MEETING ON THE GLOBAL VECTOR CONTROL RESPONSE

1–2 August 2018
Nadi, Fiji
NOTE

The views expressed in this report are those of the participants of the Meeting on the Global Vector Control Response 2017–2030 and do not necessarily reflect the policies of the conveners.

This report has been prepared by the World Health Organization Regional Office for the Western Pacific for Member States in the Region and for those who participated in the Meeting on the Global Vector Control Response 2017–2030 in Nadi, Fiji from 1 to 2 August 2018.
# CONTENTS

## SUMMARY

1. INTRODUCTION ............................................................................................................................. 1  
   1.1 Background ............................................................................................................................. 1  
   1.2 Objectives ............................................................................................................................... 1  
   1.3 Opening remarks ..................................................................................................................... 1  
   1.4 Nomination of Chair, Vice-Chair and Rapporteur ................................................................. 2

2. PROCEEDINGS ................................................................................................................................ 2  
   2.1 Technical session 1: Global and regional updates ................................................................. 2  
   2.2 Technical session 2: Achieving sustainable *Aedes* vector control ........................................ 4  
   2.3 Technical session 3: Responding to outbreaks with vector control ........................................ 5  
   2.4 Technical session 4: Strengthening evidence for action ......................................................... 7  
   2.5 Technical session 5: Novel tools and financing *Aedes* vector control ........................................ 9

3. CONCLUSIONS AND RECOMMENDATIONS .......................................................................... 10

## ANNEXES

Annex 1. AGENDA  
Annex 2. LIST OF PARTICIPANTS

---

**Keywords:**  
*Aedes* / Chikungunya virus / Dengue / Disease vectors / Regional health planning / Zika virus
SUMMARY

The Global Vector Control Response 2017–2030 (GVCR) provides strategic guidance to countries and development partners for urgent strengthening of vector control as a fundamental approach to preventing disease and responding to outbreaks. To achieve this requires realignment of vector control programmes, supported by increased technical capacity, improved infrastructure, strengthened monitoring and surveillance systems, and greater community mobilization. The recent emergence of Zika virus disease and chikungunya in the Western Pacific Region further supports the need to strengthen the response to dengue and other diseases transmitted by *Aedes* mosquitoes. It is recommended to implement proactive and sustainable *Aedes* mosquito-control measures in collaboration with sectors beyond health, including early implementation of new technologies.

In order to inform the ministries of health regarding the GVCR and the need to strengthen integrated vector control to address all vector-borne disease challenges, the WHO Regional Office for the Western Pacific convened the Meeting on the Global Vector Control Response 2017–2030. All non-malaria endemic Member States in the Western Pacific Region attended; participants were directors of communicable or vector-borne disease control programmes of the health ministries, partners, and the WHO Secretariat.

The technical sessions on the first day included global and regional updates on the burden of dengue, Zika and chikungunya. WHO recently developed the *Western Pacific Regional Action Plan for Dengue Prevention and Control (2016)* and the GVCR, and these frameworks for strengthening vector control were presented. The need for sustainable vector control was outlined, as were steps for developing sustainable programmes within current capacity limits. A detailed account of the difference between routine and epidemic vector control was followed by discussions on improving outbreak responses to reduce the impact of dengue and other arboviral diseases.

The second day included technical presentations and discussions starting with a presentation of a toolkit recently developed by WHO to assist Member States in estimating the true burden of dengue within their country. This was followed by an overview of the components of a comprehensive routine *Aedes* vector surveillance programme. Next, the status of insecticide resistance of *Aedes* mosquitoes in the Western Pacific Region was presented; then a session devoted to discussing the importance of capacity building and human resources for vector control, especially dengue vector control. The last technical presentation was an overview of the promising potential for using *Wolbachia* for dengue vector control as a novel tool. This was followed by a panel discussion about the opportunities and challenges for proactively building sustainable vector control programmes throughout the Region. During the interactive session, each of the Member States identified three key steps that they can individually take within the current capacity of their programme to enhance vector control. The last highlight was one of the underlying aims of the meeting, which was to build relationships and networks throughout the Region.
1. INTRODUCTION

1.1 Background

Mosquitoes, flies, ticks, fleas and other vectors transmit viruses, parasites and bacteria that cause various kinds of diseases. These include malaria, dengue, lymphatic filariasis, schistosomiasis, Japanese encephalitis, chikungunya and Zika virus disease. Vector control is an essential component in the prevention and control of vector-borne diseases, specifically for transmission control, if implemented in a sustained and integrated manner.

The Global Vector Control Response 2017–2030 (GVCR) provides strategic guidance to countries and development partners for urgent strengthening of vector control as a fundamental approach to preventing disease and responding to outbreaks. To achieve this requires realignment of vector control programmes, supported by increased technical capacity, improved infrastructure, strengthened monitoring and surveillance systems, and greater community mobilization. Ultimately, this will support implementation of a comprehensive approach to vector control that will enable the achievement of disease-specific national and global goals and contribute to achievement of the Sustainable Development Goals.

In the Western Pacific Region, significant progress has been made towards reducing malaria transmission. From 2009 to 2015, reported malaria deaths in the Region decreased by 85%, and overall cases reduced by 48%. On the other hand, the transmission of arboviruses, such as dengue, Zika and chikungunya have been emerging and increasing throughout the Region. The annually reported number of dengue cases in the Region has grown from approximately 213 000 cases in 2008 to over 460 000 cases in 2014. However, and importantly, improved case management has led to a 50% reduction of regional case fatality rates from 0.32% in 2008 to 0.16% in 2014.  

The WHO Regional Office for the Western Pacific convened the two-day Meeting on the Global Vector Control Response 2017–2030 on 1–2 August 2018. Participants were directors of communicable or vector-borne disease control programmes of the health ministries, partners, and the WHO Secretariat. The meeting was opened to all non-malaria endemic Member States in the Region. It provided an opportunity to inform the ministries of health regarding the GCVR and the need to strengthen integrated vector control to address all vector-borne disease challenges, especially Aedes-borne diseases through alignment and integration of national vector control strategies as outlined in the response.

1.2 Objectives

The objectives of the meeting were:

1. to review and discuss progress in implementation of vector control in countries; and
2. to identify priority actions and discuss measures to address challenges through strengthening integrated vector control in alignment with the Global Vector Control Response 2017–2030.

1.3 Opening remarks

Dr Rabindra Abeyasinghe, Coordinator of the Malaria, other Vectorborne and Parasitic Diseases, delivered the welcome address on behalf of Dr Shin Young-soo, WHO Regional Director for the Western Pacific. In response to the significant threat posed by vector-borne diseases to human health, two key documents have been developed – the GVCR and the Western Pacific Regional Action Plan for Dengue Prevention and Control (2016). The framework provided in these documents mitigates the

---

impact posed by dengue and other arboviral diseases and particularly aims at further reducing deaths due to dengue. Dr Abeyasinghe emphasized that the aim of the meeting was to guide Member States to adopt a new approach to vector control in their countries, moving away from reactive outbreak control towards sustainable reductions in vector densities, thereby possibly reducing the scale and frequency of outbreaks.

1.4 Nomination of Chair, Vice-Chair and Rapporteur

Dr Sally Gilbert, Manager, Environmental and Border Health and Public Health, Ministry of Health of New Zealand, was nominated as Chair. Mr Vacaruru Cauvilati, Acting Senior Health Inspector, Vector Control, Quarantine, Burial and Cremation Environmental Health Unit, Ministry of Health and Medical Services of Fiji, was nominated as Vice-Chair. Mr Djamil Ackburally, Senior Assistant Director, Environmental Public Health Operations Department, Singapore, was nominated as Rapporteur. The nominations were endorsed by all participants.

2. PROCEEDINGS

2.1 Technical session 1: Global and regional updates

2.1.1 Updates on Global and Regional Dengue Situation

Dr Raman Velayudhan, Coordinator, Vector Ecology and Management, WHO Department of Control of Neglected Tropical Diseases, presented an overview of the global and regional dengue situation. Globally and in the Western Pacific Region, the transmission of dengue, Zika, chikungunya and West Nile virus have been increasing. Dr Velayudhan highlighted that there are a number of underlying and interacting factors involved, including unplanned and rapid urban expansion and insecticide resistance.

Dr Velayudhan provided an overview of the objectives from the Global Strategy for Dengue Prevention and Control 2012–2020. The three key objectives are: 1) to reduce dengue deaths by at least 50% by 2020; 2) to reduce dengue morbidity by at least 25% by 2020; and 3) to better ascertain the true burden of disease by 2015. Dr Velayudhan provided an overview of the dengue cases and deaths that are reported to WHO by region. WHO has made an effort to collate key indicators of dengue data at a country level, and the interactive database is available at: http://www.who.int/denguecontrol/epidemiology/dengue_data_application/en/. Although the number of notified cases has been steadily increasing, it is important to note that as a result of improved case management regional case fatality rates have decreased by 50%.

There are two main vectors, Aedes aegypti and Aedes albopictus, that transmit more than four diseases, and there has been a “silent expansion” of the geographic distribution of these vectors. The key bionomic factors that make Ae. aegypti, in particular, an excellent vector are that it tends to take multiple blood meals and is highly anthropophagic. Another key fact is that the eggs of both species can withstand desiccation, highlighting that containers should be scrubbed to remove any eggs. Ultimately, vector control should be designed to have a combined action that targets both adults and larvae.

The discussion focused on the diversity of vector control and surveillance programmes in the region. Dr Abeyasinghe highlighted that the overall aim is to build an integrated vector control response that targets multiple diseases. In many countries of the Western Pacific Region, there is an opportunity to build on the current dengue vector control programmes, as an entry point for Aedes control, recognizing that diagnostics and case management for chikungunya and Zika would be different. Member States identified a number of challenges, including the need for support for vector
surveillance, especially in terms of capacity-building and training. Many of the island countries, in particular, required entomological support to identify mosquitoes and to undertake insecticide resistance.

2.1.2 Regional Action Plan for Dengue Prevention and Control in the Western Pacific (2016)

Dr Abeyasinghe presented an overview of the Regional Action Plan for Dengue Prevention and Control in the Western Pacific (2016). The goal of the regional action plan is to reduce the health impact of dengue by further reducing case fatality rates and strengthening evidence for action on dengue. The plan recommends a switch in strategy from outbreak containment to reducing the impact of dengue on communities. The recent emergence of Zika virus disease and chikungunya in the Region further supports the need to strengthen the response to dengue and other diseases transmitted by *Aedes* mosquitoes. The plan recommends proactive and sustainable implementation of *Aedes* mosquito control measures in collaboration with sectors beyond the health sector, and encourages early implementation of new technologies.

Based largely on the Global Strategy for Dengue Prevention and Control 2012–2020, the regional action plan embraces six enabling factors and five technical elements to strengthen diagnostics and case management, surveillance, risk assessment and outbreak preparedness, implement sustainable vector management, increase attention to community engagement and risk communication and consolidate implementation research and early adoption of emerging technologies.

A key point that Dr Abeyasinghe made is that in terms of arbovirus burden “we are only seeing the tip of the iceberg” as the majority of people are asymptomatic or present only mild symptoms, and thus only 10–15% of people present at clinics. Further, of the acute cases, many people go to private facilities and their cases are not reported. Therefore, reactive programmes are heavily compromised, as the responses are driven by information gathered from less than 10% of cases. Dr Abeyasinghe advocated for the countries to develop country-owned programmes that are meaningful for the local context, so that programmes are developed and implemented in a sustainable manner and not in the reactive manner that occurs during the heat of an outbreak. Further, there is a need to develop vector surveillance programmes that include both larval and adult mosquito indicators for evaluating the effectiveness of control interventions.

2.1.3 Global Vector Control Response 2017–2030

Dr Velayudhan presented an overview of the Global Vector Control Response 2017–2030. This response calls for improved public health entomology capacity and capability, better coordination within and between sectors, community involvement in vector control, strengthened monitoring systems, a well-defined national research agenda and novel interventions with proven effectiveness. Its goals are to: 1) reduce mortality due to vector-borne disease globally by at least 75%, by 2030, relative to 2016 baselines; 2) reduce case incidence due to vector-borne diseases globally by at least 60%, by 2030, relative to 2016 baselines; and 3) prevent epidemics of vector-borne disease in all countries by 2030.

The GVCR has four pillars, two foundational elements three enabling factors:
- Pillar 1: Strengthen inter- and intra-sectoral action and collaboration
- Pillar 2: Engage and mobilize communities
- Pillar 3: Enhance vector surveillance and monitoring and evaluation of interventions
- Pillar 4: Scale up and integrate tools and approaches
- Foundational element A: Enhance vector control capacity and capability
- Foundational element B: Increase basic and applied research, and innovation
- Enabling factor 1: Country leadership
- Enabling factor 2: Advocacy, resource mobilization and partner coordination
- Enabling factor 3: Regulatory, policy and normative support
Member States are encouraged to develop national vector control strategic plans aligned with the global vector control response with the following priority activities:

1. National vector control needs assessment conducted or updated and resource mobilization plan developed, including for outbreak response.
2. National entomology and cross-sectoral workforce appraised and enhanced to meet identified requirements for vector control.
3. Relevant staff from health ministries or supporting institutions trained in public health entomology.
4. National and regional institutional networks to support training and/or education in public health entomology and technical support established and functioning.
5. National agenda for basic and applied research on entomology and vector control established and/or progress reviewed.
6. National inter-ministerial task force for multisectoral engagement in vector control established and functioning.
7. National plan for effective community engagement and mobilization in vector control developed.
8. National vector surveillance systems strengthened and integrated with health information systems to guide vector control.

The discussions focused on the diversity of vector control programmes in the Region, and the successful aspects of the existing programmes. The programmes throughout the Region have a large range of capacity, from grass-roots to well established programmes. It was highlighted that one of the keys to a successful vector control programme is building strong partnerships and political support. Member States emphasized the need to move away from the considerable human resources that are required to maintain historical programme designs. There was support for developing community-based and -owned programmes involving community clean-ups. A major challenge for the island countries was capacity, in particular laboratory diagnosis, surveillance, and monitoring and evaluation. Another challenge that was identified was the lack of sustainable funding mechanisms. Dr Velayudhan emphasized the need to advocate that dengue is an endemic disease and to build a systematic approach to vector control that addresses Aedes-transmitted viruses as a permanent problem.

2.2 Technical session 2: Achieving sustainable Aedes vector control

2.2.1 The need for sustainable vector control, the global vector control response – an opportunity

Dr Abeyasinghe outlined the need to develop programmes based on sustainable and integrated vector control, advocating a change from reactive vector control. He highlighted that it was important to develop vector control options that could be sustainably used during “peacetime”, not just during outbreaks. The underlying reasons that compromise reactive vector control include that the majority of cases are asymptomatic and unreported, and further that the response tools are technically weak and often use compromised insecticides at the wrong concentrations. Sustainable vector control will routinely reduce vector densities, and as such there will possibly be a reduction in the frequency and intensity of outbreaks. He advocated that sustainable vector control options target the larval stage of the mosquito life cycle, while outbreak control options involve the reactive targeting of the adult stage. The indiscriminate thermal fogging of the environment during outbreaks and especially in non-outbreak seasons was discouraged because of the complexities associated with its proper implementation, its minimal impact on dengue transmission and its collateral negative environmental impacts.

A range of vector control options are available, but they are not often used to their full potential, as outlined in the GVCR. Regarding Aedes control, options include: elimination of old tyres and
containers; covering, emptying and cleaning of containers; drainage or treatment of stagnant water; larviciding; biological control of larvae; use of long clothing and topical repellents; house improvements; and indoor targeted residual spraying. It was also noted that infected patients should remain under insecticide-treated bed nets during the day to prevent further mosquitoes from becoming infected. Sustainable vector control can be supported by the decision-making process presented in the *Handbook for Integrated Vector Management*. The key components of integrated vector management are to: 1) select methods based on knowledge of local vector biology, disease transmission and morbidity; 2) utilize a range of interventions, often in combination or synergy; and 3) collaborate within the health sector and with others in the public and private sector that impact vector breeding.

The discussion focused on the challenges for developing sustainable vector control programmes. In particular, it was highlighted that politicians and the communities request fogging as an outbreak response. In response, Dr Abeyasinghe highlighted the importance of the role of education. Fogging is often requested by politicians and the communities, because it is a highly visible response and it provides reassurance that a response is being mounted against an outbreak. However, communities need to be educated that external fogging actually has little impact on transmission and is causing great environmental harm; more effective tools are available. When educating the community, messages must be relevant. In terms of developing clean-up campaigns, another key message is to actually reduce the amount of waste that is produced: reduce, recycle and reuse, especially receptacles that could serve as potential mosquito breeding sites.

2.2.2 Proactive sustainable *Aedes* vector control, the how irrespective of country capacities

Dr Tanya Russell outlined the steps for developing sustainable *Aedes* vector control programmes. The key message was that irrespective of your country's capacity, some level of effective and sustainable vector control can be achieved. Dr Russell highlighted that for vector control to be successful there is a need to sustain the intervention with sound monitoring and evaluation. Further noting that programmes need to optimize the delivery of interventions that are tailored to the local context. The local context, in terms of both the vectors and environment, but also in terms of the current capacity of the programme.

One of the keys to developing sustainable vector control is to engage and mobilize communities. It enables programmes with limited capacity to capitalize by leveraging local knowledge and skills. Community engagement aims to strengthen the capacity of the communities to identify issues where action is required. The communication between the programme and communities should use multiple channels including mass, local and social media. Targeted community members range from schoolchildren to respected community members such as church leaders. Behaviour change outcomes include seeking early medical attention, larval control, source reduction, community clean-ups and the use of personal protection measures. Dr Russell concluded that although sustainable vector control is built on a foundation of capacity, effective programmes can be designed and implemented within the limits of the available national and local capacities.

The discussion focused on community engagement and highlighted that children are an important target group. Thus, messages should be fun and exciting, including games, quizzes and songs. One major issue that was raised in terms of community clean-ups was the partnership with the solid waste management facilities. In many countries, the capacity to manage the solid waste is lacking and recycling programmes are limited. There is a need to advocate improved solid waste management.

2.3 Technical session 3: Responding to outbreaks with vector control

2.3.1 Vector control as a component of outbreak response – an introduction

Dr Abeyasinghe provided an introduction to vector control as a component of outbreak response. The key differences between “peacetime” and outbreak vector responses were highlighted. During outbreaks, vector control responses should aim to rapidly reduce the density of infected mosquitoes.
Vector control should aim to minimize further infection of vectors by reducing vector densities especially in locations where viraemic persons congregate (such as outpatient departments, clinics and health facilities). Viraemic patients should be protected when they are in the preclinical or early clinical phase; the time patients have developed severe dengue fever there is likely to be no virus in peripheral circulation of patients to infect mosquitoes.

Monitoring and evaluation should be an integral component of outbreak response. The importance of timely sharing of disease surveillance data was highlighted so that an effective outbreak response could be triggered and accurately targeted. Monitoring and evaluation of responses will facilitate the analysis of strategies and activities that contribute to reducing the scale and frequency of outbreaks in different circumstances. It was noted that the vector control responses should be designed by the vector control programmes jointly with community members, who should be empowered to have ownership over their involvement in the response.

2.3.2 Targeted residual insecticide spraying and the use of space spraying for outbreak response

Dr Scott Ritchie presented the technical elements of using targeted residual insecticide spraying (TIRS) and space spraying for outbreak control. During outbreaks, there is a sense of urgency, and vector control is reactively implemented. Dr Ritchie highlighted the importance of making informed decisions to implement considered insecticide spraying targeted towards the sites where adult female Aedes are known to rest. Importantly TIRS, should be considered the primary intervention and space spraying only a secondary intervention where programmes have sufficient capacity and resources. It is essential to know which species is responsible for transmission and where the adults are harbouring. A decision support flowchart was presented (Fig. 1).

Fig. 1: Dengue adulticiding decision support flowchart, highlighting the importance of making informed decisions

The use of TIRS for urban Aedes control was encouraged in outbreak situations. Dr Ritchie provided examples demonstrating the epidemiological impact of well applied TIRS. The application of insecticide for TIRS should be specifically targeted to areas of the household where the adult mosquitoes are known to rest such as under tables, furniture, beds, staircases; inside wardrobes, boxes and crates; narrow corridors and lower walls (<1.5 metres), in dark areas or adjacent to dark objects (suitcases, furniture, crates). Noting that where Ae. albopictus is the primary vector, vegetated and shady areas close to residential premises would also need to be targeted. Insecticide resistance management practices should involve the use of an insecticide with a different mode of action, such as larviciding with s-methoprene.
2.3.3 Monitoring and evaluation of outbreak response

Dr Russell presented on the importance of incorporating monitoring and evaluation systems into outbreak responses. Monitoring and evaluation systems are essential to facilitate managers, policy planners and other partners to understand which responses had an impact on stemming transmission. Monitoring and evaluation systems are often a very weak link in vector control programmes and need to be strengthened and integrated urgently. The key differences between monitoring and evaluation were detailed, noting that the process and developing a successful monitoring and evaluation system could be reduced to three key elements: 1) understanding what needs to be evaluated; 2) developing the data collection tools; and 3) analysis and reporting. Using one national system to collect, analyse, interpret, and monitoring and evaluating data was encouraged.

Data should be systematically collected from sentinel sites across time; during epidemics or outbreaks, these routine activities should be supplemented with focal investigations. Data collection should be designed to provide information: 1) to enable stratifying areas for further investigation; 2) to detect increases in risk or transmission; and 3) to identify threats to the effectiveness of vector control, such as insecticide resistance. The importance and challenge of identifying useful indicators were discussed, as was the range of different indicators that have the potential to provide information that will directly assess the progress of an outbreak response. With regard to vector surveillance and control, the minimum set of indicators included mosquito species present, key larval habitats and insecticide resistance status.

The discussion touched on topics across the use of vector control as a component of an outbreak response. Tonga emphasized the need for community participation and education. In their example, external thermal fogging is conducted as an outbreak response because community members are unwilling to open their homes for targeted indoor residual spraying. Samoa emphasized the need for incorporating vector control indicators into the existing monitoring and control system and lobbying for these additional indicators. Some Member States also indicated that they have already implemented successful community clean-up campaigns, noting that the excessive use of plastic and climate change were two major challenges that many countries are facing. The importance of community engagement was highlighted, noting that church leaders and women’s groups are potentially strong allies.

Dr Abeyasinghe informed the participants about the new system within WHO for recommending insecticides and vector control tools. The previous WHO Pesticide Evaluation Scheme (WHO PES) system has been converted to the WHO Prequalification of Vector Control Product Assessment. All products with WHOPES recommendations are eligible for inclusion on the List of Prequalified Vector Control Products.

Some options for capacity-building and training for vector control were discussed. In particular, the hands-on, 10-day training course in Singapore was highlighted. There are also possibilities for exchanges with established programmes in Singapore, China, and Queensland, Australia.

2.4 Technical session 4: Strengthening evidence for action

2.4.1 Strengthening evidence for action – Determining dengue burden

Dr Raman Velayudhan emphasized the need to estimate the real burden of disease compared with the number of patients actually hospitalized. This is important because approximately 80% of arbovirus cases are asymptomatic and mild, and are not reported. This is important, because the asymptomatic or mildly impacted people are still able to transmit the virus to mosquitoes. Having a true estimate of the dengue burden will facilitate calculating the economic burden of dengue to build the case for investment in surveillance and control measures. Further, it will improve the understanding of the local epidemiology and the potential for dengue to spread.
WHO, in collaboration with a number of academic partners, have developed the WHO national burden estimation toolkit, which will be published in September 2018. The tool will be a simple Microsoft Excel spreadsheet that uses national data to estimate country-wide burden of disease. Examples of how to use the toolkit were provided.

During the discussion, the toolkit was considered a possibly useful tool to provide an essential information base to advocate for increased funding within the ministry. A number of challenges were identified in terms of case reporting and surveillance.

2.4.2 Routine *Aedes* vector surveillance

Professor Qiyong Liu provided a comprehensive overview of the *Aedes* vector surveillance programme in China. Across China, a detailed routine *Aedes* vector surveillance programme targeting both adult and larval stages has been designed and implemented, and utilizes electronic data capture and an Internet-based database. There are three key components to the system: 1) vector surveillance, including species, density and distribution; 2) insecticide resistance surveillance; and 3) vector pathogen surveillance. The system has been designed to provide data reports, risk alerts, statistical summaries, web surveys and quality control.

The key points from developing the strong surveillance system in China are that minimal standard need to be defined with at least one method for surveillance and one indicator. The recommendations are to conduct *Aedes* surveillance in accordance with the local setting and requirements to establish timely reporting of the surveillance data, develop a system that will trigger risk assessments, and provide early warning of transmission. Capacity-building and training in *Aedes* surveillance are essential.

2.4.3 Insecticide resistance status of *Aedes* mosquitoes in the Western Pacific Region

Dr Russell provided an overview of the insecticide resistance status of *Aedes* mosquitoes in the Western Pacific Region. The effectiveness of vector control using insecticides is threatened by the emergence of insecticide resistance. Insecticide resistance is defined as the ability of mosquitoes to survive exposure to a standard dose of insecticide. Monitoring insecticide resistance is extremely important to ensure that the correct insecticides are selected and used, as well as to support insecticide resistance management practices. The incidence of insecticide resistance has been increasing globally at an alarming rate. In this context, the Worldwide Insecticide Resistance Network (WIN) was established to track insecticide resistance in *Aedes* at a global scale. The network is supported by WHO and the Special Programme for Research and Training in Tropical Diseases (TDR), partnering with the Big Data Institute at the University of Oxford. The datasets have been published online and are available through the IR Mapper.

Specifically, the Western Pacific Region lacks comprehensive resistance data for the *Aedes* mosquitoes. With regard to *Ae. aegypti*, pyrethroid resistance is widespread and of major concern. Resistance has been detected throughout the Asian countries, and also in Vanuatu, Kiribati and Samoa, with possible resistance in New Caledonia. In north Queensland, *Ae. aegypti* remain susceptible to pyrethroids. For *Ae. aegypti* and organophosphates, resistance data are more patchy, with some locations in South-East Asia, though no resistance yet detected in the Pacific. For *Ae. aegypti* and both organochlorines and carbamates, the level of resistance throughout South-East Asia seems to be high from the limited amount of available data. With regard to *Ae. albopictus*, there is a limited dataset available, and it indicates that the species is resistant to the four major classes of insecticides throughout South-East Asia (pyrethroids, organophosphates, organochlorines, carbamates). Resistance of *Ae. albopictus* to pyrethroids has also been detected in Vanuatu. Due to the high levels of resistance seen throughout the Region, it is essential to implement management practices that aim to reduce selection pressure, such as restricting applications to small areas and particular times, as well as rotating the use of insecticides with different modes of action.
The discussion emphasized the need for more insecticide resistance information from the Region. The lack of capacity to test for insecticide resistance throughout the Region, particularly in the Pacific, is a challenge. WHO could potentially provide assistance for conducting insecticide resistance bioassays throughout the Region, as people cannot be released for training during an outbreak. Building knowledge and competence before an outbreak is important, so that when an outbreak occurs the capacity to respond actually exists. There are training opportunities available through WHO and the WHO collaborating centres, but the countries need to make requests and identify people for training.

2.4.4 Human resources for dengue control – maximizing impact

Dr Raman Velayudhan discussed the need for capacity-building to support dengue control programmes in three key areas: public health entomology, laboratory capacity and clinical management. With regard to vector control capacities, there are opportunities for advance capacity-building in the Region, as people cannot be released for training during an outbreak. Building knowledge and competence before an outbreak is important, so that when an outbreak occurs the capacity to respond actually exists. There are training opportunities available through WHO and the WHO collaborating centres, but the countries need to make requests and identify people for training.

2.5 Technical session 5: Novel tools and financing Aedes vector control

2.5.1 Wolbachia for dengue control – an update from the Pacific

Mr Geoff Wilson provided an update from the Pacific on the potential for using Wolbachia for dengue vector control by sharing details of ongoing pilot projects. Wolbachia are safe, natural bacteria present in up to 60% of insect species, including some mosquitoes, though not usually found in the Ae. aegypti mosquito. Ten years ago, the World Mosquito Program team successfully transferred Wolbachia from insects into Ae. aegypti populations. Ae. aegypti infected with Wolbachia have a reduced ability to transmit viruses to people, decreasing the risk of Zika, dengue and chikungunya outbreaks. The World Mosquito Program’s methods have been subjected to rigorous independent assessments. The results concluded that there is negligible risk associated with the release of Wolbachia-carrying mosquitoes and that Wolbachia is safe for people, animals and the environment.

Controlled release of mosquitoes carrying Wolbachia have commenced in areas where arbovirus transmission is endemic. Over several months, male and female Ae. aegypti infected with Wolbachia have been released. Once the Wolbachia-carrying mosquitoes are released, they breed with wild mosquitoes and over time the majority of the population will carry Wolbachia. Long-term monitoring shows that Wolbachia is self-sustaining at high levels in the majority of the international project sites, up to seven years after release. These areas have had no local dengue outbreaks. Successful examples were provided from Cairns and Townsville in Australia. Within the Pacific, field sites have been established in Fiji, Kiribati and Vanuatu, where mosquito releases are commencing. Mr Wilson also discussed progress of releases of Wolbachia-infected Ae. aegypti in Yogyakarta, Indonesia, Rio de Janeiro, Brazil, and Medellin/Bello, Colombia.

2.5.2 Panel discussion – Resource mobilization for dengue control

The panel discussion highlighted a number of challenges specific to the countries of the Western Pacific Region that need to be addressed. One key issue was creative methods for sustainable funding. Dr Abeyasinghe said that it was time to start thinking outside the box and to look into new venues for funding, such as taxes on cruise ships, resorts or ports. Dr Velayudhan highlighted that ports are a business and should contribute funds to keep the ports vector free. When boats need to be fumigated, the costs should be passed onto the boat owner. Another key challenge is capacity, and Dr Velayudhan highlighted the need to map out human resources within the programme, specifically thinking about the career paths for individuals and how to retain service. Dr Abeyasinghe further emphasized the Healthy Islands concept, being defined as disease-free islands built on the foundation.
of community engagement and clean-ups, which already enjoy full political buy-in in several Pacific island countries.

Dr Abeyasinghe also discussed the value of building partnerships within the communities, stating that the partnerships and relationships need to be built before an outbreak occurs. There are a range of partners for potential resource sharing, including resorts and private business that all have a mutual interest in controlling dengue in the area. During the open session, Fiji raised the issue of community engagement and the importance of forming strong partnerships. Noting that since the urban centres (where the dengue cases occur) have no village chief system, the church needs to be involved as well as government departments, including the police and military. This is very important because civil servants are respected, and their involvement in community clean-ups will encourage the broader community.

2.5.3 Closing remarks

Dr Abeyasinghe gave the closing remarks. He thanked everyone for coming to Nadi to join the meeting. He reiterated the need to be proactive and to build sustainable vector control programmes before an outbreak occurs. By implementing sustainable and routine vector control, the intensity and frequency of outbreaks will possibly be lessened.

3. CONCLUSIONS AND RECOMMENDATIONS

The Global Vector Control Response 2017–2030 was presented and the importance of developing proactive and sustainable vector control operations was highlighted. An overall aim of the meeting was to guide Member States to move away from reactive outbreak control of dengue towards sustainable reductions in vector densities that would possibly reduce the scale and frequency of outbreaks. Subsequent discussions focused on the frameworks for vector control presented by both the GVCR and the Regional Action Plan for Dengue Prevention and Control in the Western Pacific (2016). The need for sustainable vector control was outlined as well as steps for developing sustainable programmes within the limits of the current capacity of the programme.

The inevitability of outbreaks occurring was discussed as well as the importance to respond promptly and in a meaningful manner. The key differences between routine and outbreak vector control were discussed. The purpose of routine vector control is to sustainably reduce vector densities, whereas the purpose of an outbreak response is to kill infected mosquitoes and to prevent infected vectors from further transmitting the disease and to prevent non-infected vectors from becoming infected. The framework for dengue control, including vector control programmes, needs to be developed and implemented prior to an outbreak occurring, ensuring that key pillars have been established such as building partnerships, engaging communities as well as developing a monitoring and evaluation framework. During outbreaks, it is important to make informed decisions and to implement evidence-based vector control activities based on disease surveillance information in a timely manner. The need to support vector control programmes with functional monitoring and evaluation systems was emphasized. The threat of insecticide resistance was highlighted, noting that it is important to implement insecticide resistance management practices that aim to reduce selection pressure, such as by restricting applications to small areas and particular times, as well as rotating the use of insecticides with different modes of action.

Lastly, it was highlighted that one of the underlying aims of the meeting was to build relationships and networks throughout the Region. Knowing the staff in neighbouring countries is an essential resource that can be tapped to support vector control operations.
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Presenter(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:30 – 09:00</td>
<td>Registration</td>
<td></td>
</tr>
<tr>
<td>09:00 – 09:30</td>
<td>Opening Session</td>
<td></td>
</tr>
<tr>
<td>09:00 – 09:30</td>
<td>Welcome address</td>
<td>Dr Shin Young-soo, Regional Director, WPRO</td>
</tr>
<tr>
<td>09:00 – 09:30</td>
<td>Meeting objectives</td>
<td>Dr Rabindra Abeyasinghe, Coordinator/MVP, WPRO</td>
</tr>
<tr>
<td>09:00 – 09:30</td>
<td>Self-introduction of participants and observers</td>
<td></td>
</tr>
<tr>
<td>09:00 – 09:30</td>
<td>Nomination of the Chair and Rapporteur</td>
<td></td>
</tr>
<tr>
<td>09:30 – 10:00</td>
<td>Administrative announcements</td>
<td></td>
</tr>
<tr>
<td>09:30 – 10:00</td>
<td>Group photograph followed by coffee/tea break</td>
<td></td>
</tr>
<tr>
<td>10:00 – 10:40</td>
<td>Session 1: Global and regional technical updates</td>
<td></td>
</tr>
<tr>
<td>10:00 – 10:40</td>
<td>Updates on Global and Regional Dengue Situation</td>
<td>Dr Raman Velayudhan, Coordinator, VectorEcology and Management, NTD/CDS, WHO HQ</td>
</tr>
<tr>
<td>10:40 – 11:10</td>
<td>Regional Action Plan for Dengue Prevention And Control in Western Pacific (2016)</td>
<td>Dr Rabi Abeyasinghe</td>
</tr>
<tr>
<td>11:10 – 12:00</td>
<td>Global Vector Control Response 2017 – 2030</td>
<td>Dr Raman Velayudhan</td>
</tr>
<tr>
<td>12:00 – 13:00</td>
<td>Lunch break</td>
<td></td>
</tr>
<tr>
<td>14:00 – 14:30</td>
<td>Session 2: Achieving sustainable Aedes vector control</td>
<td></td>
</tr>
<tr>
<td>14:00 – 14:30</td>
<td>The need for sustainable vector control, the Global Vector Control Response – an opportunity</td>
<td>Dr Rabi Abeyasinghe</td>
</tr>
<tr>
<td>14:30 – 14:35</td>
<td>Mobility Break</td>
<td></td>
</tr>
<tr>
<td>14:35 – 15:10</td>
<td>Proactive sustainable Aedes vector control, the how irrespective of country capacities</td>
<td>Tanya Russell</td>
</tr>
<tr>
<td>15:10 – 15:40</td>
<td>Tea Break</td>
<td></td>
</tr>
<tr>
<td>15:40 – 17:00</td>
<td>Session 3: Responding to outbreaks</td>
<td></td>
</tr>
<tr>
<td>15:40 – 17:00</td>
<td>Vector control as a component of outbreak response – what’s new?</td>
<td>Rabi Abeyasinghe</td>
</tr>
<tr>
<td>15:40 – 17:00</td>
<td>An Introduction</td>
<td>Scott Ritchie</td>
</tr>
<tr>
<td>15:40 – 17:00</td>
<td>Targeted Residual Insecticide Spraying</td>
<td>Scott Ritchie</td>
</tr>
<tr>
<td>15:40 – 17:00</td>
<td>Use of space spraying for outbreak control</td>
<td>Tanya Russell</td>
</tr>
<tr>
<td>15:40 – 17:00</td>
<td>Monitoring and Evaluation of outbreak response</td>
<td></td>
</tr>
<tr>
<td>17:30</td>
<td>Welcome Reception</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>Session 4: Strengthening evidence for action</td>
<td>Session 5: Novel tools and financing Aedes vector control</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>9:00 – 9:40</td>
<td>Strengthening evidence for action - Determining dengue burden</td>
<td>Panel Discussion - Resource mobilization for dengue control</td>
</tr>
<tr>
<td></td>
<td>Dr Raman Velayudhan</td>
<td>Raman/Qiyong/Scott – Moderated by Rabi</td>
</tr>
<tr>
<td></td>
<td>Discussion</td>
<td>Mobility Break</td>
</tr>
<tr>
<td></td>
<td>Prof Qiyong Liu</td>
<td>Mobility Break</td>
</tr>
<tr>
<td>10:30 – 10:45</td>
<td>Tea Break</td>
<td></td>
</tr>
<tr>
<td>10:45 – 11:30</td>
<td>Insecticide resistance status of Aedes mosquitoes in the WPR</td>
<td>14:20 – 15:00</td>
</tr>
<tr>
<td></td>
<td>Tanya Russell</td>
<td>Wolbachia for dengue vector control – an update from the Pacific</td>
</tr>
<tr>
<td>11:30 – 12:15</td>
<td>Human resources for dengue control – maximizing impact</td>
<td>Geoff Wilson</td>
</tr>
<tr>
<td></td>
<td>Rabi Abeyasinghe</td>
<td>World Mosquito Programme Fiji</td>
</tr>
<tr>
<td>12:15 – 13:15</td>
<td>Lunch break</td>
<td></td>
</tr>
<tr>
<td>14:20 – 15:00</td>
<td>Wolbachia for dengue vector control – an update from the Pacific</td>
<td>Geoff Wilson</td>
</tr>
<tr>
<td>15:10 – 15:40</td>
<td>Tea Break</td>
<td>World Mosquito Programme Fiji</td>
</tr>
<tr>
<td>15:40 – 17:00</td>
<td>Group work – identifying existing country capacities for vector control</td>
<td>Dr Rabi Abeyasinghe</td>
</tr>
<tr>
<td>17:00 – 17:15</td>
<td>Conclusion</td>
<td>Dr Rabi Abeyasinghe</td>
</tr>
</tbody>
</table>
LIST OF PARTICIPANTS

Mr Onosa'i Aulava, Chief Compliance Officer, Environmental Health and Sanitation Division
Department of Health, P.O. Box 5666, Pago Pago 96799, American Samoa,
Tel.No.: +684 633 7676, Email: onosai@doh.as

Mr Julaini Bin Haji Bini, Chief Health Inspector, Vector Surveillance and Control Unit
Environmental Health Services, Department of Health Services, Ministry of Health
Commonwealth Drive, Berakas, Brunei Darussalam, Tel.No.: +673 238 1640,
Email: Julainiazyan@hotmail.com

Mr Vacaruru Cavuilati, Acting Senior Health Inspector, Vector Control, Quarantine, Burial and
Cremation, Environmental Health Unit, Ministry of Health and Medical Services
G.P.O Box 2223, Government Buildings, Suva, Fiji, Tel.No.: +679 330 6177
Email: vakaruru.cavuilati@health.gov.fj

Mr Stéphane Loncke, Entomologist, Centre d'Hygiène et de Salubrité Publique, Direction De La
Santé en Polynésie Française, 156, Avenue Georges Clemenceau, Mamo, Papeete,
French Polynesia, Tel.No.: +689 40503 750, Email: stephane.loncke@sante.gov.pf

Mr Teanibuaka Tabunga, Deputy Director of Public Health, Ministry of Health and Medical Services
Tungaru Central Hospital, Nawerewere, Tarawa, Kiribati, Tel.No.: +730 69657
Email: teanibuakatabunga@gmail.com

Ms Ma Cheng Man, Senior Technical Officer, Health Bureau, Government of Macao Special
Administrative Region, Alameda Dr Carlos D’ Assumpção, 335-341 Edificio, 7º Andar, Macao,
Tel.No.: +853 85041474, Email: jcmma@ssm.gov.mo

Mr Jacklick Jackson, Vector Control Unit, Ministry of Health and Human Services
P.O. Box 4070, Majuro 96960, Marshall Islands, Tel.No.: +692 455 6244
Email: jacklicjk@gmail.com

Dr Adiyadorj Dolgorkhand, Officer, Emergency Operation Center, MoHS
Ministry of Health, Mongolia, Government Building VIII, Olympic Street, Sukhbaatar District,
Mongolia, Tel.No.: +976 9989 1091, Email: adolgorkhand@gmail.com

Mr Vincent Scotty, Food Inspector, Yaren Government Office, Ministry of Health
Yaren District, Nauru, Tel.No.: +674 5573147, Email: vmscotty@gmail.com

Ms Sally Gilbert, Manager, Environmental and Border Health, Public Health, Protection Regulation
and Assurance, Ministry of Health, PO Box 5013, Wellington, New Zealand
Tel.No.: +64 21 369 764, Email: sally_gilbert@moh.govt.nz

Ms Andy Manu, Environmental Health Officer, Niue Fou Hospital Public Health
Box 33, Kaimiti, Alofi, Niue, Tel.No.: +683 4100, Email: andy.manu@mail.gov.nu
Ms Aileen Benavente, Environmental Health/Vector Control Specialist, Bureau of Environmental Health, Commonwealth Healthcare Corporation, PO Box 500409 CK, Saipan MP 96950, Northern Mariana Islands, Tel.No.: +670 287 8774, Email: aileenbenavente.beh@gmail.com

Mr Paulo Pemita Seuseu, Principal Sanitation and Vector Surveillance Officer, National Health Surveillance and IHR Division, Ministry of Health, Private Bag P.O. Box 68100 Motootua, Apia, Samoa, Tel.No.: +685 68100, Email: paulop@health.gov.ws

Mr Djamil Ackburally, Senior Assistant Director, Environmental Public Health Operations Department, National Environment Agency, 40 Scotts Road, #21-00 Singapore 228231, Singapore, Tel.No.: +65 6731 9068, Email: djamil_ackburally@nea.gov.sg

Mr Petelo Alapati Tavite, National Public Health Advisor/NCD Coordinator, Tokelau Health Department, Nukunonu, Tokelau, Tel.No.: +690 24211, Email: alapatitavite@gmail.com

Ms Sela Fa’U, Supervising Public Health Inspector, Ministry of Health, P.O. Box 59 Nukualofa, Tonga, Tel.No.: +676 771 4092, Email: sakolofau@gmail.com

Mr Vine Sosene, Environmental Health and Surveillance Officer, Public Health Department Tuvalu Ministry of Health, Funafuti, Tuvalu, Tel.No.: +688 20480, Email: vine.sosene@gmail.com

Dr Scott Ritchie, Professor, College of Public Health, Medical and Veterinary Sciences Professor, College of Public Health, Medical and Veterinary Sciences, Australian Institute of Tropical Health and Medicine, James Cook University, Cairns Queensland 4870, Australia Tel.No.: +61 4007 86610, Email: scott.ritchie@jcu.edu.au

Dr Qiyong Liu, Professor and Head, WHO Collaborating Centre for Vector Surveillance and Management, Director, Department of Vector Biology & Control, National Institute for Communicable Disease Control & Prevention Chinese Center For Disease Control and Prevention 155 Changbai Road, Changping District, Beijing 102206, China, Tel.No.: +86 10 58900738 Email: liuqiyong@icdc.cn

Dr Tanya Louise Russell, Research Officer, Australian Institute of Tropical Health and Medicine James Cook University, Cairns Queensland 4870 Australia, Tel.No.: +478 261 873 Email: tanya.russell@jcu.edu.au

Mr Muhammad Ali Hamzah, Public Health Officer/Acting Senior Health Officer Environmental Health Services, Department of Health Services, Ministry of Health Brunei Darussalam, Tel.No.: +673 422 2498, Email: alihamzah.kasmat@moh.gov.bn

Mr Mohd Zulkefli, Deputy Head, National Environment Agency, Ministry of Environment and Water Resources, Singapore, Singapore, Tel.No.: +65 6554 5799, Email: Mohd_Zulkefli_ABD_RAHMAN@nea.gov.sg

Mr Rayong Itsimaera, Secretary of Health, Ministry of Health, aren Government Offices Republic of Nauru, Nauru, Tel.No.: 674 557-3074, Email: rayong.itsimaera@naurugov.nr
Mr Hillary Kumwenda, OIE Delegate, Chief Executive Officer, Biosecurity Authority of Fiji
Ministry of Public Enterprises, Level 3 Provident Plaza 1, Ellery Street, Suva, Fiji
Tel.No.: +679-979-8661 / 331-5250, Email: hkumwenda@baf.com.fj

Mr Geoff Wilson, Program Manager, World Mosquito Program, 38 Mariko Street
Suva, Fiji, Email: Geoff.wilson@worldmosquito.org

Dr Raman Velayudhan, Coordinator, Vector Ecology and Management, Department of Control of Neglected Tropical Diseases (HTM/NTD), World Health Organization, 20 Avenue Appia
CH-1211 Geneva 27, Switzerland, Tel.No.: +41 22 791 1868, Email: velayudhanr@who.int

Dr Rabindra Abeyasinghe, Coordinator, Malaria, Other Vectorborne and Parasitic Diseases Regional Office for the Western Pacific, P.O. Box 2932, 1000 Manila, Philippines,
Tel.No.: +632 5289725, Email: abeyasingher@who.int