Impact of socio-ecological systems and resilience (SESR)-based strategies on dengue vector control in schools and neighbouring household communities in Cambodia

Leo Braack, Malaria Consortium

Acknowledgements (research team & partners)

Chea Thy, Soun Sokha, Set Srun, Yves Bourny, Mark Debackere

Pierre Echaubard

Jeffrey Hii, John Hustedt, Jacob Bigio

Claudia P. Nieto, Koen Peters,

Didot Budi Prasetyo (NAMRU-2) and Sam Bun Leng (CNM)

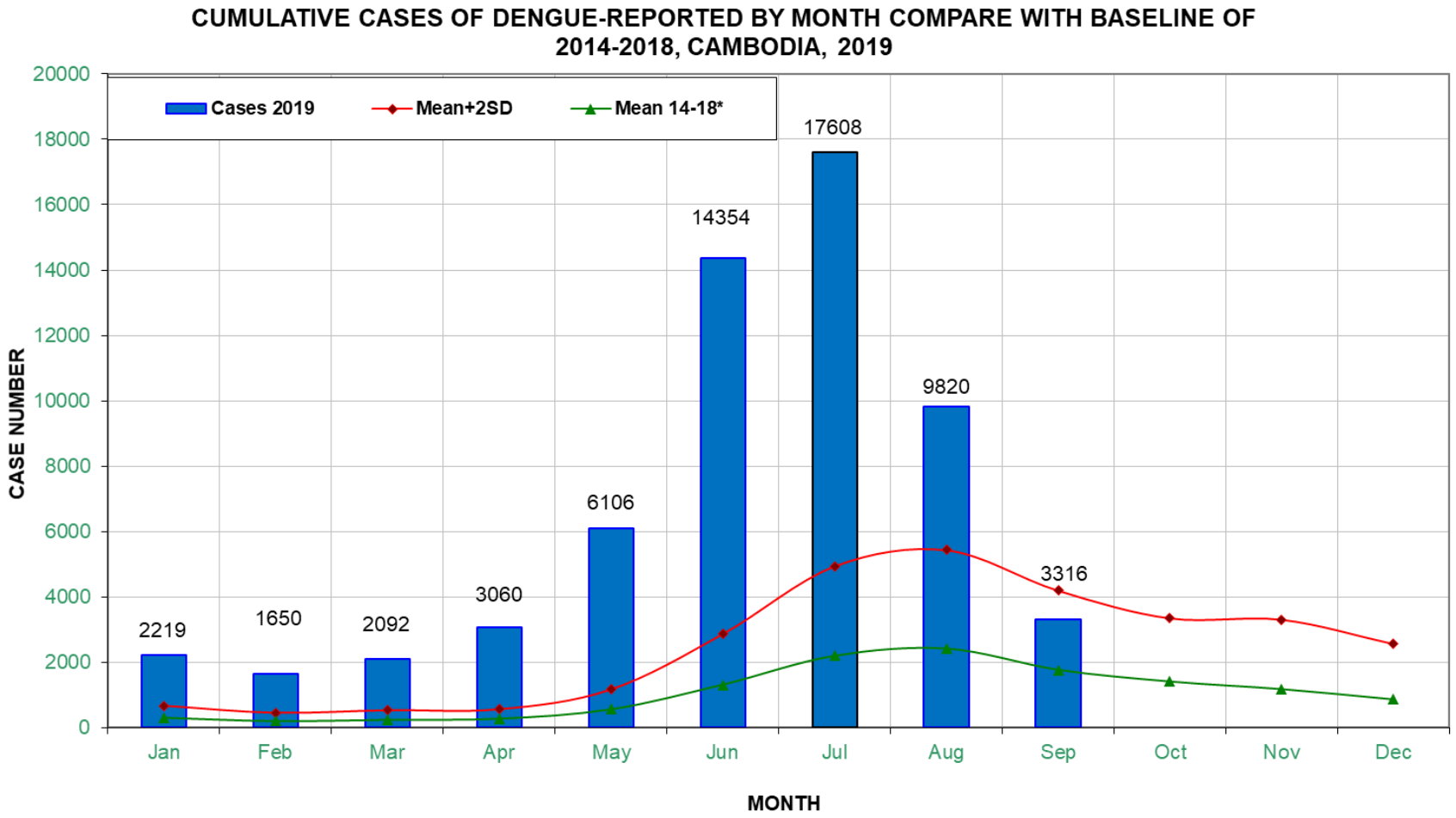
Our Cambodian government partners,

and Bernadette Ramirez from WHO TDR

Background & rationale: Research problem

- Dengue is the most rapidly spreading mosquito-borne viral disease in the world, caused by bites of infected *Aedes* mosquitoes (mainly *Aedes aegypti*, but also *Aedes albopictus*…day-biting mosquitoes).
- Asia records about 70 percent of the global dengue cases (>390 million p.a.).
- Cambodia has one of the highest per-capita incidence rates in the region (average 103 cases per 10,000 population, 5–yr ave 2014–2018).
- In 2019, more than 70,000 reported dengue cases in Cambodia.
- Children are disproportionately exposed to mosquito bites at school and home, surrounded by water jars and containers, present during peak biting times of dengue vectors.
- No practical vaccine, no treatment drugs, high and spreading insecticide resistance.
  Have to rely on vector control.

Dengue in Cambodia 2014–2018, and 2019



Objectives of the project

Investigate whether a set of disease-specific interventions, focused on Integrated Vector Management-based source reduction procedures and COMBI-based health education, will significantly reduce dengue entomological indicators in rural schools and households in two districts in Cambodia.

1. To implement multi-stakeholder-driven, ecosystem-based innovative tools and approaches to address the challenge of dengue, especially in areas with inadequate health infrastructure.
    - Social engagement element
    - Vector control element
2. To provide opportunities for research capacity building.
3. To facilitate the uptake of new knowledge and research results through translation of research for best practice and influence on policies.

Primary & secondary success measures

Primary and secondary outcome measures for evaluating dengue interventions in rural primary schools in two ODs, Kampong Cham province.

Outcome	Collected by	Frequency of collection	Source
Primary outcome			
Density of adult female *Aedes aegypti* in each school, village or wat (i.e. number of mosquitoes collected per time unit)	Entomology surveys	0 and 12 months post-intervention *(During August which is peak season)	Prokopack collections in schools/toilets, bedrooms & living rooms of HHs, prayer rooms & sleeping rooms of wats
Secondary outcomes			
Breteau index, Container index, Premise index, Pupal productivity index	Entomology surveys	At 0, 6, 12, 18 months post-intervention* (Aug, Mar, Aug, Mar)	Containers in schools, households, wats

Geographic setting

Kampong Cham province of Cambodia

Typical project village setting

Trial design

Type	Key interventions	Arm 1: 9 schools & 10 villages	Arm 2: 7 schools & 10 villages	Arm 3: 6 schools & 10 villages (control)
Bio-environmental	Adult mosquito trapping	√	√	
	Guppy fish distribution	√	√	
	Solid waste management	√	√	
Empowerment/ adaptive capacity	School training & education	√		
	Communications & behaviour change	√		
	Participatory epidemiological mapping	√		

Methods: Primary vector control tools

Primary vector control tools for this study:

Mosquito mass trapping

- Oviposition traps, made by communities themselves. 9,528 traps produced and deployed (3,228 medium size traps (MST) and 6,300 small size traps(SST); 3 traps (1MST+2SST) deployed per HH in 3,158 households.

Larvivorous fish

- 26,400 guppy fish distributed.
- Fish production facilities set up in intervention schools.
- Students learned how to manage, propagate and distribute guppies to the communities.

Container covers

- Tightly fitting lids/covers to prevent mosquito access.

Clean up campaigns/solid waste management

- ‘Reduce, reuse, recycle’.
- Waste collected to reduce breeding sites.

Production of traps

Training women’s group in mass mosquito trap production





Guppy fish production & distribution

Stocking and supplying of guppy fish

- Establish guppy banks in
  - schools
  - communities
  - health centers.
- Establish distribution networks.
- Training/education: How to rear, maintain and distribute guppy fish.

Community engagement

….but to implement these vector control tools effectively and sustainably we had to ensure a high level of community **PARTICIPATION**

Community engagement

- School parent meetings held at 16 locations to discuss the education working strategic approach, and action plan at school and community.
- Key community stakeholders got involved in discussion.
- A series of dialogues about interventions set-up and working system among key stakeholders.
- Encourage each local institution (school and community) has its own plan, to take action, monitoring and evaluation.
- With support from school, trained students provide dengue related information to their parents and neighbours; motivate their participation in dengue activities; distribute and monitor the traps; provide the guppies to peers; and participate in dengue-related activities in school and communities.

Community engagement

Capacity building and knowledge transfer

- School training (experiential learning)
- School health department/MoE got involved in
- School/teacher/parent meetings
- Teachers/school directors/officers trained
- Trained teachers further trained all their students
- Students participated in delivering education sessions in communities.

Community engagement

Key stakeholder meetings

- To prepare the planning, to guide the intervention activities, to get involvement in monitoring and evaluation, and to help to mobilise local resources and give environmental support.

Community engagement

Communications for behavioural change and social events

- Mixed methods formative research
- Baseline qualitative/quantitative surveys (IDIs, FGDs, PO) to inform community dialogues
- Source for the message and material development workshops/meetings
- Develop behaviour change communication (BCC) strategies, materials and key messages.

Community engagement

Participatory epidemiological mapping

Co-learning and spatial representation of

- breeding sites
- sites with high exposure risk
- frequency, extent and timing of people movement
- infrastructural
- epidemiological data.

Map representing the contextualised dengue epidemiological dynamics at the landscape level **+ COMBI**

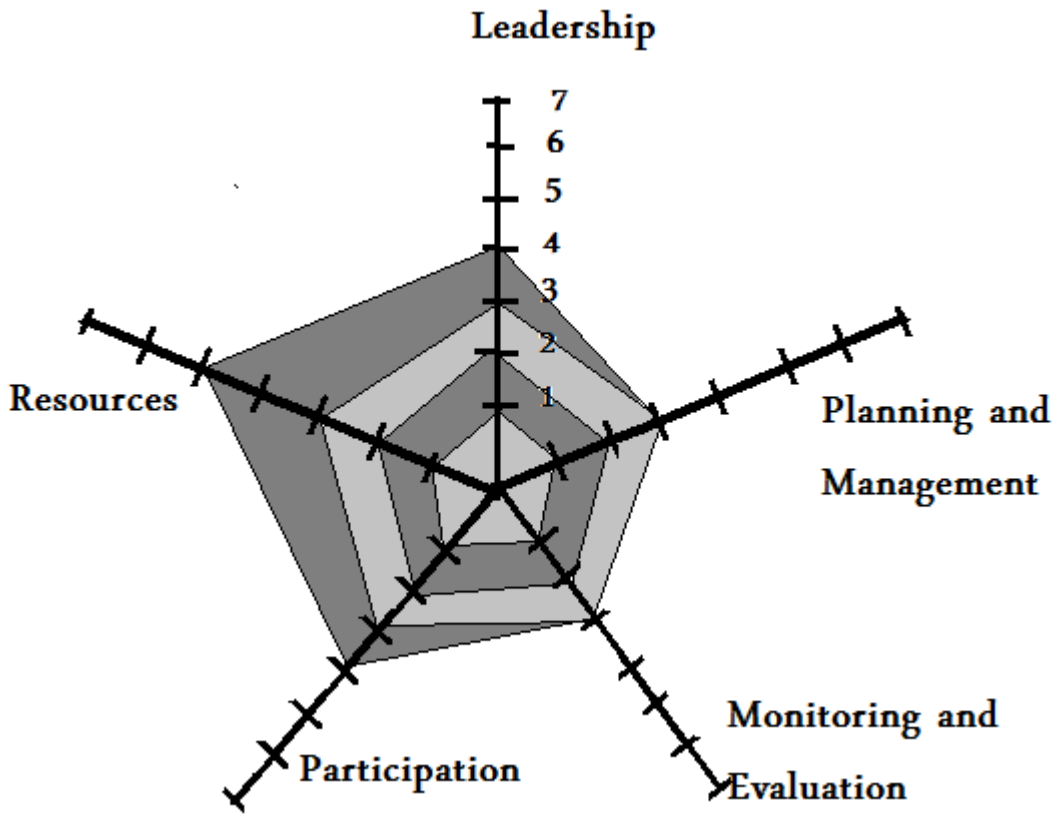
Community ownership of dengue (decentralised) surveillance/control

OWNERSHIP/EMPOWERMENT

Community engagement

Monitoring and evaluation

Assessing the level of ‘ENGAGEMENT’ by rating five elements of a spider-gram tool



Intervention results and impacts

KEY ACHIEVEMENTS
VECTOR CONTROL

Key achievements: Entomological indicators

Based on sample of 600 Households (200 per Experimental Arm)

Adult survey: Mean number of adult female *Aedes aegypti* and *Aedes albopictus* per house for August 2018, August 2019 and February 2020 surveys

	Number of adults	Number of houses	Adult Survey	95% CI	p-value*	Arm 1 Baseline p-value**	Arm 2 Baseline p-value***
August 2018							
Overall	206	600	0.34	0.30–0.39			
Arm 1	57	201	0.28	0.22–0.37	0.17		
Arm 2	71	199	0.36	0.28–0.45			
Arm 3	78	200	0.39	0.31–0.49			
August 2019							
Overall	392	600	0.65	0.56–0.76			
Arm 1	91	200	0.46	0.34–0.60	0.0006		
Arm 2	118	200	0.59	0.46–0.76		0.18	
Arm 3	183	200	0.92	0.72–1.16		<0.001	0.014
February 2020							
Overall	501	600	0.84	0.70–0.99			
Arm 1	96	200	0.48	0.36–0.64	<0.0001		
Arm 2	75	200	0.38	0.27–0.51		0.26	
Arm 3	330	200	1.65	1.30–2.10		<0.001	<0.001

Key achievements: Entomological indicators

Based on sample of 600 Households (200 per Experimental Arm)

Container Index (percentage of water-holding containers infested with mosquito larvae and/or pupae) for August 2018, February 2019, August 2019 and February 2020 surveys

	Number of containers	Number of infested containers	Container Index	95% Confidence Interval	p-value*	Arm 1 Baseline p-value**	Arm 2 Baseline p-value***
August 2018							
Overall	3160	666	21.08	19.54–22.69			
Arm 1	1386	276	19.91	17.60–22.44			
Arm 2	976	209	21.41	18.54–24.60	0.38		
Arm 3	798	181	22.68	18.42–27.60			
February 2019							
Overall	1264	193	15.27	12.36–18.72			
Arm 1	476	79	16.60	11.82–22.80			
Arm 2	398	51	12.81	7.91–20.08	0.55		
Arm 3	390	63	16.15	10.50–24.04			
August 2019							
Overall	2509	467	18.61	14.29–23.87			
Arm 1	790	104	13.16	8.18–20.49			
Arm 2	866	108	12.47	9.47–16.25	<0.0001	0.81	
Arm 3	853	255	29.89	20.03–42.06		0.001	<0.001
February 2020							
Overall	1883	317	16.83	11.49–23.99			
Arm 1	604	25	4.14	2.21–7.63			
Arm 2	606	55	9.08	4.36–17.94	<0.0001	0.05	
Arm 3	673	237	35.22	28.43–42.65		<0.001	<0.001

Key achievements: Entomological indicators

Based on sample of 600 Households (200 per Experimental Arm)

House Index (percentage of houses with containers infested with mosquito larvae and/or pupae) for August 2018, February 2019, August 2019 and February 2020 surveys

	Number of houses	Number of infested houses	House Index	95% Confidence Interval	p-value*	Arm 1 Baseline p-value**	Arm 2 Baseline p-value***
August 2018							
Overall	595	317	53.28	47.39–59.07			
Arm 1	199	115	57.79	45.33–69.33			
Arm 2	198	103	52.02	41.32–62.54	0.77		
Arm 3	198	99	50.00	39.11–60.89			
February 2019							
Overall	314	115	36.62	32.33–41.15			
Arm 1	106	45	42.45	33.41–52.03			
Arm 2	102	32	31.37	25.02–38.51	0.28		
Arm 3	106	38	35.85	28.56–43.86			
August 2019							
Overall	599	271	45.24	37.30–53.44			
Arm 1	200	66	33.00	23.97–43.48			
Arm 2	200	64	32.00	25.81–38.90	<0.0001	0.67	
Arm 3	199	141	70.85	60.69–79.29		<0.001	<0.001
February 2020							
Overall	600	222	37.00	25.44–50.27			
Arm 1	200	23	11.50	6.27–20.15			
Arm 2	200	48	24.00	10.22–46.69	<0.0001	0.08	
Arm 3	200	151	75.50	59.18–86.76		<0.001	0.001

Key achievements: Entomological indicators

Based on sample of 600 Households (200 per Experimental Arm)

Breteau Index (number of containers infested with mosquito larvae and/or pupae per 100 houses inspected) for August 2018, February 2019, August 2019 and February 2020 surveys

	Number of houses	Number of infested containers	Breteau Index	95% Confidence Interval	p-value*	Arm 1 Baseline p-value**	Arm 2 Baseline p-value***
August 2018							
Overall	595	666	112	100–125			
Arm 1	199	276	139	116–165			
Arm 2	198	209	106	87–127	0.006	0.04	
Arm 3	198	181	91	75–111		0.002	0.30
February 2019							
Overall	314	193	61	51–74			
Arm 1	106	79	75	55–102			
Arm 2	102	51	50	35–71	0.24		
Arm 3	106	63	59	43–83			
August 2019							
Overall	599	467	78	70–88			
Arm 1	200	104	52	42–64			
Arm 2	200	108	54	44–67	<0.0001	0.81	
Arm 3	199	255	128	110–150		<0.001	<0.001
February 2020							
Overall	600	317	53	47–60			
Arm 1	200	25	13	8–18			
Arm 2	200	55	28	21–36	<0.0001	0.001	
Arm 3	200	237	119	104–135		<0.001	<0.001

Key achievements: Entomological indicators

Based on sample of 600 Households (200 per Experimental Arm)

Pupal Index (mean number of *Aedes aegypti* and *Aedes albopictus* pupae per 100 houses) for February 2019, August 2019 and February 2020 surveys

	Number of pupae	Number of houses	Pupal index	95% CI	p-value*	Arm 1 Baseline p-value**	Arm 2 Baseline p-value***
February 2019							
Overall	1765.6	314	562	354–894			
Arm 1	493.8	106	466	210–1032	0.67		
Arm 2	492.7	102	483	215–1087			
Arm 3	779.1	106	735	332–1626			
August 2019							
Overall	3703.4	599	618	454–841			
Arm 1	878.1	200	439	261–740	0.005		
Arm 2	681.8	200	341	202–575		0.50	
Arm 3	2143.5	199	1077	640–1813		0.02	0.002
February 2020							
Overall	2695.4	600	449	252–800			
Arm 1	370.4	200	185	70–488	0.03		
Arm 2	439.2	200	220	83–578		0.81	
Arm 3	1885.8	200	943	360-2471		0.02	0.04

Key achievements: Entomological indicators

Based on sample of 600 Households (200 per Experimental Arm)
Container type, average capacity and range in litres and multiplication factor for the calculation of the Pupal Index

Type of Container	Average Capacity (litres)	Range (litres)	Multiplication Factor
Cement Basin	613	559 - 667	4.9
Cement Tank	825	666 - 984	4.3
Water Storage Jar	393	380 - 405	3
Drum	138	115 - 160	3
Small Pot	35	18 - 53	1
Flower Vase/Pot/Tray	22	1 - 2	1
Tyre	45	31 - 59	1
Can/Bottle	7	1 - 12	1
Miscellaneous- Domestic Use	27	25 - 30	1
Others	31	23 - 38	1

Key achievements: trap production

Training women's group in mass mosquito trap production

- 9,528 traps produced and deployed:
- 3,228 medium size traps (MST) and 6,300 small size traps (SST)
- 3 traps (1MST+2SST) deployed per HH in 3158 households
- placed in 20 implementation villages
- and 2 traps (2MST) per room in 161 rooms in 16 schools.

Key achievements: Guppy fish production and distribution

Stocking and supplying of guppy fish

- Total of 26,400 guppy fishes distributed to guppy banks
- Guppy fish bank at school (3 jars X 16 schools)
- Guppy fish bank at communities (6 jars X 20 communities)
- Guppy fish bank at health centers (20 jars X 6 HCs)

- Distribution of guppy to each HH through students
- Distribution of guppy to each HH through HC visits
- Distribution of guppy via CHWs in communities

- Training/education 100 school teachers and 94 CHWs
- and 6 HCs on importance of, how to rear, maintain
- and distribute **guppy fish.**

Key achievements: Guppy fish distribution

Success in guppy fish community uptake

- 11 percent and 42 percent of HHs in Aug 2018 and Aug 2019 respectively in intervention communities had guppy fishes.
- Feasibility: Wider sharing of guppy fishes not only in the intervention area but non-intervention locations.
- Acceptability: Part of local culture rearing and caring for guppy fishes. More boys than girls enjoy/love playing with guppies.
- Adherence and sustainability: Guppy population more growth in number in rainy season, due to habitats conditions. Maintenance of guppy initiated by students and their guardians in HHs.

Summary: Key achievements

- Combined interventions leading to reduction entomology index significantly compared between intervention and control arms.
- Increase in guppy fish rearing and distribution in intervention areas over time.
- Capacity building and knowledge transfer has played one of the important strategies in school as learned students playing crucial role as agent for change behavioural practices in dengue prevention.
- P.E. mapping visionalising local people of inter-related risks/vulnerability, how they had to act together to reduce source of transmission.

malaria consortium

disease control, better health

TDR

For research on diseases of poverty

UNICEF • UNDP • World Bank • WHO

Thank you

www.malariaconsortium.org