Dengue fever is the fastest emerging arboviral infection spread by Aedes mosquitoes with major public health consequences in over 100 tropical and subtropical countries, with 2.5 billion people globally at risk. There is no drug or vaccine for dengue control as yet. The only method for dengue prevention is vector management and personal protection against mosquito bites. The Global Strategy (2012-2020) promotes coordinated action among multisectoral partners, an integrated approach to vector management, and sustained control measures at all levels. To further strengthen and advance the country capacity for scaling up dengue vector control use integrated vector management (IVM), a Regional Workshop on Dengue Vector Management was organized at Colombo, Sri Lanka, from 13 to 17 March 2013. The workshop, attended by 43 participants, covered vector bionomics, planning vector control based on situation analysis and available resources, principles of dengue vector management, dengue vector control methods, vector sampling, operationalization of IVM to control dengue vectors, pesticide management, public-private partnerships in dengue control, and monitoring and evaluation of dengue vector management. This report is to be followed up by vector control managers in countries of the WHO SEA Region.

Dengue vector management
Report of a regional workshop
Colombo, Sri Lanka, 11–15 March 2013

World Health Organization
Regional Office for South-East Asia
World Health House
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New Delhi-110002, India
Dengue vector management

Report of a regional workshop
Colombo, Sri Lanka, 11–15 March 2013
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Acronyms

Bti  Bacillus thuringiensis israelensis
CDS  communicable diseases
CFR  case fatality rate
COMBI  communication for behavioural impact
DDT  dichlorodiphenyl trichloroethane
DF  dengue fever
DHF  dengue haemorrhagic fever
DSS  dengue shock syndrome
GIS  geographical information system
IEC  information education and communication
IVM  integrated vector management
M&E  monitoring and evaluation
PHC  public health centre
PPP  public–private partnership
IRS  indoor residual spraying
LLIN  long-lasting insecticidal net
MoH  Ministry of Health
NGO  non-governmental organization
PCO  pest control officer
SEA  South-East Asia
spp  species
ULV  ultra low volume
USAID  US Agency for International Development
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1. Background

Dengue fever is the fastest emerging arboviral infection spread by *Aedes* mosquitoes with major public health consequences in over 100 tropical and subtropical countries. Of the 2.5 billion people globally living under the threat of dengue fever and its severe forms – dengue haemorrhagic fever (DHF) or dengue shock syndrome (DSS), 1.3 billion live in countries of the WHO South-East Asia (SEA) Region. Dengue is spreading to new areas (Bhutan and Nepal reported cases in recent years) and cause frequent outbreaks. The increase of dengue is exacerbated by unplanned urban development, migration, the need for water storage in urban areas, and unsatisfactory solid waste management. *Ae. aegypti* is a domesticated species that breeds in fresh water in artificial containers. *Ae. albopictus* acts as a secondary vector in the Region. The emergence of dengue with adverse social and economic consequences in countries of the Region is a matter of deep concern.

There is no drug and vaccine for dengue as yet. The only method for dengue prevention is vector management and personal protection against mosquito bites. The Global Strategy for Dengue Prevention and Control 2012–2020 promotes coordinated action among multisectoral partners, an integrated approach to vector management, and sustained control measures at all levels. Although vector control tools are available, they require a combination of resources and strong sociopolitical will. Very few countries have successfully implemented integrated vector management (IVM) to control dengue.

Effective vector control measures are critical to achieve and sustain reduction of morbidity attributable to dengue. Preventive interventions, including vector control, aim to reduce dengue transmission, thereby decreasing the incidence of the infection and preventing outbreaks. The mosquito *Ae. Aegypti* – the primary vector of dengue – has evolved to mate, feed, rest and lay eggs in and around urban human habitation. It is a daytime feeder; its peak biting periods are early in the morning and before
dusk in the evening. Female *Ae. aegypti* frequently bites multiple people during each feeding period.

An ecosystem perspective of risks to humans from dengue and other vector-borne diseases requires an appreciation of the role played by broad environmental trends. Local ecosystems in sustaining vector habitats and facilitating disease transmission need to be understood. The most important governing concepts of dengue transmission are the reproductive rate and the carrying capacity of the local habitat. Both are influenced by broad environmental conditions. The principles of IVM seek to “improve the efficacy, cost-effectiveness, ecological soundness and sustainability of disease vector control” and it is a key component in the Asia-Pacific Dengue Control Strategy (2008–2015) and the Regional Comprehensive Guidelines for Prevention and Control of Dengue (2011). The importance of vector control in dengue cannot be overstated. WHO and the Regional Office established many initiatives for control and prevention of dengue. The important ones are:

1. The Global Strategy for Dengue Prevention and Control was developed in 1995. Based on this, the WHO South-East Asia Regional Strategy for Prevention and Control of Dengue was developed and implemented in Member States in 1996.

2. Resolution WHA55.17 on DF and DHF prevention and control was adopted at the Fifty-fifth World Health Assembly in 2002.

3. There was unprecedented commitment among Member States and WHO to implement a strategy of surveillance for planning and response reducing disease burden, changing behaviour and improve vector control.

4. In 2006, a meeting organized by WHO with support from the Government of Japan, in Chiang Mai, Thailand, laid the foundation for the Asia–Pacific Dengue Prevention and Control Partnership. Subsequently, a core group was constituted and the strategic framework developed.

5. In 2007, a meeting of the core group was held in Singapore with USAID support, where the Asia–Pacific Regional Framework for the Dengue Partnership was reviewed and endorsed. The governance component was discussed; a working group for advocacy formed; and a roadmap for implementation prepared.

(7) In May 2008, a workshop was held in Singapore, where the strategic plan was finalized and later endorsed by the Sixty-first Session of the Regional Committee.

(8) At a regional meeting on implementation of IVM held in Chiang Mai, Thailand, during 27–30 September 2010, all participating countries felt that the regional/country capacities should be strengthened to implement and scale up IVM. Recommendations regarding capacity strengthening were made as follows:

- WHO to provide support to Member States in strengthening capacity for vector management.

- Member States to strengthen entomological capacity for implementation of IVM. WHO should coordinate and harmonize training programmes (including curriculum) for medical entomologists/vector control personnel at the regional level.

- There is a clear need to further strengthen and advance country capacity for scaling up dengue vector control using IVM, and, given the rising trend of dengue, the time to do this is now.

(9) A comprehensive guideline for prevention and control of dengue was brought out in 2011 with IVM as the key component for prevention and control of dengue.

(10) After the recent global meeting on dengue at WHO headquarters in February 2012, the new Global Strategy for Dengue Prevention and Control (2012–2020) was published in September 2012. The main objective of the Strategy is to reduce the burden of dengue, and the specific objective is to reduce by 2020 mortality and morbidity from dengue by at least 50% and 25%, respectively (using 2010 as the baseline). These objectives can be achieved by applying existing knowledge.

- Dengue morbidity can be reduced by improved outbreak prediction and detection through coordinated
epidemiological and entomological surveillance and promoting the principles of IVM and deploying locally adapted vector-control measures including effective urban and household water management. Effective communication can achieve behavioural outcomes that augment prevention programmes.

- Dengue prevention and management can now exploit opportunities presented by promising advances in vector-control technology interventions.

In response to the recommendations of the regional meeting on IVM in Chiang Mai in September 2010, a short course for the workshop was finalized by WHO HQ/SEARO and a regional workshop was organized at Colombo from 11 to 15 March 2013 to strengthen the entomological capacity of member states and to advance country capacity for scaling up dengue vector control use in IVM.

2. Objectives

The specific objectives of the workshop were to:

- enable use of evidence-based decision-making for implementation of appropriate dengue vector control strategies using the principles of IVM.
- acquaint participants with the basic principles of sound management of insecticides;
- strengthen monitoring and evaluation of vector control interventions;
- discuss the basic principles of communication and intersectoral collaboration for dengue vector management.

3. Opening session

Dr Firdosi Rustom Mehta, WHO Representative to Sri Lanka, welcomed the participants and read the message from the Regional Director for WHO
South-East Asia (see Annex 1 for full text). The chief guest of the inaugural session, Dr Nihal Jayathilaka, Secretary, Ministry of Health, Sri Lanka, welcomed the participants and hoped that the workshop would be useful to combat dengue in countries. Professor AP Dash, Regional Adviser, WHO Regional Office for South-East Asia, elaborated on the objectives of the workshop. The agenda and list of participants are given in Annex 2 and 3.

4. **Proceedings**

The scientific session began after the opening Dr Sarath Amunugama, Deputy Director General, Ministry of Health, Sri Lanka and Dr P Jambulingam, Director, VCRC, Puducherry, were nominated as chair and co-chair, respectively, of the workshop while Dr B N Nagpal and Dr Megha Raj Banjara were nominated as the as rapporteurs. The workshop was conducted as per the curriculum (Annex 4).

4.1 **Epidemiology of dengue and role of vector control**

Dr Christina Liew from the Environmental Health Institute, National Environment Agency, Singapore, provided an overview of the global situation of dengue. She gave a historical perspective of dengue cases in the WHO South-East Asia Region. She pointed out that factors impacting dengue are global trends of increased urbanization, increase in human density, travel of people, and migration. The dengue situation in Singapore revealed epidemics in 2005 and 2007; serotype shifting in two consecutive epidemics in Singapore; low level immunity against dengue; and that almost 50% cases are young adults aged 25–44 years. Dr Liew also presented the geographical spread of *Ae. aegypti* (primary vector), *Ae. albopictus* (secondary vector) and dengue viruses. She noted that dengue control programmes have relied on vector control, as until now there is no vaccine.


Dr Chusak Prasittisuk, Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand, gave a presentation on the challenges to reverse the trend of dengue in twenty-first century-ecological disease, movement of
virus, lack of effective laboratory surveillance, and mosquito control, rebuilding and maintaining public health infrastructure, and political commitment. Expected results of activities by 2015 are strengthening of laboratory-based surveillance; use of IVM, improved case management, social mobilization and communication through communication for behavioural impact (COMBI), advocacy and political support, operational research, and mobilization of resources.

4.3 Vector bionomics

Dr B N Nagpal, Scientist-E, National Institute of Malaria Research, New Delhi, India, presented classification, distribution, life-cycle, resting and feeding behaviour, dispersal and longevity, and breeding sites of Ae. aegypti in different areas. A case-study of Delhi showed spread of disease using a geographic information system (GIS), container index and its correlation with dengue cases in Delhi. Various vector control strategies such as source reduction (wherever possible), use of larvicides (wherever possible), solid waste management, biological control, personnel protection, community participation and use of oviposition attracticide were also explained.

4.4 Principles of integrated vector management (IVM)

The major topics covered in the presentation on principles of IVM included: basics of integrated vector management; terminologies; vector competence; vector capacity; transmission of dengue virus by Ae. aegypti; objectives of adult vector control (reduce vector density); IVM; elements of an IVM strategy; advocacy, an integrated approach; evidence-based decision-making; research and monitoring, and evaluation; vector control needs assessment as a starting point for IVM; steps for vector control needs assessment; roles of health sectors and stakeholders; the role of national and local administrations on vector control measures; environmental management; chemical control; and biological control. Dengue vector control is everyone’s responsibility to make it successful (individual and families, community level, nongovernmental organizations, local administration, social society). Development of policies and plans, guidelines by authorities, IVM tools and training materials were also presented.
4.5 Integrated vector management

Professor A P Dash, Regional Adviser, WHO Regional Office for South-East Asia and Dr Raman Vellayudan, Scientist, Vector Ecology and Management, WHO Headquarters, presented the detailed aspects of IVM. They highlighted the vector control methods adopted by different countries; tools for vector control; summarized IVM planning and implementation process; gave examples of country implementation; such as the use of local evidence in changing policy and dengue framework; and how to use the WHO guiding questions for IVM 2012 for local situation analysis. The key elements for implementation of IVM are: policy environment; institutional arrangements; instruments (legislation, regulations and persuasions); establishment of a steering committee for IVM, appointment of focal persons and engagement of stakeholders. Also upon considering decentralization health reforms – IVM should be integrated into the health system. Other key elements are monitoring and evaluation as well as capacity building by training health staff. A monitoring and evaluation system involves suitable input, process and output indicators. IVM training was conducted in Vector Control Research Centre (VCRC) Puducherry for two weeks in October 2011 for programme managers from the countries of the South-East Asia Region.

4.6 Dengue vector control methods: environmental management

Dr P Jambulingam, Vector Control Research Centre, Puducherry, (WHO Collaborating Centre) for Research and Training on Lymphatic Filarisis and Integrated Vector Control), stressed that the key to environmental management is planning, organizing, conducting and monitoring activities for the modification and/or manipulation of environmental factors or their interaction with humans with the objective of preventing or minimizing vector propagation and reducing human–vector–pathogen contact.

4.7 Planning vector control based on situation analysis and available resources

Vector control planning should be based on situation analysis and available resources. The IVM decision-making process includes disease situation,
local determinants of diseases, selection of vector control methods, needs and resources, implementation strategy, and monitoring and evaluation.

4.8 Chemical control

In the presentation on chemical control, the history of DDT and organophosphates use, current chemical methods for vector control, larvicides including Tempephos, pyridoxiferin (insect growth regulators), *Bacillus thuringiensis* were included. Space sprays should not be used as routine vector control measures. The types of space spray are thermal fogging, cold fogging, aerosol and mists. Some considerations observed in the field were in respect of chemical control, preparation of community to accept the spray technician to enter their premises; accessibility of areas for the choice of the use of spray machine either car mounted ULV or hand held machine; time of application (early in the morning not at noon); calibration of the machines; choice and formulation of insecticides; safety precaution, monitoring and evaluation of control measures. There are WHO guidelines for quality control of insecticides and manual guidelines for effective and safe use of insecticides which should be incorporated into the national policy.

4.9 Biological control including Bti

Dr Christina Liew presented the broad aspects of biological control. A predator such as *Toxorhynchites spp.*, feeds on larvae, the toxins in a pathogen like *Bacillus thuringiensis israelensis* (*Bti*) can affect the larva growth. Other topics covered were: health risks in humans, ecological impacts, varieties of Bti, resistance to Bti, mostly by agricultural pests. The Bti can be used as a residual effect by putting it on roof gutters or as spraying of liquid at construction sites. She also explained that effectiveness of Bti depends on the distance as well as its application by pest control operators (PCO’s). An example of Bti application in Singapore was also presented (only Bti of Valent Bioscience, approved by WHO).
4.10 Personal and household protection

Methods of personal and household protection, including mosquito nets (limited use)*, household products (aerosols, coils, vaporized mats); household fixtures; insecticide-treated materials and traps were described.

4.11 Possible role of Wolbachia in dengue vector control

The possible role of Wolbachia in controlling dengue was discussed. Wolbachia is present in more than 70% of insects and its presence in Ae.aegypti prohibits development of dengue virus in the vector. He highlighted results of the studies and ongoing field trials on the subject.

4.12 Vector sampling – methods and limitations

Vector sampling methods and limitation were discussed including surveillance and its objectives; sampling methods for adult mosquitoes are: hand catch collection; spray sheet collection; landing collection; trap collection including light trap; catching outdoors; and ovitraps (effectiveness of ovitraps from research in India); entomological indices; while sampling methods for larval collection are: dipping; netting; siphoning; breeding indices (larval survey); environmental surveillance; limitations of vector sampling.

4.13 Operationalization of IVM to control dengue vector

The presentation on operationalization of IVM covered IVM components like: definition of IVM; intersectoral collaboration in IVM; a framework of intersectoral collaboration; challenges of intersectoral collaboration; summary points of intersectoral collaboration; the 3P partnership concept – people, private, public sectors; the Inter-agency Taskforce for Dengue Control in Singapore including participants, strategies of the taskforce; sharing information; review procedures; benefits of interagency dengue

* Mosquito nets have limited utility in dengue control programme since the vectors are day biters. However, treated nets can be effectively utilized to protect infants and night workers, who sleep during day time. These can also be effective for people who generally have an afternoon nap.
taskforce; and challenges including sharing of resources, and change of personnel.

4.14 Country presentations

**Bangladesh**

The case study from Bangladesh included: the first dengue outbreak in Bangladesh in 1964, the first dengue survey in 1996–1997; findings of the 2000 outbreak that got public attention; national guidelines for clinical management of dengue fever adopted in 2009; the risk factors of dengue in Bangladesh; and that there is no routine programme for *Aedes* surveillance; concluding that the dengue control programme is not well established. For reporting dengue cases, Bangladesh set up a disease control room which receives e-mail, phone calls from affected area health facilities. Components of dengue control strategies in Bangladesh were also presented. To sum up, it was stated that joint venture collaborations in dengue control are the element of success in controlling dengue; and vector control should be for the community and by the community.

**Indonesia**

The case study from Indonesia covered the dengue situation in Indonesia, national burden of dengue – first report in 1968, incidence rate and CFR; seasonality of dengue in Indonesia (January to April); strategies of dengue control; main activities of dengue control programme, integrated prevention and control, national indicators, dengue surveillance, hospital and PHC response, monitoring and evaluation, political support and national commitment for dengue control, success story of integrated vector management in Indonesia, intersectoral collaboration, programme development activities. It also included the dengue vector surveillance in Indonesia (68% indoor and 32% outdoor location of vectors), dengue vector control-Malathion is now replaced by Synthetic pyrethroids. A dengue control policy and guidelines exist in Indonesia.
**Sri Lanka**

The National Dengue Control Programme in Sri Lanka was established during 2005 with the strategies including disease surveillance, case management, vector surveillance, vector control in integrated manner, social mobilization, intersectoral coordination, capacity building, outbreak response and research. Sri Lanka faced constraints such as limited capacity for entomological surveillance and vector control; lack of facilities for virus isolation in the vector; and emergence of new breeding places due to increase of non-biodegradable plastics and polyethylene waste. In order to overcome the constraints, entomological teams consisting of entomological assistants, labourers and vector control staff and house inspection teams with public health officers were set up in 323 areas.

**Thailand**

The case study from Thailand covered vector-borne diseases in Thailand such as dengue, malaria, Japanese encephalitis, chikungunya and filariasis; vector control problems; the IVM roadmap; situation analysis of IVM; the training guidelines of IVM; the implementation plan of 2010; and a pilot project in 2011. The sub-district administration has the main responsibility of IVM. Review was done on policy, entomological assessment and susceptibility test, planning and implementation. A workshop was organized at the district level, identifying goals and objectives of IVM. The process of evaluation and indicators for monitoring vector-borne diseases in Thailand was also explained.

### 4.15 Organization and management of IVM

Major topics included in the presentation were: organization and management of IVM; situation analysis of entomological and policy framework which includes policy environment, policy instruments for outcomes and people or institutions involved in IVM; roles and responsibilities of vector control unit in IVM; organization, management, technology (as per local information and proven methods), and practices of IVM at local level as well as management of pesticides in that area. The next steps are setting goals, strategies and objectives. Further implementation steps covered advocacy and intersectoral collaboration.
within health and other sectors; integration of IVM within health sector (central level, decentralized system, health system at district or village level); institutional arrangements such as intersectoral collaboration (partnership with others); intersectoral steering committee; appointment of a focal person of IVM as a coordinator. Other topics covered were: requirements for establishing collaboration; links with other institutes–research agencies and funding agencies; mobilization of resources from existing health sectors or resources from private sectors and capacity building and training for vector control staff. Monitoring and evaluation are essential components of IVM.

### 4.16 Indicators for monitoring and evaluation of IVM

The presentation on indicators for monitoring and evaluation of IVM covered guidance on the use of M&E indicators–outcome and output indicators (17 indicators for IVM), input, process and impact indicators, outcome indicators.

Other topics covered were: sound management cycle of insecticides; pesticide registration (countries are encouraged to have own evaluation system of insecticides); responsibilities of the governments according to the code of conduct; responsibilities of the pesticide industry; the procurement process; agricultural formulation should not be used for public health as is done in the United Republic of Tanzania. Countries should have norms for bidding. Some important issues must be taken care of viz. procurement of insecticides, storage of insecticides, store safety, stock management first-in – first-out system, stock checking, transport of insecticides – safe transport, packaging, defining the waste matrix, disposal of leftover insecticide, disposal strategy and code of conduct for disposal.

### 4.17 Insecticide resistance management

The topics covered in the presentation on insecticide resistance management were: chemical control of dengue vector; control of adult vectors using pyrethroids and organophosphates; resistance to insecticides; examples of insecticide-resistance review studies; the insecticides resistance situation; variation in methodologies for monitoring resistance; causes of insecticide resistance and resistance mechanisms; assays to detect
resistance; resistance management strategies and related issues; tools for resistance management strategies, and an insecticides resistance management plan with IVM.

4.18 Integrated surveillance and disease prevention and control

The integrated surveillance and disease prevention and control highlighted key drivers of a potential outbreak of dengue; integrated surveillance; virus surveillance, vector surveillance, case surveillance – using the right tool at the right time; NS1 antigen test for promoting early diagnosis and detection; network for virus surveillance to identify dengue virus strains; virus sequencing to know clades of virus; high viral diversity in Singapore; tracking of the virus; regional surveillance, UNITED dengue – a web site for regional dengue data and virus; NS1 test for testing virus-infected mosquito (costing US$12 per test); ecological surveillance; and dengue prevention and control.

4.19 Insecticide application equipment, safety, maintenance and application procedures

The detailed presentation on insecticide application equipment, safety, maintenance and application procedures included equipment for insecticide application; maintenance of equipment; application procedure; safety; thermal fog machines; criteria for selection of equipment for spraying specification guideline: WHO/CDS/WHOPES guidelines; general characteristics of pump (machine) including technical specification of pump; operating procedure including troubleshooting; safety precautions; using thermal fog machine and ultra low volume (ULV). Other topics presented were on practical demonstration; layout plan for single storage house for indoor fogging; calculation of time for fogging in the house; direction of thermal fog outdoors; the ULV machine; and the speed of the vehicle.

4.20 Interpretation of dengue data

The topics covered in the presentation on purpose, measurement and interpretation of data from dengue were: core indicators of dengue collected by WHO from around 100 countries (among 150 dengue-
affected countries) as the current passive surveillance system does not give real dengue cases; the advantages of tracking dengue burden with better tools and estimating the burden; key issues to be addressed for data collection in dengue; integrated surveillance and response.

The purpose of monitoring and evaluation is to provide feedback. It also covered: aspects of IVM indicators; types of indicators; health impact model; management aspects indicators of IVM; evaluation methods and challenges. Evaluation of research designs such as experimental, cross-sectional, longitudinal or longitudinal control study was also presented. Further, information was given on additional methodological aspects viz. input, process and impact indicators, comprehensive plan for monitoring and evaluation; elements of monitoring and evaluation of IVM.

### 4.21 Eco-bio-social study of dengue in Gampaha district, Sri Lanka

The results of the eco-bio-social study of dengue in Gampaha district of Sri Lanka were presented which covered conceptual framework of research (ecological, social and biological components), study objectives, study area (based on poverty index), methods (selection of study sites, data collection); and finding from phase I study that included: knowledge-base of the community and other groups are good, but both attitude and practices are not well developed. Many stakeholders can be involved in the dengue control programme not only in the health sector, but also others viz. local authority, religious and educational sectors, NGOs, private sector as well as the community as a whole. Each group can play a role in dengue prevention and control programme. The result of entomological survey found that discarded containers, tyres, coconut shells, barrels, small bowls/ ceramic jars, are the main larval-breeding places.

Phase-II study aims at interventions by household waste management to reduce A. aegypti breeding places. Two hundred households were selected at random and divided into control and treatment clusters. The treatment is by distribution of compost bins for biodegradable waste and waste bags to separate solid waste as well as by improvement of the solid waste collection system.
4.22 **Public–private partnership in health**

The presentation on public—private partnerships in health (PPP) included: definitions; objectives of a PPP, concerns arising about PPPs; partnerships among governmental entities, private commercial entities and civil society; partners/stakeholders at national level; local private partners/stakeholders; resources from private sector for IVM; experiences of PPPs at the global, national and local/community levels.

4.23 **WHO pesticide management scheme and management of pesticides**

The presentation on the WHO pesticide management scheme covered the WHO pesticide evaluation scheme (WHOPES), WHOPES introduction, objectives, application dossier evaluation, WHOPES guidelines for efficacy assessment of IRS, LLINs, repellents, risk assessment guidelines, WHO specification for pesticides, international code of conduct on distribution and use of pesticides, WHO pesticide evaluation scheme, WHOPES vision, priorities and action, and technical guidelines for management of pesticides for public health.

4.24 **Intersectoral collaboration**

Areas covered under intersectoral collaboration included: factors impacting health; agencies for intersectoral collaboration – transport department, health department, hospitals, department of police, airport authorities, education department, tourism department, hotels, horticulture department, resident welfare associations, departmental stores, civil department, water supply department, government offices—and road map to intersectoral collaboration.

4.25 **Communication to achieve behavioural outcomes (including COMBI)**

It was highlighted that communication to achieve behavioural outcomes were advocacy, advocacy messages for policy-makers, communication strategies, information education and communication (IEC), communication
for behavioural impact (COMBI); 15 steps of COMBI planning; preliminary
behavioural objectives; COMBI integrated activities; three essential
managerial tasks for COMBI planning; factors in COMBI – message, media,
receiver, effect, feedback; setting.

5. **Field visit**

A field visit was organized for the participants to observe dengue vector
control activities at the Regional Antifilariasis Unit, Colombo. The Medical
Officer in Charge, entomologists, entomological assistants and vector
control teams demonstrated vector surveillance and control activities,
fogging and Bti in nearby households. The Medical Officer and the
Entomologist briefed on disease surveillance and the vector control
activities and surveillance by MoH.

6. **Closing session**

In the closing session, the participants noted that dengue is spreading
rapidly and requires immediate action for control. Dengue should be
attacked in a strategic way, and IVM is an important tool and stressed that
the programme should include personnel with entomological background
for vector control.

In his closing remarks, the WHO Representative to Sri Lanka thanked
the host country (Department of Health Services), resource persons,
consultants, and participants from Member States. He expressed hope that
recommendations made from the workshop will be used in dengue control
in the countries.

7. **Recommendations**

7.1 **For Member States**

- Dengue vector management workshops should be organized at the
  national and subnational levels.
Pilot projects to demonstrate the impact of IVM implementation on dengue should be initiated. Dengue vector control should be implemented, in an IVM mode. All stakeholders should be involved in the planning, implementation and monitoring of the programme at the grass-roots level.

- Focal points for IVM should be identified with necessary resources.
- The entomological infrastructure in countries should be critically reviewed in order to meet the requirements for effective implementation of IVM. Efforts should be made to develop adequate vector control and entomological capacities and skills at all levels for IVM.
- Insecticide resistance management for dengue vectors must be implemented and routine reporting systems established.
- Sound management of pesticides should be implemented as per the Regional Guidelines (2010).

### 7.2 For WHO

- A draft dengue vector management curriculum should be finalized for use and adaptation at the country level.
- Operational guidelines for decision-making in IVM should be developed for use at national level.
- Diagnostic doses of insecticides should be developed for resistance monitoring in dengue vectors.
Annex 1

Message from Dr Samlee Plianbangchang
Regional Director, WHO South-East Asia Region

At the end of the past century, the world faced the resurgence of many infectious diseases including dengue. Dengue – an African word meaning "bone breaking" and a mosquito-borne infection – has been referred to as the most dangerous arthropod-borne viral disease of the current millennium. The dengue virus is transmitted to man by day-biting mosquitoes, among which Aedes aegypti is the principal vector. Ae. albopictus has also gained enormous importance, as this mosquito species has been found to transmit dengue even in the absence of the principal vector in certain ecological situations. Both these mosquitoes can also transmit dengue viruses vertically – to the next generation – through transovarial transmission. Both epidemic and endemic transmission of dengue viruses are maintained through a man–mosquito–man cycle.

Although dengue was reported as early as 1779, its viral etiology was not established until the 1940s. Major changes in the epidemiology of dengue virus infections began after the Second World War and have continued to date. It is estimated that approximately 2.5 billion people worldwide live under the threat of dengue fever and its severe forms. Of this number, 1.3 billion reside in WHO’s South-East Asia Region. By 2006, 10 countries in the Region had reported dengue outbreaks. During the past few decades, the disease has spread from east to west, and northward, and the number of dengue cases continues to increase.

Owing to this tremendous burden, it is with a sense of urgency that the Asia-Pacific Dengue Partnership (APDP) was initiated in 2006 to combat dengue in this part of the world in a coordinated manner. Following this step, in 2007, the WHO South-East Asia Region and the Western Pacific Region jointly developed the Asia-Pacific Biregional Dengue Strategic Plan 2008–2015. This plan was endorsed in 2008 by the regional committees of both WHO regions and is now being used as a roadmap for the development and implementation of national dengue prevention and control plans.
The four serotypes of dengue virus are the etiological agents for causing the disease. It is a rather cryptic disease. Clinical illness due to dengue manifests in a spectrum ranging from mild flu-like symptoms to severe dengue. All these have become increasingly important public health problems in the tropics and subtropics. Lamentably, immunity developed against a given virus serotype is limited only to the same strain and does not provide cross-protection against any of the other three serotypes. Upon contracting a subsequent second infection with a different dengue serotype, a patient who already has a strain-specific immunity is at a greater risk of developing the severe form.

It is known that there is a considerable variation within each dengue serotype in the form of phylogenetically distinct subtypes or genotypes. Today, all serotypes/genotypes are circulating globally and all areas, which had reported dengue epidemics earlier, are now hyperendemic areas including the WHO South-East Asia Region. The local epidemiology of dengue is defined by the genetic diversity of the circulating dengue virus (DENV) strains.

Dengue is a disease with a complex epidemiology. In the fight against dengue, we are faced with two enemies: the virus and the vector. Therefore, dengue disease is strongly influenced by several environmental and ecological factors. Its effective prevention and control, to a large extent, relies on environmental management and community-based multidisciplinary and multisectoral actions. These efforts need to be undertaken through coordinated public health interventions and a primary health care approach. Active community participation is critical for successful dengue prevention and control. Dengue control demands a multipronged response that involves different ministries beyond the health sector.

Another formidable challenge is climate change, which contributes to more frequent and wider spread of dengue. Given the constraints and limitation in mitigating environmental changes in the foreseeable future, it is expected that dengue will stay with us for many years to come, and the dengue situation may get worse, if not successfully contained. The current control methods in dengue prevention and control include larviciding, space spraying with insecticides or fogging, and breeding-site reduction
through legal enforcement. These are in addition to case management in the community and clinical management in institutions.

These methods are, however, unable to stop the outbreaks and arrest the spread of the disease satisfactorily. This is because of many cryptic or hidden breeding habitats of vectors. In a way, dengue disease is a man-made health problem that has been exacerbated by a number of factors related to human actions, such as poor and/or unplanned urbanization, scarcity of water supply with improper water storage, inadequate solid waste management, and poor sanitary conditions in the community. These factors are conducive to the breeding of vector mosquitoes that carry and transmit dengue virus.

At present, there is no effective vaccine or specific treatment for dengue fever. We understand that some vaccine candidates are at different stages of development. WHO has been supporting the development of dengue vaccine since the 1970s, and a number of clinical trials have been undertaken by various research centres.

Reversing the trend of the disease could be further supported by introducing advanced tools such as newer diagnostics and vector control methods. Operational research is critically needed to empower the programmes with more effective tools.

Applying existing knowledge for dengue prevention and control requires collaboration among partners, organizations and countries, leadership by WHO and increased funding. In this regard, the WHO Regional Office for South-East Asia has disseminated the 2011 comprehensive guidelines on dengue control and prevention and the Asia–Pacific Biregional Dengue Control Strategic Plan (2008–2015) to strengthen dengue control and prevention activities. Both shall be used by the countries as guidance to their national programmes.

In addition to dengue, other arboviral diseases such as chikungunya have spread widely in most of the countries of the South-East Asia Region following the serious outbreaks reported in the Indian Ocean Islands (Le Union Islands) in 2005, and in India and Sri Lanka in 2006. In 2008–2009, chikungunya fever spread to Indonesia, Malaysia, Singapore and Thailand.
Since the vectors are the same, integrated prevention and control activities for dengue, if implemented well, can also have an impact on chikungunya.

It is clear that implementation of dengue vector management is an important aspect of dengue prevention. We cannot overlook the importance of: advocacy and resource mobilization; partnership, coordination and collaboration; communication to achieve behavioural outcomes or COMBI; capacity building; and a strong monitoring and evaluation system. In our attempt to control dengue disease, we should also keep in mind its significant social and economic implications, which are matters of deep concern. These implications are no less important than its medical impact. Cost–efficiency and cost–effectiveness in dengue prevention and control should be considered in both social and economic terms in addition to medical aspects of dengue.
Annex 2

Agenda

(1) Integrated vector management for dengue prevention and control
(2) Dengue vector control methods and tools
(3) IVM and sound management of insecticides
(4) Monitoring and surveillance
(5) Field visit and field demonstration
(6) Recommendations
Annex 3

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Annex 4

Workshop Curriculum

Day 1

- Epidemiology of dengue and role of vector control
- Asia–Pacific dengue control strategy (highlighting IVM)
- Vector Bionomics
- Planning vector control based on situation analysis and resources
- Principles of IVM
- Policy and institutional framework for vector control (and IVM)
- Questions and Answers: National challenges for implementation of IVM and way forward

Day 2

- Dengue vector control methods – what, where, and how:
  - Environmental management
  - Chemical Control
  - Biological control including Bti
  - Personal and household protection

- Possible role of Wolbachia in dengue vector control
- Vector sampling – methods and limitations
- Operationalization of IVM to control dengue vector
- Questions and Answers
- Case Studies:
  - Bangladesh
  - Indonesia
– Sri Lanka
– Thailand

- Questions and Answers: country experiences, challenges and way forward

**Day 3**
- Organization and management of IVM
- Indicators for monitoring and evaluation of IVM
- Sound management of insecticides
- Insecticide Resistance management
- Integrated surveillance and disease prevention and control
- Questions and Answers
- Insecticide application equipment, safety, maintenance and application procedures (Part – 1)
- Insecticide application equipment, safety, maintenance and application procedures (Part – 2)
- Questions and Answers

**Day 4**
- Eco-Bio-Social Study on Dengue in Gampaha district, Sri Lanka
- Relevance to control programmes: process, impact and outcome indicators
- Indicators- purpose, measurement and interpretation
- Public private partnership
- WHO Pesticide management scheme and management of pesticides
- Questions and Answers: country experiences, challenges and way forward
- Intersectoral collaboration
Report of a regional workshop

- Communication to achieve behavioural outcomes (including COMBI)
- Questions and Answers

**Day 5**

- Field Visit
- Panel Discussion on Field Visit
- Recommendations
- Closing
Dengue fever is the fastest emerging arboviral infection spread by Aedes mosquitoes with major public health consequences in over 100 tropical and subtropical countries, with 2.5 billion people globally at risk. There is no drug or vaccine for dengue control as yet. The only method for dengue prevention is vector management and personal protection against mosquito bites. The Global Strategy (2012-2020) promotes coordinated action among multisectoral partners, an integrated approach to vector management, and sustained control measures at all levels. To further strengthen and advance the country capacity for scaling up dengue vector control use integrated vector management (IVM), a Regional Workshop on Dengue Vector Management was organized at Colombo, Sri Lanka, from 13 to 17 March 2013. The workshop, attended by 43 participants, covered vector bionomics, planning vector control based on situation analysis and available resources, principles of dengue vector management, dengue vector control methods, vector sampling, operationalization of IVM to control dengue vectors, pesticide management, public-private partnerships in dengue control, and monitoring and evaluation of dengue vector management. This report is to be followed up by vector control managers in countries of the WHO SEA Region.