The Asia Pacific Malaria Elimination Network's Vector Control Working Group Annual Meeting

Century Park Hotel, Bangkok, Thailand
3-5th September 2018

MEETING REPORT

Contents

Acknowledgements

The 2018 Asia Pacific Malaria Elimination Network's Vector Control Working Group (APMEN VCWG) meeting was organised as a joint collaboration between the Vector Control Working Group (VCWG) host institution- Faculty of Tropical Medicine, Mahidol University, Thailand- and partner institutions within the VCWG Secretariat – Malaria Consortium and the Malaria Elimination Initiative at the University of California, San Francisco, Global Health Group (UCSF Global Health Group), and Kasetsart University, along with support from the APMEN Secretariat.

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Finally, our sincere thanks to the participating National Malaria Control Programme representatives for attending, presenting and participating in the meeting and activities, and to the partners institutions from academia, private industry and non-governmental organisations, all of whom provided invaluable contributions to the meeting.

Acronyms

API	annual parasite index
APLMA	Asia Pacific Leaders Malaria Alliance
APMEN	Asia Pacific Malaria Elimination Network
AP	Asia Pacific
CP	Country Partner
DFAT	Australian Department for Foreign Trade
DHIS2	District health information system 2
ESPT	entomological surveillance planning tool
GIS	geographic information system
GMS	Greater Mekong Sub-region
GTS	Global Technical Strategy
GVCR	Global Vector Control Response strategy
GVH	Global Vector Hub
HDT	human decoy trap
HLC	human landing catch
I2I	Innovation to Impact
IR	insecticide resistance
IRM	insecticide resistance management
IRS	indoor residual spraying
IVCC	Integrated Vector Control Consortium
ITN	insecticide-treated net
KU	Kasetsart university
LLIHN	long-lasting insecticide treated hammock net
LLIN	long-lasting insecticide treated net
IRS	indoor residual spraying
LSM	larval source management
LSHTM	London School of Hygiene and Tropical Medicine
MDA	mass drug administration
MMP	mobile and migrant populations
M&E	monitoring and evaluation
MOH	Ministry of health
MOMTN	Mekong Outdoor Malaria Transmission Network
NGO	Non-governmental Organisation
NMCP	National Malaria Control Programme
NTDs	neglected tropical diseases
OREN	online resource exchange network
PCR	polymerase chain reaction
PDP	Product Development Partnership
PQT	Prequalification Team
RMT	residual malaria transmission
SOP	Standard Operating Procedures
STAMPS	Standardised Technology Access Mapping and Pathways System
TFT-PET	transfluthrin treated plastic sheets
UCSF	University of California, San Francisco
VC	Vector Control
VBCD	Vector-bourne disease control unit

VCWG	Vector Control Working Group
WHO	World Health Organisation
WHO TDR	WHO Special Programme for Research Training in Tropical Disease
WHOPES	World Health Organisation Pesticide Evaluation Scheme

Executive Summary

The 2018 Asia Pacific Malaria Elimination Network's Vector Control Working Group (APMEN VCWG) annual meeting took place on 3-5th September 2018 at Century Park Hotel, Bangkok, Thailand. Over 90 participants from over 30 countries attended the meeting- designed to be a forum for entomological and vector control specialists from APMEN country programmes- to meet and discuss current progress and challenges related to designing and delivering effective vector control for malaria in the region, along with partners in research, academia and the private sector.

The overall objectives for the meeting were to:

1. Provide an update from the WHO Global Malaria Programme on surveillance manual and guidelines regarding vector surveillance, and to reflect on progress gained through the Global Vector Control Response 2017-2030 framework
2. Provide an update from WHO partners regarding insecticide resistance guidelines and status across the Asia Pacific (AP)
3. Discuss regional and sub-regional challenges and solutions to these barriers in strengthening entomological capacity, vector surveillance and response activities across the AP
4. Review and exchange information and experience of advances, good practices and studies for outdoor malaria transmission, including estimates of malaria attributed to outdoor transmission in selected countries
5. Discuss implications of outdoor transmission and country efforts for malaria elimination
6. Introduce and discuss concepts of access to, and pre-qualification of, new and existing vector control technologies, Product Development Partnerships (PDP), and the knowledge/resource exchange strategies across the AP

The objectives for the business meeting were specifically to:

a. Summarize and identify the key priorities to be included in the APMEN VCWG 2018-2019 workplan, and elevated to the 2019 APMEN Annual General Meeting (AGM) and relevant Ministers

The expected outputs of the meeting were to:

1. Recommend priority actions to address regional gaps in vector surveillance tools and programmatic capacity for vector control (VC)
2. Engage clear commitment by country partners to share specific Standard Operating Procedures (SOPs) and guidelines to support development where capacity/guidance is lacking, via the Online VC Resource Exchange Network (OREN)
3. Engage partners from a range of sectors to exchange information, review available tools and collectively explore solutions to meet these challenges via the OREN
4. Support ongoing mechanisms, facilitated by partners, for communication and sharing of best practices among entomology and VC in the AP region

The agenda to achieve these outcomes took place over two and a half days (detailed in Annex 1). The theme of Day 1 was 'Current Status of Vector Control across the Asia Pacific: A Situational Analysis'. The agenda for this day started with a group work session (utilising a World Café Style approach[1]), designed to explore current VC operations and activities within the National Malaria Control Programme (NMCP) under four thematic areas (Surveillance, Capacity

[1] For more on World Café discussion forums, please see: https://www.unicef.org/knowledge-exchange/files/World_Cafe_production.pdf

Building, Coverage/Targeting, and Knowledge gaps), determine fundamental operational gaps, and identify unique and shared challenges to both the design and implementation of said activities within each programme (detailed further in Session 2, below). To tailor these discussions, country partner participants were grouped according to their malaria burden, and subsequently national/sub-national malaria elimination targets, to allow for exchange of common challenges and obstacles, and joint exploration of potential solutions to these.

The afternoon session commenced with an overview of the World Health Organisation's (WHO) updated guidance frameworks for entomological surveillance and VC at both global and regional levels; overview of gaps and challenges in entomological surveillance and VC across the Asia Pacific, and within the Greater Mekong Sub-region (GMS) specifically, from two large recent surveys of entomological capacity; and the presentation of preliminary results from the use of an entomological surveillance planning tool currently being trialled in sites across both sub-Saharan Africa and within the AP. For the final session of the day, participants re-assembled into their respective groups to centre their discussion on 'Targeting risk/high risk groups: programmatic gaps and challenges' (detailed below).

Day 2 focused on 'Technical issues and current research', intended to update NMCPs on new research and findings applicable to programmatic aims and procedures. This started with a session on insecticide resistance (IR) monitoring, which comprised a WHO update of IR status across the AP, followed by presentations of *Anopheles* and *Aedes* species identification and mapping approaches, and results from a field evaluation evaluating the efficacy of transfluthrin-treated plastic sheets against exophagic malaria vectors. The next session on outdoor malaria transmission began with an overview of its definition and scope, strategies and estimates regarding the magnitude of residual malaria transmission in countries of the Asia Pacific, as well and sub-Saharan Africa, before exploring some of the current vector surveillance approaches utilised by AP country programmes, as well as progress update/trial results for new surveillance tools for monitoring outdoor transmission. Reflecting on the noted challenges from all of the meeting discussion/presentations thus far, the session ended with a final group work exercise on 'Solutions and moving forward': group members once again gathered to discuss entomological priority areas relative to each setting, and reviewed country/regional gaps in tools and programmatic capacity for vector control from the NMCP perspective. Group members also identified and recommended where additional support from APMEN could be centred to complement noted NMCP priority actions.

The second half of day 2 presented a series of 'turbo talks' on current research findings and themes in three different areas: i) Intersects of human and vector behaviour: evidence and solutions; ii) Accelerating access to vector control commodities and technologies in Asia Pacific (following on from the 2017 VCWG meeting where industry members highlighted challenges within country processes' for bringing new tools to market, this session sought to expose current progress/novel approaches currently being implemented by partners and consortia to tackle these challenges) and iii) Network-to-network information sharing and capacity building.

On Day 3, there was a recap of the scope of activities organised and conducted by the VCWG in 2017/18, and an overview of upcoming events opportunities within the Network. NMCP participants also provided short feedback presentations of the key take-away points from the meeting, and provided suggestions for key topic/focal areas for the VCWG moving forward. Both the VCWG Chair and Co-Chair closed the session with a final statement/ take home message to all participants.

Day 1

Session 1: Opening Remarks

Session speakers:

- Dr Christina Rundi, *APMEN VCWG Co-Chair* (Malaysia)
- Dr Chongrak Wachrinrat, President *Kasetsart University* (Thailand)
- Dr Suthipun Jitpimolmard, Director *Thailand Research Fund* (Thailand)
- Dr Dorina Bustros, Technical Officer, *World Health Organisation* (WHO Regional Office for the Western Pacific, Phillipines)

Following a meeting welcome provided by Dr Christina Rundi, the speakers each described the important role the APMEN VCWG has had, and will continue to have, in achieving the 2030 goal of a malaria-free Asia Pacific. The importance of increased coordination and partnerships was also highlighted, as a means to potentially achieve gains beyond malaria elimination, including universal health care and poverty alleviation.

In particular, Dr Chongrak and Dr Jitpimolmard discussed the critical partnership role between MOMTN and APMEN VCWG, highlighting that continued engagement will be crucial to combat the increased threat posed by outdoor and residual malaria transmission across much of the AP. Dr Bustos described how the malaria elimination landscape has transformed since the creation of APMEN, and reminded participants that success is contingent on continued coordinating efforts.

Session 2. Poster presentations – Responding to the challenges to implementing, coordinating, and sustaining entomological surveillance and response activities (*Chair(s): Dr Jeffrey Hii and Miss Tiff Dahmash*)

Group work discussion #1: Operational overview of key areas in entomological surveillance and vector control

Introduced by Dr Jeffrey Hii and Miss Tiff Dahmash, this group discussion saw country partners (CPs) allocated into 4 separate groups, categorised according their malaria burden, and respective elimination objectives and targets. Four discussion groups were set up, with prior nominated facilitators in place, each focused on a key topic area for entomological and vector control operations: Surveillance, Capacity Building, Coverage/Targeting, and Knowledge Gaps. CPs were also prior requested by the VCWG to complete a poster template detailing activities and data related to key vector control operations in their respective settings, that were used to as reference documents to guide discussion topics (see Annex 4). Each CP group rotated around these stations (45 minutes per station) to discuss and share current status of operations under each of these areas, and challenges associated with these. Partner institutions and observers moved between the groups to provide an opportunity to learn and engage with the variety of perspectives and perceptions presented by CP members and programmes. The objective of this discussion session was to understand a) what VC/entomological data is collated and prioritised with the NMCP, b) how data is being

used to determine VC strategy and tools utilisation, and how coverage is monitored and evaluated, and c) existing knowledge and operational gaps to achieve targets.

Session 3. Updates on entomological surveillance, vector control monitoring and evaluation, and challenges for implementation of global vector control (*Chair: Dr Mohammad Khalilur Rahman*)

The theme of session 3 was 'Updates on entomological surveillance, vector control monitoring and evaluation, and challenges for the implementation of global vector control'. Dr Tessa Knox opened by reflecting on regional progress in the AP in response to the 'Global Vector Control Response 2017-2030' (GVCR) assembled by a consortia of country, regional, and global partners in May 2017- including support from WHO's Joint Action Group for GVCR implementation. This has included the development of regional action plans, country-led VC needs assessments, and the initiation of a WHO-led focused independent needs assessment within the GMS to identify gaps and challenges to VC coordination and implementation (led by Dr Sean Hewitt, below). Dr Knox then drew attention to the revised entomological surveillance and monitoring guidelines within the 2018 WHO manual for malaria surveillance, highlighting the need to focus on adapting entomological surveillance to suit different transmission settings: a key shift to guide focused data-driven decision making at both local and national level. With regard to IRM, a WHO framework document has been published for guiding the development of national monitoring plans, highlighting that effective IR management strategies are grounded in and guided by country situational analyses: data on malaria vector species and their susceptibility status/resistance mechanisms, malaria epidemiology, and current VC interventions, for example, should be matched with information on country-specific product registration and development processes. Updated guidance on test procedures for IRM are also now available, and an independent review of the supply processes for assay test papers/kits is currently underway to identify significant bottlenecks. WHO is currently tracking resistance trends and gaps in surveillance monitoring for IRM globally, with data showing there has been notable increase in resistance and intensity to specific insecticides, mainly in the African region and in dominant vector species (An. *funestus* and An. *gambiae*). Dr Knox also highlighted how this data is being utilised within the 'Malaria Threats Map' initiative- a newly developed tool aimed at tracking biological challenges to malaria control and elimination- as well as for the development and pilot of DHIS2 modules for entomology and vector control. It was also reiterated that new VC tools are currently being evaluated by the VC advisory group (VCAG) and WHO Pre-qualification (PQ) team (previously WHOPES). Moreover, given the current plethora of guidelines and frameworks for entomological surveillance and VC, WHO is planning to develop a single, comprehensive document for malaria entomology and VC- encompassing and condensing information from all currently available guidelines and tools- to facilitate a clearer and explicit approach to VC applicable to all endemic settings.

Malaria entomology and vector control in the GMS: an independent situation analysis *Dr Sean Hewitt*

Dr Sean Hewitt presented recent findings from a recent WHO review regarding current status, capacity, and knowledge gaps in malaria entomology and VC across the countries of the GMS. Whilst significant progress has been made in the past decade to reduce burden of malaria in the region, programmes are now in danger of stalling, and 'unlikely to reach elimination targets without radical change'. Alongside the more general shared challenges across the AP, specific regional challenges highlighted included extreme heterogeneity in *Anopheles* species and species complex- with varying resting, feeding, and mating behaviours, low entomological capacity within programmes, poorly managed M&E activities, uneven coverage and poor quality of VC interventions. Dr Hewitt also highlighted that VC coverage is very low amongst forest-goers: particularly worrying given that majority of malaria transmission

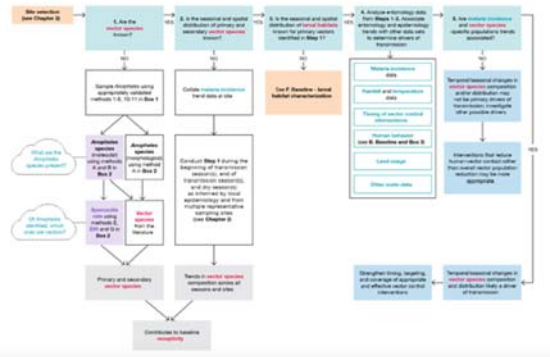
across this region is restricted to densely forested areas frequented by mobile and migrant populations (MMP), such as forest-goers. The research also highlighted low knowledge regarding the entomological and epidemiological drivers of residual malaria transmission (RMT). Whilst new prevention tools to limit RMT in these persistent foci are currently under evaluation (ranging from insecticide treating clothing (ITC), topical repellents, to ivermectin), attention should be paid to the fact that the current suite of VC tools available *are* effective to interrupt transmission of malaria in these settings. Poor-quality implementation appears to be a most critical factor undermining programme progress across the region, and is often neglected in management approaches. Capacity building for entomology that focuses on quality control and programme management, innovative coverage strategies for hard-to-reach/high risk populations (e.g. working with military and formal sector partners) and a shift toward 'epidemiology-led problem solving' should be prioritised at national down to district level, and the critical need for locally adaptable /appropriate solutions recognised and strengthened by both implementing technical and donor partners alike.

Malaria Vector Monitoring in Asia-Pacific region: how are we doing relative to other areas- *Dr Tom Burkot*

Complementary to this research, results were then presented from a recent survey evaluating the current status of vector monitoring across the AP (14 country response). Given the heterogeneity of malaria vector species and their distinctive behavioural traits in the AP, Dr Tom Burkot began by emphasising the importance of taking a proactive approach to vector surveillance (VS) to better monitor and respond to changing vector behaviours; to distinctively characterise area receptivity status to monitor the suitability and effectiveness of VC tools; and to inform appropriate selection of outbreak response tools. Whilst there is evidence for granularity of data in some settings across the AP (e.g. data of vector distribution at village level), almost 1/3 of countries do not collect information regarding vector distribution that is required to characterise and monitor receptivity status. Data to measure the relative density of vector species is not often carried out to determine annual seasonality of transmission, and to inform optimal timing of interventions. IR tests are reported to WHO annually by the majority of countries (mainly using adult samples); however, supplementary data to determine adult resistance mechanisms is rarely collected. Data for entomological indicators used to determine risk for malaria transmission, e.g. adult biting time and indoor and outdoor biting rate also remains low. The major challenge noted for conducting efficient vector surveillance activities was programme capacity (manpower), as well as little opportunities for training and skills development. Specially related to this is the recognition that preferred techniques for VS are often labour intensive and costly (e.g. human landing catch or HLC method that requires supervision, logistics, hiring often managed by central staff) . Operational research for the effectiveness and use of alternative surveillance techniques needs to be prioritised to counter the disadvantages of HLC. Also noted is the lack of priority given to entomological activities in country malaria strategic plans: technical and programmatic guidelines to facilitate good practice are often not available, especially as district level. As the arsenal of VS tools begins to expand in the AP, so too the demand and investment in comprehensive surveillance data needs to increase to ensure that selection and deployment of VC tools is both driven and informed by comprehensive, quality data.

Planning tool for entomological surveillance in elimination settings- *Dr Neil Lobo*

Dr Neil Lobo discussed a new entomological surveillance planning tool (ESPT), currently being trialled in both African and Asian settings. ESPT was initiated following country demand and developed in accordance with WHO and PMI guidance material, and focuses on a more coordinated approach for operationalising entomological surveillance to better understand both malaria transmission dynamics and VC protection gaps. Particular strengths of the tool are a) emphasis on a set of *minimum essential entomological indicators* to facilitate a more manageable and tailored approach to programme surveillance efforts, and b) an emphasis on the *practical integration* of entomological and epidemiological information to guide a more comprehensive monitoring and response processes. The tool provides users to shape their surveillance approach through a step-by-step, iterative process, the first of which is to define the key question(s) you are looking to answer (e.g. what is the baseline vector distribution? How does the impact of my intervention change over time?) before being guided to specific areas of the ESPT relevant to that question, and a list of different indicators (e.g. vector, epidemiological, intervention usage, etc) and strategy approaches and effective responses (these include both minimal and 'nice to have' indicators, the latter being optional components dependent on available resources and programme capacity). The tool also highlights effective sampling approaches and designs relevant to best capture different vector species.



Group work discussion #2: Targeting risk/high risk groups and programmatic gaps and challenges (*Chair: Dr Tho Sochantha*)

Following on from the group morning discussion, NMCP participants once again gathered into their respective groups to re-engage in a group discussion focused on targeting and managing malaria transmission amongst high risk groups (a component also featured within the pre-prepared posters). The objective of this discussion session was to explore both the proportion and characteristics of various high risk groups in each country setting, understand how VC is targeted and managed for these groups, and evaluate programmatic gaps and challenges.

Day 2

Session 4: Insecticide resistance monitoring (*Chair: Ms RDJ Harischandra*)

Malaria vector insecticide resistance monitoring and status in the Asia-Pacific- *Dr Tessa Knox*

Dr Tessa Knox provided an overview of IR monitoring across the AP, outlining WHO's digital data collection and management system for IR (through DHIS2) both at country and global level (consisting of both NMCP data as well as partner organisations in country). Support for implementation of DHIS2 is encouraged to facilitate a more coorindated overview for IR through the contribution of implementing partners within one online management system, primarily for the development of a) regional reports and status updates, b) feeding into the WHO Malaria Threats Map, and c) focused/strategic investigations at local level (e.g. spatial and temporal trends, gaps analyses, etc). Recent analysis of IR data for the AP overall highlighted a mixed picture for IR surveillance and reporting (predominantly for pyrethroids). Whilst many countries within the South Asia region have shown steady progress, evidence suggests little to no data reported for those in the Western Pacific in the last 3 years (this may be due to under-reporting or less investment in IR surveillance in some settings). The majority of the data is focused on discriminating concentration bioassay alone, with little molecular or biological bioassay information reported, and very little data on resistance mechanisms. Importantly, the data showed that there is confirmed resistance to pyrethroid and DDT in most APMEN countries with numerous vector species (and wide variation across different settings), though resistance to all 4 primary insecticide classes is evident across the APMEN countries, largely driven by India. WHO is currently working with countries in the region to strengthen IR data monitoring and management plans, and more attention needs to be directed toward supporting appropriate mechanisms for routine collection and reporting of IR data, and, in turn, using this data to assess the impact of IR on the efficacy of current vector control interventions.

Sibling species ID and review of outdoor biting vectors- *Dr Theeraphap Chareonviriyaphap*

Dr Theeraphap Chareonviriyaphap provided an overview of the methods for mosquito sibling species identification and behaviour monitoring of outdoor vectors in Thailand. Reflecting on the steady progress Thailand has made in the last decade in reducing malaria incidence and *P. falciparum* cases, Dr Chareonviriyaphap then presented a snapshot of the various dominant Anopheles species complex evident in the AP (with data showing that 14 species complex account for almost 50% of vector population), and, importantly, a need to a) use more sensitive species identification methods to capture this variability, and b) understand distinct behavioural characteristics contributing to continued malaria transmission to inform more targeted VC efforts. Given the low specificity of using morphological keys alone, it was emphasised that a combination of morphological and molecular techniques (e.g. DNA extraction and PCR) should be encouraged to facilitate correct species identification, as well as to identify specific insecticide resistance mechanisms: for example, through the use of these tools, researchers at Kasetsart University (KU) have been able to identify important sub-species within the dominant *An Dirus*, *Maculatus*, and *Minimus* complexes in Thailand, and their distinct characteristics related to host preference, peak biting times, and tropic behaviour that affect how, who, and where malaria transmission may occur. KU have also developed geo-maps across Thailand, and the wider GMS region, combining data on both vector location and related behavioural characteristics to help monitor and track species density and composition in these areas, as this will encourage more focused targeting of VC interventions as these are relevant to vector profiles across different settings.

Mapping insecticide resistance of *Anopheles sp.* and *Aedes* sp. vectors in Thailand- *Dr Rathchadawan Ngoen-klan*

Dr Rathchadawn Ngoen-Klan, also from KU, presented her research focused on developing a comprehensive IR monitoring database for Thailand for *both* Anopheles and Aedes vector species. Using GIS technology, the team have mapped both retrospective and current IR, entomological, and epidemiological data to more precisely identify, track, and predict IR patterns, highlight at-risk population groups in these locations, and better inform relevant VC strategies to help mitigate a wider range of vector-bourne disease transmission (e.g. transmission and risk of both malaria and dengue). To date, the tool has helped to identify and track, for example, changing patterns of IR in *An. minimus* species across Northern Thailand, identify specific sibling species showing higher levels of IR to different insecticides, and identify different behavioural patterns for insecticide avoidance amongst *An Dirus*, *Maculatus*, and *Minimus* species complexes across sites in Thailand.

Field evaluation of transfluthrin against an exophagic malaria vectors- *Mr Chutipong Sukkanon*

The session concluded with a presentation of the results of a recent novel study investigating the efficacy of transfluthrin (a fast acting pyrethroid with low persistency)- treated plastic sheets (TFT-PET) against *An. minimus s.l* in Thailand: a dominant outdoor biting mosquito. Current evidence for the efficacy of TFT-PET against exophagic vectors is primarily drawn from studies across sub-Saharan African settings: this is the first assessment of this novel tool in Kanchanaburi province, Thailand. Results suggested that TFT-PET provided relatively high (≈ 73% landing inhibition) and low (≈30% landing inhibition) protection in semi- and open field conditions, respectively. It was

suggested that the use of TFT-PET could serve as a complementary tool to existing VC tools, and further research is needed regarding public understanding and acceptance of use of transfluthrin.

Session 5: Outdoor Malaria Transmission – anthropological, surveillance and new tools

Session 5a – Residual malaria (*Chair: Masatoshi Nakamura*)

Residual malaria transmission: definition and scope- *Dr Tessa Knox*

Dr Knox addressed the topic of residual malaria transmission (RMT), reiterating that the issue remains contentious as the definition for entomology is often different to that used across other health/medical oriented fields. WHO had previously developed a guidance document for defining and managing RMT in 2014 (*WHO guidance note on control of residual malaria parasite transmission*, September 2014), including recommendations that local evidence for the magnitude and drivers of RMT be gathered to help better define and quantify the problem across different settings, as well as understand the limitations of current VC tools in targeting specific drivers of RMT. To support this initiative, WHO TDR established a project in 2015- 2017 to examine the extent and causes of residual malaria parasite transmission across 4 regions (including countries in the GMS and WPRO regions). A critical finding related to the drivers of residual transmission is the requirement for a *holistic analysis* of the gaps and challenges experienced within any malaria control programme, from coverage/access, vector composition to compliance/use of tools: an isolated focus on residual transition alone will only reveal one part of a much more integrated transmission cycle. Based on these results, WHO has now extended and updated the definition for RMT in 2018 and to shift the focus from entomological aspects to a more holistic, operational approach for programmes (this is detailed further in the *WHO Malaria Terminology* document, 2018).

How much residual transmission in GMS: Thailand and Viet Nam- *Dr Jeffrey Hii*

Dr Jeffrey Hii of the Malaria Consortium/APMEN VCWG, then presented results from a recent mixed methods study looking at the magnitude of RMT and factors contributing to low (<1% prevalence) but sustained transmission in rural communities on the Thai-Myanmar border and central Viet Nam. Findings suggested that primary drivers of RMT in the study sites were higher mosquito abundance in forested areas where LLINs were used less frequently or could not be used; human-mosquito interaction in sites without LLIN/IRS and/or where LLIN cannot be used (and where other effective tools have not yet been deployed); late sleeping and waking times coinciding with peak biting hours; feeding preferences of anopheles taking them away from contact with LLIN and indoor residual spraying (IRS), e.g. exophagy and zoophagy); non-use of LLIN and use of damaged/torn LLIN; high population movement across the border and into forested areas; and *Plasmodium vivax* predominance resulting in relapse(s) of previous infection. Gaps in coverage were significantly higher in the farm huts and forest where risk of anopheline biting is much greater. Recommendations included exploration of personal protection methods, appropriate for these community settings, that are easy to use, and require minimal behaviour change and communication. Importantly, the study supported the need for a more holistic definition for RMT, as net use is often overestimated and does not take into account people outside of the household, eg. those in farm huts/forest areas.

Session 5b – Entomology and vector surveillance (*Chair: Dr Than Naing Soe)*

Role of entomological surveillance to characterise receptivity and vulnerability for malaria re-introduction in Malaysia- *Ms Perada Wilson*

Ms Perada Wilson of the Malaysian MOH presented the national 'MyFoci' entomology database system: a MOH-led entomological surveillance platform developed to assist with accurate foci classification to characterise and stratify malaria risk areas to better target prevention efforts, and to curb re-introduction of malaria in areas of cleared foci (approx. 97% of localities were declared malaria free in 2015). In response to the shift from pre-elimination to elimination phase, the malaria surveillance system was re-structured to be more proactive to identifying and responding to malaria cases. Short preliminary ecological assessments coupled with entomological surveys and decentralized surveillance are used by the MOH to develop a graded receptivity and vulnerability matrix to stratify localities according to malaria risk level (cleared, active and residual non-active foci). Using this combined receptivity-vulnerability data, the MOH and local response teams customised appropriate VC response strategies within each of these areas according to their ecological and demographic profiles.

Update on Human Decoy Trap for sampling exophilic mosquitoes in Indonesia- *Dr Neil Lobo and Dr Frances Hawkes*

A novel sampling method (and preliminary trial results) for exophilic mosquitoes was jointly presented by Dr Neil Lobo and Dr Frances Hawkes of Greenwich University and the UCSF, respectively. Reiterated was the need to tailor mosquito sampling methods/tools that take into account diversity in vector behaviour across different localities (e.g. the same sampling device used in one region may not be effective in another for the *same vector*), as well as the difficulties in effective sampling of outdoor biting mosquitoes (highlighting the ethical and practical challenges associated with the use of 'gold standard' human landing catch (HLC) sampling techniques for outdoor sampling. A new tool- the Host Decoy trap (HDT)- which utilises a model of host- associated stimuli (specific visual, odour, and thermal indicators) to lure/capture mosquitoes showed higher trapping efficacy of HDT in capturing *An gambiae s.l, Mansonia spp, and Culex spp* vectors than HLC throughout all season scenarios. A multi-country trial (supported by University of Greenwich, the UK Medical Research Council, and Biogents) in sub-Saharan Africa and Asia (2017-19) is currently evaluating a standardised HDT prototype tool to determine its efficacy relative to HLC. Preliminary results across the sites highlighted important behavioural parameters to consider for use, as well as the importance of accurate molecular identification to determine efficacy. HDT evaluation in Kenya, for example, showed mixed results for vectors of the *same species complex* when using cow bait over human; in Indonesia, HDT was less effective in capturing Anopheles species than HLC, though HDT caught almost 3x more Culex mosquitoes than HLC. The project is now seeking to refine and trial the HDT tool across other sites in the AP to build the evidence base to further determine its efficacy for use in different settings/seasons.

Barrier fence for mosquito surveillance and vector control- *Dr Tom Burkot*

Dr Tom Burkot of James Cook University, Australia, presented the barrier fence mosquito monitoring tool: an inexpensive, neutral, no attractant trap that essentially intercepts the natural flight pattern of all mosquitoes in a given area for capture of blood fed and host seeking female mosquitoes. Various 'shade cloth' materials made of polyvinyl chloride (PVC), coated polyester, polyethylene mesh, or cotton netting were assessed. Trial results from Indonesia

indicated that darker netting colour seems to affect the relative numbers of specific mosquito species, e.g. higher attraction of *An. farauti* compared with *Culex* and *Aedes*; light and medium netting colour appeared to increase the number of mosquitoes captured; adding eaves to the top of the netting also led to a higher proportion of mosquito capture; and frequency of collection at 30 minutes compared to 1 hour or 90 minutes had a positive effect on the number of mosquitoes caught. Barrier fence monitoring has been highly used across sites in the AP and Latin America, with positive success rates observed, and the evidence for efficacy being built further through current trials continuing across both Asia and sub-Saharan Africa.

Group work #3: Solutions and moving forward (from programmatic & APMEN perspectives) (*Chair: Dr Jeffrey Hii and Miss Tiff Dahmash*)

A final group discussion session saw NMCP participants once again gather into their respective groups to focus on current and potential solutions to the listed challenges and bottlenecks, relative to each country context. Specific objectives of the session were to recommend priority actions to address country and regional gaps in tools and programmatic capacity for vector control from the NMCP perspective, and to identify and recommend additional support from APMEN to complement NMCP priority actions.

Box 1

Group #	**Summary of entomological priorities**	**How APMEN can support**
Group 1: Eliminated/elimination goal 2020 (Sri Lanka, China, Korea, Malaysia, Bhutan)	Technical: • Maintain knowledge, skills, and commitment of staff in low transmission settings- competing health priorities a significant issue (funding and skillset) • Reorient entomologists job from administration to more technical role • Leverage entomological capacity for arbovirus surveillance to maintain for malaria • Upskilling cadres at lower end of health system in basic entomology • Engage communities in basic surveillance and control strategies • Develop minimal requirements for entomological surveillance at local and national level Political: • Increase advocacy efforts to relevant bodies to encourage sustained investment • Invest in creating opportunities for next generation • Empower communities and household members to protect themselves, eg. housing subsidies in China	• Trainings for IR surveillance, morphological (identification and analysis techniques) • Facilitate south-south trainings- capitalise on lessons learned from near elimination/elimination country/settings Training on basic vector bionomics studies • Support research collaborations, eg. for IR mechanics • Support short courses, diplomas (regional, global) • Help track exported cases and facilitate communication between relevant bodies
Group 2: Elimination goals 2021-27 (Laos, Nepal, Cambodia (pf), Thailand, Vietnam, Myanmar (pf. in 5 regions/states, Bangladesh (*pf* in 8/13 endemic districts), Pakistan (reduce burden by 75% 2020)		• Help to engage private sector for harmonised product registration process • Support guidelines re. efficient product procurement for VC • Engage with universities to provide capacity building/training opps for next generation entomologists • Initiate cross-border meetings • Facilitate laboratory support at local level • Encourage donor sustainability and engagement techniques • Create platform for sharing of resources and tools • Develop evaluation tools for entomological surveillance- resources and guidance • Help track exported cases and facilitate communication between relevant bodies • Develop reporting system for imported/exported cases across border • Help verify approaches to above and share best practices • Cross-collaborate with SRWG

Group 3: Elimination goals 2027-30 (Indonesia, Philippines, Vanuatu, India) Group 4: High burden (Afghanistan, PNG, Solomon Islands)	Technical • Characterisation/stratification of transmission areas • Better correlation between epidemiological and entomological data to guide strategy development/tool investment- data driven programme reorientation • Generate more data through multi-sectoral collaborations (eg. research groups, MOH, universities, etc) • Standardising MOU's for research partners- empowering NMCPs Political • Build professional status of entomology (often not prioritised in wider structure of disease programme) • Ensure research agenda set by NMCP and not just donor priority (short, medium, and long term) • Realistic expectations with limited funding- prioritising activities	• Capacity building: trainings, fellowships, etc • Vector bionomics: species identification and behavioural traits (and linkages to potential for transmission)- link to epidemiological data • Generating and reporting data beyond local level- communicative skills development • Training on SOPs for field/lab studies

Session 6: Intersects of human and vector behaviour – evidence for solutions (*Chair: Dr Vu Duc Chinh*)

Effects of indoor residual spraying using bifenthrin on *Anopheles* species composition, abundance, feeding behaviours, and susceptibility to pyrethroids in malaria ecosystems of East and South Thailand- *Dr Adisak Bhumiratana*

Continuing the discussion re. evidence to better understand, document, and target the primary drivers of outdoor malaria transmission, Dr Adisak Bhumiratana of Thammasat University, Thailand, opened session 6 with a presentation of research findings looking into the effect of indoor residual spraying using bifenthrin for Anopheles vectors (currently used for VC as part of the Thailand NMCP) in sites across East and Southern Thailand. Results showed that IRS using bifenthrin reduced species diversity of night biters; reduced species composition and abundance, especially indoor density of primary vectors such as *An. dirus*, *An. minimus*, and *An. maculatus;* and seemed to affect changes in feeding behaviors of *Anopheles* vectors, likely to select for outdoor biting. The research also indicated that primary vectors in Thailand, such as *An. dirus* and *An. maculatus,* are highly susceptible at 0.05% deltamethrin as well as 0.9% bifenthrin (more detail of the study and results can be found on the APMEN VCWG website).

Contribution of daytime biting behavior of malaria vectors to outdoor exposure- *Dr Amelie Vantaux*

Dr Amelie Vantaux of Institut Pasteur, Cambodia, highlighted results of field studies investigating mosquito activity rhythms and host preference in forested areas of eastern Cambodia, where risk of malaria transmission has been shown to be highest due to low use of LLINs and inadequate housing conditions. Sampling involved the use of double mosquito net traps across a variety of high risk ecological settings (e.g. forest, village, forest near village, rubber tree plantation site) for hourly collections of female anopheles over a 48 hour period (paired human and cow baited traps) across the dry and rainy season. Findings showed that almost 70% of mosquitoes collected through human-baited traps were in the forest, mostly during night-time hours (18:00-06:00 hours) with significantly higher numbers during the rainy season. Just over 4% of all mosquitoes sampled were Plasmodium positive (mainly *P.vivax*), with a higher proportion occurring during night time hours from human-baited traps. Importantly, the data revealed zoophilic behaviour/generalist host preference (particularly for *An. dirus*- a dominant vector in this region), indicating that infectious mosquitoes may be sustained by animal hosts when humans are not (yet) present.

Seasonal change of Anopheles population in teak plantation and slash and burn cultivation area in relation to population migration and receptivity- *Dr Masatoshi Nakumara*

Dr Masatoshi Nakumara of the VBDC unit, Myanmar, presented data on the relationship between high risk population groups within slash and burn agricultural areas in Myanmar (where malaria positivity rates remain high despite relatively good access to malaria health services) and seasonal changes of anophelines. Research data revealed that slash and burn cultivation in fields gradually provide favourable breeding conditions for *Anopheles* mosquitoes: *An.*

minimus density increased after development of the teak plantation field (around December in Myanmar), and *An.dirus* habitats were also maintained in field fringes during this period. Importantly, the data highlights that highly receptive areas for malaria transmission are being created and moving year by year, as a consequence of and in line with changing agro-forestry industry practices. It was emphasised that collaboration with local government departments working in the forest is essential to better target VC and case management activities due to restrictions placed on many local NGO partners, and to build a coordinated elimination response amongst state and non-state actors (government's policy promotion for reforestation is evident in these regions). An understanding of local ecological conditions, including entomological surveillance, has therefore been crucial to developing data-driven, locally appropriate vector control measures.

Strategies to control outdoor biting malaria vectors in North Thailand- *Dr Wannapa Suwonkerd*

Dr Wannapa Suwonkerd presented an overview of vector bionomics for primary malaria vectors in in border provinces of Northern Thailand (*An. dirus* and *minimus),* where evidence and risk for outdoor malaria transmission remains high. Findings show that indoor/outdoor biting behaviour in these environments is species and location specific, suggesting that whilst conventional VC tools- IRS, ITN, LLIN- are promoted in these areas, they may not always be appropriate: preference for early and outdoor biting, for example, was demonstrated by the two dominant species complexes, though specific biting time-frames differed across different provinces, and sibling species. The research suggests that repellents may be a more suitable tool, and promising results for plant-based substitutes (*Andrographis paniculate*) have recently been shown in controlling *Aedes aegypti*, with a hope that the active ingredient can also be an effective tool against *Anopheles* vectors in the future. It was also reiterated that primary challenges faced by the MOH here is the lack of skilled entomological staff present in these areas, and lack of research/data available documenting human behaviours and risk for malaria transmission.

Private sector distribution of subsidized treated hammock nets to forest goers in Vietnam- *Dr Joselyn Neukom*

Operational research findings from a public-private partner strategy for the distribution of insecticide treated hammock nets (ITHN) in Vietnam was presented by Dr Joselyn Neukom of PSI. The collaboration between PSI and the Vietnam MOH seeks to better engage with private providers to cater to forest-going population groups in high risk malaria areas through integrated case management and prevention services- a complementary strategy to that already being managed by the MOH. Within this alliance, qualitative research on user preference for ITHN compared with two different types of nets- manufactured by TANNA and TIANJIN- revealed that, overall, TANNA nets are the preferred choice by forest-goers, primarily due to comfortable material, ease of use, extra storage compartments, and perception of protective effects. Based on this feedback, PSI and the MOH are now working with private outlets and worksites already serving/employing forest sleepers to distribute/promote TANNA ITHN for free/at a subsidised price to encourage uptake of these products (over available untreated alternative nets) in locations with less access to commercial markets. Following this, PSI plan to conduct a 12 months post project study to assess improvements in awareness, access, and use of ITHM amongst forest-goers in the same areas to inform the next stage of the research, with plans to share progress and insights with government and relevant stakeholders in the coming years.

Ivermectin mass drug administration to suppress outdoor malaria transmission- *Dr Kevin Kobylinski*

Research findings investigating the efficacy of using Ivermectin- a lethal chemical that, when ingested, becomes a toxic agent against Anopheles mosquitoes post blood-meal- to supress outdoor malaria transmission was presented by Dr Kevin Kobylinski of AFRIMS, Thailand. MDA with Ivermectin has long been used across the African continent for the prevention and treatment neglected tropical diseases (NTDs)[2]- particularly onchocerciasis and lymphatic filariasis- with high efficacy/compliancy rates, and few side effects recorded. The drug has been used against a wide range of *Anopheles* vectors globally and, to date, almost all have been susceptible at relevant safe human and animal concentrations (*in vitro* study results). In collaboration with partners, AFRIMS have conducted *in vitro* studies of mosquito survivorship when ingesting Ivermectin alone (at double concentration- 400 mg/kg), and when combined with other anti-malarial drugs, with results showing significant decrease in mosquito survival (both *An. dirus* and *minimus*) with blood given at 24-48 time intervals with Ivermectin alone, as well as Ivermectin MDA field studies showing similar killing effect for mosquitoes in west African settings. Studies also showed Ivermectin negatively affected mosquito fecundity, as well as notable reduction in human blood-meal index rate and feeding frequency, and may have an effect against liver-stage malaria (*in vitro* studies for *P. falciparum* currently underway). An AFRIMS/Mahidol University led MDA programme is also currently underway to assess the efficacy of Ivermectin to suppress outdoor malaria transmission across rubber plantation sites in southern Thailand, seeking to measure and evaluate both entomological (population age structure, vector composition and density, sporozoite rate) and epidemiological (malaria prevalence and clinical incidence, *Anopheles* salivary IgG response, drug resistant parasite ratio, and anaemia) outcomes.

Addressing risk factors and human mobility to inform targeted Malaria Elimination Strategies in GMS- *Dr Koen Peeters*

Insights into anthropological observations of population mobility and malaria risk were presented by Dr Koen Peeters of ITM, Antwerp, with an emphasis on the limitations of relying on a 'one-size-fits-all' malaria elimination model for mobile and migrant populations (MMP), and a need to recognise and better understand the flexible and diverse behaviours/characteristics, and different vulnerabilities, of sub-groups within this wider population. Research findings have shown that MMPs are often not officially registered by the state in which they work, and often *live* and not only work in forest settings, resulting in them being missed/not targeted to receive/engage with state-based interventions. It was highlighted that movement of these groups should be perceived as part of their ethnic identity, and a factor that can often lead to them being perceived as inferior to the local population. Development of this mutual distrust can often lead to MMP avoidance of NMCP managed prevention and treatment services (which can, for example, encourage purchase of medicines from unregulated, informal private outlets). It was further reiterated that there remains a need to encourage and conduct qualitative research alongside quantitative data collection by state and non-state actors, to build and communicate a holistic understanding of these nuances, develop more informed, tailored prevention/treatment strategies, and facilitate emergent strategies/methodologies congruent to the adaptable/ changing realities of MMP across the AP.

[2] Pregnant women and children <90cm excluded from MDA efforts

Session 7: Accelerate access to vector control commodities and technologies in Asia Pacific (*Chair: Dr Bambang Siswanto*)

Standardized Technology Access Mapping and Pathways System, or "STAMPS"- *Ms Allison Tatarsky*

Session 7 focused on initiatives/projects addressing the challenges to access/uptake of new and innovative VC tools currently in development. This was opened by Ms Allison Tatarsky of UCSF Malaria Elimination Initiative with an introduction to the "STAMPS" system- a platform intended to track and map access to new VC tools for the AP, and to hold relevant bodies to account with regard to development and access to these. Research conducted by the UCSF group has highlighted that of 21 VC tools developed in the 4 decades, only 7 have reached phase III trial[3] evaluation, with the evidence dominated by larval source management (LSM) strategies and topical repellents (with little evidence supporting efficacy of the latter against malaria transmission). Thus, whilst a rich pipeline of VC tools does exist, the evidence for these remains limited to a few tools (despite potential for others), largely unrecognised amongst NMCPs and wider stakeholders, and their development and access often restricted by regulatory/ policy barriers to market entry. The STAMPS initiative therefore aims to bring greater visibility to this VC pipeline for relevant bodies by, a) tracking and exposing research and development of new VC tools, b) highlighting products on the global market that can be introduced into national/regional markets, and c) improving access to information to improve field evaluation of new tools and expand the evidence base. It is intended that this platform be supplemented with a country 'access scorecard', an accountability mechanism for policy makers at national level, consisting of multiple key variables to highlight and track progress for VC innovation (e.g. documenting the current inventory of VC tools, showcasing complexity and cost of, and time required for, regulatory process approval, etc). STAMPS will also explore modelling of potential pathways to markets for various VC tools; consolidate regional groups for policy makers, donor agencies, and industry to articulate disparities and highlight opportunities for engagement and market entry of new technologies; and track countries' adoption of policy changes as new information regarding new VC tools becomes available for relevant policy makers.

Updates on pre-qualification of vector control products and collaborative registration/ Addressing capacity gaps in management and practice of public health pesticides for vector control in countries at risk of malaria and other major vector-borne diseases - *Dr Marion Law*

Dr Marion Law presented recent progress and updates to accelerate access to new and existing VC products through the WHO pre-qualification (PQ) team (previously WHOPES). The objective of the PQ-VC assessment team is to identify and evaluate the safety, efficacy, and quality of existing/new VC products, generate a list of products 'qualified for use', and provide clear, transparent, and evidence-based guidance regarding WHO recommended evaluation requirements and practices to better facilitate registration of these products in country. This is facilitated through a collaborative approach by which WHO provide appropriate in-country technical support through, for example, capacity-building and quality assurance activities throughout the product life-cycle for manufacturers, regulators, and procurement personnel (with on-the-ground facility inspections as a new development under the latter moving forward). Following the 2nd WHO PQ led Assessors meeting in Arusha, Tanzania, in May 2018, some challenges/barriers for registration noted by? for? stakeholders in this region were inconsistencies in label quality, out-

of-date evaluation data, and partial product evaluations (particularly for entomological efficacy of pyrethroids+PBO (piperonyl butoxide) LLINs against specific IR mosquito populations). Moving forward on this, the PQ team plan to work on a strategy to better define requirements for PQ vector control product (VCP) labels, support re-evaluation of active ingredients within existing products, and implement a plan for prioritised product reviews (such as for pyrethroids+PBO LLINs); currently evaluations are underway for 7 new submissions (detailed on the WHO PQ website). Facility inspection activities have so far been prioritised for net manufacturing/procurement (conducted in India, Tanzania, and Pakistan); there is an intent to expand and support these assessments for other VC manufacturers as future resourcing capacity allows. Plans for 2019/20 include identifying and engaging representatives from countries who already evaluate VC product (process underway in partnership with i2i); to document and understand the different approaches and focus in the different jurisdictions/regions to develop targeted strategy plans; and to investigate opportunities to work together / harmonise product registration processes with relevant stakeholders and partners to better facilitate access to prequalified VC tools and products.

Product Development Partnership: landscape studies of technical gaps and access to new vector control tools in Asia-Pacific- *Dr Jason Richardson*

To conclude this session, Dr Jason Richardson of IVCC discussed the role of product development partnerships (PDPs) to encourage and facilitate innovation for VC tool development within more challenging market spaces. Whilst the focus for IVCC has been primarily within the African region, the organisation is now embarking on a new project to focus on the unique challenges for VC across the AP region. Funded by the Australian Department for Foreign Trade (DFAT), the multi-partner 4 year project- 'Developing a VC toolbox to support malaria and other vector-bourne disease control in the Indo-Pacific- will assess which products in the current VC development pipeline may be applicable to countries in the AP with a focus on 2 primary activities: a *technical review* of VC gaps and opportunities, and an *access review* to better understand specific country requirements (eg. regulatory requirements, estimated local testing times, etc) to facilitate targeted product launch plans and country-specific routes to market. The organisation will work with multiples partners across the region to determine the safest, quickest, and most impactful route to get these products onto the market for use. To kick-start this process, IVCC and partners are currently in the process of conducting a landscaping study to first identify technical gaps across the AP, ascertain which tools/strategies may be of most relevance within the region, and support local institutions to trial product testing at relevant field sites to inform and refine product and strategy development.

Session 8: Network-to-network information sharing and capacity building (*Chair: Dr Liu Quiyong*)

Online Research Exchange Network to support entomology/vector control in the Asia-Pacific Region- *Dr Michael McDonald*

Session 8 was centred upon improving access to, and engagement with, existing and new information and knowledge tools related to malaria control and elimination in the AP, and globally, through the development of the APMEN VCWG Online Resource Exchange Network (OREN). Dr Michael Macdonald provided an introduction to the OREN: a platform developed following the 2017 APMEN VCWG meeting in Thailand where country partners highlighted the need for a dedicated space for inter-country information exchange, and to have better access to readily available and comprehensive information, procedures, and toolkits covering both key technical and programmatic areas and guidelines for evaluation and implementation for effective VC strategies across the AP. The OREN, as a country-led,

'community of practice' initiative, will also allow CPs and others across the AP to share experiences with different VC methodologies (for both *Anopheles* and *Aedes* vectors), tools and best practices, as well as reflect on shared challenges and locally adapted solutions, taking into account the heterogeneous environment across the AP. Importantly, it will also provide a space for career and skills development in entomology and vector control, through both online training programmes and access to information regarding practical skills training/fellowship programmes across the AP. The website is currently in development (led by Miss Tiff Dahmash of APMEN VCWG and Dr Macdonald), and is scheduled to be launched in April 2019.

The Global Vector Hub- *Ms Chelci Squires*

Ms Chelci Squires from LSHTM then presented an additional global-focused technical and communications resource website- the Global Vector Hub (GVH)- for vector control and entomology. Complementing the AP OREN presented by Dr Macdonald, the GVH will serve as an open access, interactive technical resource centre for VC and entomology, with the intention to harmonise and condense existing country/regional information networks into one centrally-led platform. Through this integration of resources, the platform aims to build programme capacity to facilitate rapid response to vector-borne disease outbreaks, increase the visibility of reliable evidence to provide guidance for implementing appropriate VC tools, and increase communication within and between countries. The GVH will host free research tools, guidelines and training packages to enable researchers, local healthcare providers and practitioners to access up-to-date resources; develop an online network through hosting a searchable registry of academic, government and industry led vector research sites and VC programmes, as well as active online discussion forums with users; and develop a real-time disease and vector information function with an easy to use database and interactive map, enabling the user to have access to relevant VC data about any country. The platform is currently in development and is set to launch in the coming year.

1st International Malaria Vector Surveillance for elimination course- *Dr Cecil Hugo*

The final presentation of the session was led by Dr Cecil Hugo of ACTMalaria, providing information regarding the first joint training (APMEN, WHO, ACTMalaria, and the Malaysian Ministry of Health) for vector surveillance in the AP, to be held in November 2018 in Kuala Lumpur, Malaysia. The course will bring together entomology and VC specialists from across the AP region, and globally, with the aim to develop the capacity of entomologists and VC staff, including technicians involved in malaria control and elimination programmes, to identify primary and secondary malaria vectors, and provide technical guidance for mosquito identification and rearing techniques, entomological surveillance, management of malaria foci, insecticide resistance and contact bioassays. The aim of this training is to contribute to the achievement of the regional and country targets set for malaria elimination, by making approaches to VC more efficient, cost effective, ecologically sound and sustainable.

Day 3

Session 9: APMEN VCWG Business Meeting (*Chair: Dr Christina Rundi and Dr Pradeep Srivastava)*

Country partner meeting summaries and APMEN take-away points

Led by Dr Christina Rundi and Dr Pradeep Srivastava- Chair and Co-chair of the VCWG- the final day commenced with a meeting feedback session from all CP participants, reflecting on each of the topic areas presented and discussed at the meeting, as well as ideas and thoughts as to priority areas for the VCWG moving forward. Summary points from each CP member are presented in Box 4 below.

Box 4. Country partner meeting feedback

Malaysia
- Would like a 'deeper dive' into key operational aspects of technical topics throughout the year- not just during annual meetings
- Believe APMEN is well positioned as productive body for networking with WHO and researchers

Sri Lanka
- Interested in collaborating on new surveillance tools; concerned about *An. stephensi*
- APMEN to support advocacy at higher levels to maintain commitment
- Welcomes capacity building effort
- Welcomes other programs to learn about elimination and certification

China
- Has a lot of expertise to contribute to APMEN; is willing and able to support south-south capacity building

Cambodia
- Would have liked to be involved in evaluation of new vector surveillance tools; has been looking for an alternative to HLC

Vietnam
- Appreciates APMEN capacity building support activies

Bhutan

- Appreciates the perspective from different countries facilitated through APMEN
- Would like to try different VC tools in Bhutan

Nepal

- Targeting malaria free, population movement is the big risk and would like to address the border issues and imported malaria

Thailand

- Need new vector surveillance tools; the vertical program will move into integrated program for vector surveillance
- Also concerned about border transmission and imported malaria
- Need new insecticide to combat IR and new tools for outdoor transmission
- Would like to increase cooperation with border countries to reduce cross-border transmission and importation

Bangladesh

- Need support on capacity building; views APMEN as important organisation to facilitate
- Also concerned about cross border movement and imported malaria

India

- Would like to include a field visit as part of APMEN meetings- include training as part of the meetings

Indonesia

- Welcomes the wealth and depth knowledge shared by all participants
- Appreciates the capacity building from APMEN for entomology/VC to support elimination

Myanmar

- Learned a lot: welcomes open, collaborative discussions experienced
- Align with MOH research and training agendas - use the agendas to inform APMEN agenda
- Need to train the next generation of entomologists
- Hoping to become a member of APMEN very soon

Philippines

- Would like share their own expertise in morphological ID- happy to share their knowledge/capacity
- Elimination is complex- no silver bullet

Pakistan

- Engaging discussions: people have been very collegial and professional
- Hope that the Pakistan government is able to join APMEN and the spirit of APMEN

Vanuatu

- Declared one province malaria free last year: three provinces are on track, two problematic provinces remain
- Hoping to get support from APMEN re. capacity building (trainings and fellowships)
- Would also like support for project proposals for entomology; really need entomology from success story from the malaria free province; needs entomological surveillance to meet epidemiology surveillance

Field training on new mosquito trapping methods: Human Decoy Trap, Barrier Fence, and Double Net Trap (September 6-10, 2018)- *Dr Jeffrey Hii*

Dr Jeffrey Hii provided an overview of the APMEN-KU joint field training to evaluate novel VC trapping methods for outdoor biting mosquitoes. Following the APMEN VCWG 2017 meeting, CPs and stakeholders discussed the need for alternative strategies for HLC in various settings (as discussed above), as well as effective methods to assess and document vector bionomics. In response to this, the APMEN VCWG has organised a capacity building workshop to test the feasibility of a new methods of mosquito surveillance in Pu Toey Village, Kanchanburi Province, Thailand. The objectives of the workshop are to, a) conduct a field workshop to test the feasibility of three new vector control tools: the Human Decoy Trap (HDT), the Barrier Fence (BF) and the Human Double Net (HDN) trap for collection of outdoor biting mosquitoes, and b) provide technical support in the development of operational research proposals with programme entomologists from participating APMEN countries. Intended outputs of the workshop will be to, a) assess the feasibility of the HDT, HDN and BF traps for collection of exophilic mosquitoes in AP settings, and b) draft operational proposals (including budget estimation) for operational field tests of three traps for other countries in the AP region. Following the workshop, a proof of concept study will be conducted in 2019 across four member countries (Malaysia, Sri Lanka, Vietnam, and Thailand), with progress updates/ results expected to shared July/August 2019.

Other business: Action Points from 1st World Malaria Congress, review of VCWG 2019 Workplan, and VCWG take-home message

APMEN Secretariat Director, Dr Effie Espino, provided a summary of 'action points' for the VCWG following the 1st World Malaria Congress in Melbourne, Australia, in July 2018. Key take-away messages and focus areas for malaria elimination in the AP included encouraging greater involvement and capacity building of CSOs, increased partnership building, strong leadership (both within AP countries and across the Network), and ensuring accountability of government commitment toward agreed meeting elimination targets. Dr Espino reiterated that the key objectives of the VCWG mission complement these objectives: to build a rigorous, quality evidence base for VC and entomology, to work alongside local and national government partners to support this, and to facilitate essential capacity building activities for CPs and partners to more better target unique VC challenges across the AP (eg. outdoor and residual transmission). The VCWG will be aiming to build a stronger south-south network in the coming year, as many countries approaching/achieved elimination status (eg. Sri Lanka, Malaysia, and Thailand) have much to share with counterparts in the region re. best practices, lessons learned, and challenges faced along the route to elimination. A focus on targeted research (eg new tools for RMT and outdoor), knowledge and information exchange, and improved programme management will take priority for the VCWG moving forward.

Dr Christina Rundi reflected on the activities and progress of the VCWG in 2018, including:

- **Entomology Fellowship in Malaysia (July-September 2018).** Evaluation of effective sampling methods for *P. knowlesi* vectors, and understanding the bionomics and ecology of Pk vectors, hosted by University of Malaya.
- **Risk and receptivity mapping using GIS technology at Mahidol University (14-31 August 2018**). Ten participants from Malaysia, Sri Lanka, Bhutan, and Thailand were trained in a four week course (curriculum consisting of lecture, practical, and group based work) focused on developing core skills in the fundamentals of statistics, epidemiology, informatics, remote sensing, and spatial analysis. Outcomes included skills

advancement in designing tailored data collection tools (including smartphone app-based tools), database management, disease mapping using a freely available GIS software package (Quantum GIS), and communication/ presentation skills.

- **APMEN Resource Centre in Entomology and Vector Control (ongoing):** Online platform in process of development, that will be hosted on the APMEN website. We anticipate the Centre will be launched in early 2019 following initial pilots across the Network

Future planned trainings

- **Outdoor entomological surveillance tools field workshop, in partnership with Kasetsart University (7-10 September 2018).** Six participants from Cambodia, Vietnam, Thailand, Malaysia, and Sri Lanka participating in a field-based practical training on three new tools for outdoor surveillance, including the barrier trap, human decoy trap, and the Ifakara tent trap. This training will kick-started the proof-of-concept studies of these new tools in four countries: Malaysia, Thailand, Sri Lanka and Vietnam.
- **Integrated vector management training, in partnership with Malaysia Ministry of Health (21-27 October 2018).** APMEN supported 7 participants from 6 non-GMS countries (Solomon Islands, Vanuatu, ROK, Sri Lanka, Indonesia, and the Philipines) and WHO/ACTMalaria supported an additional 5 participants from 3 GMS countries (Thailand, Vietnam, and Cambodia).
- **1st Entomological Surveillance for malaria elimination course, in partnership with Malaysia Ministry of Health (18-23 November 2018).** APMEN supporting 10 participants from non-GMS countries and WHO/ACTMalaria supporting an additional 5 GMS participants.

Other business announcements

- Financial funding secured until Q1, 2019; complementary funding provided by APLMA for upcoming capacity building activities
- Staff changes: Dr Jeffrey Hii will be departing his position as the technical lead of the VCWG in September; his replacement will be announced in the coming months
- Next APMEN VCWG Annual Meeting is anticipated to be in September 2019; APMEN Annual General Meeting anticipated to take place in April 2019 in Bangkok, alongside the APLMA Senior Officials Meeting

Dr Rundi also acknowledged the generous financial support provided for the VCWG through the Bill and Melinda Gates Foundation, and Sumitomo Chemicals Ltd, without whom much of the work of the VCWG would not be possible. Thanks were also given to the UCSF team, and the VCWG technical and programme coordinators.

Dr Espino announced that an independent review of APMEN has been conducted, with the final report due to be sent to programme managers soon for their feedback as to suggestions for a revised model moving forward; subsequently, voting of the Chair and co-Chair of the VCWG will not take place until this has been finalized, and current Chairs will remain in their positions in the meantime. Dr Espino and Dr James Tibenderama (Technical Director, Malaria Consortium) then gave thanks and congratulations to Dr Jeffrey Hii for his continuous support and technical contributions during his time with the VCWG, and wished him every success in his new position.

The meeting closed with Dr Rundi reflecting on and reiterating APMEN's commitment, and unique position, to continue to drive and facilitate new knowledge and capacity building to address key VC/entomology challenges to malaria elimination in the region, encouraging CPs and stakeholders alike to continue to their participation and support within the Network. The wealth of knowledge now evident in the Network, alongside increasing resources at its disposal, presents a great opportunity to lead the way for VC and entomology for malaria elimination across the region:

'We've come a long way since we started in 2009: we've brought new passengers onboard the elimination train, driven the emphasis for the importance of VC for elimination, and built and refined a more definite strategy to achieve

our objectives- all of which we will continue to strengthen together in the coming years. Crucially, we've shown that the voice of the entomologist can, and will, be heard in the fight for a malaria free Asia Pacific'.

Report prepared by: Ms. Latifeh Dahmash, Malaria Consortium/APMEN VCWG

Report approved by: Dr Jeffrey Hii, Malaria Consortium/APMEN VCWG

Annexes

Annex 1. Full Agenda

APMEN VCWG/MOMTN 2018 Meeting
3-5 September 2018
Century Park Hotel, Bangkok

Moving Towards a Vector Surveillance and Response System for Malaria Elimination

The overall objectives for the meeting were to:

7. Provide an update from the WHO Global Malaria Programme on surveillance manual and guidelines regarding vector surveillance, and to reflect on progress gained through the Global Vector Control Response 2017-2030 framework
8. Provide an update from WHO partners regarding insecticide resistance guidelines and status across the Asia Pacific (AP)
9. Discuss regional and sub-regional challenges and solutions to these barriers in strengthening entomological capacity, vector surveillance and response activities across the AP
10. Review and exchange information and experience of advances, good practices and studies for outdoor malaria transmission, including estimates of malaria attributed to outdoor transmission in selected countries
11. Discuss implications of outdoor transmission and country efforts for malaria elimination
12. Introduce and discuss concepts of access to, and pre-qualification of, new and existing vector control technologies, Product Development Partnerships (PDP), and the knowledge/resource exchange strategies across the AP

The objectives for the business meeting were specifically to:

a. Summarize and identify the key priorities to be included in the APMEN VCWG 2018-2019 workplan, and elevated to the 2019 APMEN Annual General Meeting (AGM) and relevant Ministers

The expected outputs of the meeting were to:

5. Recommend priority actions to address regional gaps in vector surveillance tools and programmatic capacity for vector control (VC)
6. Engage clear commitment by country partners to share specific Standard Operating Procedures (SOPs) and guidelines to support development where capacity/guidance is lacking, via the Online VC Resource Exchange Network (OREN)

7. Engage partners from a range of sectors to exchange information, review available tools and collectively explore solutions to meet these challenges via the OREN
8. Support ongoing mechanisms, facilitated by partners, for communication and sharing of best practices among entomology and VC in the AP region

Monday 3rd September		
08:00 - 08:40	Registration	
Welcome and Opening Remarks		
08:40- 09:00 (5 minutes each)	Welcome (Dr Christina Rundi) Welcome (Dr Chongrak Wachrinrat , President Kasetsart University) Welcome (Dr Suthipun Jitpimolmard, Director TRF) Welcome (Dr Dorina Bustos, WHO)	Dr Christina Rundi
09:05- 09:15	Meeting agenda, objectives and outputs	Dr Pradeep Srivastava
09:15- 09:30	Group photo	
Session 2: Poster presentations – Responding to the challenges to implementing, coordinating, and sustaining entomological surveillance and response activities		
09:30- 09:40	Introduction to session	Dr Jeffrey Hii
09:40-12:30 (Working break inc coffee/tea)	*Group work #1 Situational analysis of VC programme* Group 1: National elimination by 2020 and PoR (4 countries) Group 2: National elimination by 2025 (7 countries) Group 3: National elimination by 2030 (4 countries) Group 4: High to moderate burden (5 countries)	Chair – Dr Jeffrey Hii/Tiff Dahmash
12:30- 13:30	Lunch	
Session 3: Updates on entomological surveillance, vector control monitoring and evaluation, and the challenges for implementation of Global vector control		Chair – Dr. Md.Khalilur Rahman
13:30-13:45	Recent WHO guidance relevant to entomology and vector control	Dr Tessa Knox

13:45-14:00	Malaria entomology and vector control in the Greater Mekong Sub-region: an independent situation analysis	Dr Sean Hewitt
14:00-14:15	Malaria Vector Monitoring in Asia-Pacific region: how are we doing relative to other areas	Dr Tom Burkot
14:15-14:30	Planning tool for entomological surveillance in elimination settings	Dr Neil Lobo
14:30-14:45	Q&A	
14:45-16:20 (working break)	*Group work #2 Targeting risk/high risk groups and programmatic gaps and challenges* Group 1: National elimination by 2020 and PoR (4 countries) Group 2: National elimination by 2025 (7 countries) Group 3: National elimination by 2030 (4 countries) Group 4: High to moderate burden (5 countries)	Chair – Dr. Tho Sochantha
16:20-17:00	Group presentations (10 mins each)	
17:00- 17:10	Close	Dr Jeffrey Hii
17:10 – 20:00	Cocktail evening	
Tuesday 4th September		
08:00 -08:30	Registration	
08:30- 08:40	Summary of Day 1 Group work #1 Presentations	Dr Dechen Pemo

Session 4: Insecticide resistance monitoring		Chair- Ms RDJ Harischandra
08:40- 08:50	Malaria vector insecticide resistance monitoring and status in the Asia-Pacific	Dr Tessa Knox
08:50- 09:05	Sibling species ID and review of outdoor biting vectors	Prof. Theeraphap Chareonviriyaphap
09:05- 09:15	Mapping insecticide resistance of *Anopheles sp.* and *Aedes* sp. vectors in Thailand	Dr Rathchadawan Ngoen-klan
09:15- 09:25	Field evaluation of transfluthrin agaist an exophagic malaria vectors	Dr Chutipong Sukkanon
Session 5: Outdoor Malaria Transmission – anthropological, surveillance and new tools		
Session 5a – Residual malaria		Chair Dr Masatoshi Nakamura
09:25- 09:35	Residual malaria transmission: definition and scope	Dr Tessa Knox
09:35- 09:45	How much residual transmission in GMS: Thailand and Viet Nam	Dr Jeffrey Hii
09:45- 10:00	How much residual transmission in Africa including drivers (video presentation)	Dr Fredros Okumu
10:00- 10:10	Q&A	
10:10-10:25	Break	
Session 5b – Entomology and vector surveillance		Chair – Dr. Than Naing Soe
10:25- 10:35	Role of entomological Surveillance in active foci investigation in Malaysia	Ms Perada Wilson

10:35- 10:50	Update on Human Decoy trap for sampling exophilic mosquitoes in Indonesia	Dr Neil Lobo and Dr Frances Hawkes
10:50- 11:00	Barrier fence for mosquito surveillance and vector control	Dr Tom Burkot
11:00- 11:15	IHI research in vector surveillance & new tools and training: south-south links (video presentation)	Dr Fredros Okumu
11:15-12:30	*Group work #3 Solutions and moving forward (from programmatic & APMEN perspectives)* Group 1: National elimination by 2020 and PoR (4 countries) Group 2: National elimination by 2025 (7 countries) Group 3: National elimination by 2030 (4 countries) Group 4: High to moderate burden (5 countries)	
12:30-13:00	Lunch	
Session 6 – Intersects of human and vector behavior – evidence for solutions		
13:00- 13:10	Effects of indoor residual spraying using bifenthrin on *Anopheles* species composition, abundance, feeding behaviors, and susceptibility to pyrethroids in malaria ecosystems of East and South Thailand	Dr Adisak Bhumiratana
13:10- 13:20	Contribution of daytime biting behavior of malaria vectors to outdoor exposure	Dr Amelie Vantaux
13:20- 13:30	Seasonal change of Anopheles population in teak plantation and slash and burn cultivation area in relation to population migration and receptivity	Dr Masatoshi Nakumara
13:30- 13:40	Strategies to control outdoor biting malaria vectors in North Thailand	Dr Wannapa Suwonkerd
13:40- 13:50	Private sector distribution of subsidized treated hammock nets to forest goers in Vietnam	Dr Joselyn Neukom
13:50- 14:00	Ivermectin mass drug administration to suppress outdoor malaria transmission	Dr Kevin Kobylinski

14:00- 14:10	Addressing risk factors and human mobility to inform targeted Malaria Elimination Strategies in GMS	Dr Koen Peeters
Session 7 - Accelerate access to vector control commodities and technologies in Asia Pacific[4]		Chair – Dr. Bambang Siswanto
14:10- 14:20	Standardized Technology Access Mapping and Pathways System, or "STAMPS"	Ms Allison Tatarsky
14:20- 14:35	Updates on pre-qualification of vector control products and collaborative registration	Dr Marion Law
	Addressing capacity gaps in management and practice of public health pesticides for vector control in countries at risk of malaria and other major vector-borne diseases	
14:35- 14:45	Product Development Partnership: landscape studies of technical gaps and access to new vector control tools in Asia-Pacific	Dr Jason Richardson
14:45- 15:00	Q&A	
15:00-:15:15	Break	
Session 8: Network-to-network information sharing and capacity building		Chair – Dr Liu Quiyong
15:15- 15:25	Online Research Exchange Network to support entomology/vector control in the Asia-Pacific Region	Dr Michael Macdonald
15:25- 15:35	The Global Vector Hub	Ms Chelci Squires
15:35- 15:45	1st International Malaria Vector Surveillance for elimination course Jeffrey Hii, Malaria Consortium/APMEN)	Dr Cecil Hugo
15:45- 16:00	Q&A	

[4] A side meeting will be held afternoon 05 September to discuss in the detail the VCAP, a platform that resulted from the APMEN VCWG meeting last July 2017. Attendance is by invitation.

16:00-16:15	Close	Dr Jeffrey Hii
Wednesday 5th September – APMEN VCWG Business Meeting		
	Session 9: Business Meeting	Chair - Dr Christina Runda and Dr Pradeep Srivastava
08:30-09:00	Registration	
09:00- 09:15	Field training on the feasibility of Human Decoy Trap, Barrier Fence and Human Double Net in Thailand	Dr Jeffrey Hii
09:15-09:25	Action points of 1st World Malaria Congress, summary of AGM 2017	Dr Effie Espino
09:25- 10:00	Review of draft VCWG Workplan 2019 and Fellowships and training – overview of protocol for applications, selection of fellowship committee members	Dr Christina Rundi
10:00– 10:15	Coffee Break	
10:15-11:15	NMCP/PI meeting feedback	Dr Pradeep Srivastava /Dr Myo Min
11:15-11:30	VCWG Statement/take home message	Dr Myo Min
11:30-11:45	Closing Remarks	Dr Jeffrey Hii/Christina Rundi and Dr Pradeep Srivastava
11:45- 12:45	Lunch	

Annex 2. Directory of participants

Name	Last name	Organisation
Adisak	Bhumiratana	Mahidol University, Thailand
Aekthada	Chivakanit	WellTech HealthCare Limited, Phillipines
Alison	Tatarsky	Global Health Group, USA
Amélie	Vantaux	Institut Pasteur, Cambodia
Angus	Spiers	Innovation TO Impact, USA
Arada	Mahasawin	Mahidol University, Thailand
Atsuko	Hirooka	Sumitomo Chemical Co.,Ltd, Japan
Bambang	Siswanto	Ministry of Health, Indonesia
Boon Liang	Tay	SYNGENTA
Boonserm	Aumaung	Bureau of Vector Borne Diseases, Thailand
Boosaree	Titapiwatanakun	Mahidol University, Thailand
Bruce	Wilcox	Global Health Asia Inst., Thailand
Bussarakham	Sinakhom	
Cecilia	Hugo	ACT Malaria, Phillipines
Christina	Rundi	Ministry of Health, Malaysia
Colin	Ohrt	Consortium for Health Action, Cambodia
Dechen	Pemo	Vector Borne Disease Control Program, Bhutan
Deyer	Gopinath	World Health Organisation, Thailand
Duc Chinh	Vu	National Institute Of Malariology, Parasitology and Entomology, Vietnam
Edgardo	Erce	NMCP, Phillipines
Effie	Espino	APLMA, Singapire
Erika	Larson	UCSF, USA

Feliciano	Monti	U.S. President's Malaria Initiative
Ferdinand	Salazar	Research Institute for Tropical Medicine, Phillipines
Frances	Hawkes	University of Greenwich, UK
Guy Jean-Kamil	Emil	Public Health Department, Vanuatu
Hans Jorgen	Overgaard	Norwegian University of Life Sciences, Norway
Hongning	Zhou	Yunnan Institute of Parasitic Diseases, China
Jackson	Nash	
Chelci	Squires	LSHTM, UK
James	Tibenderana	Malaria Consortium, UK
Janice	Apilado	APLMA, Singapore
Jason	Richardson	IVCC, USA
Jeevanie Harishchandra	R.D.	Anti Malaria Campaign of Ministry of Health, Sri Lanka
Jeffrey	Hii	Malaria Consortium, Bangkok
Jetsumon	Prachumsri	Mahidol University, Bangkok
Jiraporn	Ruangsittichai	Mahidol University, Bnagkok
John	Gimnig	Center of Disease Control and prevention, USA
Josselyn	Neukom	Population Services International, Vietnam
Kemi	Tesfazghi	PSI, Cambodia
Kevin	Kobylinski	AFRIMS, Thailand
Lino David	dela Cuesta	BASF (represented by DFI)
Lorina	McAdam	PSI, Myanmar
Maneesh	Sharma	Vestergaard
Marie	Lamy	APLMA, Singapore
Marion	Law	WHO, Geneva
Martin	Geier	Biogents, Germany
Masatoshi	Nakamura	JICA (Japan International Cooperation Agency), Japan

Michael	McDonald	RBM, USA
Milan	Ivic	Tana Netting
Muney	Serit	Sumitomo Chemical Enviro-Agro Asia Pacific SDN BHD, Japan
Myo	Min	APLMA, Singapore
Neil	Lobo	University of Notre Dame, and, University of California, San Francisco/UCSF
Ning	Xiao	National Institute of Parasitic Diseases, China CDC
Patchara	Sriwichai	Mahidol University, Thailand
Perada	Wilson Putit	Ministry of Health, Malaysia
Pitchapa	Vutikes	Mahidol University, Thailand
Pornpimon	Adams	Mahidol University, Thailand
Pradeep Kumar	Srivastava	National Vector Borne Disease Control Programme, India
Prakash	Ghimire	Tribhuvan University, Nepal
Qiyong	Liu	Chinese Center for Disease Control and Prevention, China
Rahman	Md Khalilur	Ministry of Health and family Welfare, Bangladesh
Rajendra	Mishra	Epidemiology and Disease Control Division, Nepal
Ratchadawan	Ngoen-Klun	Kasetsart University, Thailand

Richard	Maude	MORU, Thailand
Rittika	Datta	APLMA, Singapore
Robert Allen	Farlow	R.Farlow Consulting LLC, USA
Say-Piau	Lim	Bayer, Malaysia
Scott	Miller	Bill and Melinda Gates Foundation, USA
Sean	Hewit	VC Consultant, UK
Seleena	Benjamin	VALENT BIOSCIENCES LLC
Sharon	Thangadurai	URC, Cambodia
Sochantha	Tho	National Centre for Parasitology, Entomology and Malaria Control, Cambodia
Steven	Bjorge	Institute for Sustainable Elimination of Malaria, Thailand
Sukhvir	Singh	National Vector Borne Disease Control Programme, India
Sumeth	Suebtrakul	Mahidol University, Thailand
Tessa	Knox	World Health Organization, Geneva
Than Naing	Soe	Ministry of Health and Sports, Myanmar
Theeraphap	Chareonviriyaphap	Kasetsart University, Thailand
Latifeh	Dahmash	Malaria Consortium, Thailand
Tom	Burkot	James Cook University, Australia
Wannapa	Suwonkerd	Office of Disease Prevention and Control, Thailand
Wichai	Chivakanit	WellTech HealthCare Limited
William Anderson	Hawley	Centers for Disease Control and Prevention, USA
Xin Yu	Goh	WellTech HealthCare Limited

Yi	Zhang	National Institute of Parasitic Diseases, Chinese Center for Disease Control and Prevention, China
Yukinobu	Uchimura	Mitsui Chemical Agro,Inc, Japan

Annex 3. Group work facilitation sheets

Group Work Facilitation Sheet

Each facilitator to take notes of country partner feedback and provide to Miss Tiff Dahmash at the end of each session

Day 1 (morning)- Using entomological and epidemiological data for malaria elimination

Café Style

Objectives:

- Determine what VC/entomological data is collated and prioritised with the NMCP
- Establish how data is being used to determine VC strategy and tools utilization, and how coverage is monitored and evaluated
- Highlight where there still exists knowledge and operational gaps to achieve targets set

Group 1: Surveillance

Entomological surveillance

- How do you conduct entomological surveillance in your programme? *Probe spot, sentinel, special surveys, etc*
- How is this entomological data used in your surveillance programme? How do you engage with your programme manager/surveillance and epidemiology teams at central level?
- Do you use epidemiological data to guide your entomological surveillance? Why/why not?
- If there is new active foci being reported, what do you do?
    - Is there a manual for this?
    - What are some of the challenges you have experienced for this?
- What are/is the main vector control tool(s) you use? Is this data used to guide this decision?
- (*As is applicable)* Do you do the following? And who is responsible for?:
    - Larval surveys/environmental management
    - Adult vector surveys
    - Larviciding
    - IRS
    - LLIN distribution and monitoring
    - Maintenance of reference mosquito colonies
    - Insecticide susceptibility testing
    - Data management and analysis
    - Mapping/GIS

      probe how these are done

- Do you have sentinel sites for vector surveillance?
- What activities are being done at each of these sites? *Probe*
    - Does this include insecticide resistance monitoring?

- Are spot surveys done outside of sentinel sites?
- How is this data reported/how are you reporting this data?
- What does your country still need to monitor insecticide susceptibility, or how have you done this?

Group 2: Capacity Building

Programmatic activities

- How are the following conducted in the programme:

    1. Monitoring and evaluation of VC operations
    2. Monitoring and evaluation of epidemiology related to VC operations
    3. Operational research activities
    4. Overall project management
    5. Malaria communications/awareness campaigns
    6. Other

Probe around HR gaps, technical knowledge, training opportunities, etc

- Is there a decentralized entomological activity? What is this?
- What are the biggest challenges to conducting this? *Probe HR, financial, technical knowledge/guidance(eg. sample size), etc*
- If so, managed at which level(s)?
- How does this data reported and used?
- How could this be improved?

Training

- Are there standards for careers in vector control and public health entomology?
- What are they? How are they being used?
- When was the last Vector Control training done?
- How many new and mid-level entomologists were trained?
- If training is insufficient or not available, what key topics are needed for 2019/2020? *e.g. decentralized adult vector surveys*

Group 3: Coverage/targeting

- LLIN/ITN

    - Do you use LLINS? Who decides where this are distributed? At which level? *(district/commune/village/health facility catchment area/other)*
    - What criteria is used to guide this? *(probe API >X/number of cases/or proximity to forest/other)*
    - How is LLIN/ITN distribution, uptake, and durability monitored?
    - What are the barriers to distribution/uptake/re-treatment/durability? What support do you need to increase coverage? *Probe HR, financial, user preference, other*
    - Has the malaria situation changed since the last bed-net distribution? *Explain how the situation is likely to have or have changed*

- IRS
    - Do you do any of the following? *Probe for how this is done, including target population, coverage (houses sprayed and population protected)*
        - Mass preventive IRS
        - Focal responsive IRS
        - Larval source management/environmental management

- IVM
    - Does your department conduct IVM? How many staff are trained in this?
    - Do you have a policy for this?
    - What is the capacity of the available entomological staff to do this?

Group 4: Knowledge gaps

- How are you trained to do:
    - Larval surveys/environmental management
    - Adult vector surveys. *Probe for outdoor biting/resting surveys*
    - Larviciding
    - IRS
    - LLIN distribution and monitoring
    - Maintenance of reference mosquito colonies
    - Insecticide susceptibility testing
    - Data management and analysis
    - Mapping/GIS

- Of these, which do you feel you need more guidance for?
- What would be the best way to access this? *Probe what this should like like, who should be involved, etc*
- What entomological activities are currently not being done/not prioritized? Why/why not?
    - Is outdoor transmission important in your programme? Why/why not? *If yes, probe for what data has been collected/is collected*
- Do you have access to manuals/training guides for your work?
    - What are these?
    - If no, how do you access technical guidance?

Day 1 (afternoon)- Targeting risk/high risk groups and programmatic gaps and challenges

Objective:

- *To define high risk groups in each country setting, understand how VC is targeted and managed for these groups, and evaluate programmatic gaps and challenges*

Guiding questions:

Understanding targeting of high risk groups

- Who are the high risk groups in your country? How have you determined this? Probe for how 'hot spots' are recognised
    - How do you address migratory populations moving from high to low risk areas, and visa versa
- In your opinion, what are the most appropriate vector control tools for these groups? How is this determined?
- What adjustments or modifications are needed to target these risk groups with vector control?
- What entomological indicators are most useful for VC decision-making for these groups?
- What are the biggest challenges with targeting these/this group(s)?
- What do you need to do to address these challenges? How do you think APMEN could assist?

Understanding outbreak response in high risk areas

- What are the entomological drivers of outbreak(s) in
    - active foci
    - prevention of reintroduction
    - cleared foci
- Why is transmission increasing and what do toy think is the most effective response strategy? (i.e. outbreak investigation)?
- What should be done in an area with no transmission but with a history of transmission (i.e., 'receptive' areas)?
- What is the most effective way to monitor and manage receptivity in these areas (i.e. prevention of reintroduction)?

Day 2- Solutions and moving forward

Objective:

- *To recommend priority actions to address country and regional gaps in tools and programmatic capacity for vector control from the NMCP perspective*
- *To identify and recommend additional support from APMEN to complement NMCP priority actions*

Guiding questions:

- Taking into consideration the challenges noted above and recent developments in epidemiological surveillance, what should our entomological priorities be from a programmatic perspective?
- What is the best way to integrate these into the existing malaria programme? What do you foresee to be the biggest challenges to this?

- How can we better use/incorporate epidemiological data to inform entomological activities? Is this currently done? Why/why not?
- How can vector control operations be made more relevant to the malaria programme? How can we raise the profile of entomological activities to ensure entomological capacity for vector-borne disease control is maintained during and following malaria elimination?
- Taking into account the challenges noted above, why do you feel you continuing to face the same challenges?
    - What is needed to do to address these challenges
        - Presently?
        - In the next 3 years?
        - In the next 5 years?
    - What can APMEN do to assist?

Annex 4. Country VC Poster Template

Group no. **Country:**

Name of the presenter:

1. **Current status of vector control operations**

Interventions	Year of last bed-net survey	Bed-net distributions since this date? *Yes/No/ Don't know*	Coverage (% of households with at least 1 ITN or sprayed with IRS- please specify)	% households with sufficient ITNs to cover all household members	% of population with access to ITN	A. % population sleeping under LLIN or ITN previous night (all ages, inc. <5) B. % population sleeping under a net of any kind
LLIN						A: .....% B: .....%
ITN						
LLIHN						
Notes for table above	If no % data, please state the number of nets distributed in the population/population at risk					

2. **Targeting risk groups with vector control**

Risk groups	Are they present in your country *Yes/No*	Estimated %? (Population at risk)	Are they targeted for vector control? *Yes/No/ Don't know*	What interventions are used to target this/these group(s)?	What is the estimated VC coverage (%) amongst this/these population(s)?
Highland and hilly communities					
Coastal communities					
Traditional farming communities					
Forest-goers					
Seasonal workers					
Defence Services					
Internally Displaced People (IDP)					
Cross-border workers					
Non-state actors					
Construction/mine workers					
Formal and informal cross-border workforces					
Visitors					
Others (please specify)					

3. **Programmatic challenges & gaps in entomological knowledge affecting the impact of vector control operations**

4. **Solutions and moving forward: What can APMEN do to assist?**

Type in or paste your text here

Annex 5. Session speakers

Dr Jeffrey Hii

Malaria Consortium/ APMEN VCWG, Thailand

Jeffrey is the current Senior Vector Control specialist in Malaria Consortium and has worked with malaria and vector-borne disease control programs since 1975, starting as an entomologist in the Sabah (East Malaysia) Malaria Control Program, Ministry of Health. Jeffrey went on to study Ph.D. at London School of Hygiene & Tropical Medicine on the biosystematics of Anopheles dirus-balabacensis complex in Southeast Asia and then lived in Papua New Guinea, Solomon Islands, Philippines and Thailand with periods in Bhutan, Cambodia, Lao PDR, Viet Nam, Bangladesh, Timor Leste, DPRK, Sri Lanka and Geneva supporting programs throughout Asia, working for ACTMalaria, James Cook University, Global Fund, WHO and NGOs.

Dr Tessa Knox

WHO, Switzerland

Dr Tessa Knox is a public health entomologist in the WHO Global Malaria Programme in Geneva, Switzerland. She works with the Entomology and Vector Control unit to support development of global vector control policy, as well as national malaria vector control strategies and insecticide resistance monitoring and management plans. Dr Knox established the WHO global database on malaria vector insecticide resistance and the online Malaria Threats Map, which provides interactive maps of data on vector resistance, *hrp2/3* gene deletions, and antimalarial drug efficacy and drug resistance (www.who.int/malaria/maps/threats). She also coordinated development of the *WHO Global vector control response 2017-2030,* which was adopted by the World Health Assembly in May 2017 and resulted in a dedicated resolution (WHA70.16).

Dr Sean Hewitt

WHO/ Consultant, UK

Sean Hewitt is a malaria control specialist with 29 years broad-based experience in overseas development. He holds a Master's degree in Medical Parasitology/Entomology from the London School of Hygiene and Tropical Medicine and a PhD in the epidemiology and control of malaria in Afghan refugee communities in Pakistan (also from the University of London). He has had extensive experience working in the field of vector-borne disease control. He has held long-term positions in the Turks and Caicos Islands (MoH/VSO, Dengue Control Coordinator), Pakistan-Afghanistan (MSF-Holland/HealthNet International, Malaria Entomologist), Vietnam (Vietnam-Australia Malaria Control Programme, Malaria Adviser) and Cambodia (European Commission-Cambodia Malaria Control Programme, Malaria Adviser).

After leaving Cambodia he established a UK-based consulting company (VBDC Consulting Ltd). As the principal consultant for this company he has carried out more than 120 assignments since 2003, often as principal investigator/team-leader, for a broad range of clients operating throughout Asia,

Africa, the Middle East and the Pacific.

Dr Tom Burkot

James Cook University, Australia

Professor Tom Burkot is a Tropical Leader in the Australian Institute of Tropical Health and Medicine at James Cook University in Cairns, Australia. He received his B.Sc. from the University of Notre Dame (USA) and M.Sc. and PhD degrees from the University of Wisconsin-Madison in medical entomology.

Prior to joining James Cook University, he was a research entomologist with the Centers for Disease Control and Prevention from 1991 to 2011 where he worked on the transmission and control of malaria in Africa and Asia as a member of the Division of Parasitic Diseases and Malaria and the President's Malaria Initiative. Prior to CDC, Professor Burkot was based at the Queensland Institute of Medical Research (1988-91), the Papua New Guinea Institute of Medical Research (1983–88) and the Walter Reed Army Institute of Research (1981–83). He has served as a consultant for the Secretariat of the Pacific Community and the World Health Organization on malaria, filariasis and dengue. As a National Research Council Fellow, Professor Burkot developed the first ELISAs to identify and quantify human sporozoites in vectors.

Professor Burkot has served on the Global Fund's Technical Review Panel, the WHO Vector Control Advisory Group and Expert Review Groups for malaria elimination that developed the WHO *Global Technical Strategy for Malaria 2016–2030* and the *Framework for Malaria Elimination*. He presently serves on the Malaria Policy Advisory Committee and the Malaria Elimination Oversight Committee of the Global Malaria Programme of the World Health Organization and is on the management board for Building Out Vector Borne Diseases in Sub-Sahara Africa. He has authored or co-authored more than 135 scientific journal articles, book chapters and other publications.

Dr Neil Lobo

Notre Dame University, USA

Neil Lobo's lab focuses on mosquito-borne disease transmission, with studies both in the lab as well as in the field. He has worked on research related to the entomology and epidemiology of diseases like malaria and Dengue, including transgenics, genomics, vector species compositions, vector bionomics, control strategies, intervention evaluation, vector population biology, and, human behavior and epidemiology spanning laboratory to field conditions. Research is directed towards collecting evidence that both elucidates the understanding of, and, directs decision making, strategies and policy towards protecting the world's most vulnerable people from these diseases.

Diseases like malaria are transmitted by species of Anopheles mosquitoes that vary markedly in biological attributes - including when, where and how they blood feed, and, responses to insecticides. Such variation in behavior impacts the effectiveness of interventions such as Insecticide Treated bed nets (ITNs), indoor residual spraying (IRS), Spatial Repellants (SRs) and larval habitat treatments or modifications. The correct identification of local mosquito species and their behaviors, contribution to disease transmission, how these behaviors overlap with intervention functionality, as well as human

behavior, is vital for strategic selection of interventions to reduce disease burden. The range of local drivers of malaria transmission combined with the diversity of *Anopheles* species capable of transmitting malaria increases the complexity around malaria transmission and prevention. A particular focus is drivers of residual transmission – transmission of the disease occurring outside the scope of protection of present interventions.

The Lobo lab research supports several international ministry of health malaria programs in making evidence-driven decisions on vector control strategy and intervention selection, to include operational approaches and priority indicators to expand understanding of local vector bionomics (e.g. indoor versus outdoor biting), identify gaps in protection with current vector control interventions (e.g. low coverage of LLINs, insecticide resistance, outdoor biting), and investigate drivers of transmission (e.g. rainfall, human movement, increased vulnerability and/or receptivity) in combination with epidemiological and other meta-data. In turn, this data will help programs tailor solutions, reduce vector populations and human-vector contact, and drive down transmission using a minimum capacity-based dataset towards maximum impact.

Over the last 20 years, his lab has conducted research in many countries, including Indonesia, Bangladesh, Solomon Islands, Kenya, Tanzania, Zambia, Mali, Namibia, Mozambique, The Democratic Republic of the Congo, and Ethiopia. In short, his lab studies malaria transmission dynamics from a global perspective – investigating mosquito vector species, their bionomics, the effects of both human and vector behaviors on disease transmission and intervention effectiveness - all towards evidence-based decisions to protect vulnerable humans. “Everyone deserves to lead a healthy and productive life” (Bill Gates) - the Lobo Lab conducts research, training, and service with academic, NGO, and country ministry of health programs towards advancing health standards for everyone – especially people those disproportionately impacted by preventable diseases.

Dr Rathchadawan Ngoen-klan

Kasetsart University, Thailand

Dr Ratchadawan Ngoen-Klan is a lecturer in the Department of Entomology, Faculty of Agricultre, Kasetsart University located in Bangkok, Thailand. Ratchadawan was graduated from Chiang Mai University, where she received Doctoral Degree in Parasitology, After graduation, Ratchadawan began her career with her specialization in Geographic Information Systems (GIS) Techniques focusing on vector-borne disease management. That eventually led to 6 years of experience working on map prediction. Soon afterward, her expanding expertise in GIS allowed her to included projects in mosquito vectors. Training module for GIS which providing a basic overview on the use of vector data and remote sensing to assist in minimizing malaria risk and focusing on anopheline mosquito management were launched and targeted to Program Monitoring officer PMO and open to professionals in the health sector.

Ms Perada Wilson

Ministry of Health, Malaysia

Ms Perada is an Entomologist working at National Vector Borne Disease Control Sector, Ministry of Health Malaysia with responsibility for planning and implementation of the National Malaria Elimination Programme. In her current job, she was involved in the preparation of the framework for the elimination strategy, preparation of budgetary requirement, procurement of insecticides and preparation of various vector control guidelines for Malaysia. She is the coordinator of the International Integrated Vector Management Course which will be organized annually by the Ministry of Health Malaysia. This year she will also be involved in organizing the International Malaria Vector Surveillance for Elimination Course, collaboration between MOH Malaysia, APMEN and ACTMalaria to be held in November 2018. You can also contact her via email at perada@moh.gov.my**.**

Dr Masatoshi Nakumara

JICA, Myanmar

Dr Nakamura is field entomologist and engaged in malaria control in Myanmar since 2003. The project is aiming to develop appropriate elimination model based on local context. Especially, he is recognizing the understanding of interaction between human and mosquito ecology is the integral part of malaria elimination in Mekong countries.

Dr Frances Hawkes

Greenwich University, UK

Frances Hawkes is a Research Fellow in Behavioural Entomology at the University of Greenwich's Natural Resources Institute. Her research focuses on the detailed study of vector behaviour in the laboratory and field. She is currently collaborating with industry to improve surveillance and control tools by incorporating specific stimuli into their design, thereby eliciting quantified behavioural responses in vectors and ultimately optimizing lure and kill effectiveness of the tools.

Dr Theeraphap Chareonviriyaphap

Kasetsart University, Thailand

Dr. Theeraphap Chareonviriyaphap is currently a full Professor at the Department of Entomology, Faculty of Agriculture, Kasetsart University, Bangkok, Thailand. His researches are focused on vector ecology, behavior and vector control in response to insecticides used in control interventions and in response to the use of repellents and candidate botanicals. One of his major accomplishments is the patenting of the "Excito-Repellency Box" (PATENT N0. 19319 on Excito-Repellency Escape Chamber for Behavioral Test in Mosquito Vectors) which is considered very useful in studying mosquito behavior towards different insecticides used in the disease control programs.

Dr Joselyn Neukom

Population Services International (PSI), Vietnam

Ms. Josselyn Neukom has more than twenty years of experience designing, managing and evaluating successful public health programs in emerging market contexts. Ms. Neukom has driven business growth for non-profit organizations in both Asia and Africa by developing public-private partnerships, by delivering measurable results at scale through evidence-based, high-quality public health programs and by building high-performing multi-national teams. As the Country Director for PSI Vietnam since 2011, Ms. Neukom has overseen programmatic, organizational and financial growth to support social marketing of essential health products and services as well as social and behavior change communication campaigns related to the Ministry of Health's commitment to eliminate malaria by 2030, improve contraceptive choice, increase rural sanitation coverage, achieve HIV/AIDS 90-90-90 targets and reduce hypertension burden. Since 2015, Ms. Neukom has led the design of research, private sector surveillance and programming to utilize private sector channels to improve forest goer access to treated hammock nets as well as quality malaria case management in high-burden provinces of Vietnam. Ms. Neukom holds a Masters degree in Public Affairs from Princeton University and a Bachelor of Arts in Anthropology from Dartmouth College.

Dr Kevin Kobylinski

AFRIMS, Thailand

Dr. Kevin Kobylinski is a medical entomologist focused on developing and characterizing novel vector control interventions. His primary research interest has been characterizing the utility of ivermectin mass drug administration (MDA) for malaria parasite transmission suppression. Ivermectin is a broad spectrum anthelminthic used to treat and eliminate numerous neglected tropical diseases in humans. His work in Senegal demonstrated that ivermectin MDAs can kill wild *Anopheles gambiae* and reduce sporozoite prevalence in the mosquito population. He has also assessed ivermectin susceptibility of important malaria vectors in Southeast Asia and South America. In addition to the direct killing effect, he has shown that ivermectin has sub-lethal effects including inhibition of mosquito re-feeding and sporontocidal effect against *Plasmodium falciparum* in *An. gambiae* and *P. vivax* in *An. dirus*, *An. minimus*, and *An. darlingi*. He has initiated clinical trials to assess the safety, tolerability, pharmacokinetics, and mosquito-lethal efficacy of ivermectin with dihydroartemisinin-piperaquine and primaquine. Field studies of ivermectin MDA are being initiated in Southeast Asia to assess capabilities to suppress *P. vivax* and *P. falciparum* transmission.

Dr Amelie Vantaux

Institute Pasteur, Cambodia

After a PhD in entomology in Belgium, I have started to work on *Anopheles* mosquitoes-malaria parasites interaction in Burkina Faso with IRD. My researches were aiming at better understanding the influence of environmental factors on this host-parasite interaction. In 2014, I have joined the Pasteur Institute in Cambodia. My researches aim at better characterizing *Anopheles* vector ecology

and behavior to inform novel vector control tools development, as well as investigating the infectivity of malaria parasite carriers to mosquitoes and malaria parasite development in its mosquito host.

Dr Wannapa Suwonkerd

ODPC 1, Thailand

Dr Wannapa has more than 37 Years experiences on Vector Boren Diseases Prevention and Control with more than 80 publications including the international experiences working in:

- Cambodia-Thailand Malaria-Dengue collaboration Project since 2007 – present.
- WHO short term professional (Entomology and Vector Control) to Sri Lanka the Tsunami Relief project : (6 months February – August 2005)
- JICA the Third country expert on Parasitology and Entomology to LAOS PDR: (one month)
- WHO Short term consultant (Entomologist and Vector Control Expert) to Laos July 2014.
- Various Experiences on International Meeting / Conferences and research projects.

Dr Koen Peeters

ITM, Belgium

Prof. Koen Peeters heads the Unit of Medical Anthropology at the Institute of Tropical Medicine in Antwerp. Prof Peeters is also a senior lecturer at the Nagasaki University School of Tropical Medicine and Global Health and is affiliated to the Amsterdam Institute of Social Science Research. He holds a PhD in social and cultural anthropology and has conducted extensive research on sociocultural factors related to infectious disease transmission dynamics, perceptions on health and illness, and their impact on the effectiveness of prevention, control and elimination strategies. His professional experience is characterized by high international mobility and extensive field research on malaria in low-income countries, including West Africa, Latin America and Southeast Asia (Vietnam and Cambodia).

Dr Adisak Bhumiratana

Faculty of Public Health Thailand

After graduation, Adisak Bhumiratana has been trained in the fields of public health, epidemiology, entomology, ecology, and molecular biology of infectious diseases and environmental pathogens from USA: Laboratory of Environmental Pathogens, Center of Marine Biotechnology, University of Maryland Biotechnology Institute, Baltimore, Maryland; Centers for Disease Control and Prevention (CDC); FDA Regional Office, Atlanta, Georgia; and FDA's Gulf Coast Seafood Laboratory on Dauphin Island, Alabama; Japan: Research Institute for Microbial Diseases, Osaka University, Osaka; and Research Center for Zoonosis Control, Hokkaido University, Sapporo, Hokkaido; Thailand, Faculty of Public Health, Mahidol University. He is at the Center for Ecohealth Education and Research (CEER), Faculty of Public Health, Thammasat University, Thailand. Recently, he has been

working on research and education in the fields of one health, ecohealth, and global health. He has published more than 35 papers including 25 papers in internationally refereed journals.

Jason Richardson

IVCC, UK

Dr. Richardson was born in Asmara, Eritrea (then Ethiopia) and spent much of his childhood in living in Ethiopia, South Africa, Ghana, Liberia, and Zimbabwe. He received his Bachelor of Science in Biology from Vanderbilt University in 1992 and a Master of Science in Entomology from Clemson University in 1994. During his time at Clemson he conducted insecticide susceptibility studies on *Aedes albopictus* and assisted in field trials using *Bacillus thuringiensis var. israelensis* to control *Simulium* spp. in support of the WHO onchocerciasis eradication program. He was then commissioned as an Officer and Medical Entomologist in the United States Army. For the following ten years Dr. Richardson served in a variety of applied public health and entomology related positions throughout the United States where he worked on a wide range of vector-borne diseases—including Lyme disease, hantavirus, and plague. Returning to the world of research, in 2002 he started his Ph.D. studies at Colorado State University, Fort Collins, Colorado, where he conducted research on dengue viruses and quantitative aspects of vector competence of *Aedes aegypti*.

Following his PhD program, Dr. Richardson was stationed in Kisumu, Kenya where he directed the Entomology Program of the Walter Reed Project in collaboration with the Kenyan Medical Research Institute. He moved from there to Bangkok, Thailand in 2007 to lead the Department of Entomology at the Armed Forces Research Institute Medical Sciences (AFRIMS). During this period Dr. Richardson coordinated teams working on a wide range of vector and rodent-borne diseases including malaria, dengue, Rift Valley fever, chikungunya, leishmaniasis, leptospirosis, and hantaviruses. In 2010, he moved back to the U.S. to serve as the Chief of the Entomology Branch at the Walter Reed Army Institute of Research (WRAIR). In addition to working on vector and pathogen surveillance and detection methods, risk assessment techniques, personal protective measures, vector identification, and vector control methods, the Entomology Branch at WRAIR was a keystone of multiple malaria, dengue, leishmaniasis and scrub typhus vaccine and drug development efforts. Dr. Richardson capped off his military service managing and directing translational research programs focused on developing new tools to prevent mosquito-borne diseases as the Research Liaison Officer at the Armed Forces Pest Management Board. Dr. Richardson retired from the U.S. Army in 2016 having served as a medical entomologist for 22 years.

Dr. Richardson joined IVCC in June 2016 as a Senior Technical Coordinator of the Next Generation IRS project (NgenIRS), focused on improving access to new IRS products and shaping the IRS market to expand the use of state-of-the-art IRS tools and methods. He also works closely with and provides technical support to a matrixed team of IVCC portfolio, programme and product managers working on a variety of new tools for vector control.

Ms Allison Tatarsky

UCSF, USA

Allison Tatarsky is the Associate Director for Vector Control with the Malaria Elimination Initiative (MEI) at the University of California, San Francisco (UCSF) Global Health Group. In this role, Allison leads the MEI's portfolio of work on innovative vector control and entomological surveillance for malaria elimination and eradication. Prior to joining the MEI, Allison worked with the Clinton Health Access Initiative (CHAI) in southern Africa on malaria elimination strategy, policy, and operational research and then in Boston where she coordinated CHAI's HIV, TB, and Health Financing efforts across the organization and 23 countries. Allison has a master's degree in public health and bachelor's degree in science from Boston University.

Dr Cecil Hugo

ACT Malaria, Phillipines

Cecilia Hugo is presently the Executive Coordinator (EC) of the Asian Collaborative Training Network for Malaria (ACTMalaria), responsible for the management of the secretariat (on behalf of the Coordinating Country Director) and training courses, meetings and workshops (involving the 11 ACTMalaria member countries and partners) organized for and by the network. In addition to her present work, Ms. Hugo is a member of the Malaria Elimination Certification Panel, Vector Control Working Group of APMEN and the Technical Review Panel of Global Fund. She was educated in the University of the Philippines System for her bachelor of science degree and masteral units in entomology (UPLB) and in Public Health (UP-CPH). Post-graduate studies include DAP&E from IMR in Kuala Lumpur, Diploma in Epidemiology from the Institute pour Le development de l'Epidemiologie at Fondation Marcel Merieux in Annecy, France and JSPS Fellowship on Malaria Biology Research in Osaka University, Japan. In line with her present work, she took her 2nd degree on Education from the Philippine Women's University and obtained her Professional Teacher's Licensure from the Philippine Professional Regulations Commission.

Dr Marion Law

WHO PQ, Switzerland

Marion Law, Group lead of the Vector Control Products Team, is a microbiologist by training. Before joining RHT she held a number of senior management positions in Health Canada leading science evaluation, science policy development and regulatory science operations in the areas of medicines, medical devices, blood products as well as pesticides and pest control products. Marion has extensive international experience and as the Chief Registrar of the Pest Management Regulatory Agency of Health Canada, she was head of the Canadian delegation to NAFTA and also to the OECD where she was the Chair of the OECD Working Group on Pesticides for a 2 term.

Ms Chelci Squires

London School of Hygiene and Tropical Medicine (LSHTM), UK

Ms Squires is a Research Scientist and Assistant Trials Manager at the Department of Disease Control and Faculty of Infectious Tropical Diseases with the London School of Hygiene & Tropical

Medicine's Arthropod Control Product Test Centre (ARCTEC). Working on international projects for both institutions and industry in the public health sector. Focused on design and implementation of MHRA, NICE, WHO, EPA and CDC approved protocols for the lab and field evaluation of vector-borne diseases and vector control technologies.

Dr Michael McDonald

Consultant, USA

Michael has been working with malaria and vector-borne disease control programs since 1977, starting as a Peace Corps Volunteer in the Sabah (E. Malaysia) Malaria Control Program. Dr. Macdonald went on to earn an Sc.D. from Johns Hopkins on research on ecology of malaria transmission in Pakistan and then lived in Burma, Thailand, Cambodia and Zambia with stints in the US and Geneva supporting programs throughout Africa and Asia, working for Johns Hopkins and Boston Universities, USAID, various UN Organizations, including WHO, RBM and NGOs.

Mr Chutipong Sukkanon

PHD student, Thailand

Chutipong is a PhD student from the Department of Entomology, Faculty of Agriculture, Kasetsart University, Thailand. I am working on the evaluation of synthetic and natural repellents for the control of mosquito vectors, funding by The Royal Golden Jubilee (RGJ) PhD Program Scholarship, Thailand Research Fund Organization (TRF).