ADB

Technical Assistance Report

Project Number: 47197-001
Regional—Capacity Development Technical Assistance (R-CDTA)
May 2014

Malaria and Dengue Risk Mapping and Response Planning in the Greater Mekong Subregion

(Cofinanced by the Republic of Korea e-Asia and Knowledge Partnership Fund and the Regional Malaria and Other Communicable Disease Threats Trust Fund under the Health Financing Partnership Facility)

Asian Development Bank

ABBREVIATIONS

ADB	–	Asian Development Bank
CDR	–	call data record
GIS	–	geographic information system
GMS	–	Greater Mekong Subregion
ICT	–	information and communication technology
JAXA	–	Japan Aerospace Exploration Agency
RSDD	–	Regional and Sustainable Development Department
SMS	–	short message service
TA	–	technical assistance
WHO	–	World Health Organization

NOTE

In this report, "$" refers to US dollars.

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CAPACITY DEVELOPMENT TECHNICAL ASSISTANCE AT A GLANCE

1. Basic Data **Project Number:** 47197-001

Project Name	Malaria and Dengue Risk Mapping and Response Planning in the Greater Mekong Subregion	**Department /Division**	RSDD/RSPG
Country	REG	**Executing Agency**	Asian Development Bank
Borrower	not applicable		

2. Sector	**Subsector(s)**	**Financing ($ million)**
✓ Health	Disease control of communicable disease	0.35
	Health system development	0.35
Industry and trade	Industry and trade sector development	0.02
Information and communication technology	ICT industries and ICT-enabled services	0.15
	ICT strategy and policy, and capacity development	0.15
	Total	**1.02**

3. Strategic Agenda	**Subcomponents**	**Climate Change Information**	
Inclusive economic growth (IEG)	Pillar 2: Access to economic opportunities, including jobs, made more inclusive	Climate Change impact on the Project	Low
Environmentally sustainable growth (ESG)	Global and regional transboundary environmental concerns		
Regional integration (RCI)	Pillar 4: Other regional public goods		

4. Drivers of Change	**Components**	**Gender Equity and Mainstreaming**	
Governance and capacity development (GCD)	Client relations, network, and partnership development	No gender elements (NGE)	✓
	Civil society participation		
Knowledge solutions (KNS)	Knowledge sharing activities		
	Pilot-testing innovation and learning		
Partnerships (PAR)	Civil society organizations		
	Implementation		
	Private Sector		
	Regional organizations		
	South-South partner		
	United Nations organization		
Private sector development (PSD)	Conducive policy and institutional environment		

5. Poverty Targeting		**Location Impact**
Project directly targets poverty	Yes	Not Applicable
Geographic targeting (TI-G)	Yes	

6. TA Category: A

7. Safeguard Categorization Not Applicable

8. Financing

Modality and Sources	**Amount ($ million)**
ADB	**0.00**
None	0.00
Cofinancing	**1.02**
e-Asia and Knowledge Partnership Fund	0.42
Regional Malaria and Other Communicable Disease Threats Trust Fund	0.60
Counterpart	**0.00**
None	0.00
Total	**1.02**

9. Effective Development Cooperation

Use of country procurement systems	No
Use of country public financial management systems	No

I. INTRODUCTION

1. Regional cooperation and integration is one of three institutional objectives of the Asian Development Bank (ADB) corporate guidance in Strategy 2020, which recognizes the control of communicable diseases as a regional public good.[1] The Operational Plan for Health and the Regional Cooperation and Integration Strategy also highlight ADB's role in supporting Asia and the Pacific to expand opportunities for addressing health challenges at regional and subregional levels.[2] ADB's strategy towards E-development in Asia and the Pacific points out that ADB shall integrate information and communication technology (ICT) applications in its activities in the health sector to improve service provision and data management.[3] Moreover, ADB as a knowledge bank, has a mandate to advance the capacity of regional centers of excellence and foster the application of innovations in development.

2. The countries of Asia and the Pacific continue to face communicable disease challenges, including a continuing burden from malaria, and drug-resistant malaria in the Greater Mekong Subregion (GMS), particularly in border areas. At the same time, the region is experiencing increasing incidence of dengue, which is linked to rapid, unplanned urbanization. Containing drug-resistant malaria, preparing a malaria elimination agenda, and understanding the increase and spread of dengue requires active and real-time surveillance. The technical assistance (TA) will assess how surveillance and control of reemerging communicable diseases can be strengthened by applying cost-effective modern technology (geographical information systems [GISs], mobile phones, and satellite remote sensing) to limit the spread of disease through human mobility.

3. The participating developing member countries were involved in the TA preparation and they welcome this initiative.[4] ADB will not undertake this regional TA unless a no-objection confirmation has been received.[5]

II. ISSUES

4. Regional cooperation in the GMS and ADB investments have played an important role in facilitating connectivity and economic links within the GMS, contributing to increased trade, competitiveness, and economic growth. However, increased connectivity has been accompanied by increased risks to regional health security (an important public good) and it has also been recognized under the Regional Cooperation and Integration Strategy and addressed in the Second GMS Regional Communicable Diseases Control Project.[6] With more than

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[1] ADB. 2008. *Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank, 2008–2020.* Manila.

[2] ADB. 2008. *An Operational Plan for Improving Health Access and Outcomes Under Strategy 2020*. Manila; ADB. 2006. *Regional Cooperation and Integration Strategy*. Manila.

[3] ADB. 2003. *Toward E-Development in Asia and the Pacific*: *A Strategic Approach for Information and Communication Technology.* Manila.

[4] Fact-finding missions were conducted in August–December 2013 and January and March 2014 in Cambodia, Myanmar, and Thailand. The TA was discussed at regional events such as the World Health Organization (WHO) biregional healthy border meeting in August 2013, and the Second GMS Regional Communicable Diseases Control Project steering committee meeting in September 2013.

[5] The TA first appeared in the business opportunities section of ADB's website on 4 April 2014.

[6] The TA aims to build on and support the Second GMS Regional Communicable Diseases Control Project through piloting innovative technology for disease surveillance. The team leader of the Second GMS Regional Communicable Diseases Control Project suggested linking of capacity building of this TA with activities under the Second GMS Regional Communicable Diseases Control Project.

2 million mobile workers moving around the GMS, labor mobility threatens public health and the well-being of the population in the GMS and beyond.[7] The link between increased mobility of people within and across national borders and accelerated transmission of vector-borne diseases is well established.[8] Moreover, increasing mobility of people from malaria hot spots, such as mountainous border areas, or from urban centers (often hot spots of dengue infections), adds to the risk of spreading contained infections.[9]

5. Overall, malaria infections are decreasing in Cambodia, Myanmar, and Thailand but malaria is still the main cause of death among migrants in Thailand, followed by mosquito-borne diseases such as dengue fever, the incidence of which is increasing throughout the GMS.[10] Looking at the economic costs of these reemerging infectious diseases, both malaria and dengue pose a substantial economic and disease burden in the GMS. For example, dengue cases are 17 times more prevalent than hepatitis B or even upper respiratory diseases (footnote 10).

6. Although GMS countries have made great strides in combating malaria, tracking progress is still a major challenge since malaria surveillance systems detect only about one in 10 cases. [11] The recommended first-line antimalarial drugs such as artemisinin-based combination therapies are becoming less effective, and there are no new drugs in the pharmaceutical pipeline to take their place.

7. Malaria is mostly a rural problem, spreading radially to urban areas through peoples' mobility. Dengue, on the other hand, spreads from the larger cities (where it is often linked to unplanned urbanization, standing water, and weak sanitation systems) to smaller communities**.** [12] Variable weather conditions, increases in temperature, changing monsoon patterns, and the circulation of counterfeit drugs have added to the problem of fighting these reemerging diseases.

8. Increased monitoring and surveillance, and cross-border collaboration are required to address these problems. Early identification of disease hot spots (dengue, malaria, drug-resistant malaria) helps to contain the spread of these vector-borne diseases efficiently since it facilitates tailoring disease control programs to high-risk sites. Earth observation and space technologies, such as GISs, mobile phones, and satellite remote sensing, can provide information in real time and identify the source and destination (also called "sink") of these vector-borne diseases. This allows the mapping of the routes of parasite dispersal by human carriers for additional targeted control by identifying both the regions where imported infections

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[7] World Bank. 2006. *Labor Migration in the Greater Mekong Subregion, Synthesis Report: Phase I*. http://siteresources.worldbank.org/INTTHAILAND/Resources/333200-1089943634036/475256-1151398858396/LM_in_GMSs_Nov06.pdf

[8] A.J. Tatem and D.L. Smith. 2010. International population movements and regional Plasmodium falciparum malaria elimination strategies. *Proceedings of the National Academy of Sciences of the United States of America.* 6 July. http://www.pnas.org/content/107/27/12222.full

[9] Rabba, M. A. et al. 2013. Frequent In-Migration and Highly Focal Transmission of Dengue Viruses among Children in Kamphaeng Phet, Thailand. *PLoS Neglected Tropical Diseases.* Volume 7(1): e1990. http://www.plosntds.org/article/info%3Adoi%2F10.1371%2Fjournal.pntd.0001990 (accessed 30 June 2013); Barmak, D. H. et al. 2011. Dengue Epidemics and Human Mobility. *Cornell University Library.* http://arxiv.org/pdf/1102.3869.pdf (accessed 30 June 2013).

[10] K. Souvannaphoum. 2008. *Migration and Health Impacts among Low-Skilled Labors in the Greater Mekong Subregion: A Case Study*. Khon Kaen: Mekong Institute.

[11] World Health Organization. 2012. *World Malaria Report*. Geneva.

[12] E. Ooi and DJ. Gubler. 2009. *Dengue in Southeast Asia: Epidemiological Characteristics and Strategic Challenges in Disease Prevention*. Cad Saude Publica.

originate and where they may contribute substantially to transmission.

9. Targeting mobile populations in surveillance and control programs will require different approaches than used when controlling local transmission hot spots. Programs required are those which communicate risks to mobile populations to alter their behaviors, restrict travel patterns, and conduct routine surveillance in high-risk areas. Using mobile phone call data records (CDRs) to analyze how human movement affects the spread of mosquito-borne diseases was spearheaded in studies in Kenya, where mobile phone ownership ranges from 14% in rural to 80% in urban areas.[13] This study helped to inform policy decisions on how to refocus control and prevention efforts, as well as identify highly mobile groups for targeting of surveillance efforts.

10. The TA will improve surveillance of malaria and dengue in mobile populations and, thus, will assist in mitigating negative effects of increased mobility in Cambodia, Myanmar, and Thailand linked to improved regional cooperation and integration. The TA will strengthen regional networks of centers of excellence; build capacity of local epidemiologists, national malaria programs, and GIS experts; and facilitate partnerships with the private sector.

III. THE TECHNICAL ASSISTANCE

A. Impact and Outcome

11. The impact of the TA will be improved malaria and dengue surveillance, and control programs for mobile populations in Cambodia, Myanmar, and Thailand. The outcome of the TA will be improved understanding of the impact of human mobility on malaria prevalence and dengue incidence in Cambodia, Myanmar, and Thailand.

B. Methodology and Key Activities

12. The TA will analyze the potential for national malaria programs to use valuable, complementary, and contemporary datasets from CDR and GIS technology to strengthen malaria and dengue prevention, surveillance, and control in mobile population groups and to guide disease control and elimination strategies.

13. The TA will support analysis of CDRs to track people's movement patterns anonymously, linking them with dengue and malaria prevalence data in Cambodia, Myanmar, and Thailand. This will be an additional surveillance tool to (i) improve targeting of control programs by identifying sources and sinks of the diseases, (ii) target highly mobile populations and disease hot spots, and (iii) map the routes of parasite (malaria) and virus (dengue) infection. The TA will evaluate the usefulness of this methodology to improve surveillance and control programs, and build capacity for real-time surveillance.

14. In 2011, the mobile penetration rate exceeded 100% in Cambodia and Thailand.[14] In

[13] Wesolowski, A. et al. 2012. *Quantifying the Impact of Human Mobility on Malaria*. http://www.sciencemag.org/content/338/6104/267.abstract (accessed 30 June 2013); Wesolowski, A. et al. 2012. Heterogeneous Mobile Phone Ownership and Usage Patterns in Kenya. PLoS ONE 7(4): e35319. doi:10.1371/journal.pone.0035319 (accessed 30 June 2013).

[14] Ministry of Posts and Communications of Cambodia. 2012. *Telecom Status in Cambodia.* http://www.itu.int/ITUD/asp/CMS/Events/2012/socialmedia/S6.2_Cambodia.pdf (accessed 30 June 2013); National Broadcasting and Telecommunications Thailand. 2011. *Telecommunications in Thailand.*

Myanmar, the mobile penetration rate was still less than 5%. However, Myanmar's Ministry of Communications, Posts and Telegraphs has begun to extend mobile phone coverage with a view to achieving penetration of 45% by 2016.[15] Mobile-phone-based technology covers a broad network that includes poorer segments of the population who can access cheaper prepaid subscriptions.

15. **Output 1: GIS-based visualization system of human mobility, malaria prevalence, and dengue incidence established, and methodology evaluated.** Private mobile phone providers will provide anonymous CDRs for a 6–12 month period. The data will be stored on a server in one of the participating countries and will be analyzed by experts. Human mobility will then be linked with malaria and dengue incidence data. Findings of the analysis and visual models will be presented at the midterm review workshop.

16. **Output 2: Prevalence and incidence data of malaria and dengue analyzed**. Twelve months of retrospective incidence data will be used to develop a malaria and dengue risk map. The map will be supplemented by real-time surveillance data collected by short message service (SMS) and mobile phones. The epidemiological data will be used to model parasite dispersion linked to human mobility. The output will also support a feasibility study prepared in collaboration with the Japan Aerospace Exploration Agency (JAXA) for the methodology of (i) geospatial analysis using satellite remote sensing data and GISs to identify influential factors of endemic malaria, and (ii) near real-time monitoring of major factors of endemic malaria using remote sensing in the pilot area in the participating countries. This could provide conclusions on possible changing vector behavior with increasing deforestation in the case of malaria, and with increased urbanization and changing water storage in rural areas in the case of dengue.

17. **Output 3: Policy recommendations for targeting mobile populations in malaria and dengue surveillance and control programs communicated to ministries of health.** The key findings of the analysis of the CDRs and malaria and dengue incidence maps will be presented to government counterparts, and regular application of the analysis and maps for strengthening malaria and dengue control program will be assessed. The added value of applying modern technology to improve case detection for malaria elimination programs will be analyzed. The TA will support a regional workshop where study findings will be presented to GMS counterparts, development partners, civil society organizations, the private sector, and research centers.

18. **Output 4: Capacity of government public health experts for application of GIS-based visualization developed.** The TA will support the development of national and subregional capacity to use GIS-based visualization technology on a routine basis and for research projects. This includes CDR data being stored and maintained on a local server to allow sustainable application of the methodology.

19. A major assumption is that local telecommunication companies cooperate in providing CDRs, and a major risk is that not all malaria and dengue cases are correctly reported and registered in national surveillance systems.[16]

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http://www.itu.int/ITU-D/asp/CMS/Events/2011/ITUADB/FinalWorkshop/Thailand-S2.pdf (accessed 30 June 2013); International Telecommunication Union (accessed 30 June 2013).

[15] International Telecommunication Union. 2012. *Wireless broadband masterplan for the Union of Myanmar* http://www.itu.int/ITU/tech/broadband_networks/WirelessBDMasterPlans_ASP/WBB_MasterPlan_Myanmar.pdf

[16] Several local telecommunication companies were consulted in Cambodia and Thailand and they verbally agreed to provide CDRs for this project. The TA will ensure that malaria and dengue incidence data is used from reliable sources recognized by national malaria programs.

C. Cost and Financing

20. The TA is estimated to cost $1,017,000 equivalent, of which (i) $417,000 will be financed on a grant basis by the Republic of Korea e-Asia and Knowledge Partnership Fund, and (ii) $600,000 will be financed by the Regional Malaria and Other Communicable Disease Threats Trust Fund [17] under the Health Financing Partnership Facility. Both funds are administered by ADB. The governments of Cambodia, Myanmar and Thailand will provide counterpart support in the form of in-kind contributions.[18]

D. Implementation Arrangements

21. ADB, through the Regional and Sustainable Development Department (RSDD), will be the executing agency and RSDD will lead the overall implementation in collaboration with the Southeast Asia Department. All disbursements under the TA will be made in accordance with ADB's *Technical Assistance Disbursement Handbook* (2010, as amended from time to time).

22. The TA will establish an advisory group with representatives from the involved partners and centers of excellence to advise on the TA implementation. ADB will enter nondisclosure agreement private with phone providers.[19]

23. The expected outputs, outcome evaluation, and lessons will be disseminated through the websites of ADB and other partners, including the WHO and centers of excellence such as the University of Tokyo and the Harvard School of Public Health. The TA will strengthen regional ICT for development innovation networks. It also envisages publishing the findings in peer-reviewed public health journals.

24. The TA will be implemented from June 2014 to June 2016.

IV. THE PRESIDENT'S DECISION

25. The President, acting under the authority delegated by the Board, has approved (i) ADB administering technical assistance not exceeding the equivalent of $417,000 to be financed on a grant basis by the Republic of Korea e-Asia and Knowledge Partnership Fund, and (ii) ADB administering technical assistance not exceeding the equivalent of $600,000 to be financed on a grant basis by the Regional Malaria and Other Communicable Disease Threats Trust Fund under the Health Financing Partnership Facility for Malaria and Dengue Risk Mapping and Response Planning in the Greater Mekong Subregion, and hereby reports this action to the Board.

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[17] Financing partners are the governments of Australia and the United Kingdom.

[18] TA fact-finding was undertaken in August 2013 in Thailand and in January 2014 in Cambodia, and follow-up discussions with Thailand last March 2014.

[19] Discussed during TA fact-finding with private phone providers. Private phone providers agreed to provide CDRs as long as individual identities are protected.

DESIGN AND MONITORING FRAMEWORK

Design Summary	Performance Targets and Indicators with Baselines	Data Sources and Reporting Mechanisms	Assumptions and Risks
Impact Improved targeted malaria and dengue surveillance and control programs for mobile populations in Cambodia, Myanmar, and Thailand	Coordinated and integrated surveillance systems for malaria and dengue in place across borders in Cambodia and Thailand by 2020 (baseline: 0 - not in place) Strengthened information management for early detection of emerging diseases across borders in Cambodia and Thailand by 2020 (baseline: 0 - not in place)	Progress report of implementation of the WHO Emergency Response to Artemisinin Resistance Framework, and Asia Pacific Strategy for Emerging Diseases Asia Pacific Leaders Malaria Alliance Scorecards	**Assumption** Relevant actors respond quickly to reported malaria and dengue incidents
Outcome Improved understanding of the impact of human mobility on malaria prevalence and dengue incidence in Cambodia, Myanmar, and Thailand	National malaria and dengue surveillance programs include targeted surveillance and control of mobile populations by December 2015 (baseline: 0 - not in place) Visual map of transmission routes of malaria and dengue developed by December 2015 (baseline: 0 - not in place) Framework developed to support operational ICT-related public health research in Asia and the Pacific	National malaria and dengue program documents Website with GIS-based visualization tool	**Assumption** Mobile phone survey is valid for identifying malaria prevalence and dengue incidents **Risks** Not all reported cases are diagnosed with diagnostic blood tests Lack of cross-border movement rate quantification limits assumption about cross-border spread of malaria and dengue
Outputs 1. GIS-based visualization system of human mobility, malaria prevalence, and dengue incidence established, and methodology evaluated.	Estimations of human mobility from CDRs established by June 2014 (baseline: 0 - not in place) GIS data of human mobility prepared and analyzed by September 2014 (baseline: 0 - not in place)	Ministry of Public Health surveillance data	**Assumption** Local telecommunication companies in pilot countries cooperate in providing CDRs **Risks** Lack of mobile phone base stations in some border areas Only certain percentage of the population is represented in the CDRs. This could be biased towards specific age and income groups.

Design Summary	Performance Targets and Indicators with Baselines	Data Sources and Reporting Mechanisms	Assumptions and Risks
2. Prevalence and incidence data of malaria and dengue analyzed	Map of malaria incidence and prevalence in participating countries developed on the basis of existing data by June 2014 (baseline: 0 - not in place) SMS-based survey on malaria and dengue prevalence conducted to collect real-rime data by end of October 2014 (baseline: 0 - not in place) Feasibility study conducted with recommendation on how to include GIS mapping of high incidence district as additional data set by September 2014	Ministry of Public Health surveillance data WHO Global Outbreak Alert and Response Network database Consultant report	**Assumption** Reported malaria cases are confirmed via blood test
3. Recommendations for targeting mobile populations in malaria and dengue surveillance and control programs communicated to ministries of health	Recommendations for strengthening active malaria and dengue surveillance and control in mobile populations in Cambodia and Thailand disseminated by December 2015 (baseline: 0 - not in place) Two national workshops held by February 2016 One regional workshop held by February 2016	Policy brief posted on ADB website TA report	
4. Capacity of government public health experts for application of GIS-based visualization developed.	Advisory group established System administrator manual and training programs of the GIS-based visualization system prepared for public health experts by March 2014 (baseline: 0 - not in place) Data host server in place including maintenance in one of the participating DMCs	Consultant report and website with GIS-based visualization tool	**Assumption** Effective cooperation with government public health experts

Design Summary	Performance Targets and Indicators with Baselines	Data Sources and Reporting Mechanisms	Assumptions and Risks
	Results of pilot study published in peer-reviewed journal		
Activities with Milestones **TA management** (i) Establish advisory steering committee by June 2014 (ii) Conduct inception workshop in July 2014 in Phnom Penh with all collaborating partners (iii) Conduct midterm review workshop with all collaborating partners in Q4 2015 **1. GIS-based visualization system of human mobility data established** 1.1 Develop requirement specification for CDR data (July 2014) 1.2 Develop memorandums of understanding between ADB and telecommunication companies regarding provision of CDRs and necessary technical information (July 2014) 1.3 Develop data of human mobility (October 2014) 1.4 Prepare a GIS-based visualization tool and training materials (January 2015) 1.5 Conduct dry runs and make minor fixes and improvements (December 2014) **2. Prevalence and incidence data of malaria and dengue analyzed** 2.1 Collect existing epidemiological data by district (October 2014) 2.2 Analyze data (November 2015) 2.3 Roll out SMS-based survey tool and analyze data (throughout 2015) 2.4 Model parasite dispersion with human mobility (November 2014) 2.5 Conduct feasibility study of GIS map application (November 2014) **3. Recommendations communicated to ministries of health and other stakeholders** 3.1 Summarize key findings and recommendations for active surveillance systems and share with stakeholders (December 2015) **4. Capacity of application of GIS-based visualization developed** 4.1 Train system administrators (throughout 2015) 4.2 Train end users of the GIS-based visualization tool (e.g., government public health experts) (throughout 2015)			**Inputs** Republic of Korea e-Asia and Knowledge Partnership Fund: $417,000 Regional Malaria and Other Communicable Disease Threats Trust Fund under the Health Financing Partnership Facility: $600,000

ADB = Asian Development Bank, CDR = call data record, DMC = developing member country, GIS = geographic information system, GMS = Greater Mekong Subregion, ICT = information and communication technology, Q = quarter, SMS = short message service, TA = technical assistance, WHO = World Health Organization.
Source: Asian Development Bank.

COST ESTIMATES AND FINANCING PLAN
($'000)

Item	Amount
A. Republic of Korea e-Asia and Knowledge Partnership Fund[a]	
1. Consultants	
a. Remuneration and per diem	
i. International consultants[b]	140.0
ii. National consultants	30.0
b. International and local travel	75.0
c. Reports and communications	2.0
2. Equipment[c]	20.0
3. Training, seminars, and conferences	
a. Facilitators	10.0
b. Training program	60.0
4. Surveys	15.0
5. Miscellaneous administration and support cost[d]	25.0
6. Contingencies	40.0
Subtotal (A)	**417.0**
B. Regional Malaria and Other Communicable Disease Threats Trust Fund under the Health Financing Partnership Facility[e]	
1. Consultants[f]	
a. Remuneration and per diem	
i. International consultants	200.0
ii. National consultants	60.0
b. International and local travel[g]	60.0
c. Reports and communications	20.0
2. Equipment	30.0
3. Training, seminar, and conferences	100.0
4. Surveys	60.0
5. Miscellaneous administration and support cost	10.0
6. Contingencies	60.0
Subtotal (B)	**600.0**
Total	**1,017.0**

GIS = geographic information system, ICT = information and communication technology, TA = technical assistance.
[a] Administered by the Asian Development Bank.
[b] ICT and GIS experts.
[c] Includes ICT hardware required for computing human mobility and GIS-based visualization tool. Equipment will be handed over to government counterparts or participating research institutes once the TA is completed.
[d] Translation, printing, and dissemination costs associated with the publication of TA-related documents.
[e] Financing partners: the governments of Australia and the United Kingdom. Administered by the Asian Development Bank.
[f] Consulting firm providing epidemiologist, ICT experts, and TA coordination.
[g] Includes travel cost and remuneration of resource persons from collaboration partners and ADB.
Source: Asian Development Bank estimates.

OUTLINE TERMS OF REFERENCE FOR CONSULTANTS

A. Implementation Arrangements, Responsibilities, Work Modality, and Time Frame

1. The Asian Development Bank (ADB) will coordinate and support the technical assistance (TA) activities to improve disease surveillance in the Greater Mekong Subregion (GMS). With the improvements in surveillance systems linked to improved diagnosis of malaria, detailed satellite imagery being readily available, and mobile phone usage data continually being collected by network providers, the potential exists to make operational use of such valuable, complimentary, and contemporary datasets on an ongoing basis in infectious diseases control and elimination. The TA will be implemented in two phases, with the first phase starting in Cambodia with a focus on malaria, and the second phase roll out in Myanmar and Thailand including modeling for dengue as appropriate.

2. The TA will bring together local and international research institutes such as the Harvard School of Public Health and the University of Tokyo. Harvard has pioneered this approach to understand the impact of human mobility on infectious disease transmission, specifically related to malaria, publishing the first large-scale study of this kind.[1] Furthermore, the institutes bring together a world-renowned group of malaria and vector-borne disease researchers and public health practitioners, with the interdisciplinary capabilities to provide expert technical support in the fields of infectious disease epidemiology, biostatistics, and mathematical modeling. The University of Tokyo has leading expertise in geographic information system (GIS) technology and utilizing call data records (CDRs) to model human mobility. It has also established a good network of partners in the region, including the Asian Institute of Technology.[2] The project will also collaborate with civil society stakeholders and other research institutes such as the Institut Pasteur. All project activities will be closely coordinated with the World Health Organization (WHO) Emergency Response to Artemisinin Resistance Hub in Phnom Penh and with national malaria programs.

3. An advisory steering committee with members from centers of excellence, research institutes, the private sector, civil society organizations and development partners will be established to provide guidance and advice, and to ensure coordination of project activities. The committee will explore opportunities to establish a sustainable mechanism to support operational information and communication technology (ICT) and public health research in the region beyond this project. The committee will meet once a year and teleconferences will be held as needed to allow a close working relationship. Travel expenses and per diem for the participating representatives will be covered under the TA.

4. Individual consultants and a firm will be recruited by ADB in accordance with its Guidelines on the Use of Consultants (2013, as amended from time to time). A firm or nongovernment organization will be recruited through consultants qualification selection to provide 40 person-months of national consultant input. Other consultant services will be provided by individual consultants. Consultants qualification selection seems the most appropriate recruitment methods since the contract amount will be less than $200,000 and the skills needed are highly specialized to support the epidemiological data collection and real-time surveillance survey.

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[1] Wesolowski, A. et al. 2012. *Quantifying the Impact of Human Mobility on Malaria.* http://www.sciencemag.org/content/338/6104/267.abstract (accessed 30 June 2013)

[2] People Flow Project (PFLOW). http://pflow.csis.u-tokyo.ac.jp/

5. The project requires a total of 17 person-months of international consulting services and 40 person-months of national consulting services and short-term resource person inputs for the inception and midterm review workshop.

B. Support for Epidemiological Analysis and Formulation of Recommendations for National and Regional Surveillance Programs

6. **Epidemiologist** (international, 7 person-months, intermittent). The consultant will be responsible for (i) taking the technical lead in collection and analysis of epidemiological data-related activities and ensuring relevance of CDRs for analyzing links between mobility patterns and disease spreading, (ii) producing knowledge products resulting from the project, and (iii) leading technical inputs for capacity development including serving as a resource person. He or she will ensure the quality of all products developed through the project. The consultant's main tasks will be to

(i) lead technical input for all outputs on disease prevalence and incidence;
(ii) develop detailed terms of reference for data collection;
(iii) ensure proper collection of epidemiological data and supervise the national consultant;
(iv) identify data gaps and advise on approaches to estimate prevalence and incidence rates or to design and implement short message service (SMS) and phone-based case reporting;
(v) support the formulation of policy recommendations based on the evidence of the epidemiological data collection and CDR mapping;
(vi) lead planning and conduct of the capacity development and knowledge sharing workshops;
(vii) closely coordinate with research teams at Harvard School of Public Health and University of Tokyo and other centers of excellence;
(viii) establish the advisory steering committee;
(ix) identify sustainable mechanisms to ensure operational research in ICT applications in health in Asia and the Pacific;
(x) serve as a resource person at capacity development events; and
(xi) ensure appropriate ethics review and data privacy assurance.

7. **Public health expert** (national, 15 person-months, intermittent, based in Cambodia). The consultant is responsible for (i) supporting the international consultant, (ii) supporting the development of knowledge products resulting from the project, and (iii) providing technical inputs for capacity development including serving as a resource person. He or she will ensure the quality of all products developed through the project. The expert’s main tasks will be to

(i) support technical input for output 2 on disease prevalence and incidence;
(ii) coordinate collection of epidemiological data at the district level and collect if needed;
(iii) support planning and conduct of the capacity development and knowledge sharing workshops (inception and midterm); and
(iv) serve as a resource person at capacity development events.

8. **Coordinator** (national, 12 person-months, intermittent [6 person-months intermittent per participating country, based in Thailand]). The consultant will be responsible for the coordination of the TA activities and coordination between the implementing partners. The consultant will also ensure close coordination with the national malaria programs. He or she will coordinate the implementation of the mobile-phone-based survey and real-time data collection. The consultant's main tasks will be to

(i) ensure adequate communication between implementing partners;
(ii) liaise with the national malaria programs;
(iii) coordinate timing of data collection;
(iv) coordinate mobile-phone-based survey and real-time data collection;
(v) coordinate collection of epidemiological data at the district level and collect if needed;
(vi) coordinate logistics for the capacity development and knowledge sharing workshops (inception and midterm).

C. Generation of Human Mobility Data from Call Data Records

9. **Information and communication technology expert** (national, 3 person-months, intermittent). The consultant will be responsible for (i) taking the technical lead in the generation of human mobility data, (ii) taking the technical lead in acquisition of CDRs from telecommunication companies, and (iii) technical assessment of mobile phone infrastructure in pilot countries. The expert's tasks will include the following:

(i) lead technical input for output 1 on human mobility data;
(ii) lead planning and conduct of acquisition of CDRs from telecommunication companies;
(iii) conduct technical assessment of mobile phone infrastructure in the pilot countries;
(iv) define technical requirements of CDRs by coordination with big data expert;
(v) develop nondisclosure agreement and/or memorandum of understanding on sharing CDRs; location information of base stations; and relevant technical information such as technical specifications of CDRs among ADB, telecommunication companies, and partners; and
(vi) arrange acquisition of CDRs for big data expert.

10. **Big data expert** (international, 7 person-months, intermittent). The consultant will be responsible for (i) assisting the ICT expert in the acquisition of CDRs from telecommunication companies, and (ii) modeling and analyzing human mobility data from CDRs. The consultant's tasks will include the following:

(i) assist the ICT expert in defining technical requirements of CDRs in terms of GIS data handling;
(ii) develop a proposal of specification of human mobility data, following technical specification of CDRs provided by telecommunication companies;
(iii) customize a computer program for modeling and analysis of human mobility from CDRs, which includes people's movement pattern for yearly average, seasonal average, and other aggregated pattern requested by the end users;[3]
(iv) data processing of CDRs provided by telecommunication companies;
(v) develop an end-user manual of the generated human mobility data; and
(vi) develop an algorithm theoretical basis document with source codes of the generation of human mobility data from CDRs.

[3] The output data shall be compatible with the standard specified of the Open Geospatial Consortium (http://www.opengeospatial.org/standards).

D. Geographic Information System-Based Visualization System

11. **Geographic information system expert** (2 national experts [Thailand and Cambodia only], 5 person-months each, total 10 person-months). The experts will be responsible for identifying of coordination for data sharing through the GIS-based visualization system and design of the system according to the coordination identified. The experts will also be responsible for the implementation of the GIS-based visualization system for visualizing data layers of human mobility, malaria prevalence, and dengue incidents. The experts will be assigned for each pilot country. The experts' tasks will include the following:

(i) conduct a needs assessment on the GIS-based visualization system;
(ii) assess data resources required (availability in geographical extent, frequency, format, and cost);
(iii) assess capacity of data acquisition by local partners;
(iv) assess current process of data acquisition;
(v) assess feasibility and cost of GIS map preparation from new sources;
(vi) identify a process of data sharing among partners for development and operation of GIS-based visualization system;
(vii) assess capacity building needs for system development and operation;
(viii) define system architecture and specification of the GIS-based visualization system to be compatible with data on human mobility, malaria prevalence, and dengue incidents;
(ix) coordinate with local agencies on use of ICT infrastructure for operating the GIS-based visualization system;
(x) implement the GIS-based visualization system;
(xi) localize the GIS-based visualization system for use in local language in the pilot countries;
(xii) develop training materials for the GIS-based visualization system for system administrators and end users;
(xiii) conduct training on the GIS-based visualization system for system administrators and end users;
(xiv) conduct an experimental operation(s) and collect user feedback; and
(xv) conduct improvements to the GIS-based visualization system according to user feedback.

E. Geographic Information System Feasibility Study

12. **Geographic information system and public health expert** (international, 3 person-months, intermittent). The expert will conduct a feasibility study in collaboration with the Japan Aerospace Exploration Agency (JAXA) for the methodology of (i) geospatial analysis using satellite remote sensing data and GISs to identify influential factors in endemic malaria, and (ii) near-real-time monitoring of major factors in endemic malaria using remote sensing in the pilot area in the participating countries. The consultant's tasks will include the following:

(i) Conduct above-mentioned feasibility study for the pilot areas in collaboration with JAXA and other consultants to clarify the methodology including identification of necessary remote sensing, field data and people mobility data, the sustainable way to collect those data, and method of geospatial analysis (coordinate with preparatory work for Technical Assistance for Strengthening Resilience to Climate Change in the Health Sector (under processing).
(ii) Survey the availability of field data from local clinics and communities and establish the collection mechanism through coordination with coordinator and local clinics and communities.