitoes and send them to SMRU for morphological identification. The vectors are then sent to the entomology laboratory at Kasetsart University (KU) in Bangkok where a team from the Institut de Recherche pour le Development studies the vector species composition and infectivity by real-time PCR.

Monitoring of MPs:

MPWs have weekly contact with their MP supervisors to aggregate individual patient data into standard reporting forms. This allows follow-up of any event occurring in the previous week. During the initial months of the programme all used RDTs were sent to SMRU for a second reading. The activities of the MPs are continuously monitored via the weekly data reporting system. MPs that cease to transmit data, report no activity or stock outs are visited by MP supervisors.

MP weekly data reports monitoring:

Data reporting is monitored weekly at the zone level before transmission and at SMRU where data from all sources are aggregated. Completion reports are sent to Area and Zone coordinators for missing data, signalling any MP(s) that has triggered an alert signal. These include: no data, no patients seen for the last 4 weeks or a high number of invalid RDTs performed. Surveillance reports of *P. falciparum* malaria case incidence are also sent to Area and Zone staff that relay relevant information to MP supervisors. After aggregation, MP data completion and correctness are assessed by searching for duplicate and missing data in paper records. A double entry is performed on a subset of records. All errors recorded are transmitted to field staff and used during MP supervisor meetings and MPW refresher trainings.

Monitoring of surveys:

METF teams conduct survey campaigns in selected villages within a defined sector. These campaigns can include up to 30 villages over several weeks. Monitoring occurs at the planning phase and when the teams come back to base. Reports include modifications of the number of samples collected to match the observed number of households in the selected village and replacement of villages by neighbouring ones when surveys cannot be performed. Sample transportation is also closely documented. When survey teams return from the field the samples, the lists and consent forms are checked to ensure proper conservation, labelling and recording. In the laboratory a negative control is included for every 10 samples to detect potential contamination.

Monitoring of MDA:

MDA activities are conducted in a stepwise process and all steps are documented and controlled. Teams of health staff are trained before each MDA. Consent forms and MDA logbooks are used daily to record inclusion and to track participant presence and drug uptake. Team members review the logbooks with the team supervisor daily to check for correctness of inclusion criteria, weight measurements, drug dosage and adverse events (AE). After each of the 3 consecutive months and at the end of the 3-month period, the logbooks are reviewed again. Data are transferred to spread sheets for follow-up and when the 3 months are finished, entered into an Access database. The medical team documents all complaints reported after taking the drugs. A medical doctor reviews all symptoms reported to identify potential drug-related causes. The procedure for severe AEs involves alerting a medical doctor for further investigation and management.

A. Mapping and geographic information system

Logistic results:

Over 1,200 villages were surveyed and mapped. These villages were aggregated into administrative units by Zones and Areas. There are 3 main Areas with up to 10 Zones each (Figure 8). The 3 Areas have now been mapped twice. The second mapping included more detailed data on available health services. A third mapping is being conducted to include basic developmental and economic information.

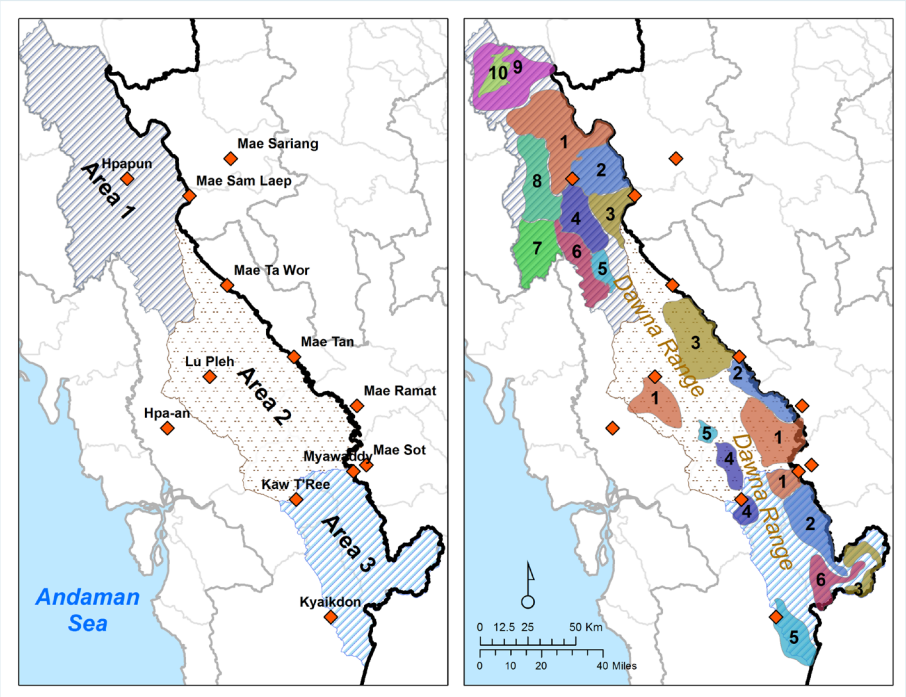


Figure 8: METF Areas (left panel) and Zones (right panel)

Geography and settlement demography:

The mapped area spans a geographic range of approximately 16,719 km^2 (Area 1 = 6,747 km^2; Area 2 = 6,241 km^2; Area 3 = 3,731 km^2). Some general patterns have emerged through these geographic surveys. The northern area (Area 1) consists mostly of small, evenly distributed villages. It is the least developed economically with fewer all-season roads, less electricity and generally more difficult access. Area 2 on the eastern side of the Dawna Range has more sparsely distributed villages clustering along the Moei River and several larger population centres. The western side of the Dawna Range in Area 2 also has large population centres but is less sparsely populated, with small farming communities distributed across the landscape. Area 3 is a mixture of settlement types. The southeast is sparsely inhabited with small villages interspersed with forests and mountains. In the far south and far west of Area 3 are clusters of villages and large towns. A major road network linking Myawaddy to populations on the other side of the Dawna Range divides Areas 2 and 3. The total population living in the 1,200 mapped villages is estimated to be 330,495 (95%CI:318,326-342,024)

B. Community engagement

The CE team conducted numerous workshops and meetings with community leaders and with the population(Figure 9 page 35). Most CE activities were related to surveys and the 3 rounds of MDA.

MDA participation:

Perhaps the best metric for assessing the effectiveness of community engagement (CE) is the participation to MDA. The METF was regularly able to achieve greater than 80% participation of the villagers present during a round of MDA (Figure 10). In one village the participation dropped to less than half of the community during the second round because of rumours. The METF CE team organised focus group discussions to uncover and address the concerns. The third round achieved greater participation.

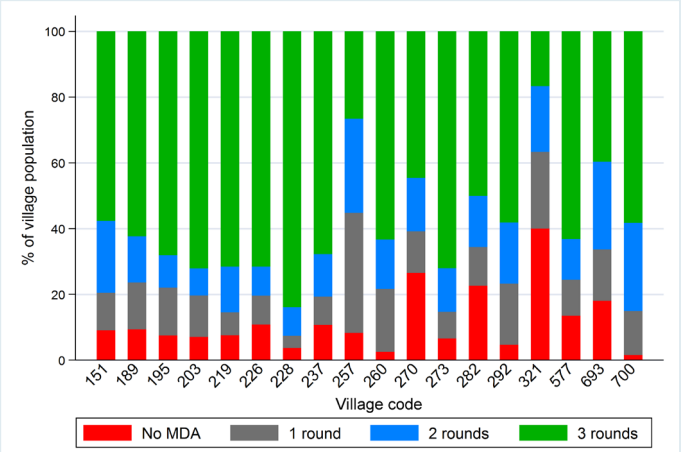


Figure 10: Summary of final coverage in villages receiving MDA. Each bar represent a village and each colour is proportional to the percentage of the village population who took 0, 1, 2 or 3 rounds of MDA.

Rumour control:

Rumours have typically been related to two main factors: 1) blood surveys (dangers or side effects related to sampling, fear of needles, fear of being tested for other conditions or that the blood will be sold, superstitious beliefs related to blood) and 2) MDA (concerns about side effects and fear of being poisoned). Seasonal illnesses sometimes overlap with the timing of MDA or blood surveys and this can result in rumours that the medication is causing illness. The CE team found that if leaders and local village health workers understand and take ownership of the malaria programme, people have more trust in the programme and rumours either do not start or are easily quelled. Focus groups discussions are effective to elucidate potential trust problems, worries, doubts, or misperceptions.

Picture 14 : A community engagement meeting in one of the villages.

Other "soft" indicators of CE include:

- Requests from community health leaders for P. vivax infections
- Requests by community leaders for METF to expand its coverage to villages outside of the current target area

METF has trained 983 MPWs, 86 MP supervisors, 36 Zone coordinators and opened 700 MPs covering more than half of all villages mapped (Figure 1 page 8). During this period 100,320 fever cases were seen by MPWs and 101,767 RDTs were performed. The overall RDT-positivity rate was 14.5% (Figure 11). A total of 14,589 malaria cases were treated: 5,433 *P. falciparum* cases and 9,156 *P. vivax* cases. Four deaths related to malaria and 37 severe malaria cases were reported.

Malaria clinical case incidence:

The incidence of clinically confirmed *P. falciparum* and *P. vivax* cases was followed through weekly activity reports and showed important differences between the three project areas. Area 1 had a higher incidence and marked seasonality with one peak at the start of the rainy season (June-July) and one in the cold season (December) and similar numbers of *P. falciparum* and *P. vivax* cases (PF/PV ratio=1). Areas 2 and 3 had generally lower incidence rates, higher proportions of *P. vivax* cases (PF/PV ratio<1) and one main malaria peak at the start of the rainy season. Over the period reported here the *P. falciparum* (but not *P. vivax*) incidence rate decreased in all three areas (Figure 12). Comparing the beginning and the end of the period reported, the incidence declined by 78% in Area 1, 99% in Area 2 and 68% in Area 3. The increase in the incidence of *P. falciparum* in Area 1 in November 2015 is partly explained by the opening of new MPs at the start of the second annual transmission peak, but undetected "hotspots" could also be a contributing factor.

MP impact on malaria incidence:

The data show that the number of *P. falciparum* cases recorded is highest during the first weeks of opening the MP and during the first malaria season. The probability of an MP declaring at least one *P. falciparum* case in a given week was 20% during the first month following opening, similar to the probability of declaring one *P. vivax* case. After 12 months the corresponding figure was ≤ 1% for *P. falciparum* while that of *P. vivax* remained stable (Figure13). This translated into a decrease in the PF/PV ratio by about 50% after 12 months of MP activity (Figure 14). Thus the opening of MPs in the villages had a very significant

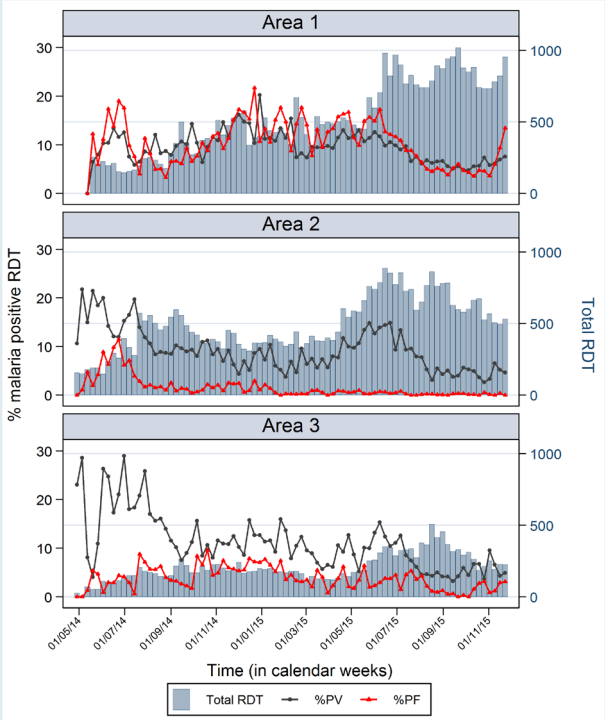


Figure 11: Seasonality of malaria positivity in the 3 areas of the programme: weekly number of RDT (bars) and percentage of positive P. falciparum (red line) and P. vivax (black line).

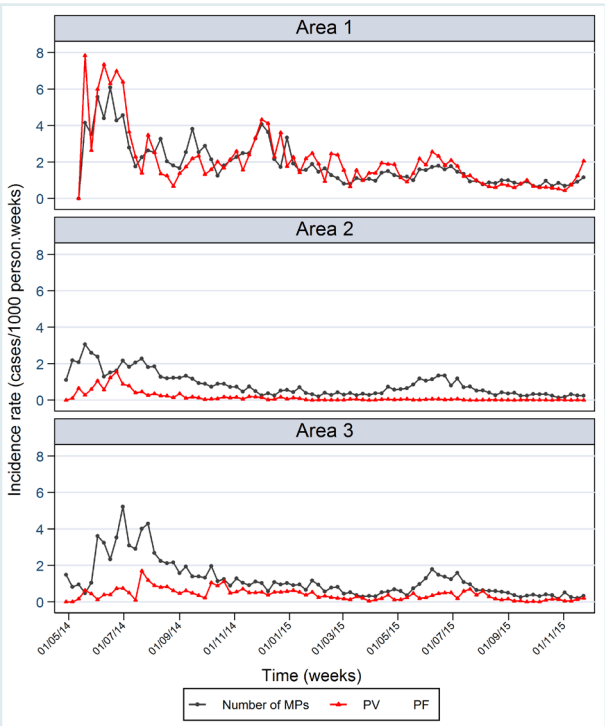


Figure 12: Weekly incidence rates of clinical P. falciparum (red) and P. vivax (black) malaria in the 3 areas of METF programme.

impact on subsequent *P. falciparum* clinical malaria incidence. A negative binomial multilevel model accounting for geographic and temporal heterogeneities has been developed. After adjusting for seasonality of transmission, spatial and temporal auto-correlations as well as changes in coverage of neighbouring villages, preliminary results indicate that for every 10 weeks of MP activity, the incidence rate of *P. falciparum* cases decreased by 16%. The Incidence Rate Ratio (IRR) for each incremental 10 weeks of MP functioning was 0.84 [95%CI:0.82-0.87]. The same model also suggests an impact of MDA on the incidence of *P.falciparum* clinical cases. Before MDA, treated villages had a 3-times higher incidence rate than untreated villages (IRR [95%CI] =2.8 [1.7-4.6]) but after MDA there was no difference between them (IRR=0.97 [0.4-2.1]). If confirmed, these results will support the use of MDA to accelerate elimination.

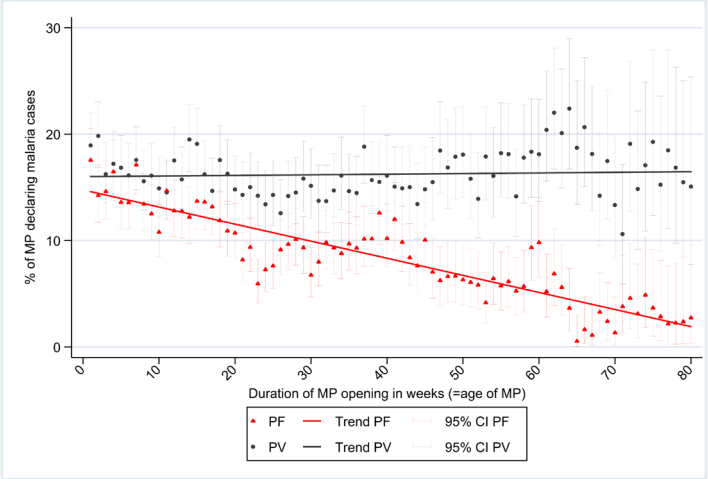


Figure 13:Probability of reporting malaria cases (vertical axis) by number of weeks since MP opening (horizontal axis). The crude trend was estimated by simple linear regression. The graph illustrates the differential impact on P. falciparum and P. vivax.

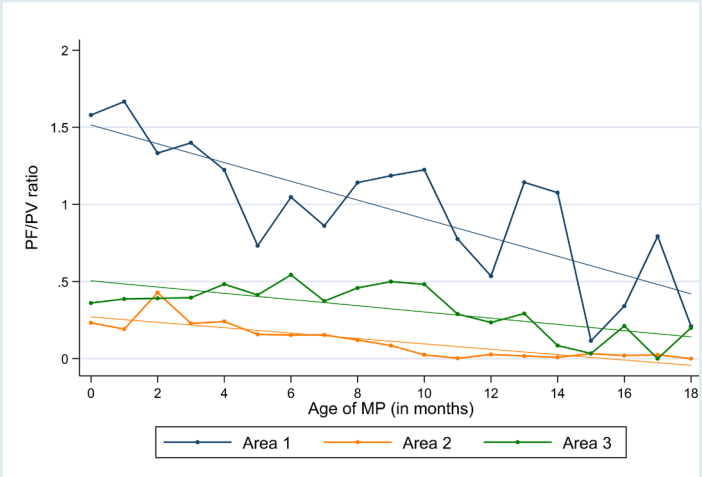


Figure 14: PF/PV ratio by age of the MPs in each of the 3 METF areas.

Spatial analysis of K13 variants:

P. falciparum positive RDTs were collected and K13 genotyping performed on 1,241 specimens. The yield was low with only 269 successful extractions (22%). Overall, the prevalence of wild-type K13 was 40% (Figure 15). There are apparent gradients in the distribution of alleles across the landscape with areas immediately bordering each other sharing more common mutations. The most prevalent alleles are E252Q/F446I in Zone 1, C580Y/F446I in Zone 2 and G449A/F446I in Zone 4. Variant F446I is highly prevalent in all three neighbouring zones but it is only the most dominant in Zone 1. This pattern may indicate that parasite populations in Area 1 are partially isolated from each other.

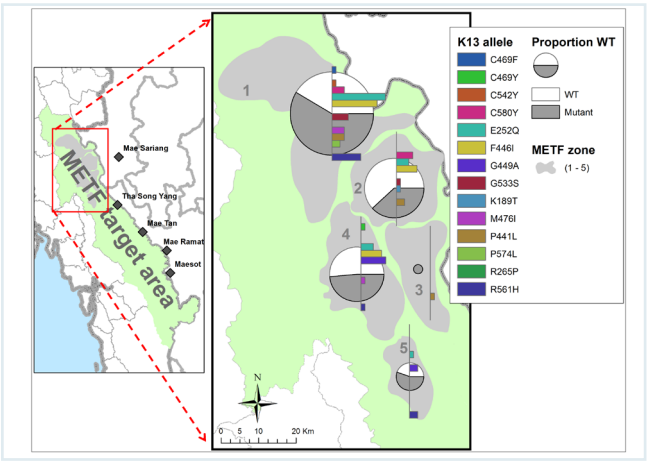


Figure 15: Distribution of K13 mutations across part of the METF Area 1. The figure indicates the number of samples per zone (the sizes of the pie charts are proportional to this number); the proportions of wild type (WT) per zone (WT are white, mutants are grey); and the bar charts indicate the number of alleles per zone. Interestingly E252Q is predominant in Zone 1.

D. Real-time data collection and reporting

The main indicators for the monitoring of the real-time data collection are the level of data completion and the delay observed between the end of a reporting week and the availability of data in the database. Out of 700MPs opened by 30 November 2015, 286 sent data using smartphones, while paper data sheets were used for 414 MPs. Among MPs transmitting by paper forms, 362 are located in remote villages of Area 1. Of the 700 MPs, 467 (67%) presented no reporting gap in their series of data, while 171 (24%) had one or several one-week gaps. Only 62 MPs (9%) presented reporting gaps of more than one week as a result of transmission or entry errors. Across all data the median delay was 8 days (interquartile range (IQR)=3-10 days) but there was strong heterogeneity by transmission method. Gradual introduction of smartphones resulted in a steep decrease in delay: data transmitted by SMS were available after a median of 2 days (IQR=2-4 days) while data relying on porter carriage (mainly in Area 1) were available after a median of 9 days (IQR=7-10) (Figure 16).

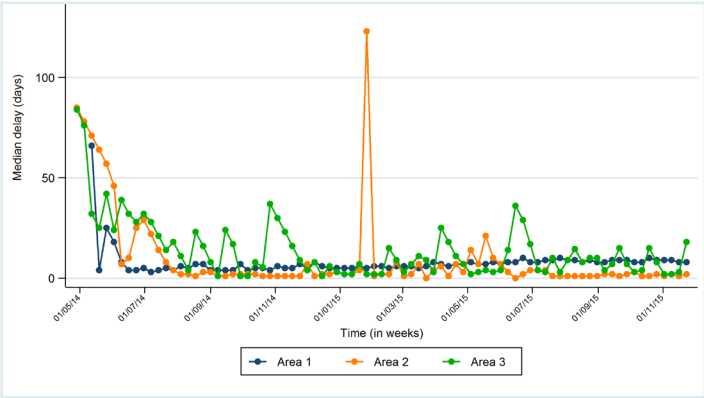


Figure 16: Evolution of median delay of data reporting in the 3 METF areas. The peak in delay observed in Area 2 corresponds to the Karen NewYear break.

E. Submicroscopic malaria prevalence surveys

Survey progress and results:

From April 2014 to November 2015, 190 surveys were completed and the results of 145 surveys were available for analysis. The prevalence of asymptomatic malaria carriage was highly variable as well as the relative proportion of *P. falciparum* and *P. vivax* infections (Figure 17). The highest prevalence was 35% for *P. falciparum* and 64% for *P. vivax.*

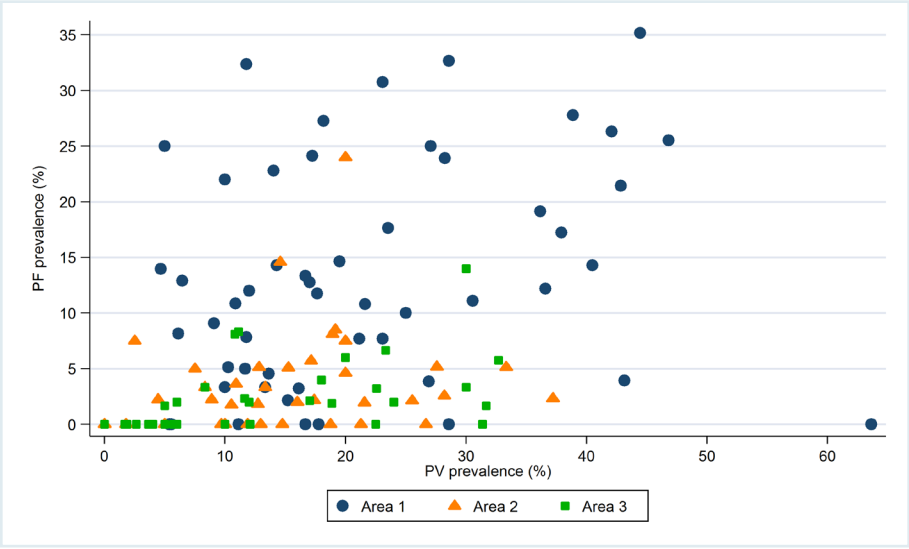


Figure 17: Prevalence of P. falciparum against prevalence of P. vivax in sub-microscopic malaria surveys in the 3 METF areas.

Detection of "hotspots":

Out of these 145 surveys, 30 villages meeting "hotspot" criteria were identified (Figure 18). A large majority of these villages were in Area 1 (Figure 19) where the incidence of *P. falciparum* clinical episodes is the highest.

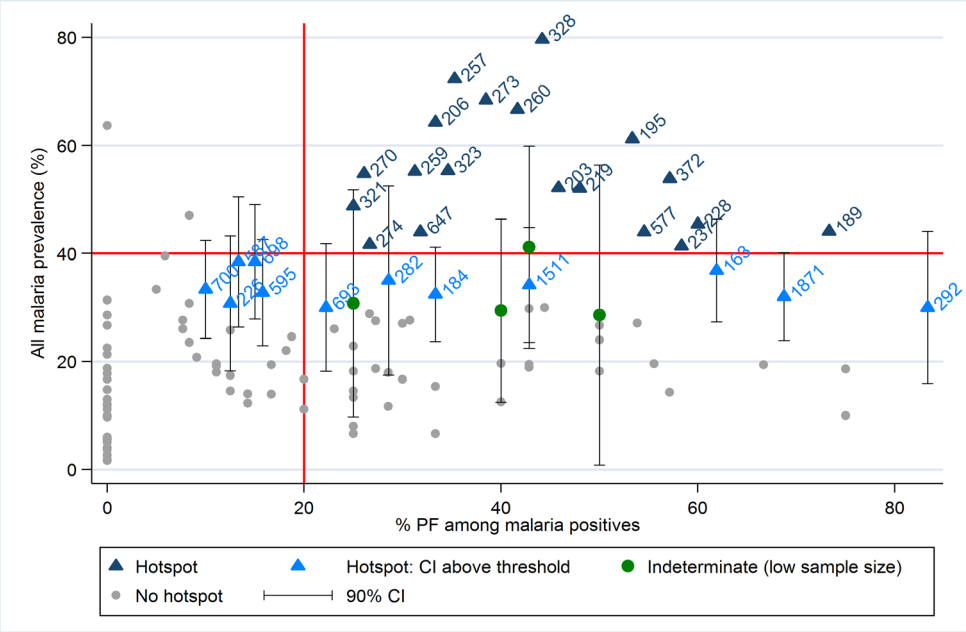


Figure 18: Identification of "hotspots" from blood survey results. Triangles indicate "hotspot" villages while closed circles indicate"non-hotspot" villages. Red lines indicate the thresholds: horizontal for the overall positivity and vertical for the proportion of P.falciparum amongst positives. When CI had sufficient precision (CI width<25%) and upper limit of CI was above the 40% threshold, villages qualified as "hotspots" (light blue). Large CI (>=25%, due to insufficient sample size in the survey) were considered too imprecise to characterise villages accurately (green).

Spatial analysis of survey results:

Sub-microscopic malaria "hotspots" tend to cluster across the landscape. Most "hotspots" were found in the northernmost region, despite roughly proportional testing in all three areas. Even within sub-regions there appears to be clustering of "hotspot" villages. The vast majority of "hotspot" villages are within 5 km of one another, and this pattern remains even when considering *P. falciparum* or *P. vivax* independently. A logistic regression controlling for area, village elevation and the number of houses in a village indicated that a village 1 kilometre closer to a "hotspot" than another village, has about a 31% greater odds of also being a "hotspot".

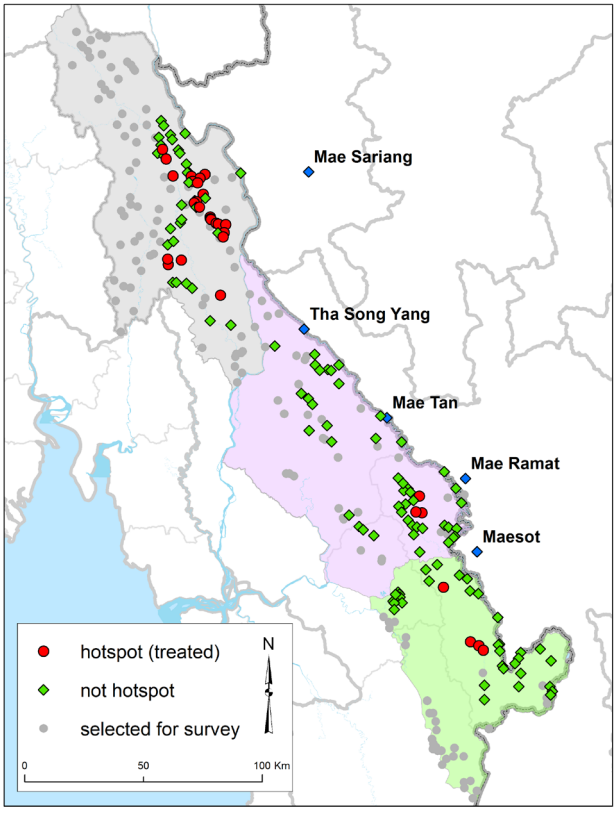


Figure 19:Map of surveys in METF area showing villages selected for survey (grey), hotspots (red) and non-hotspot (villages). All hotspots detected so far have been treated.

MDA was conducted in the 30 detected "hotspots" in three phases: 11 villages were treated in the first quarter of 2015, two villages in the second quarter and 17 in the third quarter. Data from 18 villages were available for this report.

Monthly participation and population stability:

Participation in MDA activities was satisfactory. The median (IQR) proportion of the population that received at least one 3-day course of DP was high: 92% (89-94%). In all villages participation was above 80% (Figure 10 Page 24) except in 1 village where it dropped to 48% at the second round because of rumours. MDA coverage was measured by the proportion of the population that received 0, 1, 2 or 3 complete 3-day courses over the 3 months of intervention. This was dependent on participation at each round but also on the stability of the population. In villages with important population movements, only part of the population could be reached during each round. Population stability was estimated by the percentage of people present in the village during the 3 months of activity. This stability was lower in Areas 2 and 3 (median 68%) compared to Area 1 (median 87%). At the end of the 3-month intervention, complete coverage (i.e. the proportion of people that received 3 rounds of MDA) was 63% (IQR=58-72) and was significantly correlated with population stability.

Reasons for non-participation:

Overall the 3-day courses of DP were well tolerated and no severe adverse events were reported. The main reasons for not participating were refusal (55% of non-participants), absence from the village (27% of non-participants) and exclusion criteria (10%). Amongst people refusing the main reason was not wanting to take medicine, mostly because villagers did not feel sick, did not trust "western" medicine or because they did not see malaria as a problem. Some participants already had other conditions or felt weak and did not want to take another drug. Overall these results show that MDA intervention is feasible and well accepted by the population.

MDA efficacy:

MDA efficacy on the prevalence of sub-microscopic carriage of malaria will be assessed with malaria prevalence surveys performed 12 months after start of MDA starting in early 2016.

Picture 15: The team with supplies during a round of MDA.

G. Entomology

Between February and May 2015, 18511 Anopheles mosquitoes were captured in 16 "hotspots" and sent to the entomology laboratory at Kasetsart University (KU) in Bangkok. 83% of the Anopheles mosquitoes collected were malaria vectors (Figure 20 A). Among the primary vector species, An. maculatus s.l. (71%) and An. minimus s.l. (22%) were the dominant species whereas An. dirus s.l. (1%) An. barbirostris s.l. (2%) and An. annularis s.l. (4%) were less abundant (Figure 20 B). Malaria vectors showed a clear zoophilic preference and outdoor biting behavior (Figure 20 C).

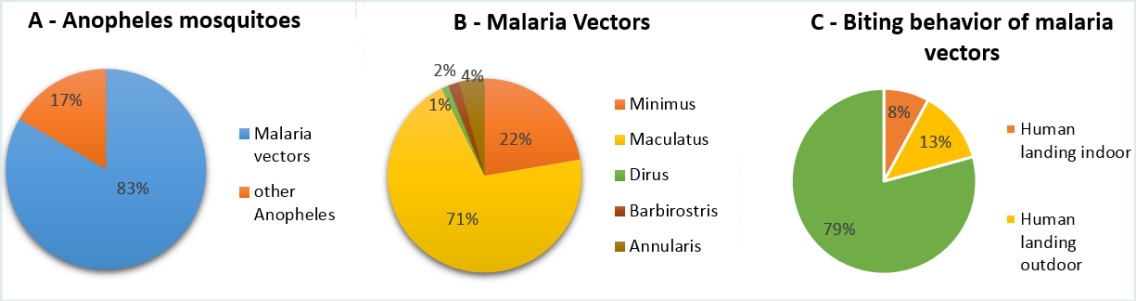


Figure 20: Abundance and behavior of malaria vectors caught on humans and cow in 16 malaria hotspots

Plasmodium infection

A total of 2397 primary and secondary vectors were tested by qPCR for Plasmodium. 15 (0.7%) Anopheles mosquitoes (both humans and cow) were found positive for Plasmodium species. The highest prevalence was found in mosquitoes collected on humans (0.8%): 0.23% for P.falciparum, 0.11% for P.vivax and 0.46% for unidentified Plasmodial species (P.spp). In mosquitoes caught on cows the prevalence of infection was 0.64%: 0.08% for P. vivax and 0.56% for unidentified species. (Figure 21).

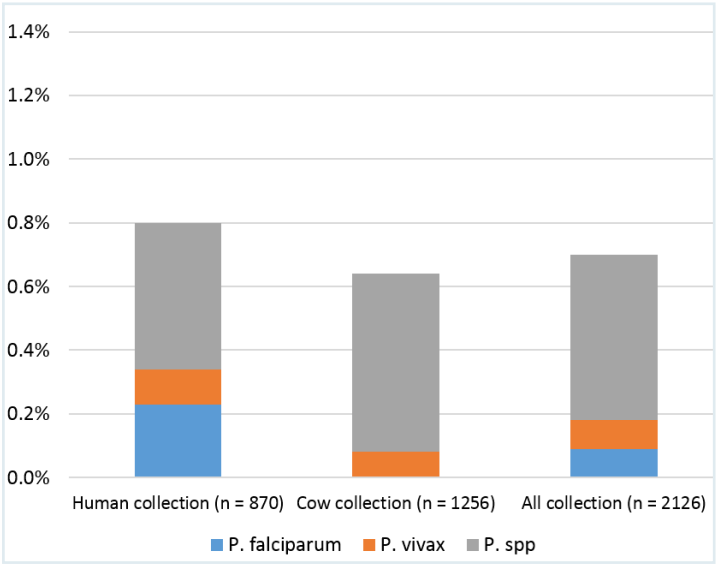


Figure 21: Prevalence of Plasmodium species in malaria vectors

H. Monitoring

Out of 17,227 RDTs from 22 MPs, 1.3 % had errors: 1.2% [0% - 7.3%] called negative by the MPWs where considered positive at the second reading and 0.1% [0% - 0.3%] had a speciation error. The quality of the MP weekly data reports was assessed by double entry for 4,076 records (14% of all records) for 27 variables and 110,052 entries. Overall, the percentage of errors was 1%. Most of these errors (date format error, coding/spelling error, ambiguous handwriting) occurred within the first week of MP activity (111/4,076 i.e. 2.7%). In the remaining 3,965 records the proportion of errors was 0.4%.

DISCUSSION AND PERSPECTIVES

This interim report of the METF activities shows the considerable progresses made in the rapid elimination of *P. falciparum*. The strategy used for **elimination** complements the **standard** control approach. In malaria control the focus is on the host: preventing infections and treating clinical cases. In the elimination strategy the focus is on the parasite: treating patients **before** their parasites are transmitted to the vectors, searching and eliminating the **sub-microscopic** reservoirs because they maintain transmission and **preventing** new infections by using long acting drugs and adapted vector control measures.

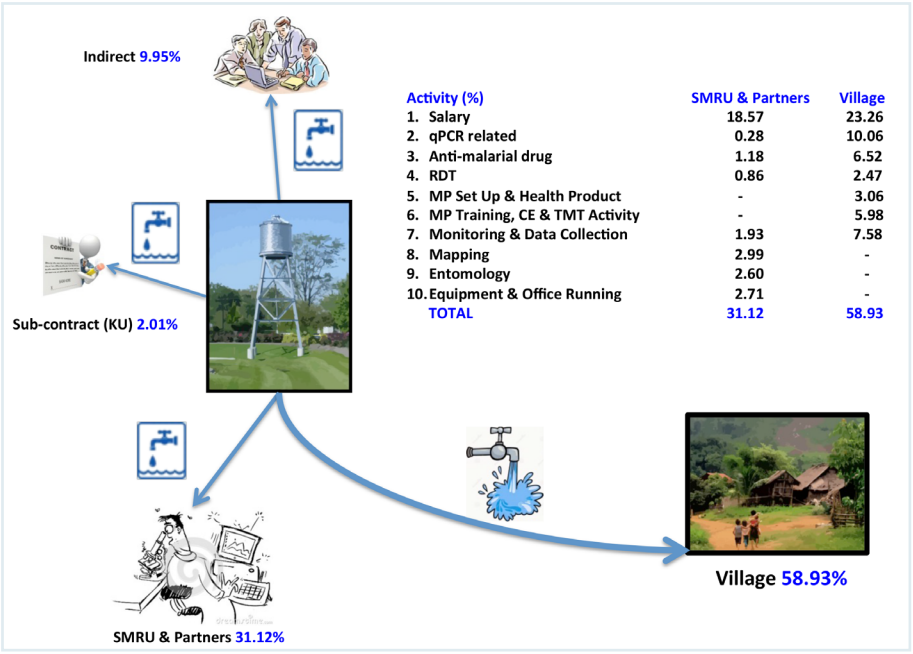
The detailed geographic knowledge (mapping), the strict terms of reference of the MPs (detect and treat within 24-48 hours), the real-time data and intelligence gathering and analysis (weekly), the search and treatment of the sub-microscopic reservoirs (MDA) are all essential components of this aggressive elimination programme. The quality of the CE is key to ensure community participation. The involvement of all health related Karen organisations (CBOs, NGOs) is crucial as well as a robust structure to ensure proper management and supervision. The preliminary results presented here are all very exciting and encouraging. Participation of the communities has exceeded expectations largely because of the trust built by the CE team. The MPWs have done a fantastic work and turnover is extremely low. The number of *P. falciparum* cases is indeed dropping fast, mainly because of the early detection and treatment by MPs but also because of the removal of the sub-microscopic infections by MDA.

All operations are going smoothly thanks to the dedication of the supervisors, coordinators, trainers and surveys/logistic teams, all working under difficult circumstances. So overall this project is going in the right direction, but much remains to be done. Hundreds of villages need to be equipped with a functioning MP, the difficult search for "hotspots" continues and better protection against vectors is needed, and qPCR surveys can be scaled up on a relatively large scale.

Time is of the essence because resistance to the artemisinins means that the ACTs will soon stop working and new drugs are years away. We have not detected any decline in the efficacy of piperaquine as a result of MDA but resistance to this drug has emerged in Cambodia. In addition there is a growing demand from the population to tackle *P. vivax* malaria, an even greater challenge. Finally, the transition from MP to health-post to ensure that the system remains effective will have to be addressed in the coming months.

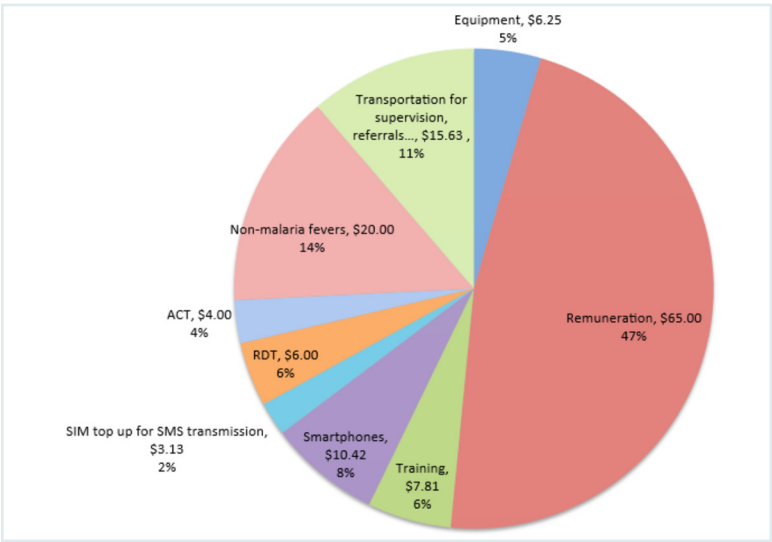
A. Budget analysis

All funds used in the project are clearly marked to an activity. The main expenses are related to salaries and stipends: although the central coordination team is kept to a minimum, all personnel working in the field receive monthly monetary compensation. Other important costs are the procurement and supply of ACT and RDT (11% of the budget) followed by expenses related to the malaria surveys (10%). Monitoring and data collection consume 10% of the budget. Most of these expenses are related to transportation costs. The set-up of the MPs represents only 3% of the budget (excluding RDT and ACT). Training and all community engagement activities represent 6%. Mapping and activities related to entomology represent around 3% each. It is important to note that despite important expenses related to laboratory procedures(i.e. qPCR) committed at the central level, almost 60% of the funds are spent in the villages (Figure 20).



Activity (%)	SMRU & Partners	Village
1. Salary	18.57	23.26
2. qPCR related	0.28	10.06
3. Anti-malarial drug	1.18	6.52
4. RDT	0.86	2.47
5. MP Set Up & Health Product	-	3.06
6. MP Training, CE & TMT Activity	-	5.98
7. Monitoring & Data Collection	1.93	7.58
8. Mapping	2.99	-
9. Entomology	2.60	-
10. Equipment & Office Running	2.71	-
TOTAL	31.12	58.93

Figure 20: Distribution of METF funds across the programme. Note that nearly 60% of the money go to the villages.



As MPs are the cornerstone of the programme, it is interesting to look closer at the cost of their maintenance. In this programme, the cost of one MP (set up and operation) is estimated at USD 138 per month, distributed as shown in Figure 21. This translates in a cost of 0.024 USD per fever case.

Figure 21: Monthly direct cost of a Malaria Post.

B. Figures

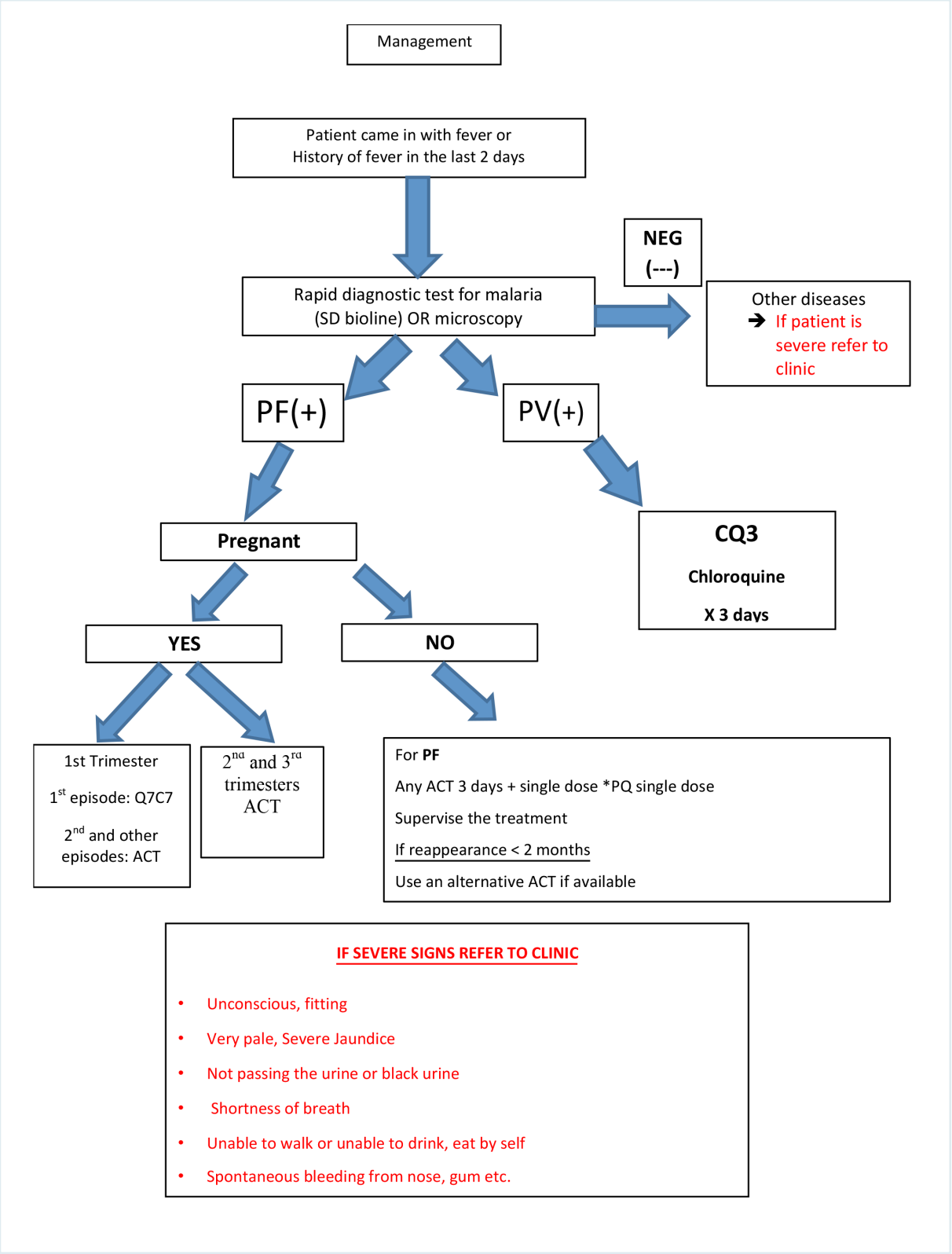


Figure 5: Treatment algorithm used by the MPWs

MP Village Name: |_____|	MP (village) code: |___|___|-|___|___|___|___|___|
	Report by: |_____| name

Malaria Elimination Task Force weekly report form (SD BIOLINE)

*From date:|___|___| |___|___| |___|___| to date: :|___|___| |___|___| |___|___|
Day Month Year

*Please count from **MONDAY** to **SUNDAY** always:
စဆိုင်ရှုးနေ့်လဖျော်တနဲ့်တဘုလဖျော်ဆိုင်ဘုံးထိတိ ။

Table 1: Total fever cases ပုံဆေါတက်ကိါထိုင်(Number of cases of **FEVER** တက်ကိါထိုင်းအနိုင်ဂ်ါ)

	Fever cases
<5 years	
5 to 15 years	
Older than 15 years (>15)	
Total	

Table 2: Laboratory results တါမဟ္ဂါးသဒါတမဉ် SD BIOLINE

	Pf	Pv	Neg	Invalid	Total
<5 years					
5 to 15 years					
Older than 15 years (>15)					
Total					

Table 3: Number of patients **TREATED** for malaria. ပုံဆေါလဲအဒိးန္ဒါတ်ညဉ်ဂိါကယံဉ်နိုဉ်ဂ်ါ

	Pf		Pv		Total
	Male	Female	Male	Female	
<5 years					
5 to 15 years					
Older than 15 years (>15)					
Total					

A. **Severe cases** within reporting week: ပုံဆါလာအနုးဖဲတန်ဲအံါတါဟ်ဖျါ |_____|cases

B. **Death due to Malaria or suspected of Malaria** within reporting week: |_____|cases
ပုံဆါသံလာတါညဉ်ဂိါ(မှ)ဆိမိဉ်လာတါညါဂိါအယိဖဲတန်ဲအံါတါဟ်ဖျါ ။

C. Total pregnant women within reporting week: Neg |____| Pf |____| Pv|____|
ပုံမိါဇာနိဉ်ဂိါလာတန်ဲအံါတါဟ်ဖျါ

Remaining number of SD BIOLINE tests in stock: တါမဟ္ဂါ SD BIOLINE လာအခိုဉ်တုံ |_____|

Remaining number of COARTEM boxes for Pf treatment: ကယံဉ်လာတ်ညဉ်ဂိါဃ် Pfအဂိါဆိုဉ်တုံ |_____| boxes

တါဂုါတါကျိုးအဂုးအဂၤတဖဉ်အဂိါကွဲးအိုးလာအချုတကဃ.

METF weekly report form v3 11 November 2015

Figure 6: Weekly data collection sheet used by MPWs

METF Meeting Records
2013 to 2015

	Type of meeting	Target	Duration	Location
Introduction meetings				
1	Introduction of METF meeting with stake holders	KNU leaders	1 day	KDHW office Maesot
2	Introduction of METF meeting with stake holders	Partners representatives	1 day	KDHW office Maesot
3	Introduction of METF meeting with stake holders	BGF leaders	1 day	Shwe Ko Koe BGF head quarter
4	Introduction of METF meeting with stake holders	Peace council (PC)	1 day	Way Ler Moo PC head quarter
5	Introduction of METF meeting with stake holders	DKBA northern region	1 day	Mae Ta Wor
6	Establishing METF executive committee	CBO+KDHW	1 day	BMA office
Training for community engagement				
1	Basic community engagement 8 dimension 1	METF partnership representative	3 days	Mae Meiw National park
2	Review 8 dimension	CE coordinators and area coordinator	2 days	Don Sak resort
3	CE for CE coordinator workshop (people, place, power)	CE coordinators and area coordinator	2 days	Don Sak resort
Preparation for opening malaria post				
1	Developing MP manual	Zone coordinators and area coordinators	2 days	Queen palace and Khun Pow MS
2	MP manual and CRF workshop	Zone coordinators and area coordinators	1 day	SMRU office
3	Financial and HR meeting	METF accountants and area coordinator	1 day	SMRU office
CE activities				
1. Pre-MP establishment				
	Area 1 Purpose of MP establishment and collaboration	Village leader and members, local authority	1 day	All villages with MP
	Area 2 local authority informing and collaboration	local authority (army/health)	1 day	All villages with MP
	Area 2 Purpose of MP establishment and collaboration	Village leader and members, local authority	1 day	All villages with MP
	Area 3 local authority informing and collaboration	local authority (army/health)	1 day	Kaw Kariake
	Area 3 Purpose of MP establishment and collaboration	Village leader and members, local authority	1 day	All villages with MP
2.Pre-Survey				
	Area 1 Objective , process for survey	community leaders and members	1 day	All surveys villages
	Area 1 Objective , process for survey	community leaders and members	1 day	All surveys villages
	Area 1 Objective , process for survey	community leaders and members	1 day	All surveys villages
3.MDA				
3.1 Pre MDA				
3.1.1 Workshop				
	Area 1 Preparation workshop for MDA activities	Zone coordinators and area coordinators	3 days	Day Bu Noe
	Area 1 MDA workshop	area representatives	5 days x 2	Day Bu Noe
	Area 1 meeting with community for MDA	community members	1days x 3 times x 25 villages	MDA 25villages
	Area 2 Preparation workshop for MDA activities	area representatives	2 days x 9 times	Ko Ko clinic
	Area 3 Preparation workshop for MDA activities	area representatives	1 day	Thay Baw Boe clinic
	Area 3 Preparation workshop for MDA activities	area representatives	2 days x 4 times	TOT clinic
	Area 3 Preparation workshop for MDA activities	area representatives	1 day x 6 times	Thay Baw Boe , TOT , Bae Hta , Ta Blu Koh Kee
3.1.2 Planning				
	Area 1 strategy planning meeting	with area 1 representatives	1 day	Mae Nu Htar
	Area 1 Gathering information for MDA activities before MDA started	villagers	1 week	25 villages
	Area 1 CE with community leaders	community leaders	1 day x 2 times x 3 villages	Leh Nar del,Pro Kay, Blerper problems villages
	Area 1 Meet with local authority about refused villages	stake holders	1 day	Day Bu Noe
	Area 1 Meet with community for MDA	villagers	1 day	Chaw Bwe Del and Baw Kaw Pa Kho
	Area 2 Gathering information for MDA activities before MDA started	villagers	3 days	Thay Boe Kyu , Tw Oak , Pa Klu
	Area 2 Strategy plan for MDA	zone coordinators	1 day	KK
	Area 2 Preparation for MDA	area coordinator and zone coordinator	1 day	Htee Kaw Taw
	Area 2 Action plan workshop for MDA	zone coordinators and supervisor	1 day	KK
	Area 3 Gathering information for MDA activities before MDA started	villagers	3 days	TOT , Kwee Ler Su , Ta SU Khee , Bar Hta , Ta Blu Koh Kee
	Area 3 Preparation and planning TOT	SMRU-METF and TCE team	1 day x 3 times	SMRU office 1 tme
	Area 3 Preparation and planning TOT	area representatives / stakeholders	1 day	Thay Baw Boe clinic
	Area 3 Meet village leader for MDA planning	Community leader	1 day x 2 times	TOT temple
	Area 3 Meet villagers for MDA planning	TOT villagers, community leaders ,METF, Stakeholders	1 day x 2 times	TOT temple
	Area 3 Meet local authority , villager leader and members	Villagers, community leaders ,METF, Stakeholders	1 day	Kwee Ler Su , Ta Au Khee , Bar Hta , Ta Blu Koh Kee
3.1.3 Group discussion				
	Area 1 CE for MDA once a month for 3 months continues for 25 villages, small group discussion with participants for continuing participation and rumour solving	villagers	1 day x 2 groups x 3 times x 25 village	MDA 25 villages
	Area 2 Group discussion with villagers for MDA understanding	community leaders and members	2 days x 3 times	Thay Boe Kyu , Tw Oak , Pa Klu
	Area 3 Group discussion with TOT for collaboration on MDA	community leaders and members	2 days x 5 times	TOT village , Kwee Ler Su , Ta Au Kee, Bar Hta , Ta Blu Koh Kee
Works review activities				
1	Area 3	Zone coordinator and MP supervisors area 3		
		zone 1,2,3,4,6	3 days	Thay Baw Boe
		Zone 5,7	3 days	A Zin
		zone 4	1 day	Ah Pah Gyi
	Area 3 work plan meeting	Area co, logistic officer , trainer , finance	1 day x 4 times	SMRU office or BMA office
2	Area 2	Zone coordinator and MP supervisors area 2		
		Zone 1,2,3,	3 days	KK
		Zone 4,5	3 days	Tel Bu
	Area 2 & 3 Technical Workshop	Area co, Zone co, trainer , logistic , MP sup.,	2 days	Wattana resort , Mae sot
	Area 3 work plan meeting	Area co, logistic officer , trainer , finance	1 day x 4 times	SMRU office , KK clinic , Ta Song Yang
3	Area 1	Zone coordinator	3 days	Mae Sariang
	CE on malaria post functioning workshop	MP workers	1 day	Tar Oh Del
Collaboration meeting				
1	3 areas with CBO health coordination meeting	all METF staff and local authorities and CBO staff	3 days for 2 places	Day Bu Noe for area 1, Nong Kaing for area 2 & 3
2	NGO health coordination meeting in Myawaddy district	IOM & save the children	1 day x 2 times	Myawaddy
3	Meeting with KDHW and MOH Myanmar	GO,NGO	3 days	Pa-an
4	Meeting with Save The Children Malaria program	NGO	1 day	Myawaddy
5	Meeting with Save The Children and IOM Malaria program	NGO	1 day	Myawaddy
6	KDHW strategic plan workshop	KDHW partners	1 day	Mae Sot
CE for decision-makers				
1	Pa-an district administrative officer	villager track level to district level	1 day	MSL
2	Duplayar	villager track level to district level	1 day 2 times	Kyate Doe
3	Meet with KDHW , BP for TOT MDA	KDHW and Back Pack leader	1 day	KDHW office
4	Meeting with community at TOT Duplaya	community members	1 day	TOT temple

Figure 9: List of CE meetings and other activities related to community engagement.