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To End Malaria

4 March 2026

Work Steam3 - Implementing the Global Vector Control Response

Introduction to session

Co-Leads: Tessa Knox, Joseph Chabi

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WORKSTREAM 3: Who We Are?

.

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WORKSTREAM 3: Implementing the Global Vector Control Response



Tessa Knox
(PacMOSSI / JCU)



Joseph Chabi (Abt Global)

Introduction to Team leads

Task Team 1: Integrated Vector Management (IVM): Best Practices and Local Capacity

Objectives:

- Review status of implementing GVCR
- Document & disseminate best practices & share lessons learned
- Identify & promote training opportunities
- Strengthen collaborations with research & education institutes



Eleanore Sternberg (Tropical Health)



Elodie Vadja (UCSF)

Introduction to Team Leads

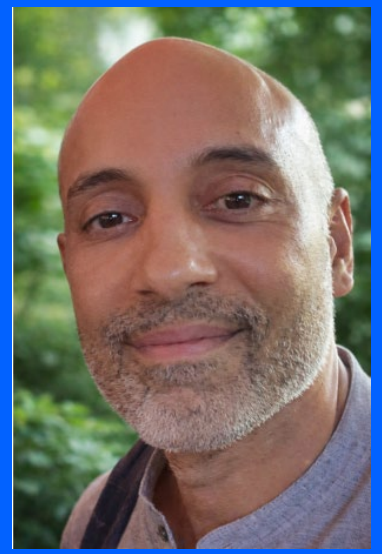
Task Team 2: *Anopheles stephensi* response



Susanta Ghosh
(Magalore University)

Objectives:

- Compile and disseminate best practices & research
- Facilitate virtual exchanges to share national & regional experiences
- Collaborate with WHO, other task teams, & research groups for knowledge exchange



Neil Lobo (UCSF)

Introduction to Team leads

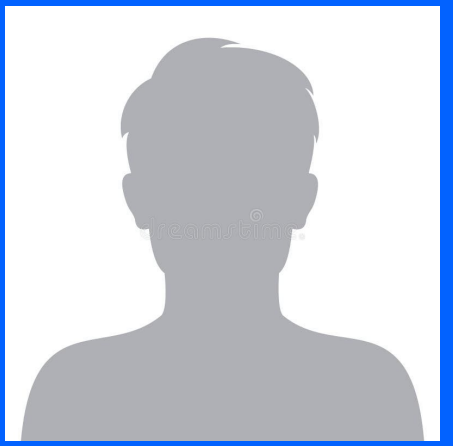
Task Team 3: Vector control in humanitarian emergencies



Joe Lewinski
(UNHCR Uganda)

Objectives:

- Identify appropriate tools & document best practices for emergency contexts
- Support development & field deployment through defined use case scenarios & research priorities
- Strengthen guidance, knowledge sharing, training & collaboration



Leclair Corey
(MSF)

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THANKS FOR JOINING US AND CONTRIBUTING TO THE SESSION

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Task Team 1: Integrated Vector Management (IVM): Best practices and local capacity

Introduction and set-up

Eleanore Sternberg, VCWG Task Team lead

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4 March 2026

Presentation: Malaria control strategy in Ethiopia: In sight into the best IVM.

Emana Getu Degaga, Addis Ababa University

Malaria Control Strategies in Ethiopia: Insights into Best Practices in Integrated Vector Management (IVM)

Emana Getu Degaga (PhD), Professor of Entomology

Addis Ababa University, College of Natural and Computational Sciences, email emana.getu@aau.edu.et, mobile phone +251911019166

As an icebreaker

- **Ethiopia**, landlocked country on the Horn of Africa
- The country lies completely within the tropical latitudes and is relatively compact, with similar north-south and east-west dimensions
- The capital is Addis Ababa ("New Flower"), located almost at the centre of the country
- Ethiopia is the largest and most populated country in the Horn of Africa. With the 1993 secession of Eritrea, its former province along the Red Sea, Ethiopia became landlocked.



Figure 1. Ethiopia On Map

Presentation outlines

- Introduction
- Research overview on malaria vector in Ethiopia
- Integrated Vector Management practices in Ethiopia
- Conclusion and recommendations

Introduction

- Malaria remains one of the most significant public health challenges in Ethiopia, where ecological diversity, seasonal rainfall patterns, and widespread mosquito breeding habitats create favorable conditions for transmission
- Despite substantial progress achieved over the past two decades, malaria continues to threaten millions of people living in lowland and mid-altitude areas of the country
- Ethiopia's malaria epidemiology is complex, characterized by unstable and seasonal transmission, periodic epidemics, and strong geographic variation, which necessitates adaptive and locally tailored control strategies

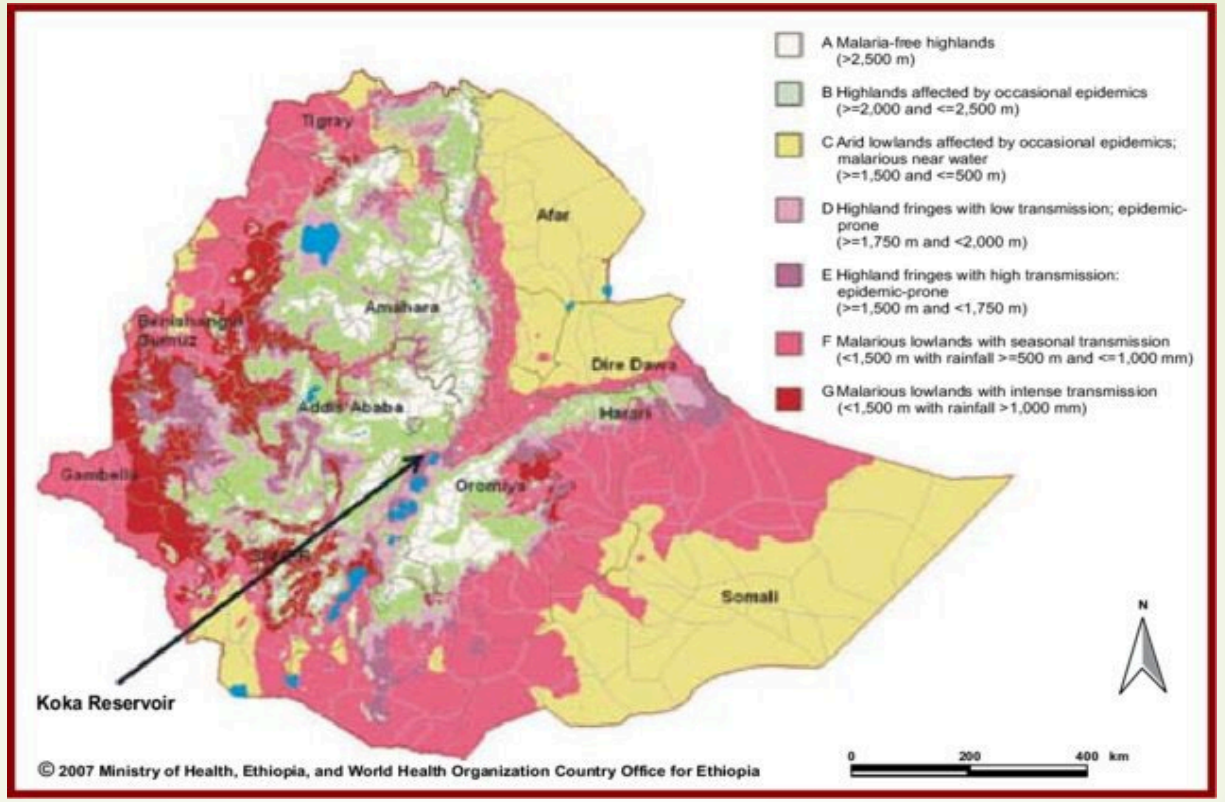


FIGURE 2. Distribution of endemic malaria in Ethiopia (source: Ethiopian Ministry of Health and World Health Organization, 2007)

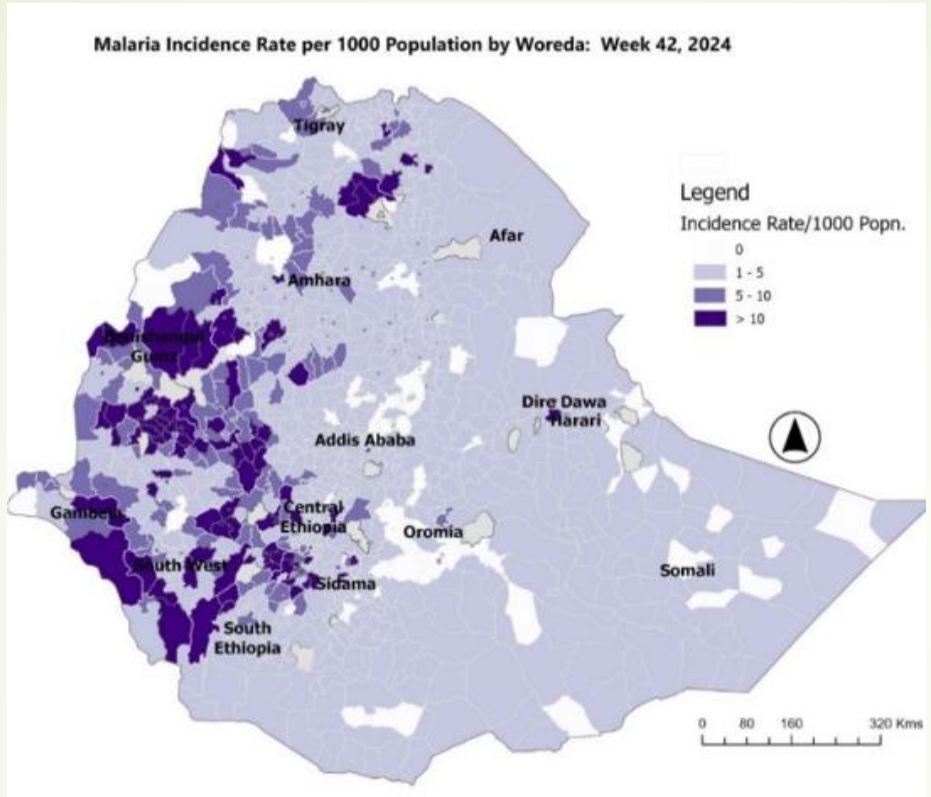
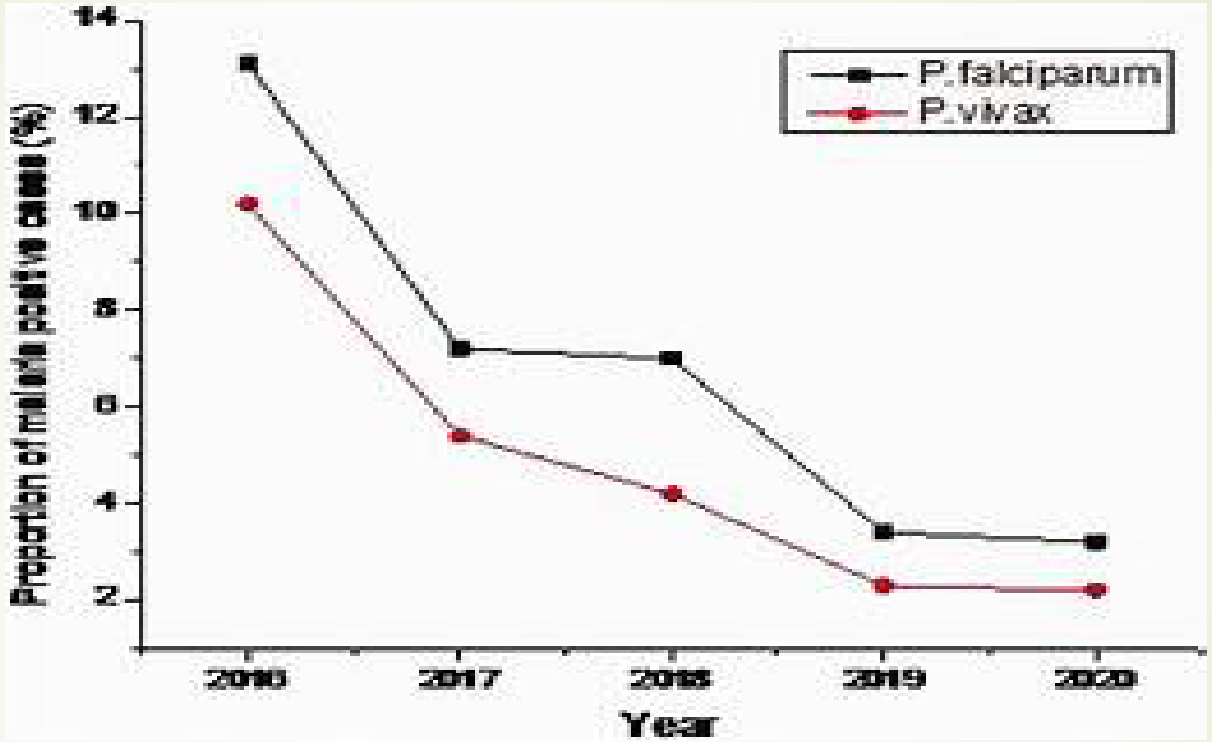
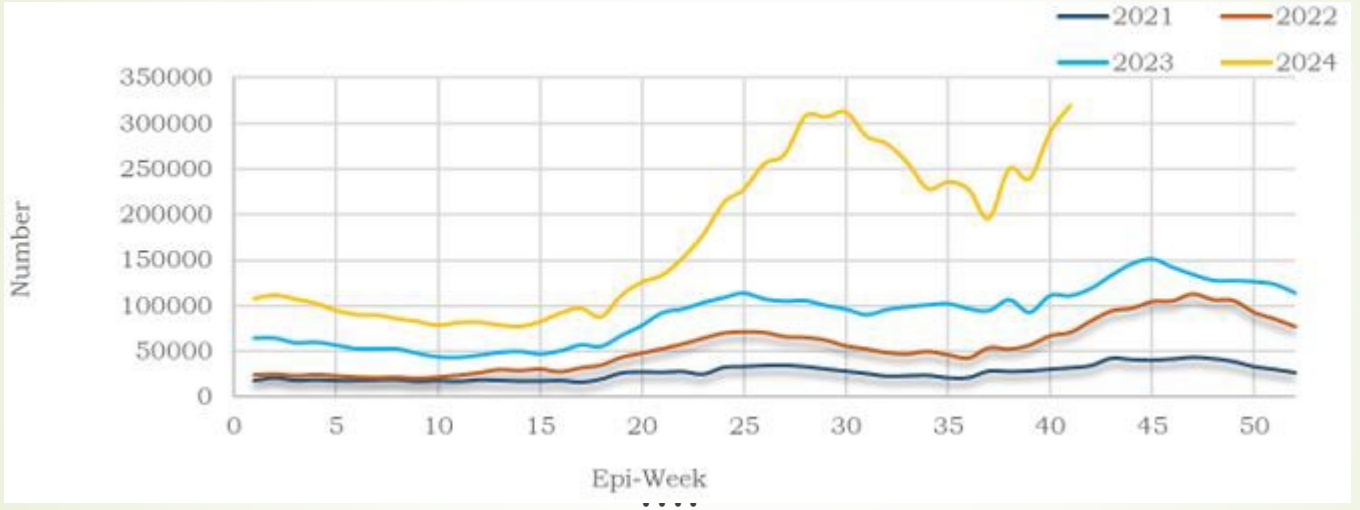


Figure 2. Malaria prevalence in Ethiopia in 2024



Assessment of malaria prevalence in Boset District, East Shawa Zone



Weekly PHEM/IDSR data, EPHI

Introduction.....

- In response, Ethiopia has developed comprehensive national malaria control and elimination programs aimed at reducing morbidity and mortality while moving toward long-term elimination
- The National Malaria Elimination Program emphasizes universal access to diagnosis and treatment, strengthened surveillance systems, and large-scale vector control interventions such as long-lasting insecticidal nets (LLINs) and indoor residual spraying (IRS)
- These interventions are strategically deployed based on transmission intensity and risk classification to maximize impact and ensure efficient use of resources

Introduction.....

- However, reliance on single interventions has proven insufficient due to emerging challenges such as insecticide resistance, environmental changes, population mobility, and outdoor mosquito biting behavior
- Consequently, Ethiopia increasingly adopts **Integrated Vector Management (IVM)** as a core malaria control strategy
- IVM is defined as a rational, evidence-based decision-making process that optimizes the use of multiple vector control methods in a cost-effective, environmentally sound, and sustainable manner
- Rather than focusing on one intervention, IVM combines complementary approaches including LLINs, IRS, larval source management, environmental modification, surveillance, and community participation

Introduction….

- Evidence from Ethiopia and other endemic regions shows that integrated approaches significantly reduce mosquito density and malaria transmission compared to single-method strategies
- Studies demonstrate that combining interventions with community engagement and intersectoral collaboration improves effectiveness, enhances local ownership, and strengthens long-term sustainability of malaria control programs
- Furthermore, Ethiopia's current strategic plans incorporate vector surveillance, insecticide resistance monitoring, and targeted interventions tailored to local epidemiological conditions, reinforcing IVM as a central pillar of malaria elimination efforts

Introduction……

- Therefore, understanding the principles and best practices of Integrated Vector Management is essential for strengthening malaria control in Ethiopia
- This topic explores how optimized integration of vector control tools, scientific evidence, and community participation can enhance program efficiency and accelerate progress toward malaria elimination in the country

Research Overview on Malaria Vectors in Ethiopia

- Malaria remains a major vector-borne disease in Ethiopia, with transmission occurring mainly in lowland and mid-altitude areas below 2,000 meters above sea level
- The disease is transmitted by female *Anopheles* mosquitoes, whose distribution, behavior, and ecology strongly influence malaria epidemiology
- Understanding malaria vector species, their breeding habitats, seasonal dynamics, and resistance patterns is essential for designing effective control strategies, particularly within Integrated Vector Management (IVM) frameworks

Major Malaria Vector Species in Ethiopia

- Research conducted across Ethiopia has identified several *Anopheles* species, but only a few play a significant role in malaria transmission:
- **Anopheles arabiensis** – The principal malaria vector in Ethiopia. It belongs to the *Anopheles gambiae* complex and is widely distributed across malaria-endemic regions. It shows flexible feeding behavior, biting both indoors and outdoors and feeding on humans and animals.
- **Anopheles pharoensis** – A secondary vector commonly found near irrigated fields, lakes, and riverine environments. It contributes to transmission particularly in areas with extensive water bodies.
- **Anopheles funestus** – Reported in some western and southwestern regions; associated with permanent water habitats and capable of sustaining transmission.
- Other species such as *Anopheles nili*, *Anopheles coustani*, and *Anopheles demeilloni* may play localized or minor roles depending on ecological conditions.
- Anopheles stephine??

Geographic and Ecological Distribution

- Malaria vector distribution in Ethiopia is influenced by altitude, rainfall, temperature, and land use patterns:
- **Lowland areas**: High vector density due to warm temperatures and stable breeding habitats.
- **Highland fringes**: Seasonal transmission with epidemic potential following unusual rainfall or temperature increases.
- **Irrigation and agricultural schemes**: Expansion of irrigation projects has created new breeding sites, increasing vector populations.
- **Urban and peri-urban settings**: Poor drainage and water storage practices support localized mosquito breeding.

Breeding Habitats and Ecology

- Malaria vectors in Ethiopia typically breed in:
- Temporary rain-filled pools
- Irrigation canals and agricultural fields
- River edges and flood plains
- Puddles, hoof prints, and stagnant water collections
- *Anopheles arabiensis* prefers sunlit, shallow, and temporary water bodies, which makes vector abundance highly seasonal and linked to rainfall patterns.

Insecticide Resistance

- One of the most critical research findings in Ethiopia is the increasing development of insecticide resistance, particularly in *Anopheles arabiensis*:
- Resistance to pyrethroids commonly reported
- Emerging resistance to other insecticide classes in some regions
- Resistance threatens the effectiveness of long-lasting insecticidal nets (LLINs) and indoor residual spraying (IRS)
- Continuous resistance monitoring is therefore a key component of malaria vector research and control programs

Vector Behavior and Transmission Dynamics

- Research shows that Ethiopian malaria vectors exhibit behavioral adaptability:
- Both **indoor and outdoor biting** patterns
- Peak biting activity often occurs late at night
- Opportunistic feeding on humans and livestock (zoophilic tendency)
- Seasonal population peaks following rainy seasons
- These behaviors can reduce the effectiveness of indoor-focused interventions alone, highlighting the need for integrated approaches

Surveillance and Research Approaches

- ✓ Malaria vector research in Ethiopia commonly includes:
- Entomological surveillance (larval and adult mosquito sampling)
- Species identification using morphological and molecular methods
- Monitoring biting behavior and resting habits
- Insecticide susceptibility testing
- Environmental and climate-based risk mapping
- These studies provide evidence for targeted interventions under Integrated Vector Management.

Integrated Vector Management (IVM)

- ✓ Research findings emphasize that effective malaria control in Ethiopia requires:
- Combining LLINs and IRS with larval source management
- Environmental modification and water management
- Community participation in habitat reduction
- Evidence-based insecticide rotation strategies
- Strengthened entomological surveillance systems

Conclusion

- Malaria vector research in Ethiopia demonstrates that transmission is driven primarily by *Anopheles arabiensis*, supported by ecological diversity and changing environmental conditions
- Behavioral flexibility and growing insecticide resistance pose challenges to traditional control measures
- Therefore, sustained research and integrated vector management approaches are essential to optimize interventions and support Ethiopia's goal of malaria elimination

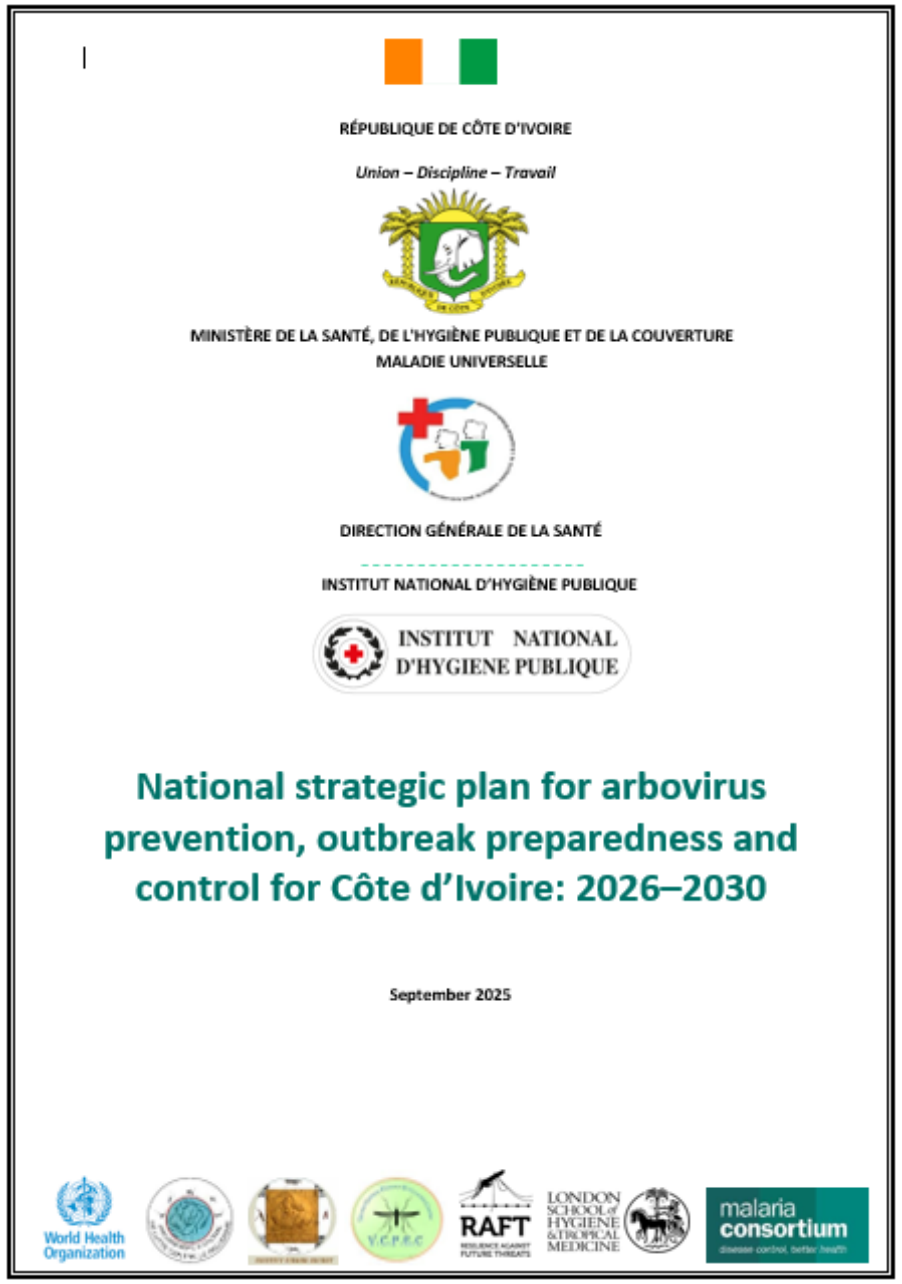
Thank you for your attention!

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4 March 2026

Presentation: Developing a National Strategic Plan for Arbovirus Preparedness – A Case Study from Côte d'Ivoire

Poe Poe Aung, Malaria Consortium



Developing a National Strategic Plan for Arbovirus Preparedness: A Case Study from Côte d'Ivoire

Nairobi, Kenya, 3- 5 March 2026

RAFT
RESILIENCE AGAINST FUTURE THREATS

globalvectorhub.lshtm.ac.uk/raft

Poe Poe Aung

Malaria Consortium

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01. Background

- Arboviruses transmitted by day-biting *Aedes* mosquitoes are increasing as a public health threat across the world
- Despite Africa being the ancestral home of several of these pathogens, arboviruses remain inadequately researched and the true incidence is poorly known for most of Africa
- A WHO survey in 2022 covering 47 nations in the WHO AFRO region indicated a “huge gap” in the capacity of African countries to adequately conduct surveillance and response to these expanding arboviral threats

02. Justification

- Partly in response to these findings, the FCDO-funded Resilience Against Future Threats (RAFT) project conducted assessments within four African countries (Burkina Faso, Cameroon, Cote d'Ivoire, Tanzania) in 2024
- Identified shortfalls and a desire for support to develop remedial measures to improve the state of arbovirus preparedness in their countries
- Needs a **"National Strategic Plan"** that provides policy guidance, surveillance and response procedures, and institutional structures, responsibilities as well as staffing and resource guidelines
- Developing a National Strategic Plan for Arboviruses in Cote d'Ivoire as a demonstration model and template for replication by other countries

03. Methods

Desk review

A systematic review was conducted to identify policy documents, guidelines, and standard operating procedures.

Key informant interviews

We conducted 3–5 with key informant interviews with representatives from health ministries, national programmes, WHO, PMI and academic institutions.

Rapid analysis

Self-assessment survey

An online KOBO toolbox questionnaire with 69 questions across nine domains was administered.

Workshop

Key findings were presented in a workshop with group work and discussion on each country's state of preparedness, priorities and proposed solutions.

Figure 1. Country's self- assessment methodology

Process of NSP development

Sept-Dec 2023	Country selection	Approved by LSHTM during ASM, 2023
Jan 2024	Initial meeting	Develop a committee or TWG
Feb 2024	Meeting with MOH	Identify external consultant
Mar 2024	Kick off meeting	Led by MOH, with all key stakeholders
		Conduct review of technical documents, policy, regulations, research publications, interviews and write the first version of NSP
Apr-May 2024	Draft NSP v1	
Jun 2024	Writing workshop	
Jul 2024	Draft NSP v2	Review and feedback by advisory team
Aug 2024	Draft NSP v3	Review and feedback by TWG
Sept 2024	Final draft NSP v4	Stakeholder validation workshop & process evaluation
		Revise the final draft
Sept-Oct 2024	Final NSP v5	Final report



Formation of different groups

TWG	11 Technical Working Group members from MOH, research institutions, LSHTM, Malaria Consortium and WHO
CORE writing team	4 Members composed of external consultant, MOH and research institutions
Sub-writing team	3 sub-writing teams with 20 members composed of different departments from MOH and other ministries/ departments

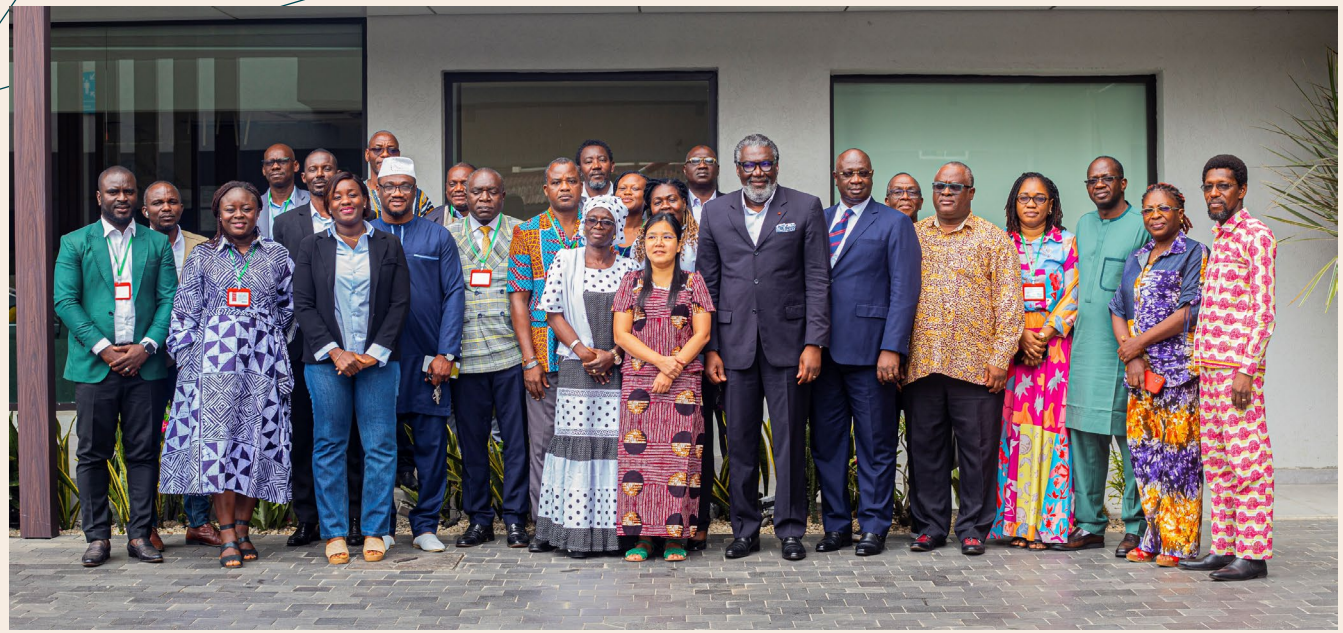
Kick-off meeting, 21 March 2025

Opening remark by the Director General of Health



- Total 25 participants attended
- Representatives from 15 departments joined
- Opening remark – Director General of Health
- Accompanied by – Director of National Malaria Control Program, Deputy Representatives from INHP

Kick-off meeting (Mar 2025)









Writing workshop (June 2025)











Validation workshop (Aug 2025)









04. Key Strategic Interventions



Objective 1: Reduce the risk of arboviral diseases transmitted by Aedes mosquitoes within the population through vaccination and prevention measures.



Objective 2: Enhance surveillance of Aedes-borne viruses and prediction of outbreak risks.



Objective 3: Enhance vector control strategies for the management and containment of epidemics.



Objective 4: Promote state-of-the-art approaches in risk prediction, response and control.



Objective 5: Foster national multisectoral coordination and collaboration among stakeholders and partners for preparedness, response and resilience to Aedes-borne arboviral diseases.

05. Finalising the NSP

1. Revision, translation & sharing version 5

Revise, translate and share the version 5 to the stakeholders

2. Finalise the NSP

Finalise the NSP version 6 according to the feedback from the stakeholders

3. Copy editing & design for printing

Copy editing of English and French version, design for printing

4. Submission to MOH

Submit the MOH the final version (v6) of the NSP

06. Conclusions

- Developing a WHO-aligned National Strategic Plan on Arboviruses in Côte d'Ivoire shows that a participatory, evidence-driven approach can rapidly strengthen national preparedness.
- The resulting plan offers a practical, locally owned framework for improving surveillance and response and provides a replicable model for other countries seeking to close critical gaps in arbovirus readiness.

Acknowledgements

- We sincerely acknowledge the invaluable support of stakeholders from various departments within the Ministry of Health in Côte d'Ivoire, as well as representatives from partner organisations, academic institutions, donors and collaborators.
- We are especially grateful for the leadership and guidance provided by the London School of Hygiene & Tropical Medicine and Malaria Consortium.

Study team

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Merci

Collaborateurs du projet RAFT

- Direction Générale de la Santé (DGS), Côte d'Ivoire
- Institut National d'Hygiène Publique (INHP), Côte d'Ivoire
- Programme National de Lutte contre le Paludisme (PNLP), Côte d'Ivoire
- Centre Pierre Richet (CPR), former Institut Pierre Richet (IPR), Cote d'Ivoire,
- LSHTM, UK
- Malaria Consortium, UK & Thailand

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Mahidol University Faculty of Tropical Medicine

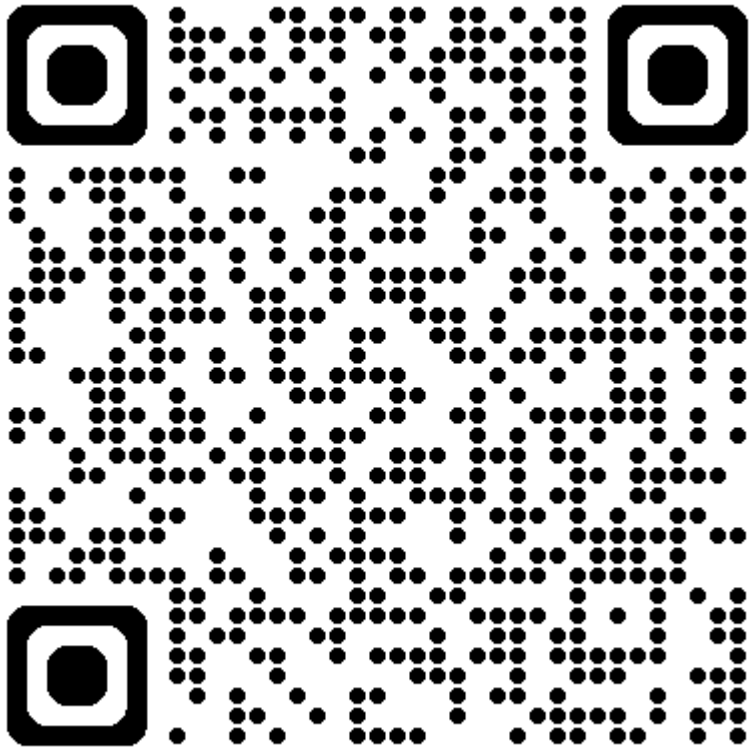
malaria consortium
disease control, better health

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LIVE Q&A >>>

You can post

Questions >>>



4 March 2026

QA and discussion

Moderated by VCWG Task Team lead Eleanore Sternberg

Session presenters

RBM Partnership
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4 March 2026

Task Team 2: *Anopheles stephensi* response

Introduction

Susanta Ghosh & Neil Lobo, VCWG Task Team leads

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4 March 2026

Presentation: *Anopheles stephensi* larval habitat super productivity and its relevance for larval source management in Africa

Solomon Yared, Jigjiga University

Anopheles stephensi larval habitat superproductivity and its relevance for larval source management in Ethiopia

Solomon Yared[1], Dereje Dengela[2], Peter Mumba[3], Sheleme Chibsa[3], Sarah Zohdy[4], Seth R Irish[4], Melissa Yoshimizu[5], Meshesha Balkew[2], Albert Akuno[6], T. Alex Perkins[6], Gonzalo M Vazquez-Prokopec[7]

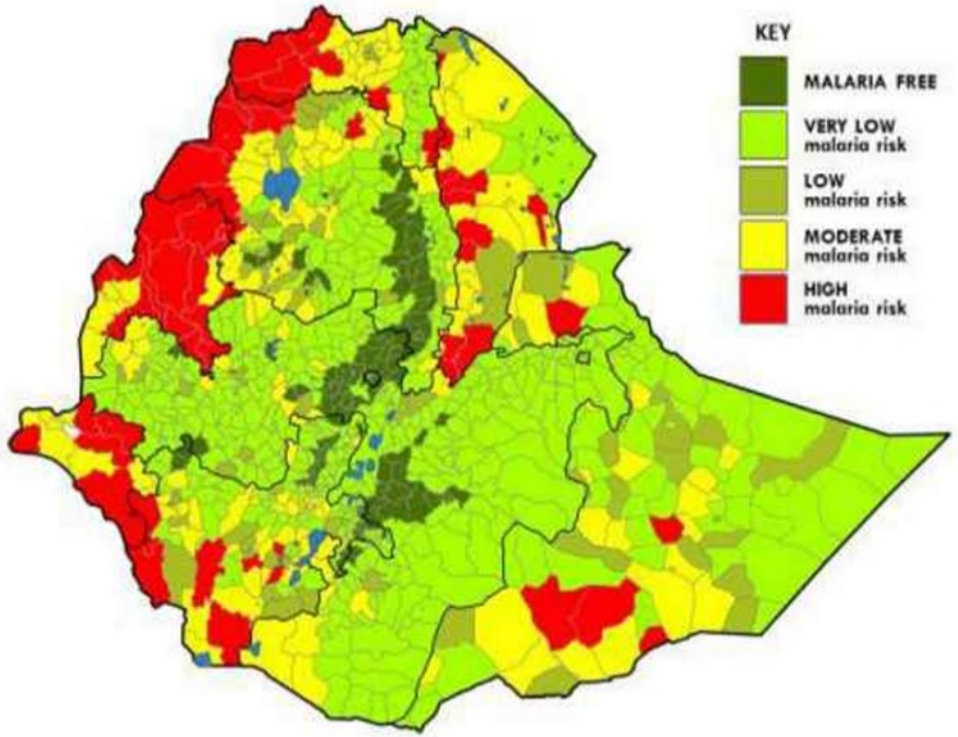
Solomon Yared(PhD)

Department of Biology

Jigjiga University, March 2026

Malaria cases in Ethiopia

- 2019: The country reached a low point for malaria cases in 2019, with approximately 900,000 cases reported.
- 2022: Around 1.6 million cases were reported, a rebound from the low of 994,000 cases in 2019.
- 2023-2024: Some reports indicate over 7.3 million malaria cases in 2023, which was a surge from earlier years.



Plasmodium falciparum and Plasmodium vivax: Main malaria parasites

- **Western and Northwestern Zones: higher malaria risk**
- **Seasonal/Unstable**

- **Presently, vector control relies on LLINs and IRS**

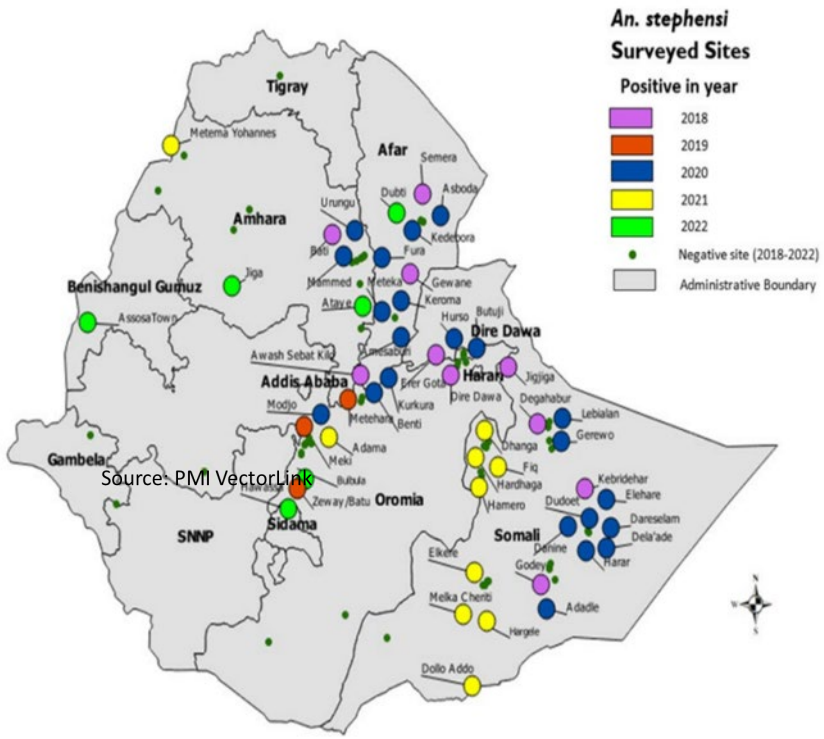
- Species of mosquito
- *Anopheles arabiensis*: primary vector
- *An. funestus* and *An. pharoensis* : consider secondary vector
- *Anopheles stephensi*: This invasive species, first detected in Kebridehar town in 2016.

Ethiopia: *An. stephensi's* gateway to Africa

First detection of *Anopheles stephensi* Liston, 1901 (Diptera: culicidae) in Ethiopia using molecular and morphological approaches

Tamar E. Carter[a,b,*,1], Solomon Yared[c,1], Araya Gebresilassie[c], Victoria Bonnell[a], Lambodhar Damodaran[a], Karen Lopez[a], Mohammed Ibrahim[d], Seid Mohammed[e], Daniel Janies[a]

[a] Department of Bioinformatics and Genomics, University of North Carolina at Charlotte, 9201 University City Blvd, Charlotte, NC, 28223, USA



An. stephensi detected in 51 sites in Ethiopia.

Established in Urban areas

Vector of *P. falciparum* and *P. vivax* ***Emiru et al (2023)***

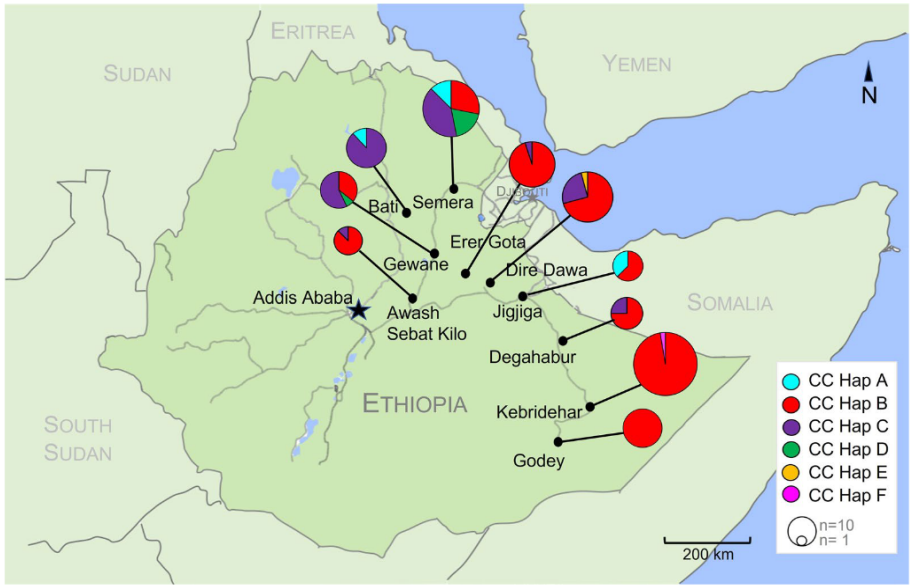


Fig. 1 Distribution of *An. stephensi COI-CytB* (CC) haplotypes (Hap) per site in eastern Ethiopia, November–December 2018. Pie charts are proportional to the sample size. Each color represents a different haplotype. Map was created using Adobe Illustrator version 2019 (Adobe, San Jose, CA, USA) and Pages for iOS 13 (Apple Inc., Cupertino, CA, USA) based on maps from Google Maps (https://www.google.com/maps)

Carter et al. Parasites & Vectors (2021) 14:602

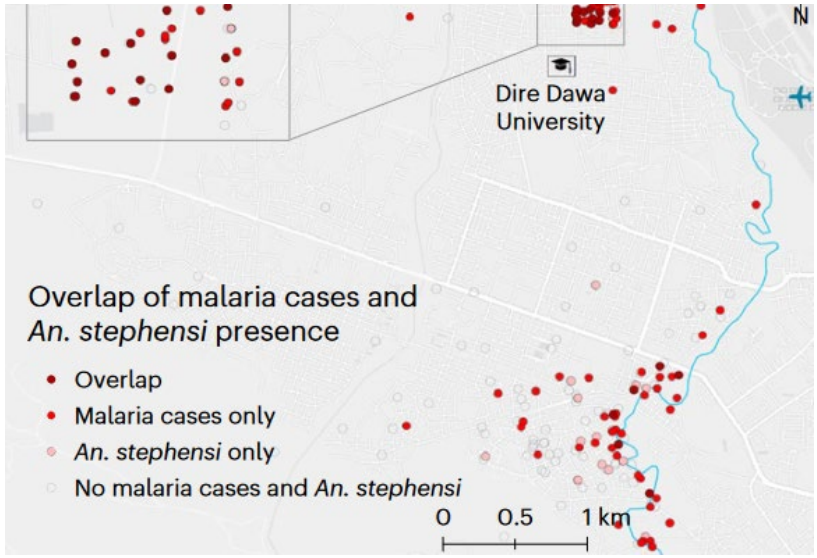
An. stephensi distribution is widespread in Ethiopia. Multiple haplotypes (evidence of genetic diversity) are found,

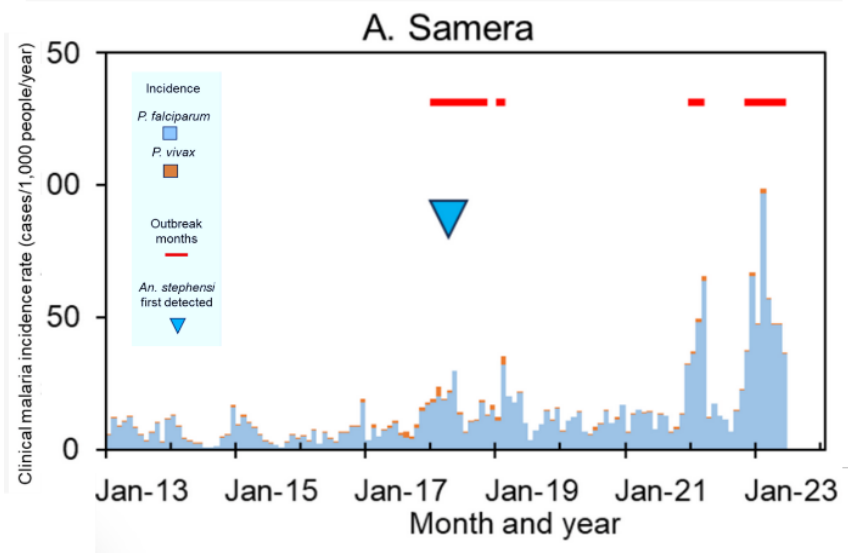
suggesting multiple introductions.

An. stephensi beginning to play a role as malaria vector in Ethiopia

Article https://doi.org/10.1038/s41591-023-02641-9

Evidence for a role of *Anopheles stephensi* in the spread of drug- and diagnosis-resistant malaria in Africa





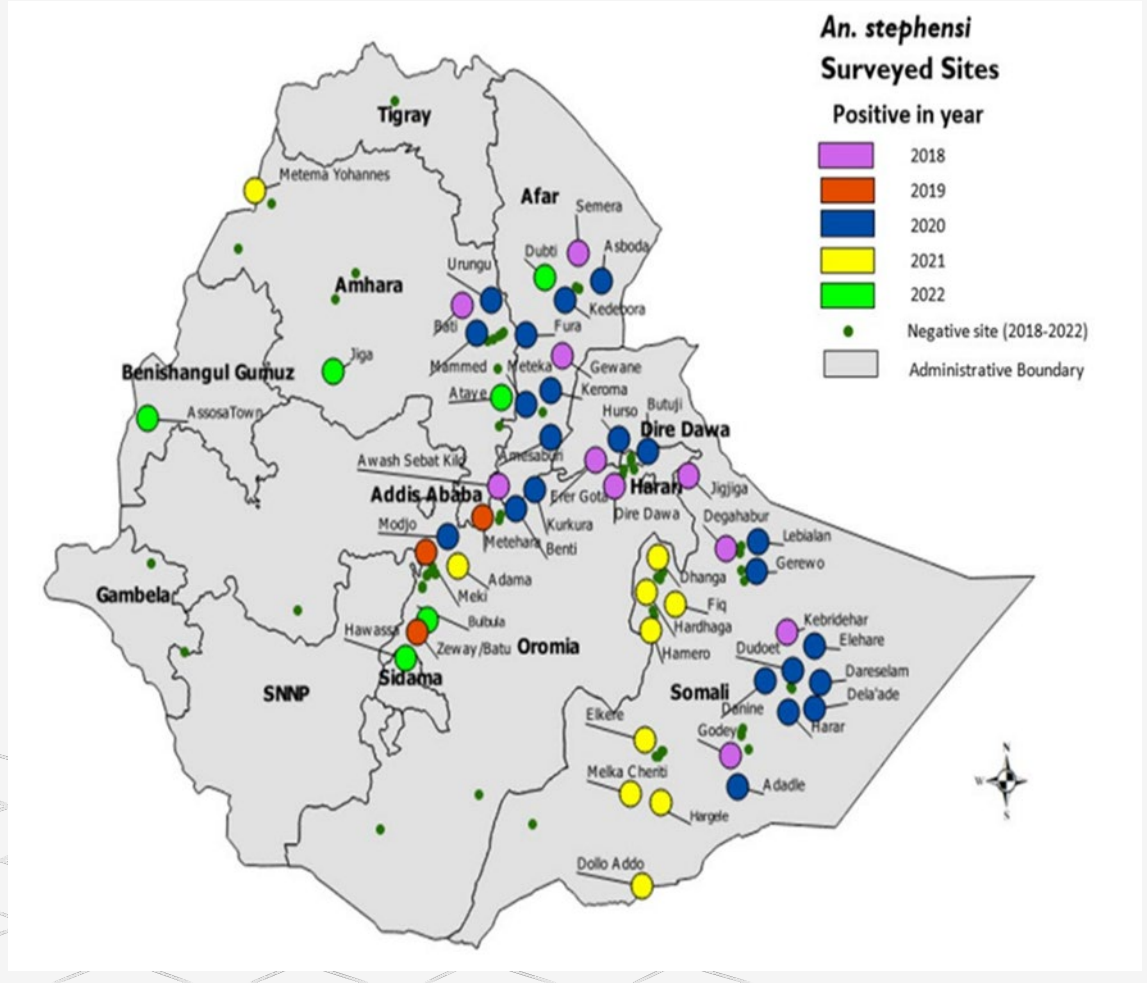
Zhou, G. et al. Resurgence of Clinical Malaria in Ethiopia and Its Link to *Anopheles stephensi* Invasion. *Pathogens* **2024**, *13*, 748.

Spatial clustering of *P. falciparum* infections around patients with malaria in strong association with the presence of *An.stephensi* in the household vicinity.

Cont.

Anopheles stephensi

- Vector of Pf and Pv
- Detected in 51 sites in Ethiopia.
- Established in Urban areas: availability of large and permanent habitats in construction sites (Yared et al. 2023)
- Breeds in water reservoir containers



Cont.

- Reports of larval habitats for *An. stephensi* in Ethiopia have either focused on cross-sectional characterizations during the dry season (Yared etal. 2023) or rainy season (Carter *et a 2018;* Balkew *et al. 2020*).

- *An. stephensi's* ability to persist in artificial habitats creates opportunities for populations to survive and thrive throughout the prolonged dry season of Ethiopia.
- Understanding the seasonal transition between rainy and dry periods is critical to identify better approaches for vector control.

- This study focused on the seasonal fluctuation in *An. stephensi* populations by investigating the transition in larval productivity between the rainy and dry seasons in an established Ethiopian population.






Study area and mosquito collections

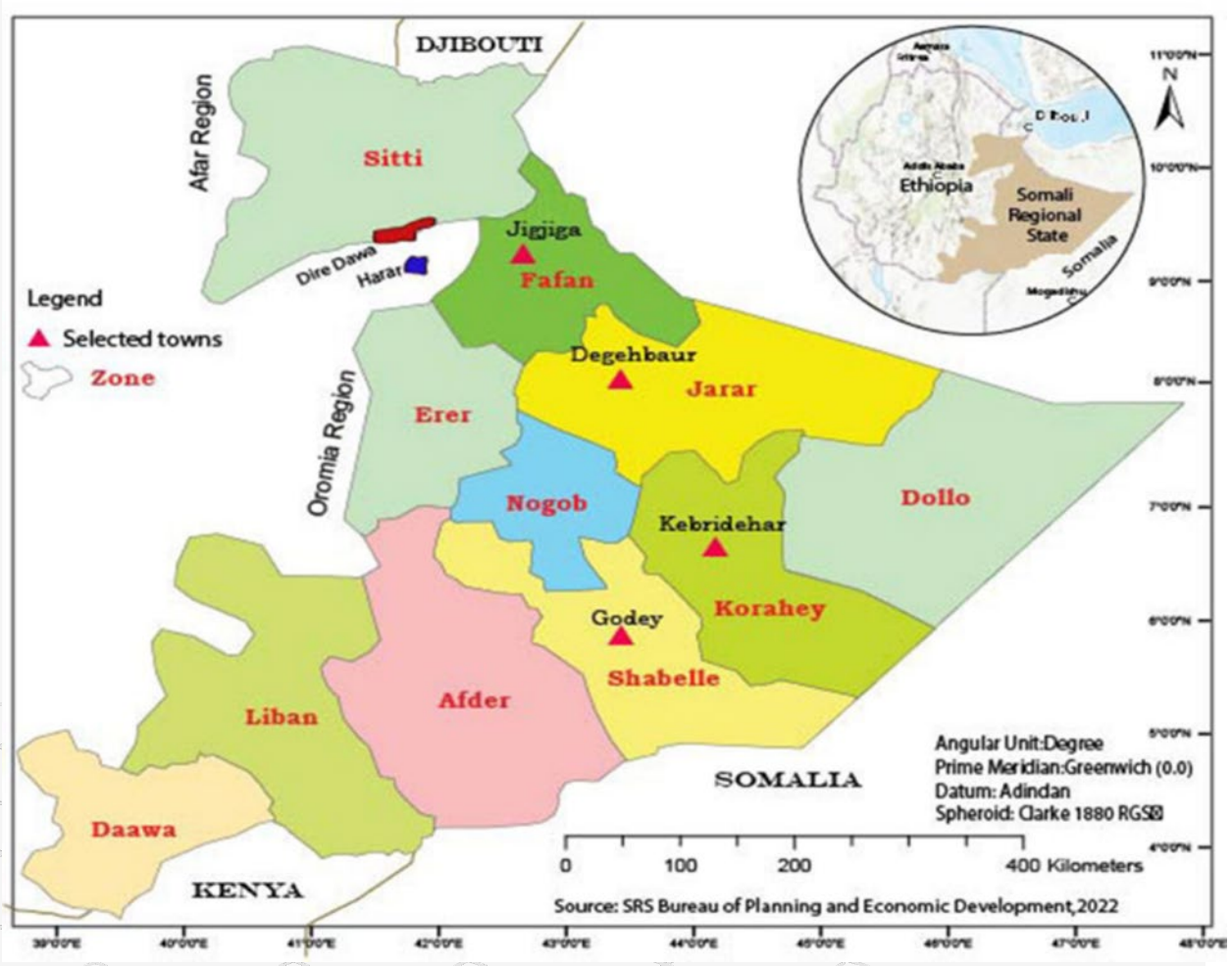
Somali Region

Total land size: 327,068 square kilometers

Total population: 7,445,219, (3,472,490 men and 3,972,729 women);

Urban inhabitants number 1,489,044 or 20% of the population, a further 5,956,175 or 80% were pastoralists and farmers.

High population movements, IDPs and refugees characterize the Region. Frequent floods and man-made water reservoir contribute to periodic epidemics of malaria.



Malaria cases in Korahey zone2019-2024

Region	Total Cases	Total deaths	CFR	Outpatient	Inpatient	PF	PV	Mixed cases
Somali	**55,058**	**0**	**0.000%**	**54785**	**280**	**17948**	**3220**	**1**
Bodaley	5,176	0	0.000%	5169	7	2690	238	0
Debeweyin	5,970	0	0.000%	5941	29	1405	970	0
El-Ogaden	3,765	0	0.000%	3752	15	650	180	0
Goglo	3,490	0	0.000%	3477	13	444	24	0
Higloley	3,726	0	0.000%	3715	11	2106	98	0
Kebridehar	7,075	0	0.000%	7007	68	2574	387	0
Kebridehar town	7,055	0	0.000%	7020	26	1822	285	0
Lasdhankayre	2,954	0	0.000%	2945	9	617	258	0
Marsin	2,151	0	0.000%	2129	32	1091	68	1
Shaygosh	4,866	0	0.000%	4817	49	1741	424	0
Shilabo	8,830	0	0.000%	8813	21	2808	288	0
Total	**55,058**	**0**	**0.000%**	**54785**	**280**	**17948**	**3220**	**1**

Other Vector Borne Diseases

- Dengue virus (out break, in 2018)
- chikungnya, (Outbreak in 2019)

Habitat characteristics and sampling

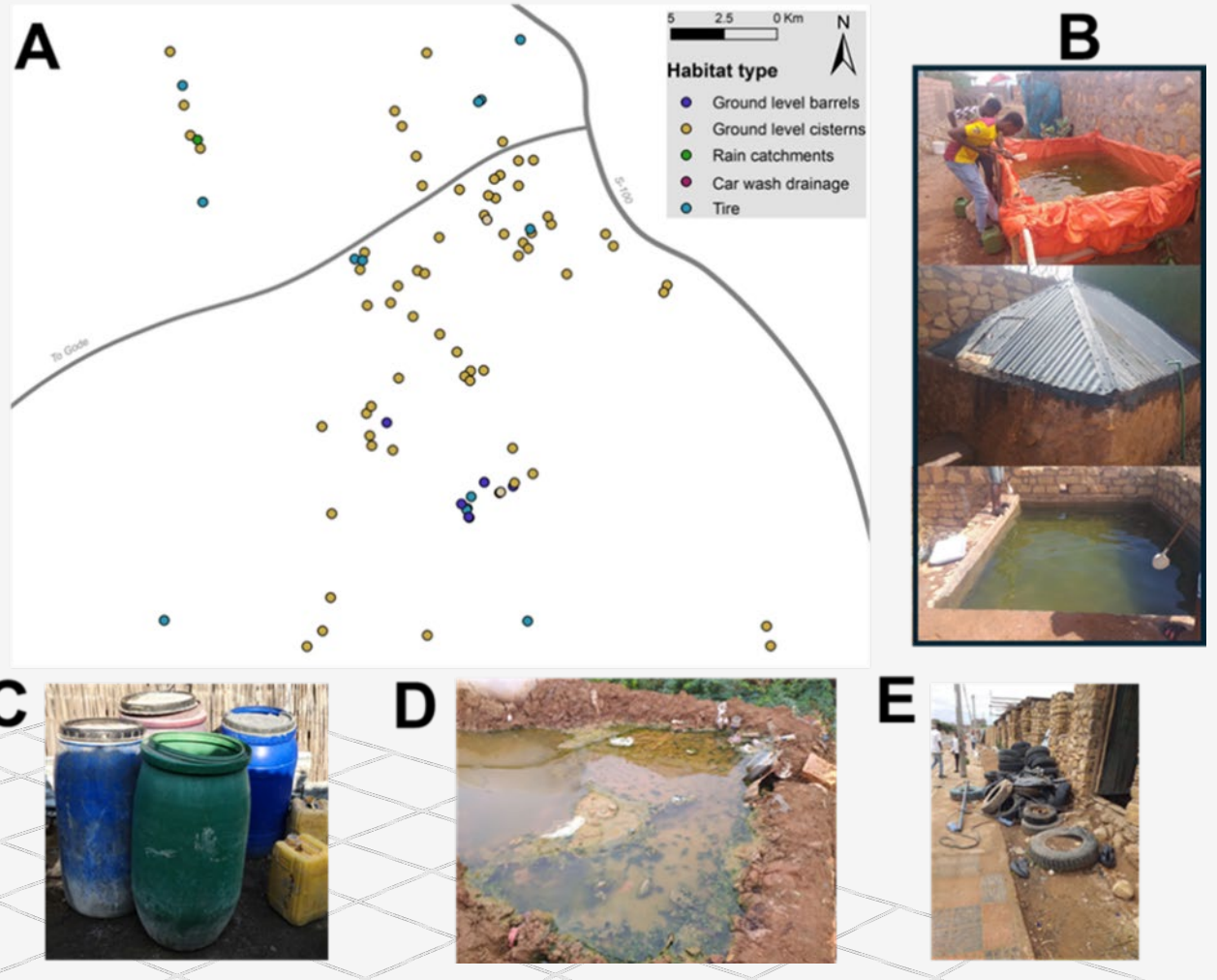
RESEARCH Open Access

Anopheles stephensi larval habitat superproductivity and its relevance for larval source management in Ethiopia

Solomon Yared[1], Dereje Dengela[2], Peter Mumba[3], Sheleme Chibsa[3], Sarah Zohdy[4], Seth R. Irish[4], Melissa Yoshimizu[5], Meshesha Balkew[2], Albert Akuno[6], T. Alex Perkins[6] and Gonzalo M. Vazquez-Prokopec[7*]

(A) Map of Kebridehar with the location of the 90 water-holding containers that were followed from the end of the rainy season (November 2020) and until the peak of the dry season (February 2021).

- (B) Ground level cisterns (they could be used for construction [top panel] or residential water use with different levels of cover).
- (C) Plastic containers (100 or 200L drums).
- (D) Car wash drain areas.
- (E) Discarded car and truck tires.
-



Morphological Identification of *An.stephensi*

Anopheles stephensi



The palpomere five was completely pale

The palpomere four is white at the base and apex

Pale spots

Thorax. Upper proepisternal setae is absent

Pale scale

The legs femora and tibiae were speckled with

Statistical Analysis

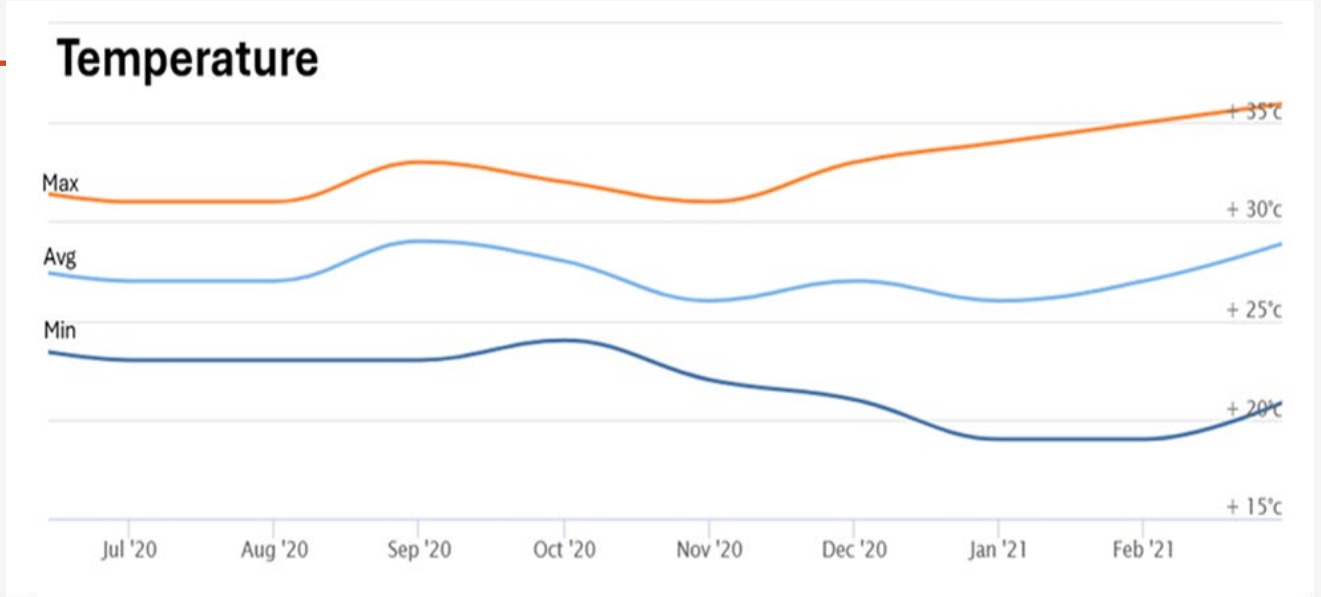
Larval productivity was quantified as the total number of larvae present in the 20 dips per habitat and month.

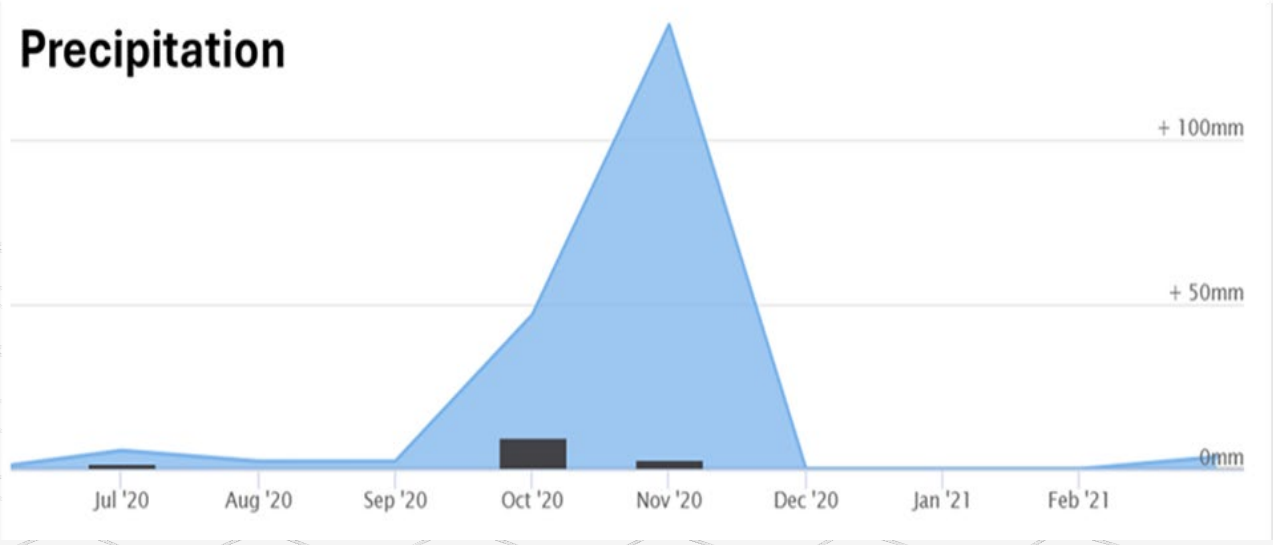
Heterogeneity in habitat productivity was quantified in two ways. A negative binomial fit to the distribution of larvae per container (per 20-dips) was used to estimate (via Maximum Likelihood) the parameter k, which is a measure of overdispersion in the data.

The Pareto fraction was used to further quantify heterogeneity for each month

From the Pareto fraction, we identified the %ith larval sites that contributed the most to total larval productivity (e.g., the top 20% of sites that contribute to 80% of larvae collected).

Temperature and rainfall for the period July 2020 to February 2021, covering the time prior and during *An. stephensi* sampling in Kebri Dehar. Data obtained from Kebri Dehar airport weather station.





Description of each potential larval habitat type identified in visited houses and followed monthly between November 2020 and March 2021. 75

		Mean			Number with water (sampled)			
Row Labels	Count of Type	distance to house (m)	Mean area (m2)	Mean volume (L)	November	December	January	February
Ground level cisterns	70	6	11	873	70	68	70	70
Tires	12	8	6	8	12	0	0	0
Ground level barrels	6	5	7	268	6	6	6	6
Rain catchments	1	15	4	20	1	0	0	0
Car wash drainage	1	3	2	40	1	1	1	1
Total	90	7	10	683	90	75	77	77

Characterizing *An. stephensi* habitat productivity

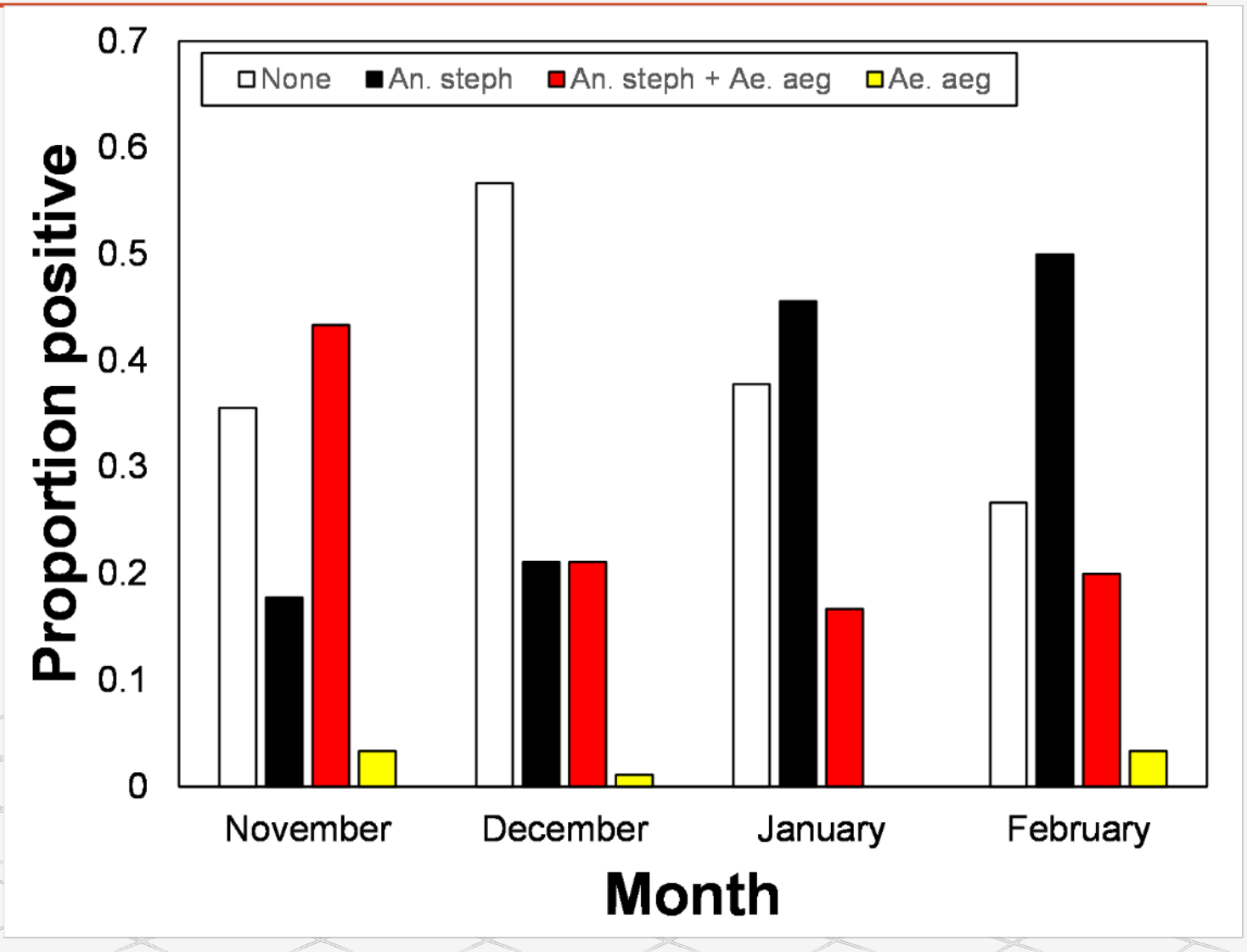
- A total of 90 water holding containers and potential larval habitats were identified in the 100 houses surveyed in November 2020.
- with the majority (75%) being ground level cisterns (a mix of large water reservoirs used for household needs or construction purposes).
- In those habitats, 13,635 *An. stephensi*, 1,168 *Ae. aegypti*, and 757 *Culex* spp. were collected throughout the four survey months.

Habitat positivity

Positivity (measured as proportion of habitats with either species alone or together) throughout the seasonal shift

For An. stephensi, positivity decreased from 61% (55/90) in November to 53% (38/72) in December, followed by an increase to 74% (52/70) in January and 82% (63/77) in February

Conversely, Ae. aegypti positivity reduced and maintained reduction from 47% in November to 28% in December, 20% in January and 21% in February

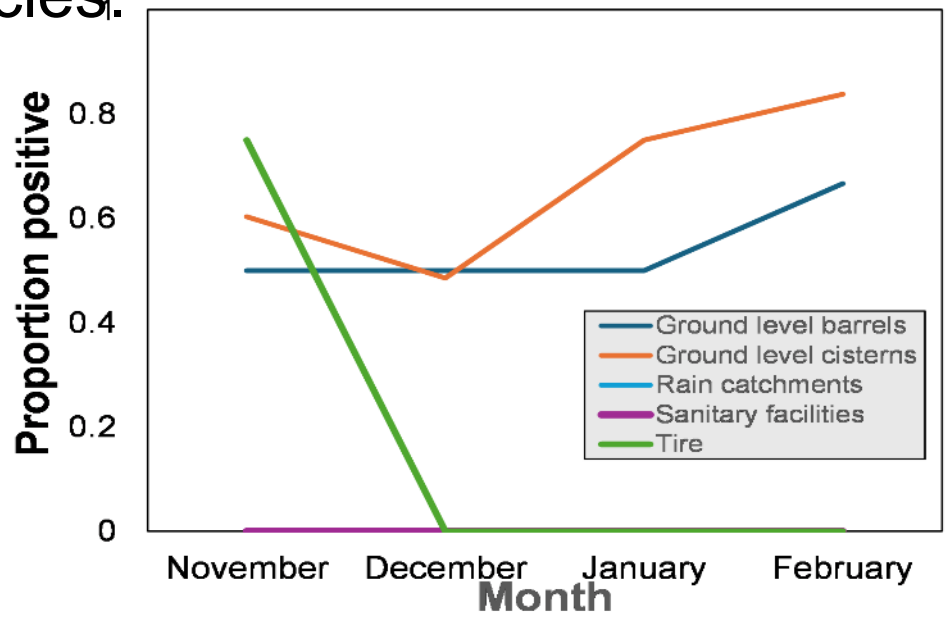


Positivity by type of larval habitat for each species.

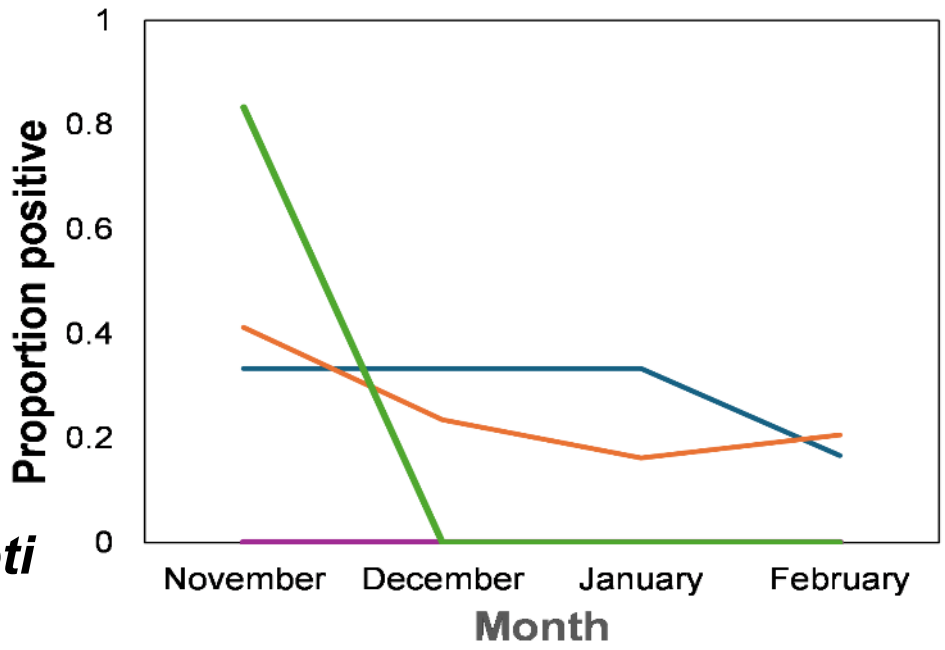
An. stephensi

Construction pits and cisterns were habitats where *An. stephensi* concentrated.

Tires were main *Ae. aegypti* habitat.



Ae. aegypti



Heterogeneity in *An. stephensi* and *Ae. aegypti* larval productivity

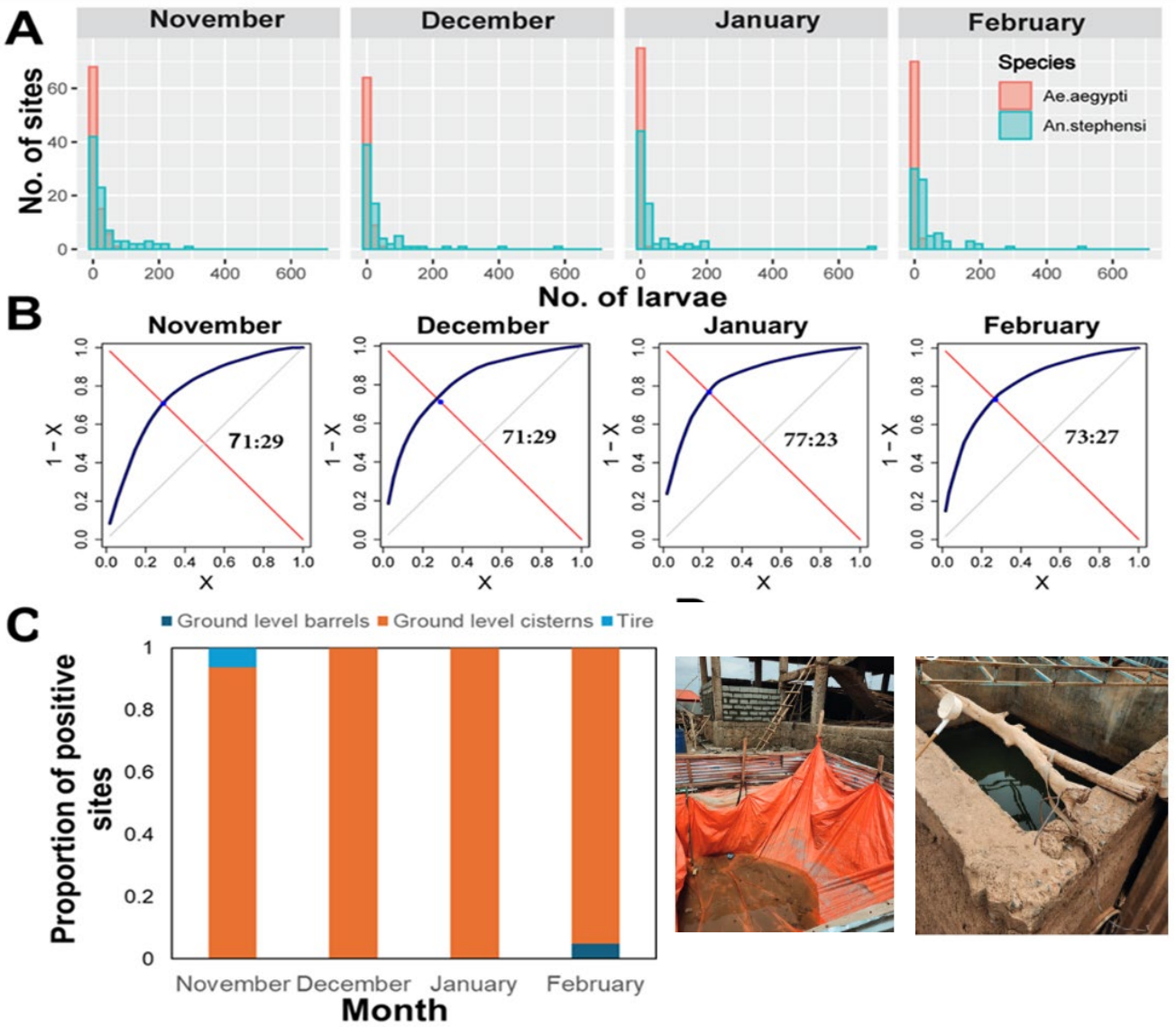
Overall, significant heterogeneity was detected across all months.

In November, 29% of containers contributed 71% of *An. stephensi* larvae (71:29).

- Fit to negative binomial distribution on all months.
- Parameter k indicates strong overdispersion (most mosquitoes come from a few sites).

Up to 77% of *An. stephensi* larvae came from 23% of larval sites

Superproductive sites: construction pits and ground level cisterns.



Conclusion

- *An. stephensi* populations may be seasonally-driven.
- *Aedes aegypti* and *An. stephensi* show that the level of overlap varies with the season and the type of habitat.
- Conducting LSM campaigns targeting ground level cisterns and large plastic tanks during the dry season may be more cost-effective than conducting blanket larviciding of every container.
- More research on the larval ecology of both *Ae. aegypti* and *An. stephensi* species is needed to understand whether cohabiting can be used to leverage LSM implementation.
- As research of vector control approaches against *An. stephensi* widen, considering optimized LSM approaches may be an approach for immediate control or even containment of the species at it continues its range expansion throughout Africa.

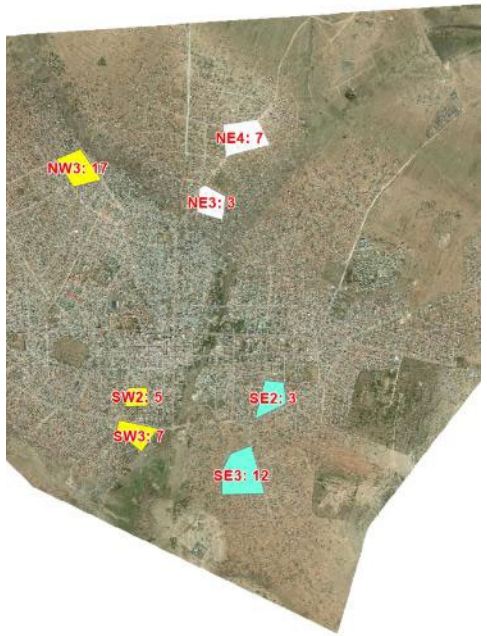


NextGen LSM:

Using high-res remote sensing and residual larvicides to optimize the control of *Anopheles stephensi* in urban Ethiopia









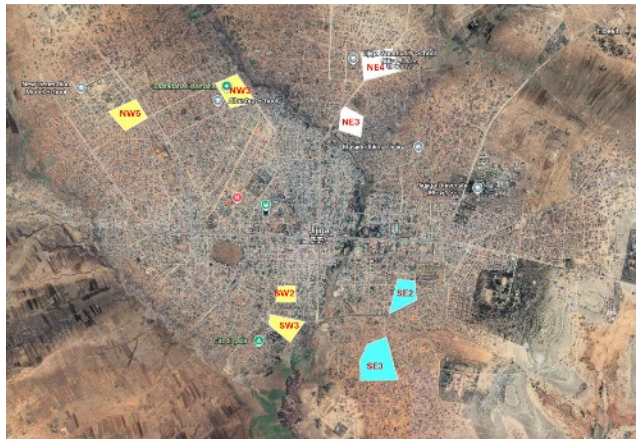


Gates Foundation:INV-080534

Lulumi Project

Project Objective

We will develop a method for rapid and efficient LSM implementation in urban centers that relies on the integration of remote sensing, machine learning/deep learning algorithms and web-based apps which will be used to guide the delivery of residual (long-lasting) larvicides.









Lulumi Project: developing an AI algorithm that will identify superproductive *An. stephensi* breeding habitats



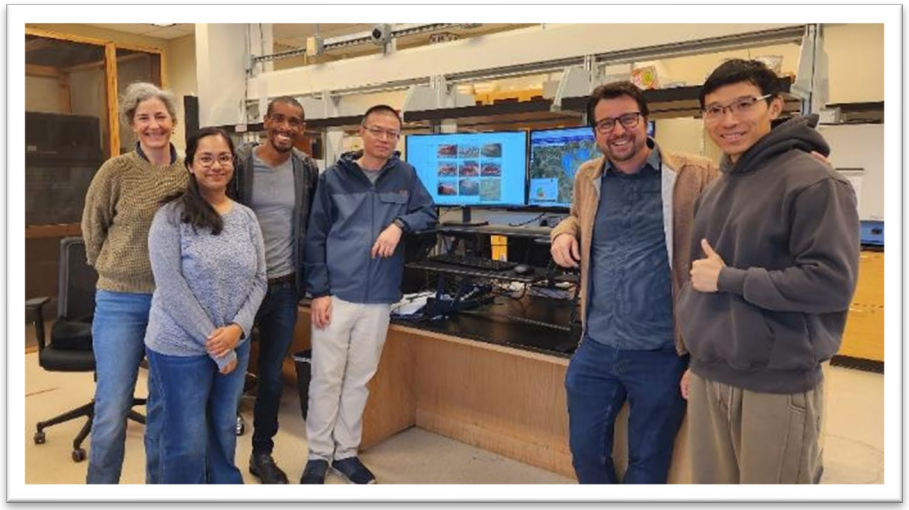
We structured our project around 3 working packages (WPs):

- **WP1**: Automated Mapping of *An. stephensi* habitats using remotely sensed data by satellite and aerial imagery, and AI/deep learning algorithms.
- **WP2:** Integration of habitat maps into Zzapp and develop app interface suitable for LSM activities in urban areas.
- **WP3:** Quantify the entomological impact of residual (long-lasting) larvicides during the dry season and its impact on the density and spatial distribution of *An. stephensi* during the subsequent rainy season.

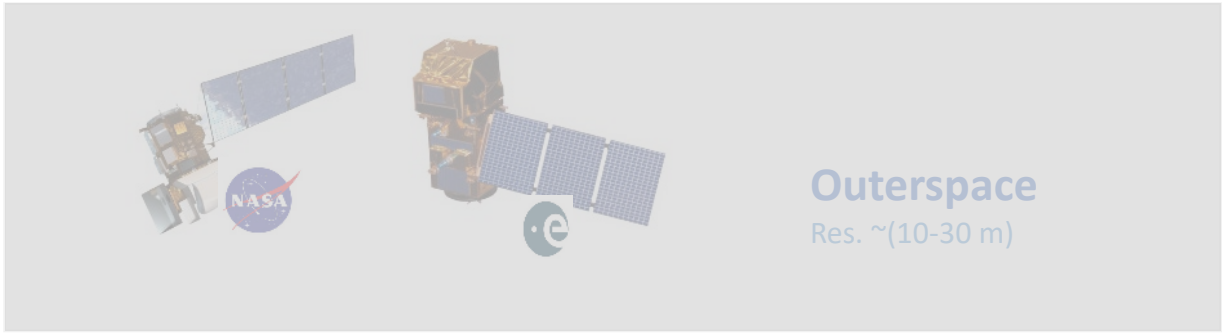
WP1: Automated Mapping of *An. stephensi* habitats using remote sensing and machine learning algorithms



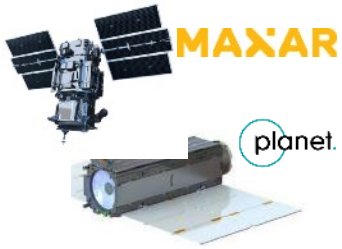


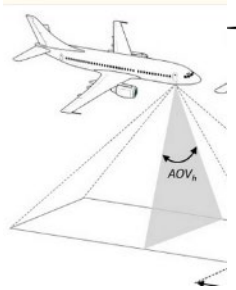


Lulumi Project AI+mapping team



Outerspace
Res. ~(10-30 m)







Innerspace & Aerial
Res~ (0.3-1 m) Res.~ (0.01-0.3 m)







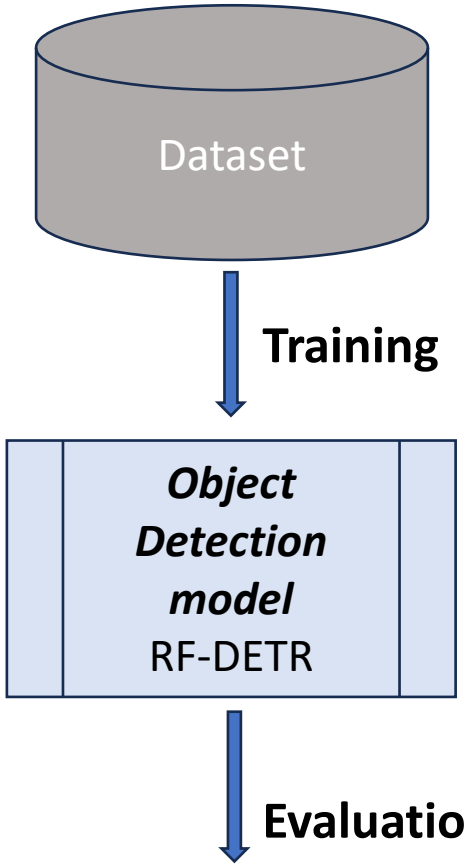
On the ground Sampling
Verification & training

Resolution

Occupancy Model Training

RF-DETR is an object detection transformer-based model developed by RoboFlow.





From 3 classes, initial training on the most productive habitat class (construction pits):



97% Precision, 85% Recall



WP3: Evaluate the entomological impact of residual (long-lasting) larvicides during the dry season on the density of An. stephensi and Plasmodium infection during the subsequent rainy season.

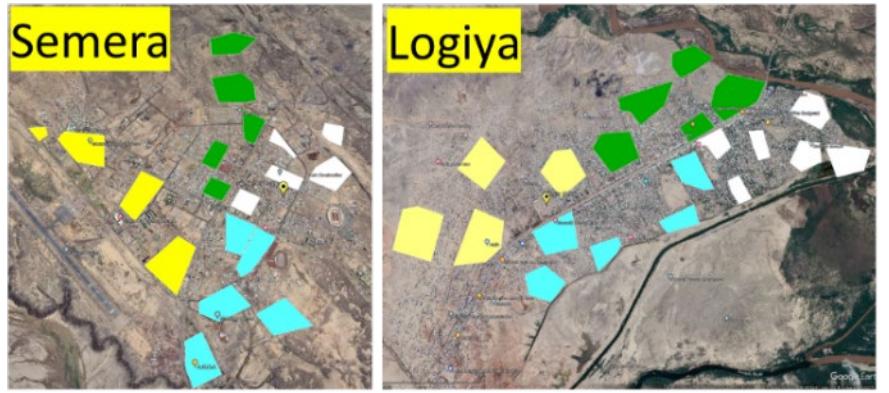
Study Design: three-arm, unblinded, cluster randomized controlled trial with primary entomological endpoints.

We will identify 36 clusters measuring 400x400m within Semera, Logiya, Jigjiga and Kebri Dehar.

We will randomize within those clusters three arms at 1:1:1 between:

1) Control (no treatment);
2) 'Targeted' (applying larvicide only in locations identified by our mapping algorithm);
3) 'PMI' (follow same practices as PMI did).

Location of clusters in two of the four localities of study.







SUMITOMO CHEMICAL





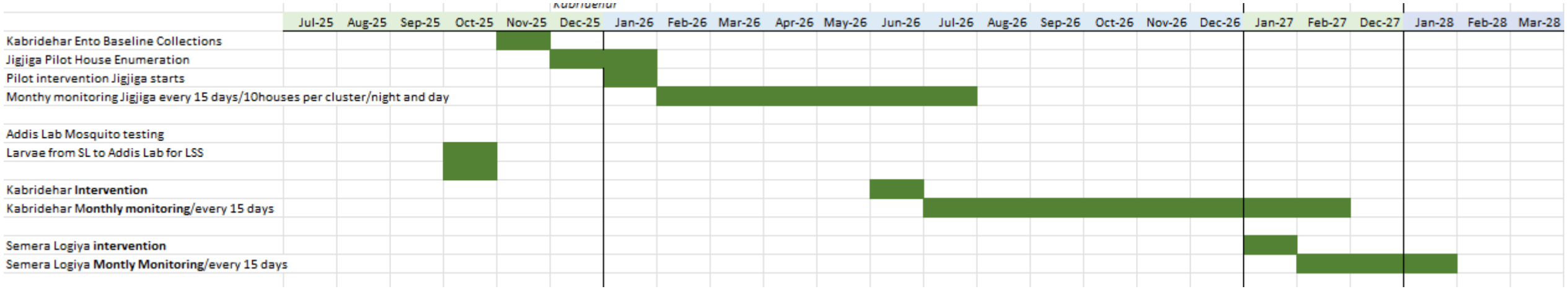
clarke

Updates:

- IRB approval at Emory and Jigjiga University
- MOH approval underway
- MTA with Sumitomo and Clarke.
- Product delivery and customs clearance next.

Project timeline

- 2025-2028.
- Plan for a pilot study April 2026, where we will test algorithm, larvicide deployment. Jigjiga City will be the place for the pilot.



- Main study will begin differently on each town, timing application to peak dry season.

Acknowledgements





EMORY UNIVERSITY





Gates Foundation

Support for this study was provided by the US President's Malaria Initiative, the US Centers for Disease Control (CDC-BAA-75D301-23-R-72545) and Gates Foundation (INV-080534).

RBM Partnership
To End Malaria

4 March 2026

Presentation: Cooccurrence of native and invasive malaria vectors in anthropogenic larval habitats in Metehara, Ethiopia – opportunities for urban malaria control

Temesgen Ashine Amenu, Armauer Hansen Research Institute

CEASE

Controlling emergent *Anopheles stephensi* in Ethiopia and Sudan

Co-occurrence and Relative Contribution of Native and Invasive Malaria Vectors: Implications for Urban Malaria Control

Temesgen Ashine

21st Annual Workshop: Vector Control Working Group

March 3-5, 2026

Movenpick Hotel & Residences Nairobi, Kenya

LSTM LIVERPOOL SCHOOL OF TROPICAL MEDICINE

Ahri Armauer Hansen Research Institute

Malaria in Urban Ethiopia

The burden

- Malaria remains a significant global health issue
- Africa bears disproportionate burden, with significant significant proportion accounted by urban areas
- Unplanned urbanization might increase transmission transmission risks, mainly in underserved communities communities
- **In Ethiopia, 15% of malaria burden** comes from urban urban settings, with the prevalence exceeding adjacent adjacent rural areas in some parts

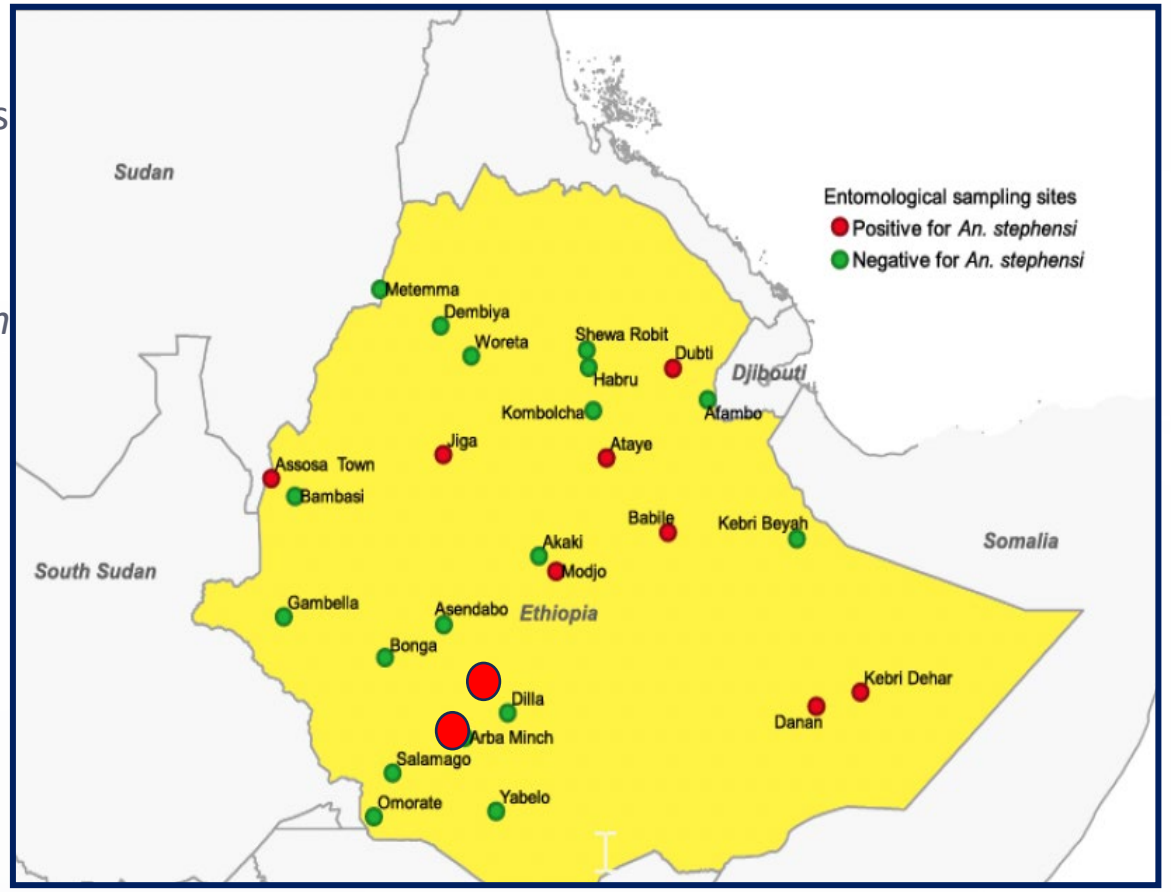
Vector adaptation and invasion

- **Increasing adaption of native vector** to urban ecology is ecology is documented
- The urban-adapted, ***An. stephensi* is spreading** across across Africa, potentially placing 120 million people at risk people at risk
- Evidence on the **urban ecology of malaria vectors**, especially in areas where **multiple species co-exist** is is needed for integrated intervention

Conflicting Roles of *An. stephensi* in Ethiopia

While ***An. stephensi* was implicated in a 2022** Dire Dawa Dawa outbreak, its **overall role in driving malaria** transmis transmission in Ethiopia is debated.

- Urban malaria trend analysis shown some sites with *An* with *An. stephensi* have lower malaria cases
  - **No clear link** between *An. stephensi* presence and and urban malaria trends (2014-2019)
- A nationwide geospatial model (2013-2022) **did not identify *An. stephensi* as a primary driver** of malaria risk
- While its spread is continued, recently reported from **Hawassa** and **Arba Mich**, Southern Ethiopia



Native Vectors and Urban Malaria in Ethiopia

Urban malaria is growing in Ethiopia, with urban districts accounting for **15.3% of the national burden** (2014-2019)

Proportional burden was occurring in areas where *An. stephensi* is not reported

Higher malaria burden in Dilla town compared to compared to surrounding rural areas (2012-(2012-2019)

Rural Focus

Malaria control efforts traditionally traditionally focused on rural areas, areas, where vectors breed in natural habitats.

Urban Adaptation

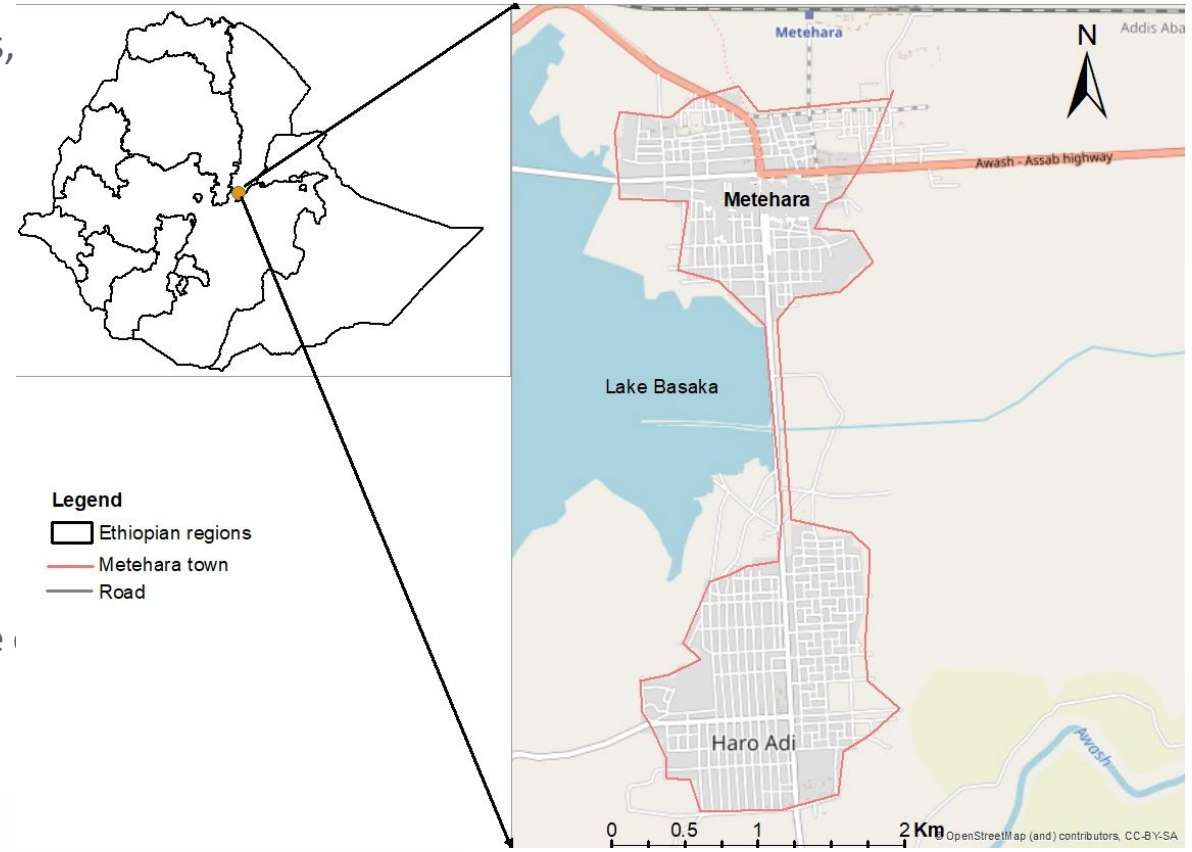
Primary vectors are adapting to anthropogenic habitats in urban settings, posing new risks.

Coexistence

The ecology of urban malaria requires attention to both invasive (*An. stephensi*) and adapted native vectors.

Aim of the study is to understand the bioecology and relative role of malaria vectors in Metehara town

- To shed light on relative roles of *An. stephensi* and native vectors, 2-year long case-control study was conducted
  - Risk associated with household exposure to *An. stephensi* and endemic malaria vectors was measured
- Additional, in-depth entomological investigation
  - To characterize larval habitats, species composition, blood-meal sources, and sporozoite rates
- Metehara town:
  - Located along Ethio-Djibouti transportation corridor, at an altitude 947m
  - Is malaria-endemic area, perineal transmission with seasonal peaks
  - ***An. stephensi* and native vectors (*An. arabiensis*, *An. pharoensis*) coexist**
  - Warm, humid climate with Lake Basaka creates ideal mosquito breeding conditions



Position of the Metehara town administration within Ethiopia (left panel) and details of the Metehara town kebeles (right panel)

Key Findings From In-depth Entomological Study

Larval Breeding Habitats: An Anthropogenic Problem

The majority (98.3%) of potential larval breeding habitats were anthropogenic

Water Storage Drums

34.2% of habitats

Local Reservoirs

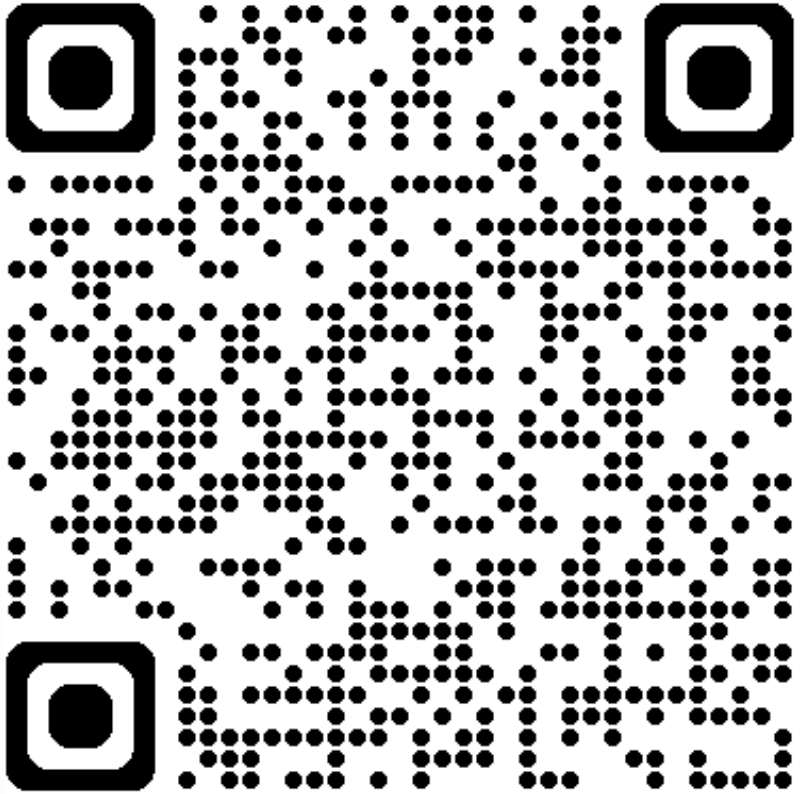
32.8% of habitats

Deep Wells/Pits

13.9% of habitats

Discarded Tyres

7.6% of habitats



Abandoned containers also contributed significantly

Ahri
አርማወር ሐንሰን የምርምር ኢንስቲትዩት
Armauer Hansen Research Institute
Since 1970

Habitat Characteristics & Usage

- Habitat materials: **Plastic (33.2%), concrete (21.2%),** earth earth (17.9%), and metals (13.3%).
- Location: **68.2% within compounds** of occupied houses.
  - Stored for **Household/hotel consumption consumption (37.3%), construction (20.8%), (20.8%),** and farming (13.4%).
- **Accessibility: 72.7% fully accessible, 24.1% partially accessible for oviposition**.

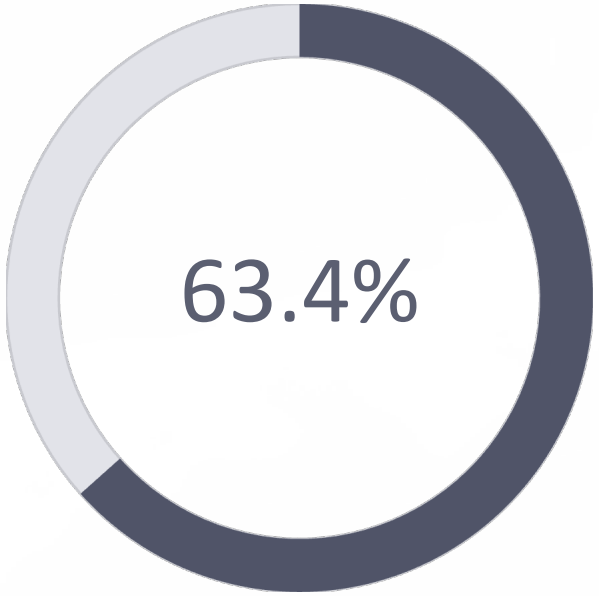






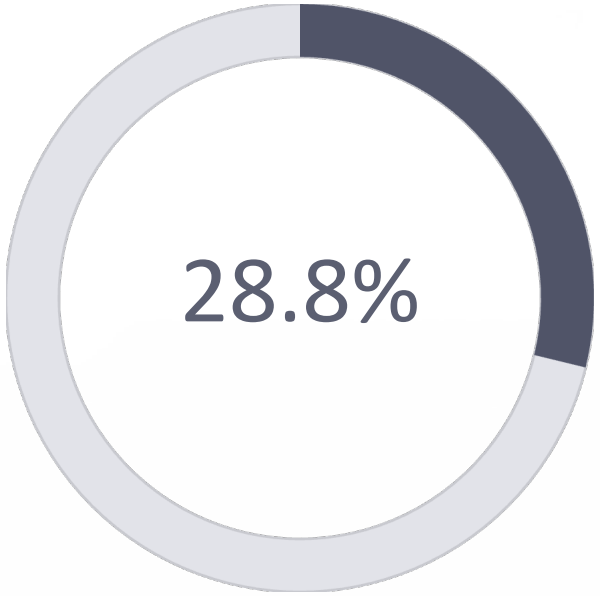


Larval Breeding Habitat Positivity



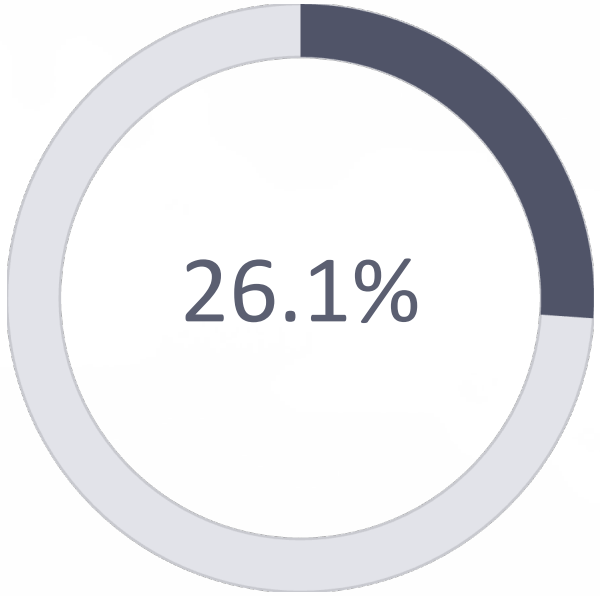
Overall Positivity

Positive for any mosquito immatures



Anopheles spp. Only

Positive for *Anopheles* species alone



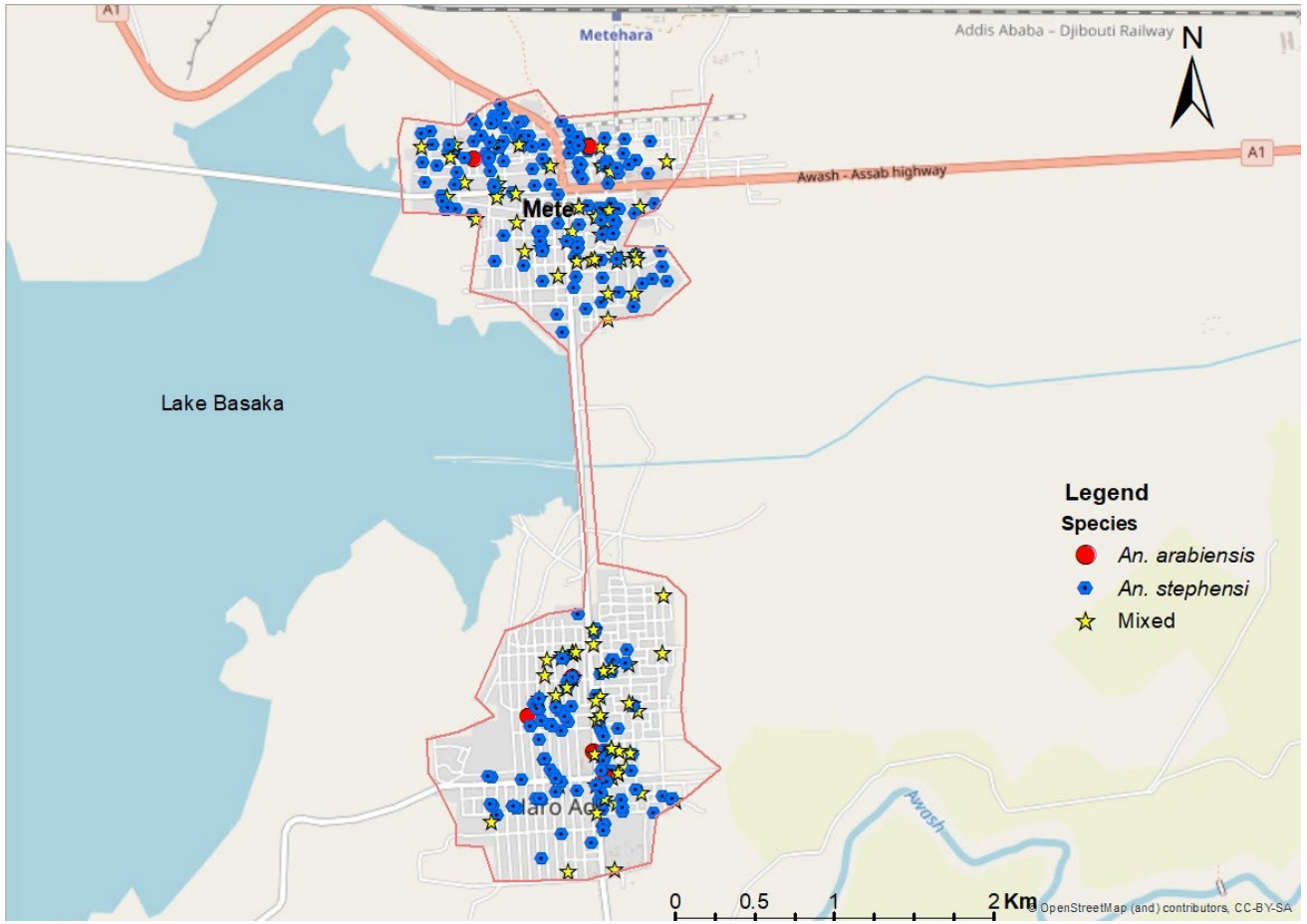
Both Species

Positive for both *Anopheles* and culicines culicines

Over half of the surveyed habitats were positive for mosquito immatures, with a significant proportion showing co-occurrence co-occurrence of *Anopheles* and culicines.

Habitats with Larval Positivity: Characteristic and Location

- Discarded vehicle tyres: 93.0% positivity.
- Religious/institute compounds: 71.2% positivity.
- Near animal shelters: 65.3% positivity.
- Abandoned containers: 78.6% positivity.



Distribution of *Anopheles* immature positive larval habitats in Metehara town, central Ethiopia, November 2023 to October 2024.

Co-occurrence of *An. stephensi* with *An. arabiensis*

An. stephensi Only

70.4% of positive *Anopheles* samples.

samples.

Co-habitation

28.1% with *An. arabiensis*.

An. arabiensis Only

1.5% of positive *Anopheles* samples.

While *An. stephensi* was the most common species found alone, co-habitation with *An. arabiensis* was also significant, particularly in **abandoned** particularly in **abandoned construction pits** and **drainage channels**.

Factors Influencing *Anopheles* Habitat Positivity

Habitat Type

Anthropogenic habitat type, land use, and water storage purpose

Environmental Factors

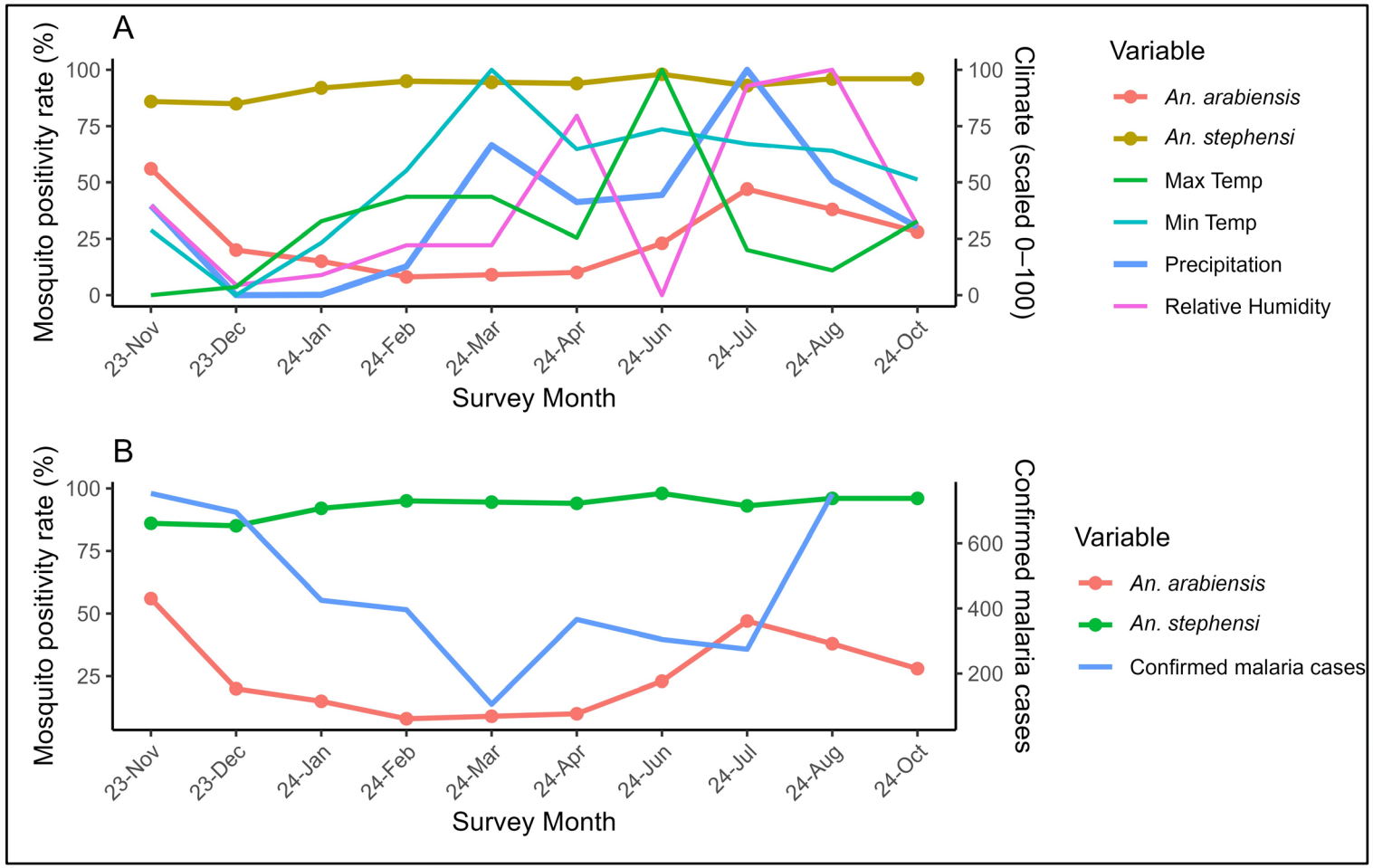
Presence of green algae, aquatic vegetation, and water temperature influenced positivity

Container Cover

Covered containers were less likely to harbor *Anopheles* immatures.

Habitat fabric, water storage purpose, container cover and aquatic vegetation are key determinants

Seasonality of Larval Positivity and Association with Malaria Cases



Anopheles arabiensis

- Significant seasonal variation, peaking with precipitation and relative humidity
- The trend in confirmed monthly malaria cases also varied in relation to the habitat positivity of *An. arabiensis*

Anopheles stephensi

- Less seasonal, detected across all months with no significant variation

Trends of larval habitat positivity, climatic variables, and confirmed malaria cases in Metehara town, central Ethiopia.

Adult *Anopheles* Species Composition, Blood Meals and Sporozoite Rates

Dominant Species

- *An. arabiensis* (63.7%), followed by *An. pharoensis* (26.4%) and *An. stephensi* (8.3%).

Blood-meal Sources

- *An. arabiensis* fed on cows (23.4%) and humans humans (21.8%).
- *An. pharoensis* (44.6%) and *An. stephensi* (58.5%) preferred cows.

Sporozoite Rates

- *An. pharoensis* had a higher rate (4.2%) (4.2%) than *An. arabiensis* (0.4%).
- No *Plasmodium* detected in *An. stephensi*. *stephensi*.

Preliminary Findings of Case-Control Study

An. stephensi detected more frequently around case house

Presence and density of malaria vectors in and around case and control households in Metehara town, Ethiopia.

Characteristics	Categories	case (N=487)	control(N=915)	Overall (N=1402)
Presence of *An. stephensi* (adult)	No	455 (93.4%)	877 (95.8%)	1332 (95.0%)
	Yes	**32 (6.6%)**	**38 (4.2%)**	**70 (5.0%)**
Presence of non-*stephensi* (adult)	No	205 (42.1%)	546 (59.7%)	751 (53.6%)
	Yes	**282 (57.9%)**	**369 (40.3%)**	**651 (46.4%)**
Presence of *An. stephensi* (larvae)	No	425 (87.3%)	857 (93.7%)	1282 (91.4%)
	Yes	**62 (12.7%)**	**58 (6.3%)**	**120 (8.6%)**
Presence of non-*stephensi* (larvae)	No	477 (97.9%)	894 (97.7%)	1371 (97.8%)
	Yes	**10 (2.1%)**	**21 (2.3%)**	**31 (2.2%)**
Density of non-*stephensi* (adult)	Mean (SD)	8.03 (24.3)	3.91 (14.1)	5.34 (18.4)
Density of *An. stephensi* (adult)	Mean (SD)	0.08 (0.34)	0.054 (0.29)	0.06 (0.31)

Adult *An. stephensi* were detected in **6.6%** of case households vs **4.2%** of control households

An. stephensi larvae were detected in **12.7%** of case households vs **6.3%** of control households.

Both adult and immature *An. stephensi* presence was independently associated with case

Result of conditional logistic regression to estimate odds ratios for the association between An. stephensi and native malaria vectors presence and malaria case status

Factors	Categories	OR (95%, CI)	p-value
Presence of *An. stephensi* (adult)		**2.5 (1.5, 4.4)**	**<0.001**
Presence of non-*stephensi* (adult)		**2.7 (2.0, 3.6)**	**<0.001**
Presence of *An. stephensi* (larvae)		**2.3 (1.5, 3.5)**	**<0.001**
Presence of non-*stephensi* (larvae)		**1.1 (0.5, 2.4)**	**0.909**
Wealth index	Poorer	0.6 (0.4, 0.9)	0.018
	Middle	0.9 (0.6, 1.3)	0.615
	Richer	1.1 (0.7, 1.6)	0.717
	Richest	1.5 (1.0, 2.3)	0.035
Presence of domestic animal		1.2 (0.9, 1.5)	0.19

Implication

- Both native and *An. stephensi* malaria vectors were significantly associated with malaria cases
- *An. stephensi* adult and larval surveys capture complementary information

Conclusions & Recommendations

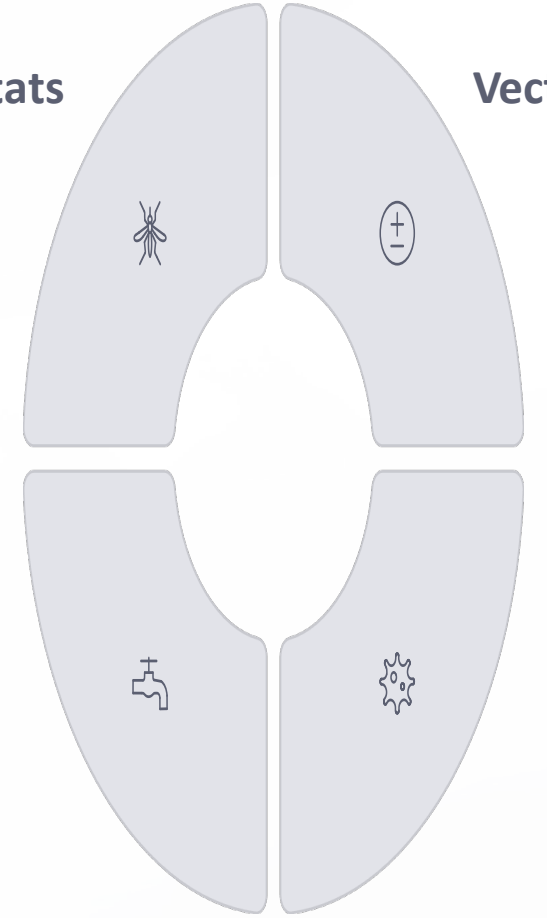
Bioecological study

Primary Habitats

Anthropogenic water storage containers

Vector Co-occurrence

An. stephensi and native native vectors co-occurred, with ***An. stephensi* showing less less seasonality**



Multisectoral Action

Enhance access to safe water and improve water water storage practices

Infection Rates

An. pharoensis exhibited exhibited higher *Plasmodium* infection rates despite *An. arabiensis* dominance

Case-Control study

- *An. stephensi* presence is strongly associated with malaria case
  - Approximately 2–3 times higher odds
- Robust association after adjusting for other anopheline species, socioeconomic status, animal presence, housing features, and exclusion of recent travelers
- Both adult and larval indicators show independent associations, **strengthening the evidence that *An. stephensi* exposure is linked to malaria risk**

Integrated intervention through active community participation is needed

Integrating the existing vector control intervention with :

Improved Water Management

Remove non-active containers and make water storage mosquito-proof with proper coverings.

Reliable Piped Water

Provision of safe, piped water can reduce mosquito-borne diseases by limiting open storage.

Larviciding

Complement LLINs in urban areas, especially where insecticide resistance resistance is present.

These observations underscore the need for improved environmental and water management practices.

Acknowledgements

Study HCF

&

Population

wellcome trust

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MINISTRY OF HEALTH · ETHIOPIA

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To End Malaria

4 March 2026

Comprehensive assessment of the biology and public health importance of Anopheles stephensi in Africa (AnoSTEP -- AFRIKA Project)

Samson Kiware, PhD & Eric Ochomo, PhD

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Comprehensive assessment of the biology and public health importance of *Anopheles stephensi* in Africa (AnoSTEP -- AFRIKA Project)

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21st RBM VCWG Annual Workshop

March, 2025

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KENYA MEDICAL RESEARCH INSTITUTE
KEMRI

AnoSTEP

Timeline and Partners

Project Timeline: January 2025 – January 2029

Consortium Members:

- Ifakara Health Institute, Ifakara, Tanzania
  - Samson Kiware Ph.D., PI, Technical Support: Yeromin Mlacha, Ph.D., Dickson Wilson, Ph.D and Peter Sangoro, Ph.D, Project Management: Janice Maige
- Kenya Medical Research Institute/Research World, Kenya: Eric Ochomo, Ph.D. Co-PI
- Armauer Hansen Research Institute, Addis Ababa, Ethiopia: Fitsum Girma, Ph.D. Co-PI
- Association Mutualis, Djibouti City, Djibouti: Bouh Abdi Khaireh, Ph.D. PI, Djibouti site
- Nigeria Institute of Medical Research, Abuja, Nigeria: Dr. Adeogun Adedapo Olufemi. PI, Nigeria site
- Lancaster University, Lancaster, UK: Luigi Sedda, Ph.D. Bayesian data analysis and modelling
- Wellcome Sanger Institute, Hinxton, UK: Mara Lawniczak, Ph.D. Genomics
- University of Glasgow, Scotland, UK: Heather Ferguson, Ph.D., Fredros Okumu, Ph.D. Technical Support
- National Malaria Programs, Kenya, Nigeria, Djibouti, Ethiopia
- Advisory Board

Advisory Board



Dr El Hadji Amadou NIANG
Senior medical entomologist and Deputy Director at the Laboratoire d'Ecologie Vectorielle et Parasitaire (LEVP)



Dr Seth Irish
Technical Officer at the WHO (Malaria and Neglected Tropical Disease Department).



Dr Sarah Zody

Disease ecologist and Global Health Leader, CDC



Prof Nick Golding

UWA Chair in Infectious Disease Modelling at the University of Western Australia and Head of Infectious Disease Ecology and Modelling at The Kids Research Institute Australia.



Dr Tamar Carter
Associate Professor of Biology
Baylor University



Prof Gerry Killen
AXA Research Chair in Applied Pathogen Ecology, University College Cork, Republic of Ireland



Prof Delenasaw Yewhalaw

Professor of Medical Entomology, School of Medical Laboratory Sciences, College of Health Sciences, and Founding Director of TIDRC at Jimma University, Ethiopia

Knowledge Gaps

- Current distribution, dispersal patterns, and population dynamics of *An. stephensi* in Africa are poorly understood
- Limited data exist on its bionomics and behavior in African contexts
- Relative contribution to malaria transmission compared to native vectors remains unclear

AnoSTEP AFRIKA Project aims to provide a multi-country, multi-disciplinary investigation of *An. stephensi* across diverse ecological settings in Africa

Specific Objectives

1. Characterize the biting and resting behavior of *An. stephensi* mosquitoes compared to sympatric Anopheles populations.

2. Describe the geographical distribution of *An. stephensi* across invaded or likely to be invaded areas.

3. Determine the population structure, relatedness, parasite infection status, and spread of *An. stephensi* populations across diverse study sites using genomic approaches.

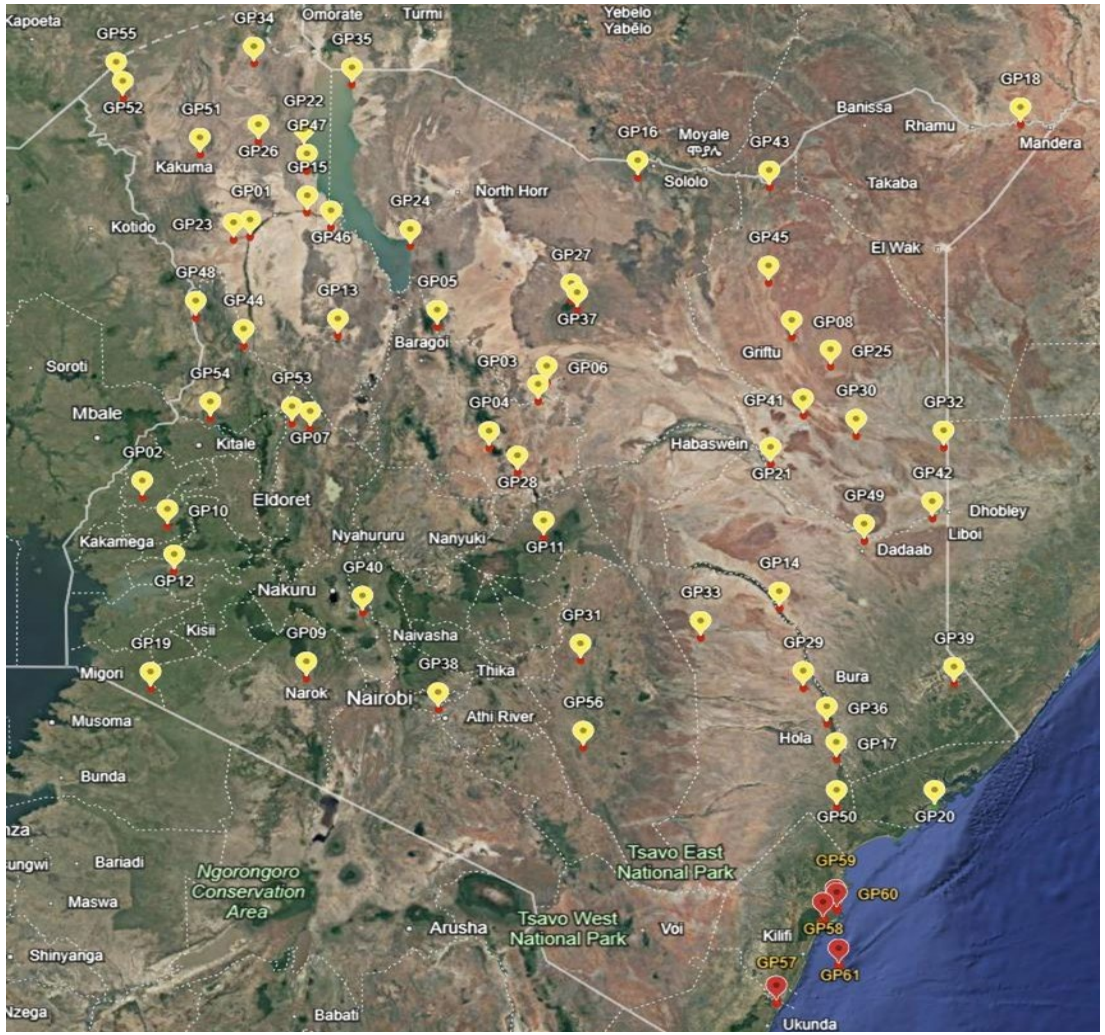
4. Identify and assess climatic, ecological, and sociodemographic factors associated with local *An. stephensi* establishment.

5. Characterize *An. stephensi* larval habitats, examine their co-occurrence with larvae of other vectors, and estimate the fitness of emergent mosquitoes in field and semi-field settings.

Progress– Jan 2025 to Present

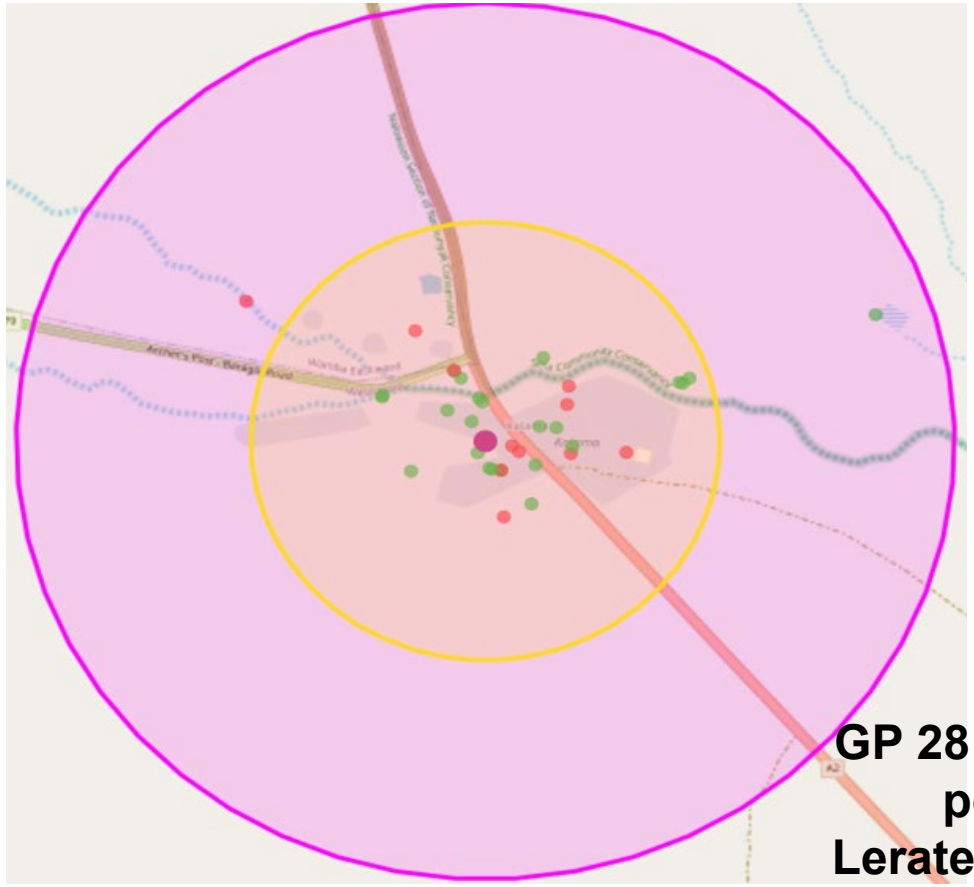
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Kenya



WP1

- Laval collection done in 60 sites
- All collections are taking place within a 2km radius.
- Larvae are collected twice every week.

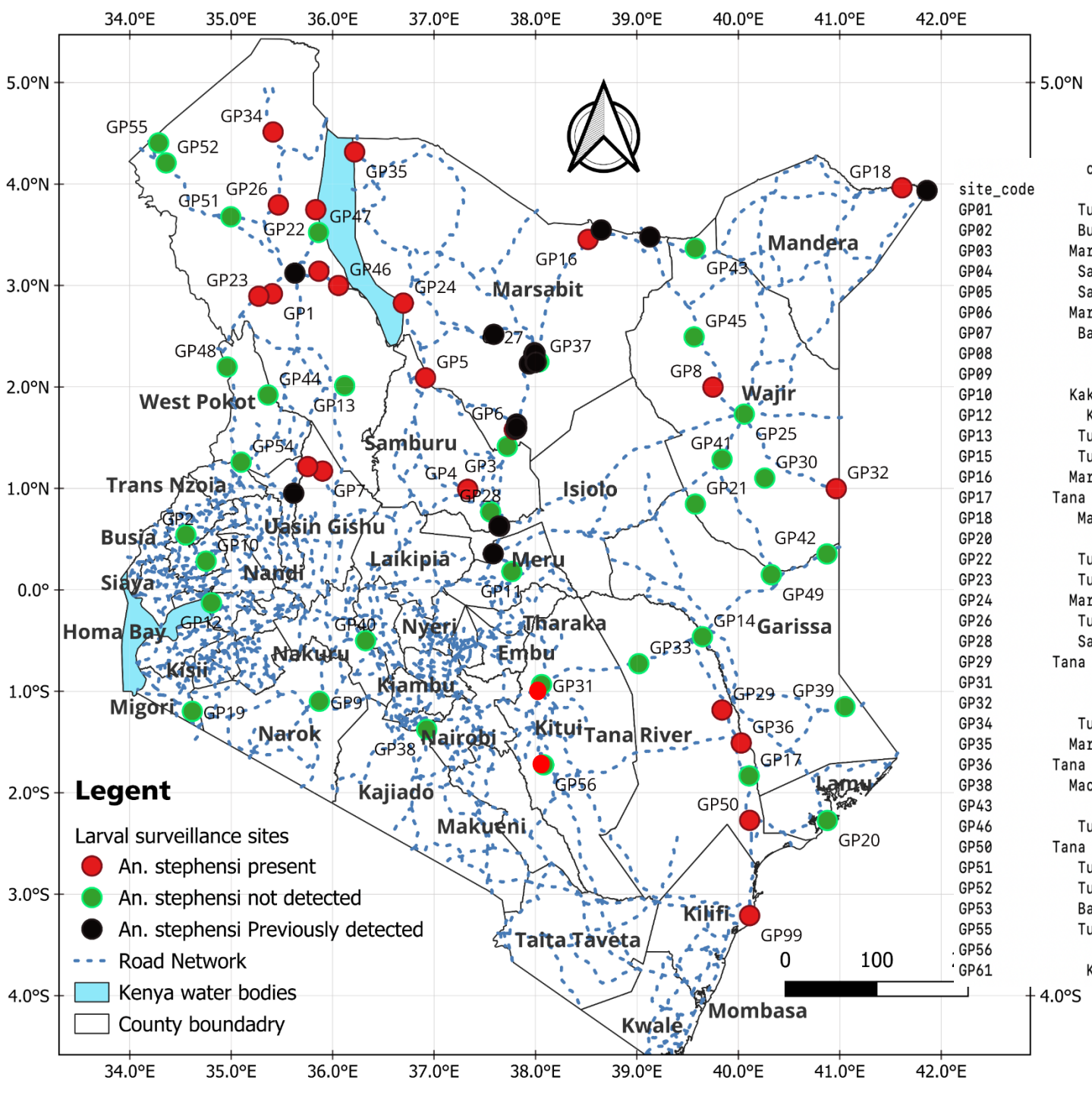


GP 28 sampling points Lerate Samburu









WP3: PCR results

site_code	county	lat	long	total_samples	An.arabiensis	An.coluzzii	An.gambiae s.s	An.stephensi
GP01	Turkana	35.405711	2.918908	203	128	31	11	33
GP02	Bungoma	34.553038	0.542103	6	6	0	0	0
GP03	Marsabit	37.721868	1.414404	7	0	0	0	7
GP04	Samburu	37.331491	0.990786	22	20	0	0	2
GP05	Samburu	36.915177	2.089835	106	101	0	2	3
GP06	Marsabit	37.791053	1.579676	12	3	0	0	9
GP07	Baringo	35.900641	1.171040	28	13	0	0	15
GP08	Wajir	39.749459	1.998155	180	3	0	0	177
GP09	Narok	35.869570	-1.098332	5	5	0	0	0
GP10	Kakamega	34.752475	0.283177	35	35	0	0	0
GP12	Kisumu	34.805090	-0.127640	720	720	0	0	0
GP13	Turkana	36.118814	2.011978	63	46	12	1	4
GP15	Turkana	35.863987	3.141020	250	195	43	1	11
GP16	Marsabit	38.517679	3.454072	25	4	0	0	21
GP17	Tana River	40.106123	-1.833359	86	79	1	2	4
GP18	Mandera	41.612733	3.963072	68	0	0	0	68
GP20	Lamu	40.900389	-2.273538	1	1	0	0	0
GP22	Turkana	35.833459	3.747219	93	64	1	0	28
GP23	Turkana	35.271882	2.894451	207	190	3	2	12
GP24	Marsabit	36.696522	2.826494	15	11	0	0	4
GP26	Turkana	35.465027	3.794058	173	155	1	1	16
GP28	Samburu	37.557386	0.768639	40	10	0	0	30
GP29	Tana River	39.838373	-1.183901	13	10	0	0	3
GP31	Kitui	38.059495	-0.933132	49	48	0	0	1
GP32	Wajir	40.964471	0.997827	32	2	0	0	30
GP34	Turkana	35.423086	4.519724	259	254	3	0	2
GP35	Marsabit	36.216445	4.316648	3	2	0	0	1
GP36	Tana River	40.028201	-1.508857	87	20	0	0	67
GP38	Machakos	36.926990	-1.375145	1	1	0	0	0
GP43	Wajir	39.574637	3.366466	3	0	0	0	3
GP46	Turkana	36.057970	3.000639	188	85	60	1	42
GP50	Tana River	40.111176	-2.271325	171	142	0	0	29
GP51	Turkana	34.995855	3.677492	19	13	0	0	6
GP52	Turkana	34.357986	4.208460	43	28	3	0	12
GP53	Baringo	35.754209	1.215003	40	10	0	0	30
GP55	Turkana	34.284823	4.405344	46	46	0	0	0
GP56	Kitui	38.081251	-1.724713	21	0	0	11	10
GP61	Kilifi	39.850000	-3.680000	8	2	0	0	6



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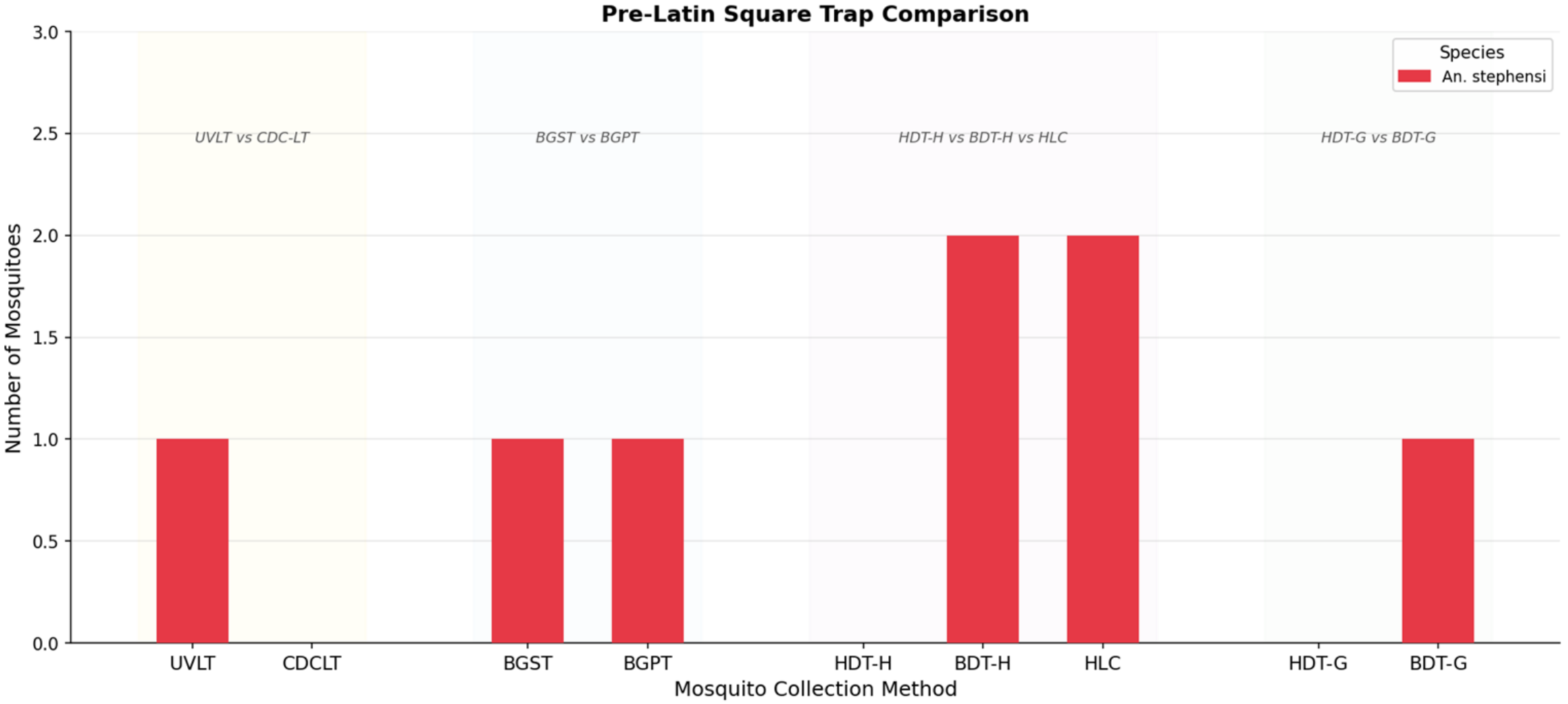
WP2: Preliminary Evaluation of Mosquito Trapping Methods

Trapping method for host-seeking mosquitoes

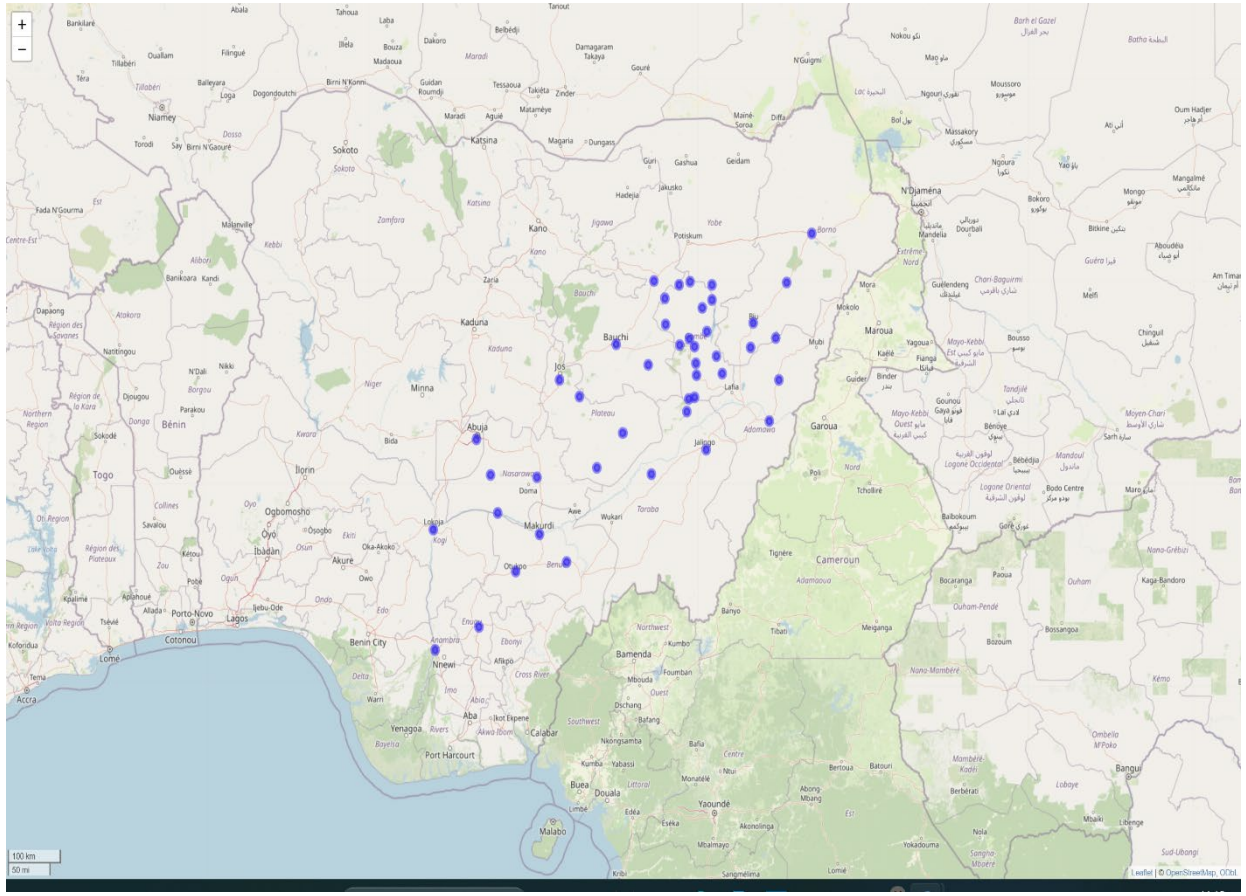
1. HLC Vs DBT-Human Vs HDT-Human
2. BDT-Cow Vs HDT-Cow
3. UV-LT Vs CDC-LT
4. BGPT (BG-Pro Trap) Vs BGT (BG-Sentinel Trap)



Results: Pre-Latin Square, Trap comparison, 5 rotations



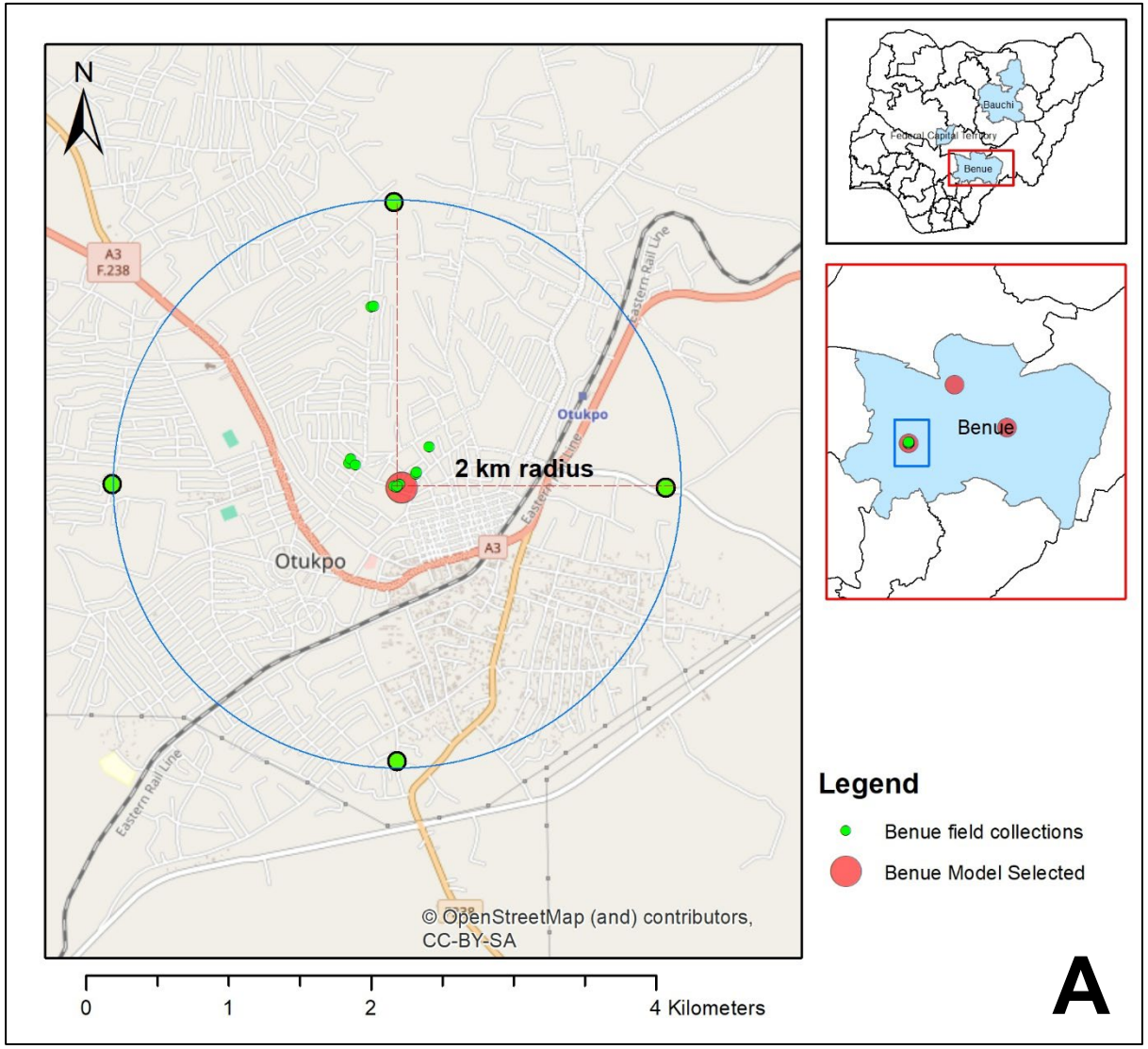
Nigeria – Collection sites



Selected locations in Nigeria

S/N	States	Number of Locations
1	Abuja	1
2	Adamawa	3
3	Anambra	1
4	Bauchi	3
5	Benue	3
6	Borno	4
7	Enugu	1
8	Gombe	16
9	Kogi	1
10	Nasarawa	3
11	Plateau	4
12	Taraba	3
13	Yobe	1
	Total	44

To ensure we get to the exact location as much as possible, a locus map is used



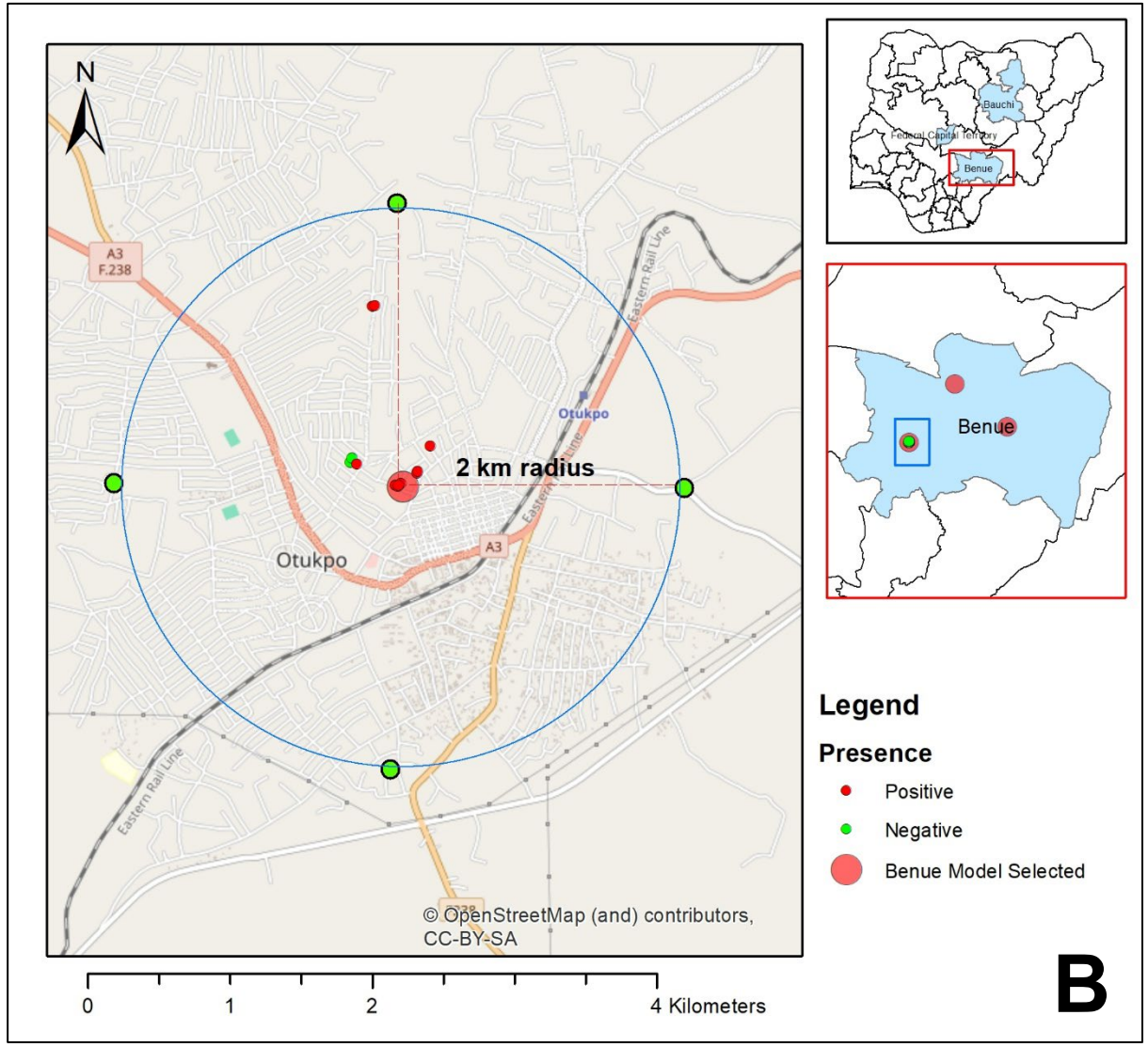
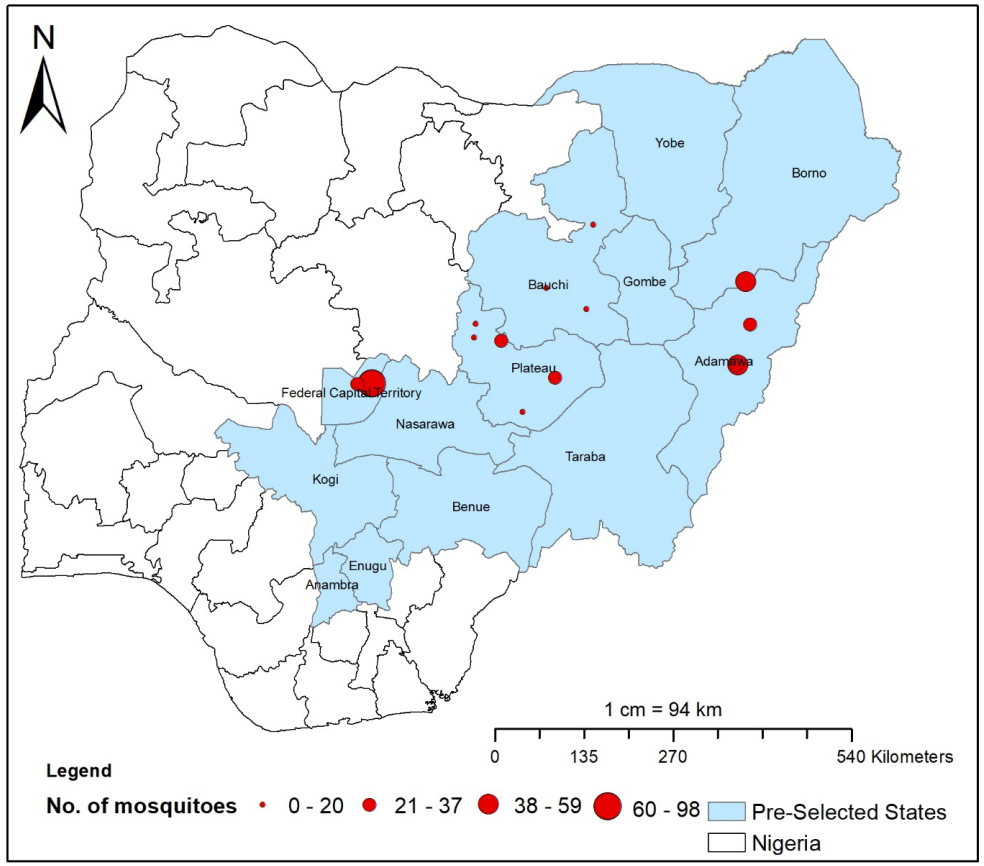
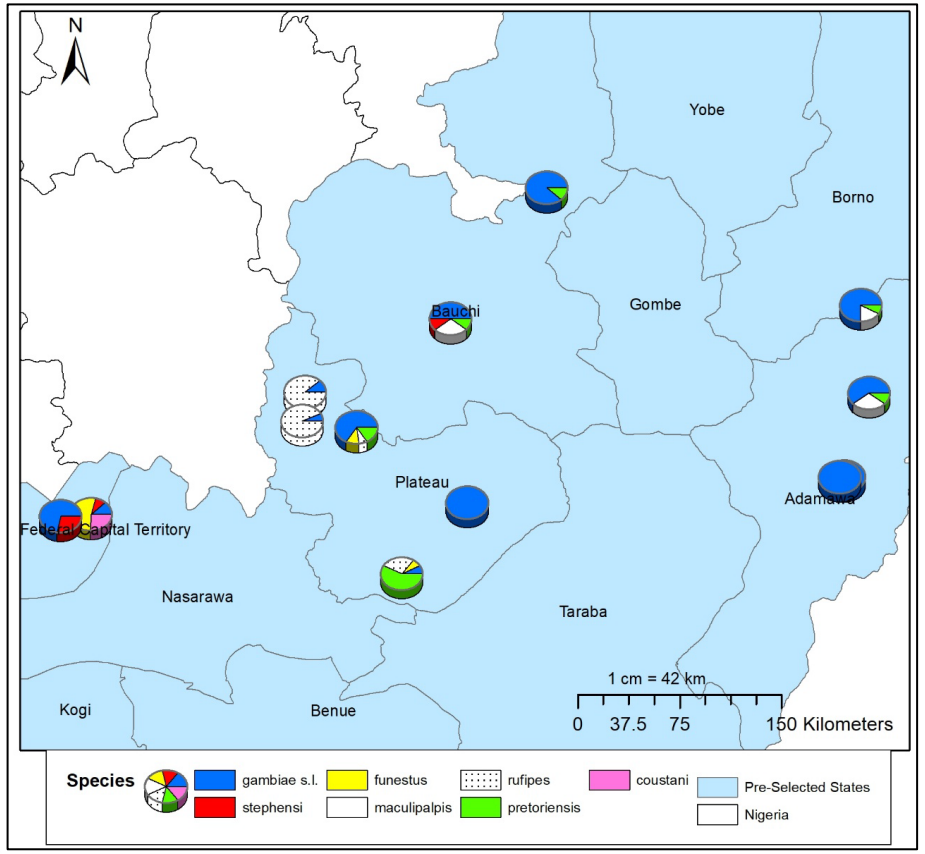


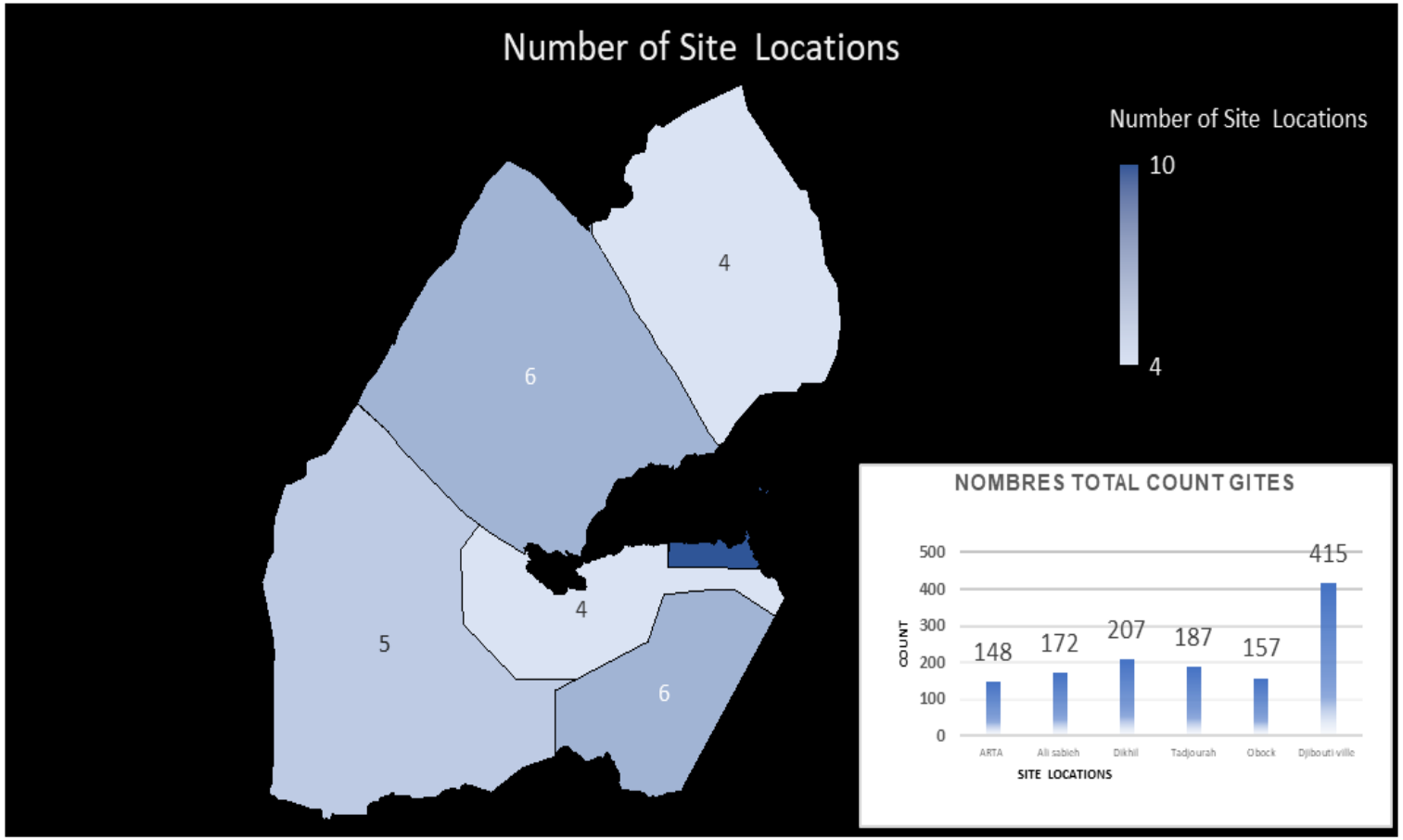
Figure: (a) Locations sampled within 2 km radius to the model selected locations (b) Site positivity Status in Abuja





1. 437 adult mosquitoes identified from 4 States (14 of 51 Sites)
2. 63.2% (276 of 437) were *Anopheles,* while the rest were *Culicines*
3. Of the *Anopheles*, 2.5% (7 of 276) were suspected to be *An. stephensi*
4. The samples have been sent to the central Lab for further confirmation

Djibouti Survey Locations



Selected locations in Djibouti

Number of points visited

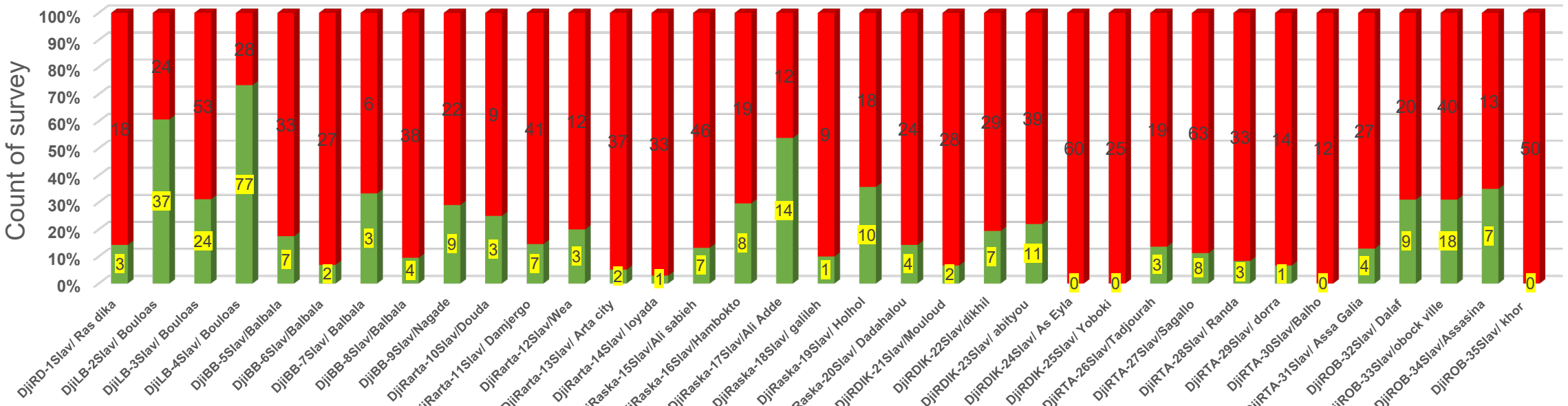
S/N	Region	Number of Site Locations
1	ARTA	4
2	Ali sabieh	6
3	Dikhil	5
4	Tadjourah	6
5	Obock	4
6	Djibouti-ville	10
	Total	35

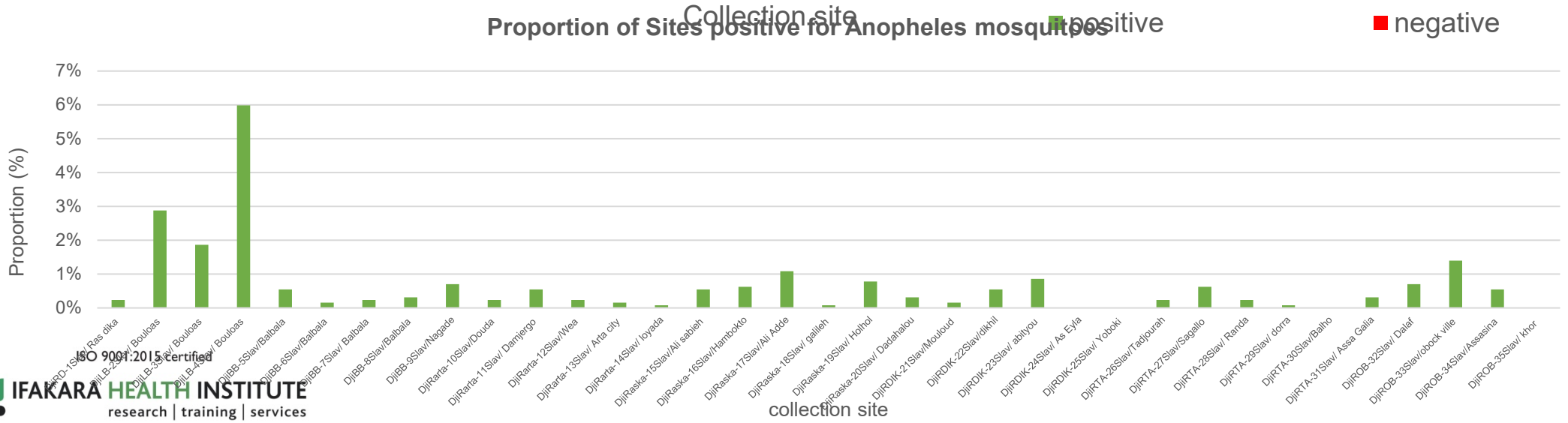
As at the 20th of January , a total of 974 points have been visited across the 35 locations predicted ***(First Rounds)***

Extensive sampling conducted around each sampling point at about 2km

Data

Survey count round one *and* two by collection laval site ***(Total : 1286 survey)***

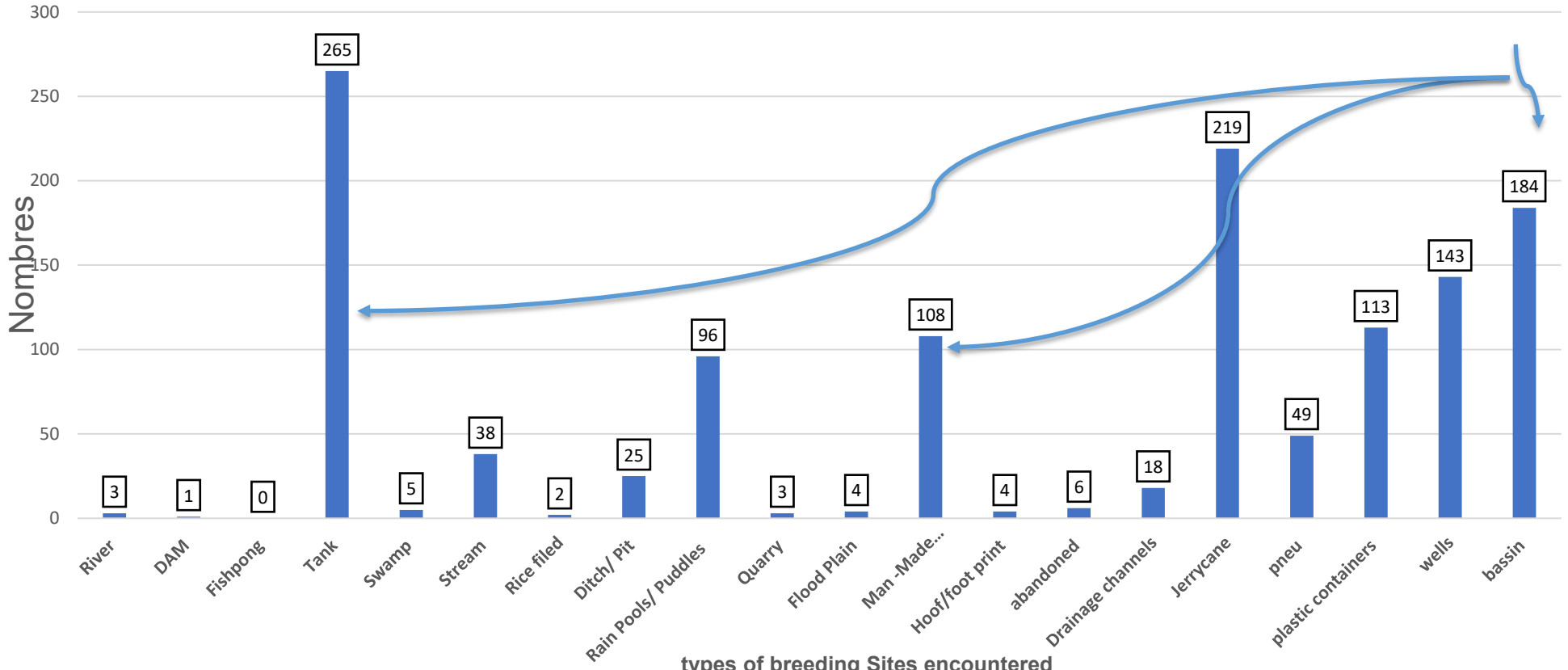




WP1: Larval positivity by site and region

T2-PSL-v19.0

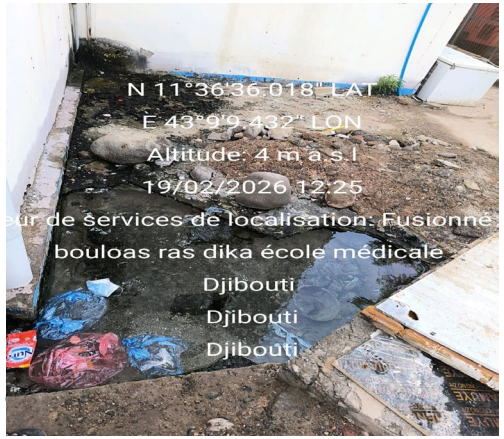
Different larval habitat sites encountered N (1286)



types of breeding Sites encountered

Positivity rate per larval habitat collection

Abundance of housing in Djibouti City.
Site 4, widespread housing, and also Highest housing positivity (%) = (n = 141/299; 47.15%)



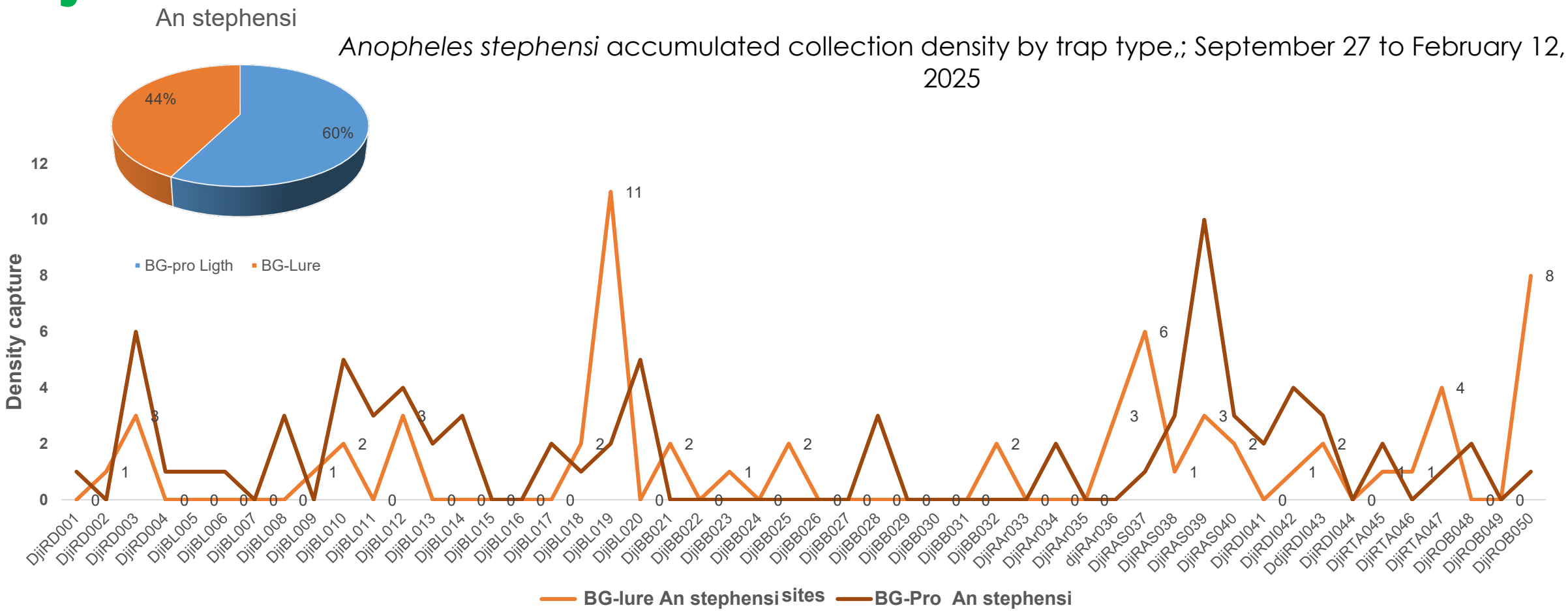






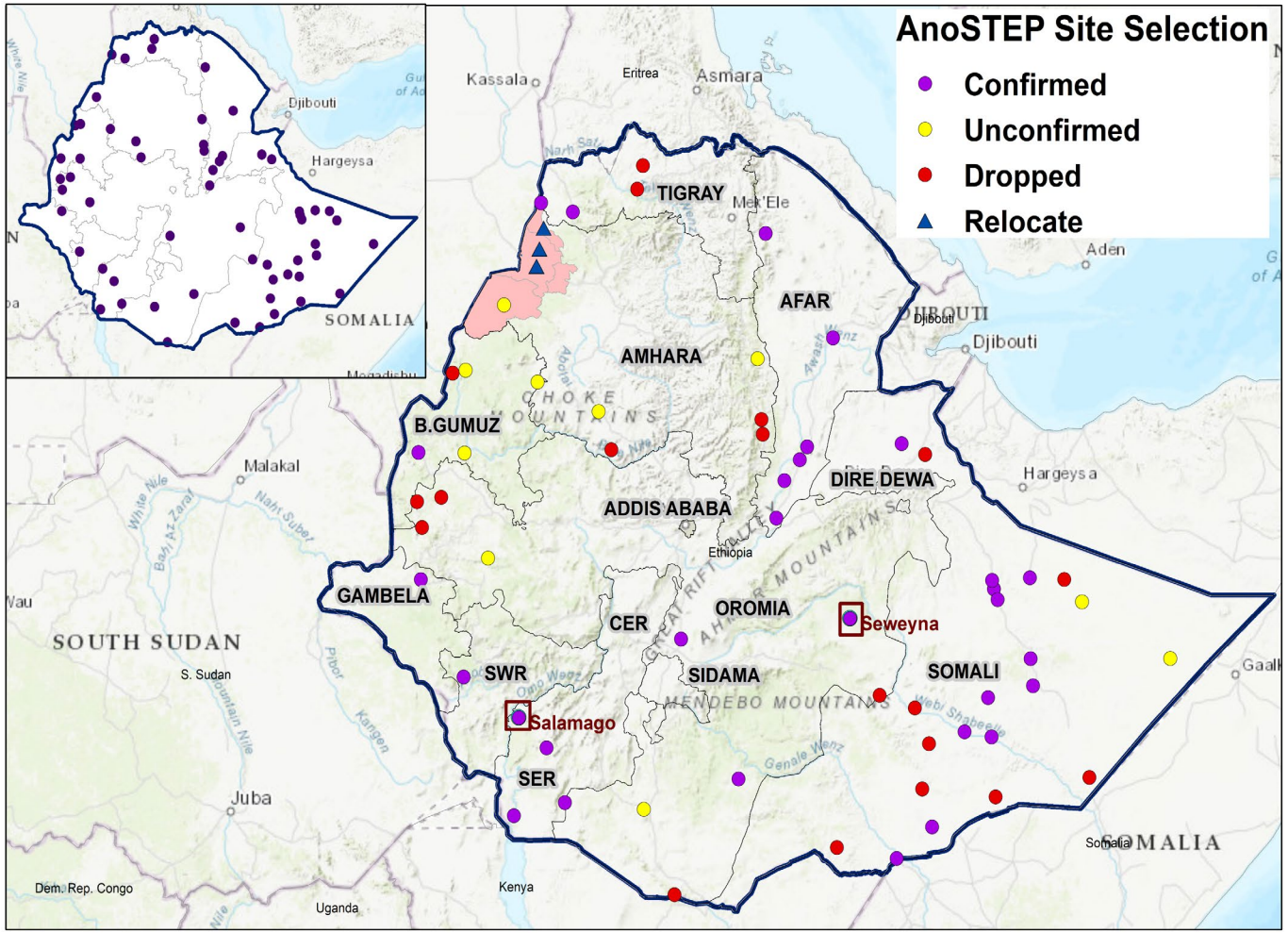


Djibouti WP2 – Adult collections



1. **141** adult mosquitoes were identified from all sites (50 of 50 Sites) in the 18 weeks.
2. **0.2%** (141 of 58178) were Anopheles stephensi while the rest are Culicines(**2.3%** (1367of 58178) Aedes aegypti et culex**(97,4 %)**

Ethiopia – Site selection



Bayesian Model Predicted sites:

- **59 sites, in 9 regional administrations**

However, reselected the sites to

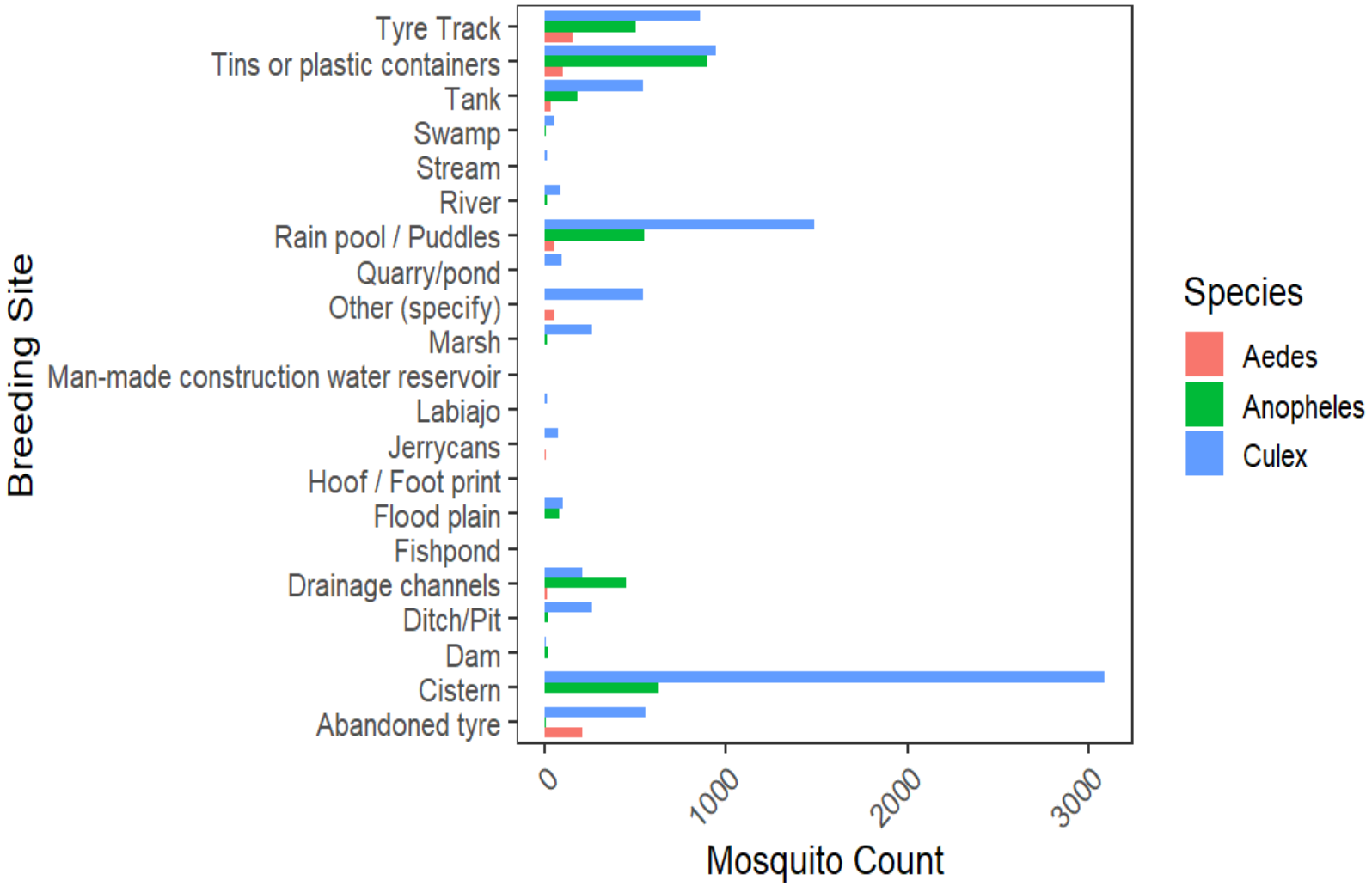
- 34-41 sites (34 sites)
- Distributed in 6 regions

Key factors for site reselection:

- Security
- Accessibility: hard to reach
- Logistical feasibility
- Budget

Mosquito larva positivity and co-occurrence

- The total number of habitats surveyed: 1135
- Overall positive habitats = 459 (40.4%)
- Total number Anopheles +ves =130 (28%)



Mosquito species positivity and major breeding site

Larval Survey: Artificial Habitats













Expected Outcome and Applications

- Evidence on An. stephensi contribution to urban and rural malaria transmission
- Targeted vector control strategies adapted to An. Stephensi ecology in urban and rural settings
- Monitoring facilitators for spread allows early warning systems for predicting spread to new areas
- Guidance on insecticide rotation & resistance management
- Harmonized data collection on VBDs360 to support informed policy recommendations to WHO & national programs
- Foundation for novel urban malaria vector control tools











Thank you!













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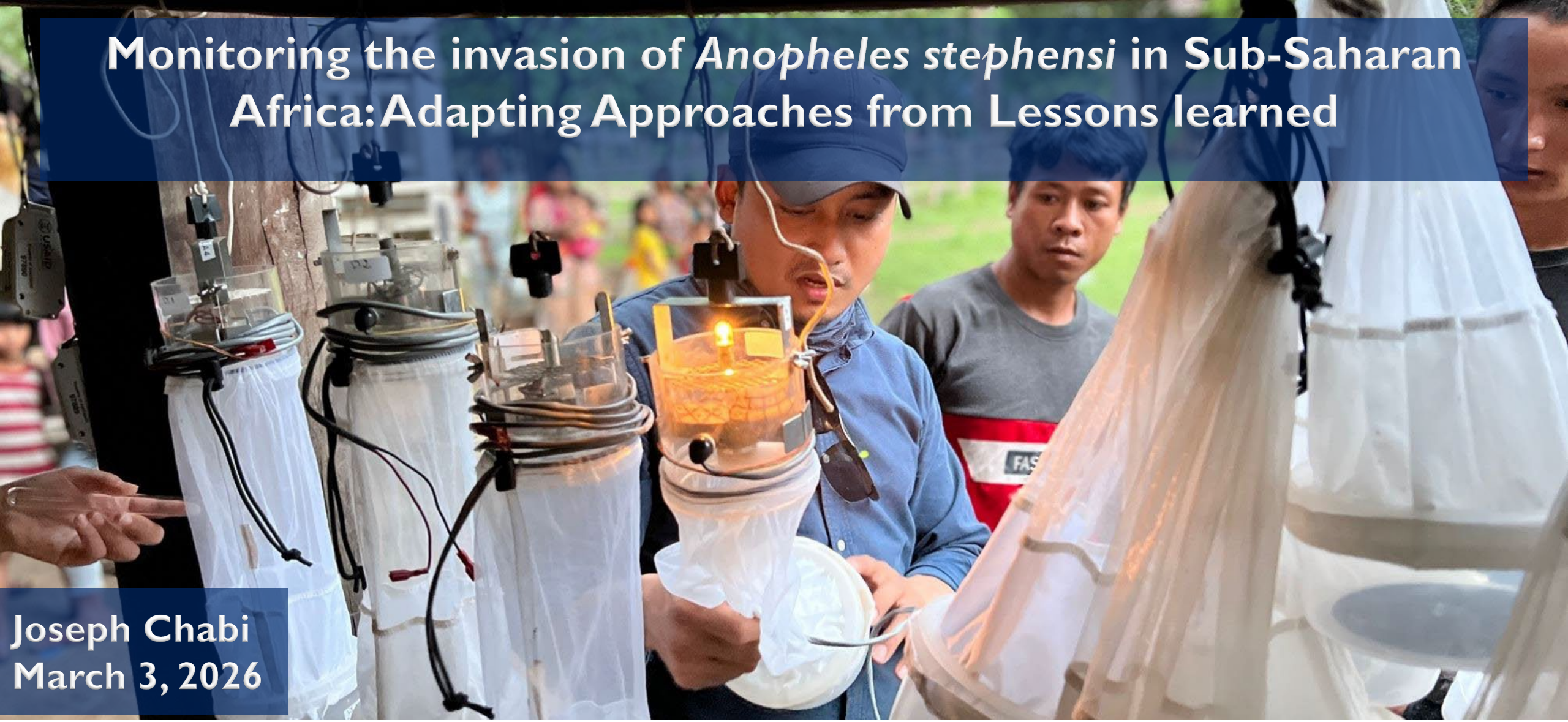
Panel discussion: Re-thinking *An. Stephensi* invasion in Africa: Current status from predicted expectations

4 March 2026

Introduction presentation: Monitoring the invasion of Anopheles stephensi in Sub-Saharan Africa: adapting approaches from lessons learned

Moderated by VCWG Work Stream lead Joseph Chabi

Monitoring the invasion of *Anopheles stephensi* in Sub-Saharan Africa: Adapting Approaches from Lessons learned



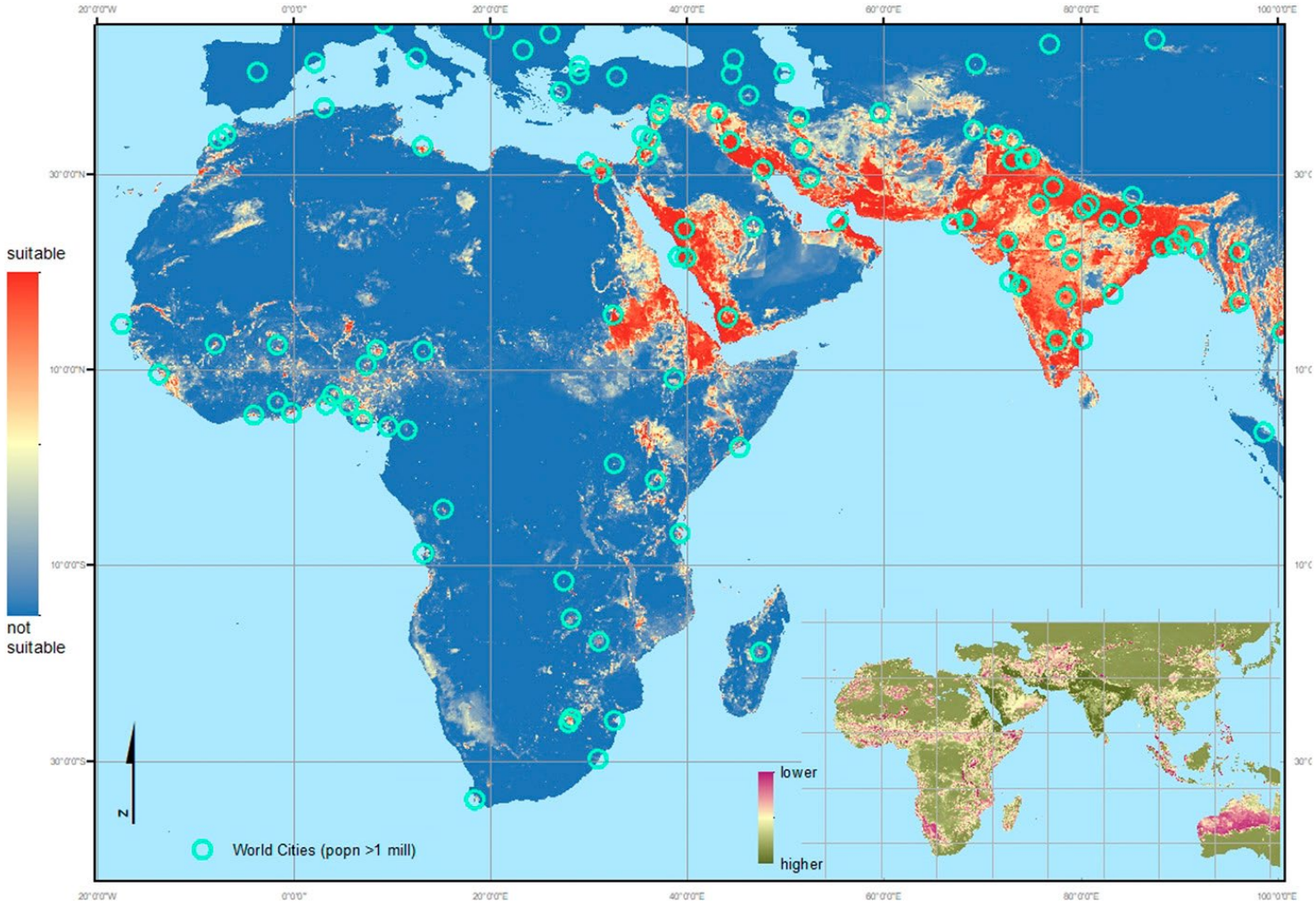
Joseph Chabi
March 3, 2026

United States Government

PMI Evolve
Evolving Vector Control to Fight Malaria

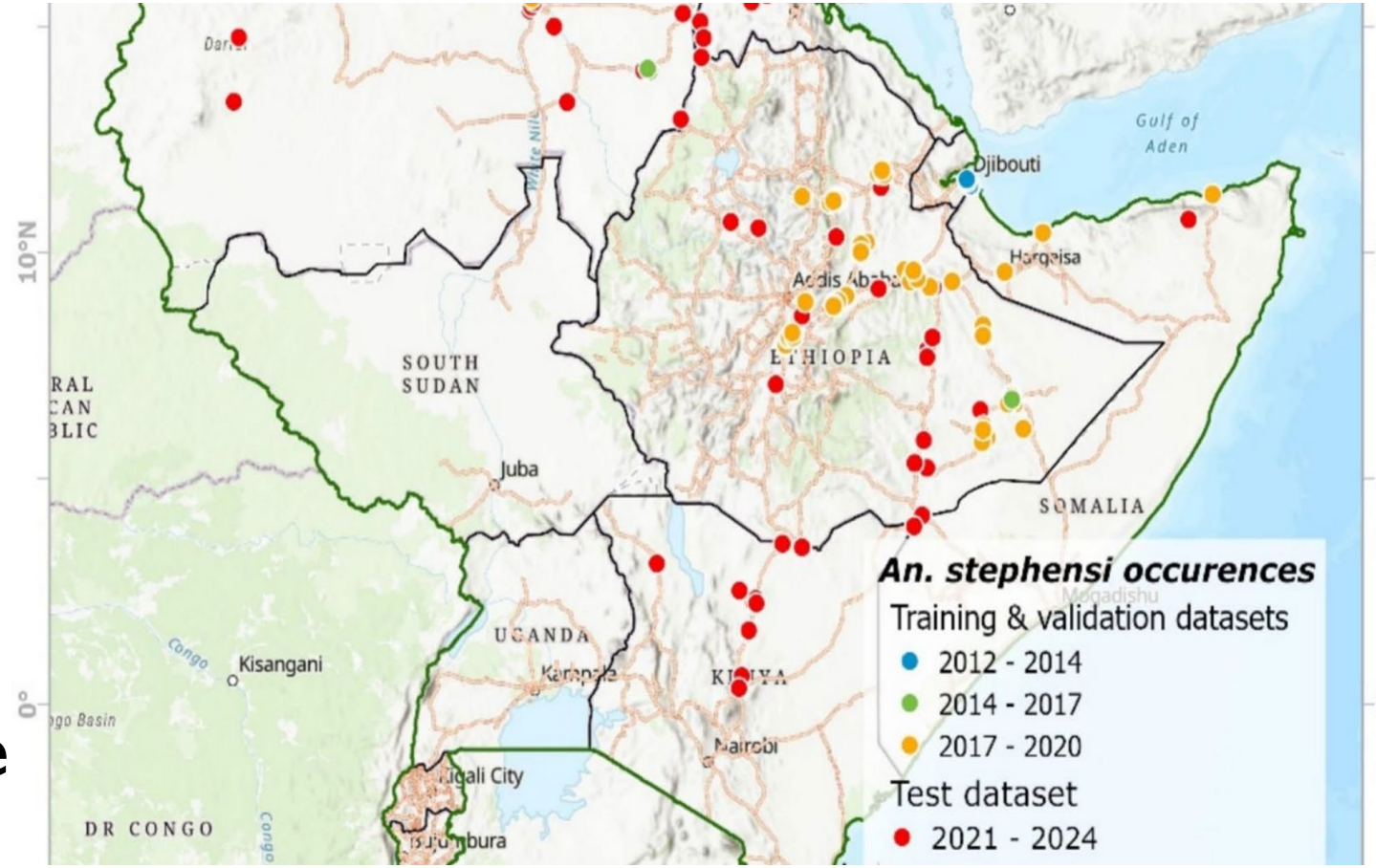
An. stephensi spread predictions

- Sinka et al, predicted a rapid spread map and countries at risk at the early stage of the species invasion
- This highlighted the expected invasion conditions and countries that were most likely to host the species



Progression at the Horn of Africa

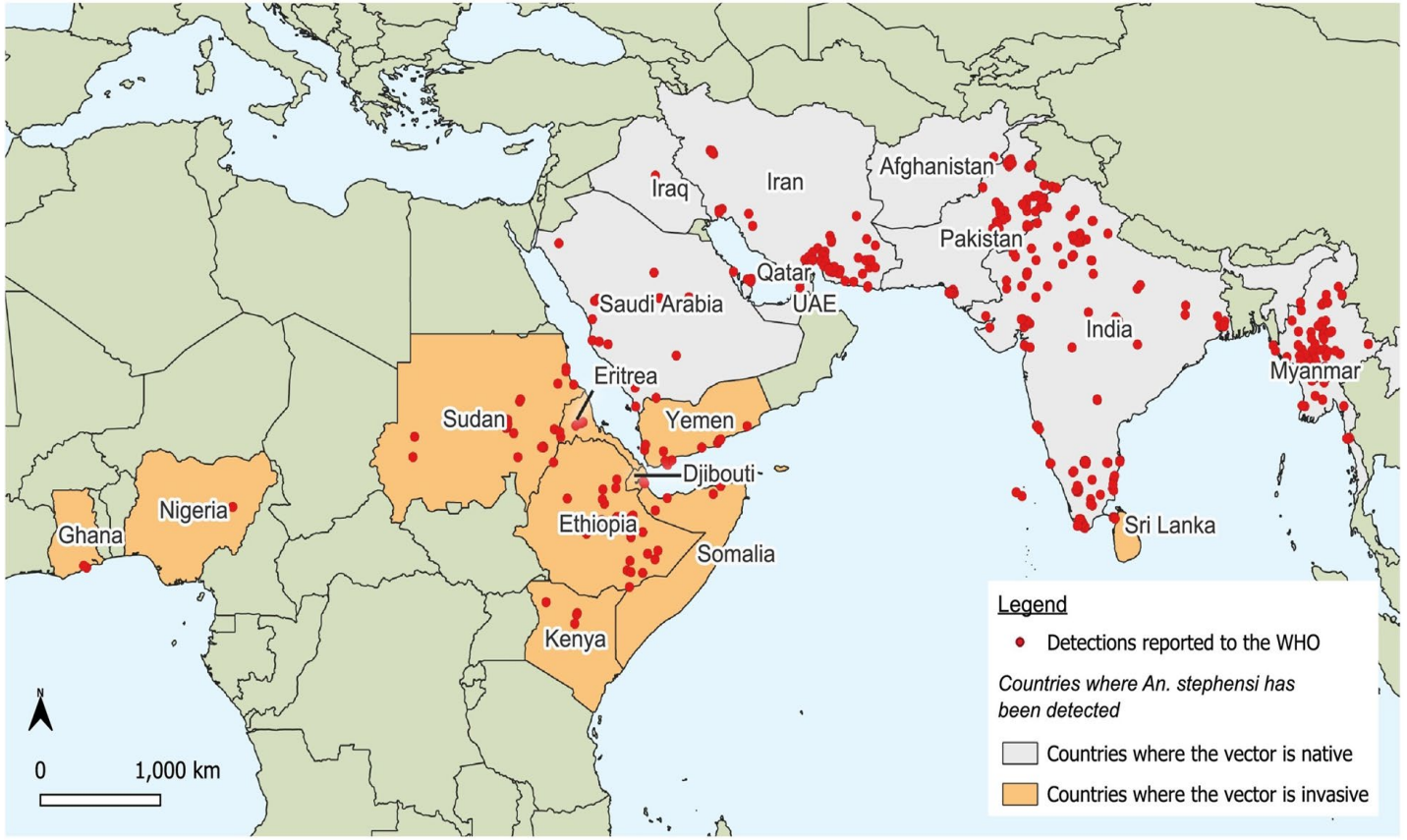
- The species has gradually invaded Ethiopia from Djibouti, and surrounding countries between 2012 and 2025
- This invasion expansion seems to be progressive, implying a very slow movement from countries bordering Ethiopia where the species is well established



Jinyang Li , Ming-Chieh Lee, Ai-Ling Jiang, Guiyun Yan, Kuolin Hsu, 2026

Countries reporting the presence of *An. stephensi*

- If per the above, all countries around Ethiopia except Uganda reported the presence of the species, all other part of the continent are still safe of invasion
- Ghana and Nigeria reported the species once, however no further detection has occurred.
- Though the spread was predicted, the trend of West Africa presence requires further investigation

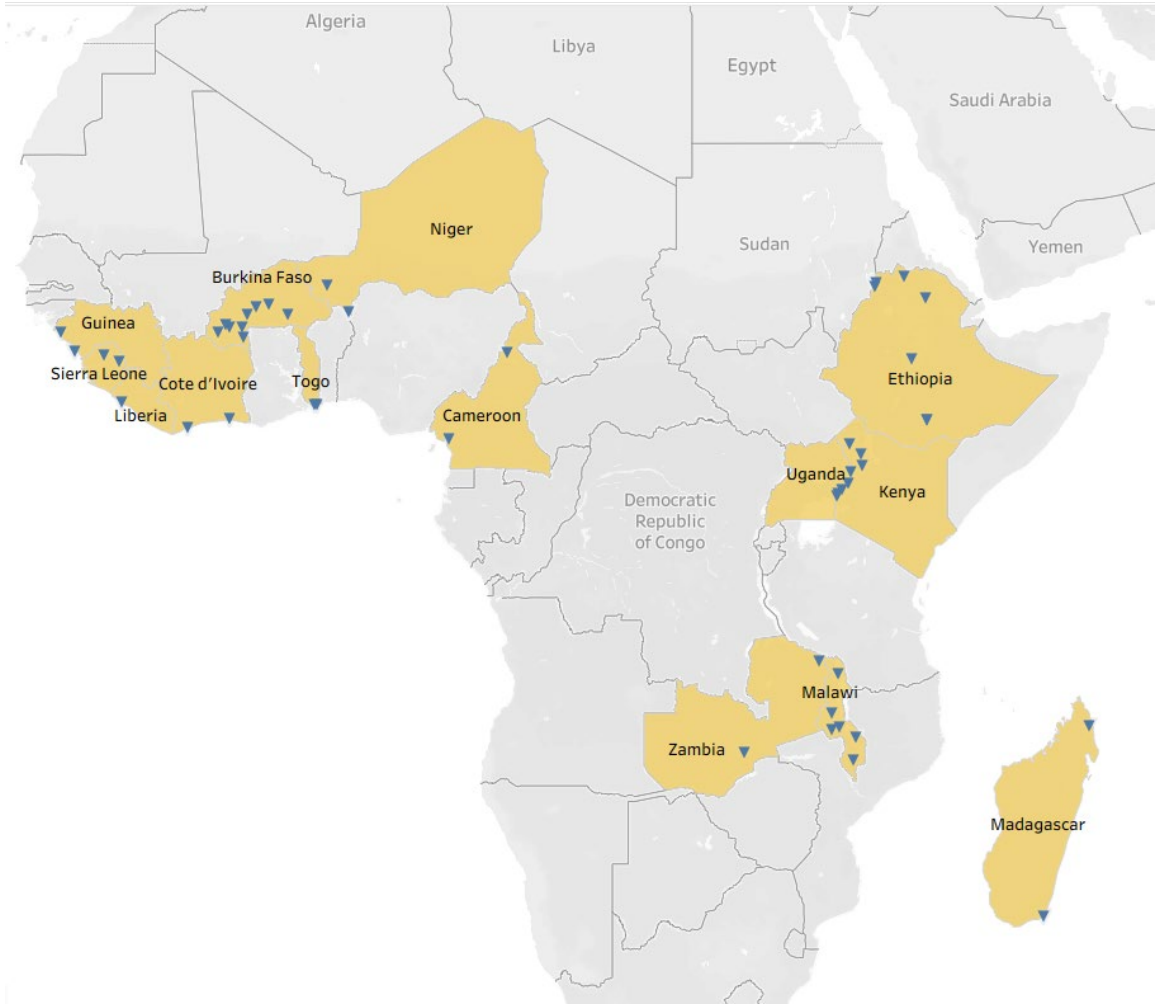


Trends in Parasitology

Roz Taylor, Louisa A. Messenger, Tarekegn A. Abeku, Sian E. Clarke, Rajpal S. Yadav, Jo Lines, 2024

PMI Evolve investigation efforts

- From all documented and predicted invasion, PMI Evolve has initiated the investigation of the species in about 15 countries where we work
- Entomological monitoring activities were conducted in targeted sites using either larval collection or/and adult mosquito collections (CDC light traps/Prokopack)
- Aside Ethiopia and Kenya that reported *An. stephensi* presence, none of the countries have found the species yet
- Furthermore, PMI Evolve will survey 2-3 sites up to 2 times a year in each country in 2026



QUESTION!! BRAINSTORMING!!



- What are we missing in terms of appropriate investigation to find the species?
- Is the conditions of the Horn of the continent the most suitable to host the species?
- Should we expect the species in the other countries at a longer term than now following the trends observed in Ethiopia and surrounded countries?
- How to increase investigation in an era of limited resources
- What actions both country NMPs and scientist should take?

United States Government

PMI Evolve
Evolving Vector Control to Fight Malaria



RBM Partnership
To End Malaria

Panel discussion: Re-thinking *An. Stephensi* invasion in Africa: Current status from predicted expectations

4 March 2026

Moderated by VCWG Work Stream lead Joseph Chabi

Panel:
Raymond Tabue (Cameroon NMCP), Dr Aminu Umar (Nigeria NMEP),
Gudissa Assefa (Ethiopia NMEP), Eric Ochomo (KEMRI)

RBM Partnership
To End Malaria

LIVE Q&A >>>

You can post

Questions >>>

4 March 2026

VCWG Art competition 2026

Competition Theme

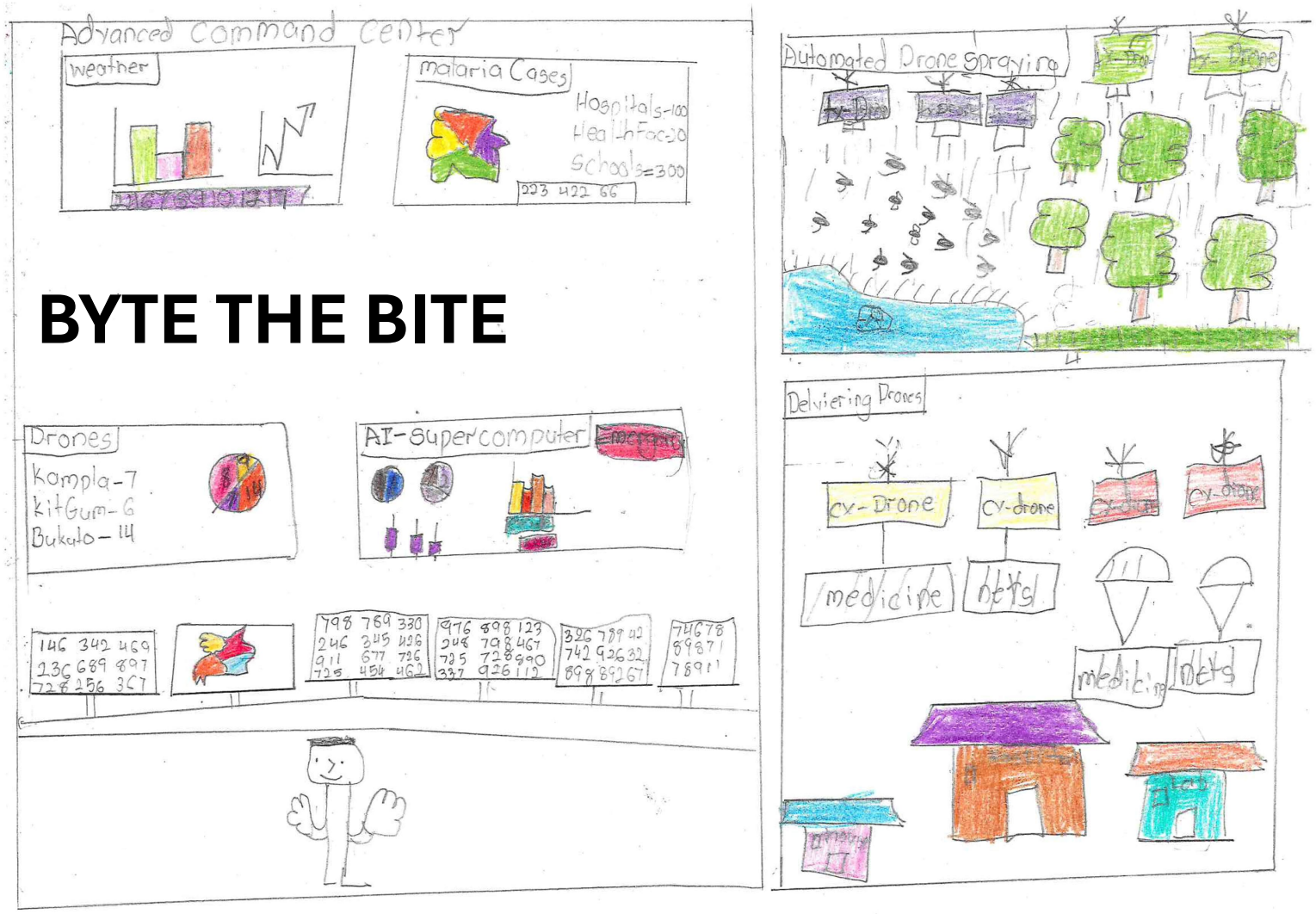
Artists were invited to explore the crossroads where science, sustainability, and human resilience meet.

Suggested angles include:

- **The burden of malaria today:** How do resource limitations affect communities still battling malaria?
- **Innovation under constraint:** How can new tools, strategies, and partnerships drive impact despite financial and operational challenges?
- **Human stories of adaptation:** Show how individuals and communities navigate the changing landscape of malaria control.
- **The future of vector control:** What does success look like in a world of competing priorities and limited funding?

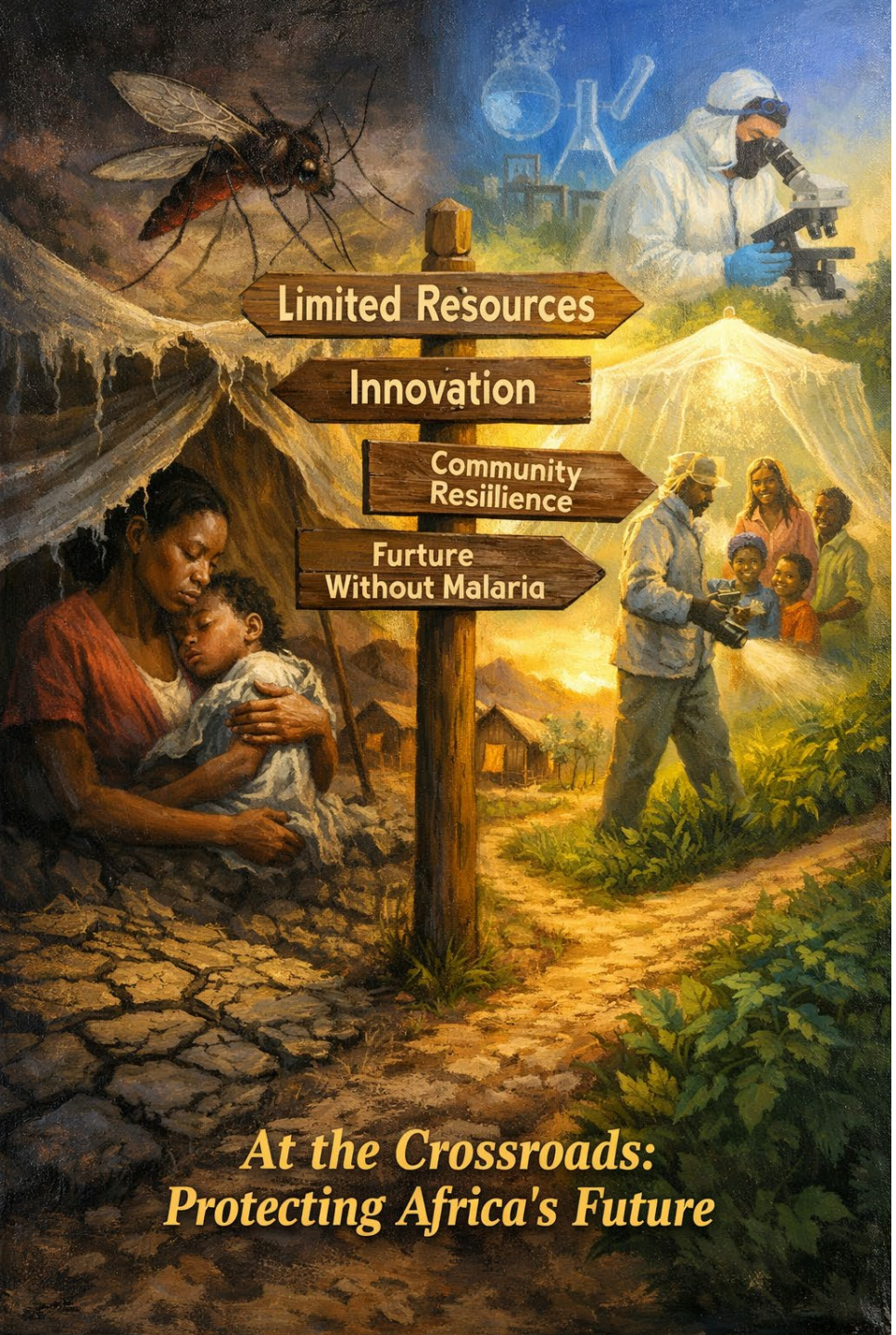
Eden Manzi, Kinua Foundation, Uganda

3rd PLACE



"To eliminate malaria in Uganda, the government needs to use advanced technologies like drones and AI to end malaria. The AI will analyze data quickly and in real time and send drones to areas where there is more rain to spray mosquitoes. Also analyse data of clinics and hospitals and quickly send drugs to places where there might be a shortage. Drones can easily go to places where cars can't reach since many roads in Uganda are bad. Also, AI analysing data, it can pick out outbreaks that may be about to happen.

2nd PLACE



This artwork captures Africa's epidemiological crossroads in malaria control. Despite major gains from insecticide-treated nets, indoor residual spraying, and effective case management, progress is threatened by funding gaps, insecticide resistance, climate pressure, and operational constraints. The central shield symbolizes integrated vector management—where surveillance, innovation, and community engagement converge. Woven threads reflect health systems strengthening and multisectoral collaboration essential for resilience. The mosquito net represents more than a tool; it is protection, hope, and collective action. Inspired by frontline malaria program experience, the piece underscores that sustained investment, data-driven decisions, and adaptive strategies are critical to achieving malaria elimination.

Agnes Band Mapala, Malawi NMCP, Malawi

Interruption

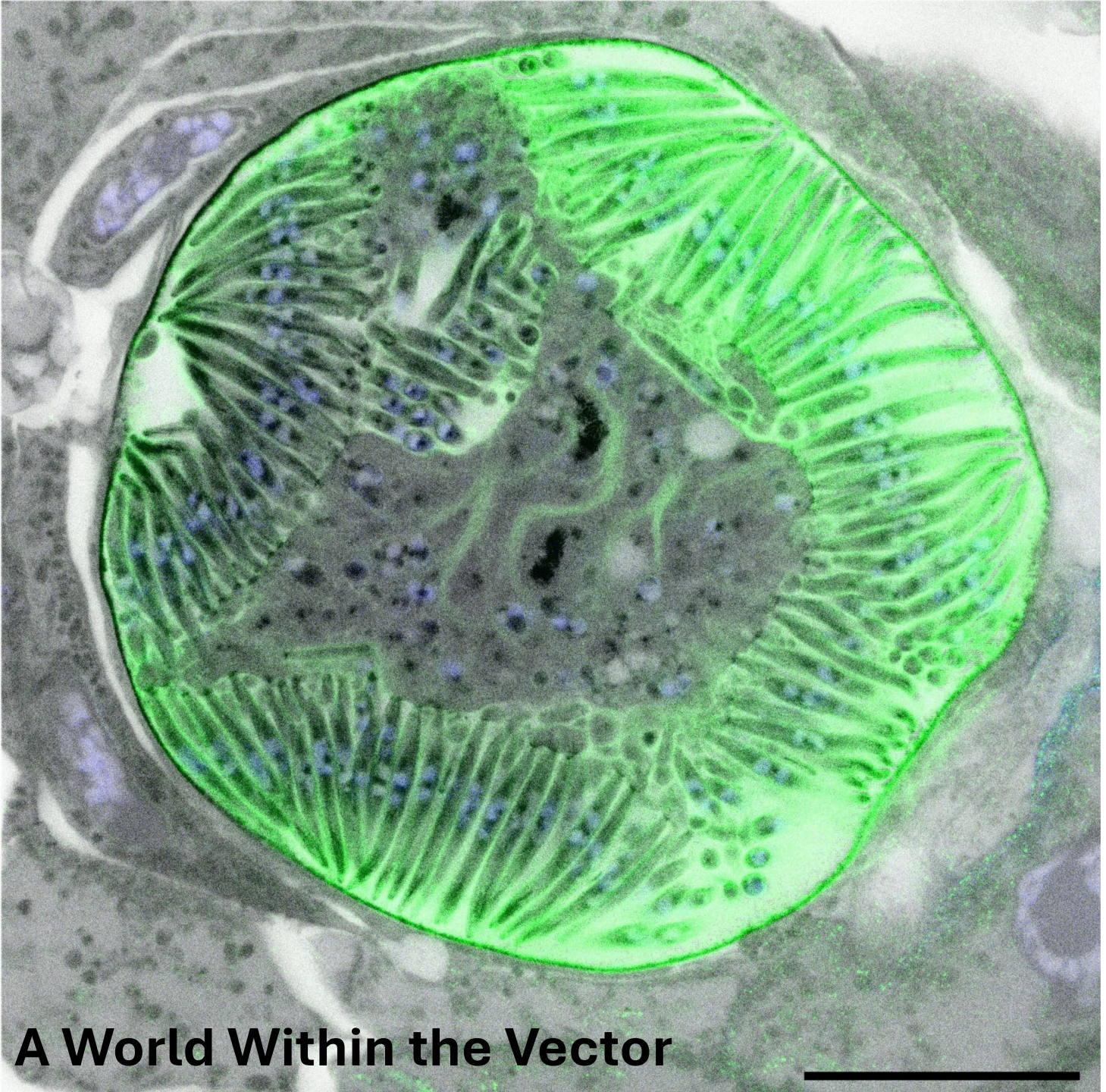
1st PLACE



This work is inspired by the biological violence of malaria, a disease carried by a tiny vector yet expressed through blood. The red stroke evokes invasion, fever, and bodily fragility, while also suggesting interruption: the possibility that vector control can halt transmission before unseen damage unfolds. The textured background reflects environmental instability and structural constraints in malaria-endemic regions. Rather than depicting mosquitoes or technologies, the piece explores tension between vulnerability and protection. Malaria is both invisible and deeply physical, inscribed in the body’s most fundamental medium: "blood"

Masaki Umeda, SORA Technologies, Japan

OF MERIT

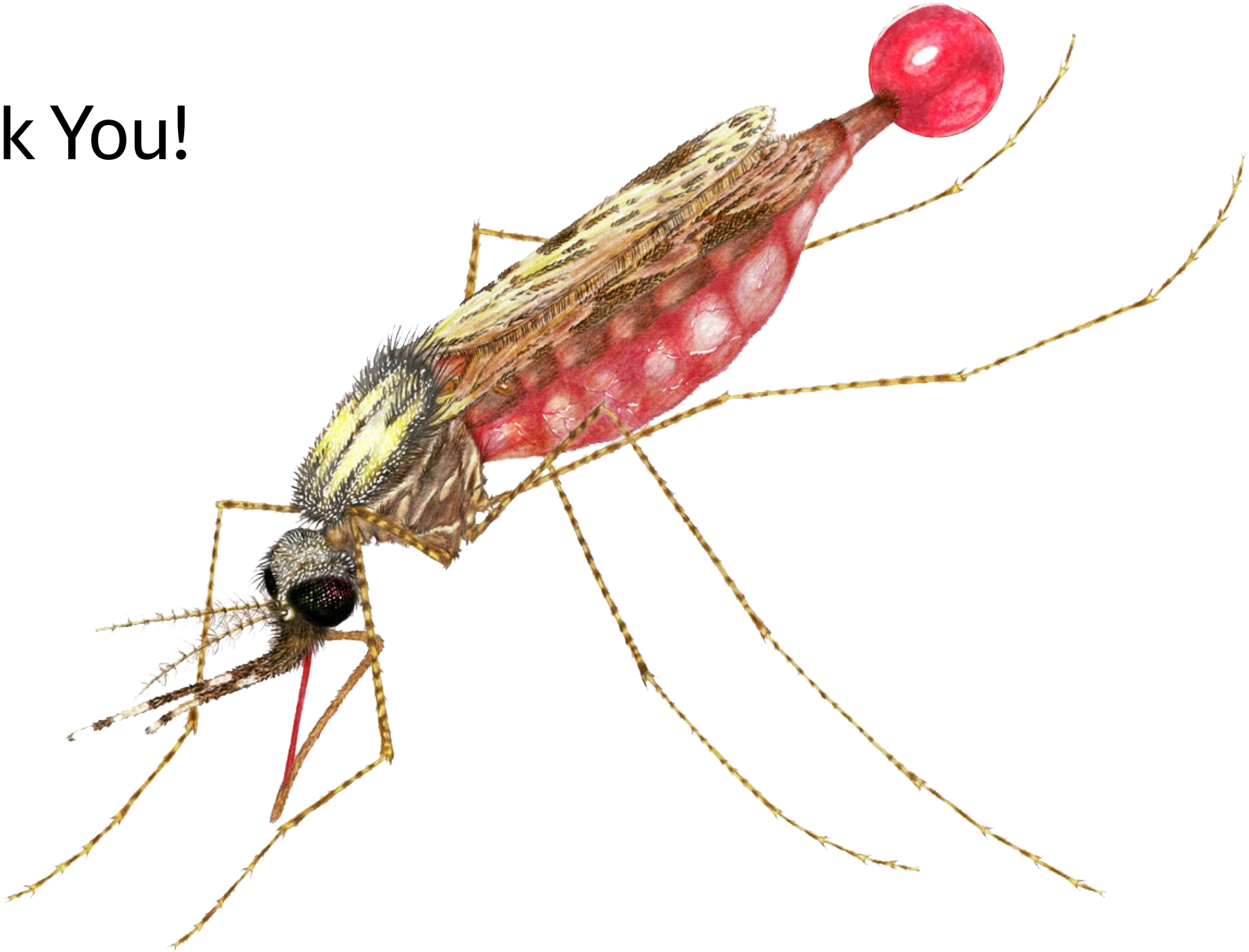


A World Within the Vector

This image captures a Plasmodium oocyst developing within the mosquito midgut and undergoing sporulation, a process by which a single oocyst forms thousands of sporozoites. This stage procedes sporozoite egress from the oocyst and migration to the salivary glands, where they infect the next human host. By targeting the parasite within the mosquito, transmission-blocking strategies aim to halt malaria before the next bite. With limited resources and rising insecticide resistance, new strategies to block malaria transmission are required. This image was obtained by ultrastructure expansion microscopy of Plasmodium-infected midguts, stained with NHS ester (total protein, grey), anti-CSP antibody (sporozoite surface marker, green), and Hoechst (DNA, blue). Scale bars 50 µm.

Natalie Portwood, Heidelberg University, Germany

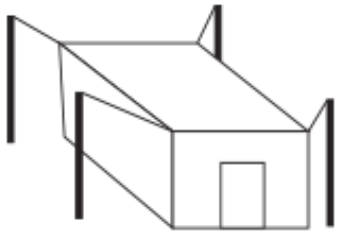
Thank You!



Inclusion of the hard-to-reach and mobile population for malaria control in Sub-Saharan Africa.



Good housing for
malaria vector control gap



Supply Insecticide treated tents

IMPROVEMENT
STRATEGIES



Availability of Malaria Vector
Control tools gap





SE

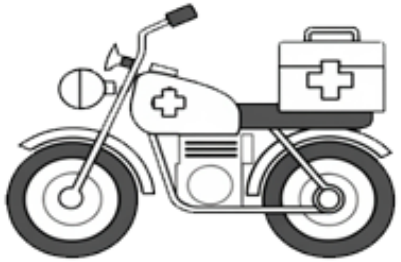


INSECTICIDE
BLANKET

Supply Special repellents & Blankets



Accessibility to
Anti-malaria drug gap



Community malaria volunteers
and Mobile clinic

In Sub-Sahara Africa malaria is the leading cause of morbidity and mortality. Socio-economically it contributes highly to poverty. The National malaria Elimination Programs strategic plan advocates four main approaches; improved case management, vector control using insecticide treated mosquito nets, prevention and control of malaria in pregnancy and epidemic preparedness. However, continued transmission in hard-to-reach populations (HTRP), remains an important challenge. New HTRP tailored approach such as treated-tents, treated-blankets, spatial-repellents, mobile clinics and community-volunteer malaria workers need to be adopted in the MoH strategy. A change in policy by the malaria programs in Sub-Sahara Africa will be required to accommodate minority groups by considering their uniqueness.

Kenio Benson, KCMC-University, Tanzania

Awaiting submission

"Malaria remains one of the leading public-health challenges in sub-Saharan Africa, despite decades of investment in vector-control interventions such as long-lasting insecticidal nets (LLINs), indoor residual spraying (IRS), larval source management (LSM), and environmental modification. While these strategies have saved millions of lives, sustained community participation and behavioral change are critical for long-term success.
Conventional health-education campaigns often struggle to reach diverse audiences, especially young people and rural communities with limited access to formal information channels. Art—through painting, illustration, sculpture, digital media, photography, poetry, and mixed media—offers a powerful alternative for translating scientific evidence into culturally resonant messages. The competition will serve as a platform for disseminating information on malaria control.

Damtew Bekele, Public Health Institute, Ethiopia

RBM Partnership
To End Malaria

4 March 2026

Afternoon break

RBM Partnership
To End Malaria

4 March 2026

Task Team 3: Vector control in humanitarian emergencies

Introduction and session framing

Joseph Lewinski & Corey LeClair, VCWG Task Team leads



RBM Partnership To End Malaria

Vector Control Working Group Meeting 2026

WS3 TT3: Vector Control in Humanitarian Emergencies

Leads: Joseph Lewinski + Corey LeClair

4 March 2026

Call to Action

Any goal short of eradicating malaria is accepting malaria; it's making peace with malaria; it's rich countries saying: 'We don't need to eradicate malaria around the world as long as we've eliminated malaria in our own countries.' That is just unacceptable.

-MGF 2007

If malaria control cannot reach displaced populations and people living through conflict and crisis, then we are not eliminating malaria—we are accepting it where it is hardest to address.

Current Situation

117.3 million

people are forcibly displaced from their homes.

1 in 70

This equates to 1 in every 70 people on Earth.

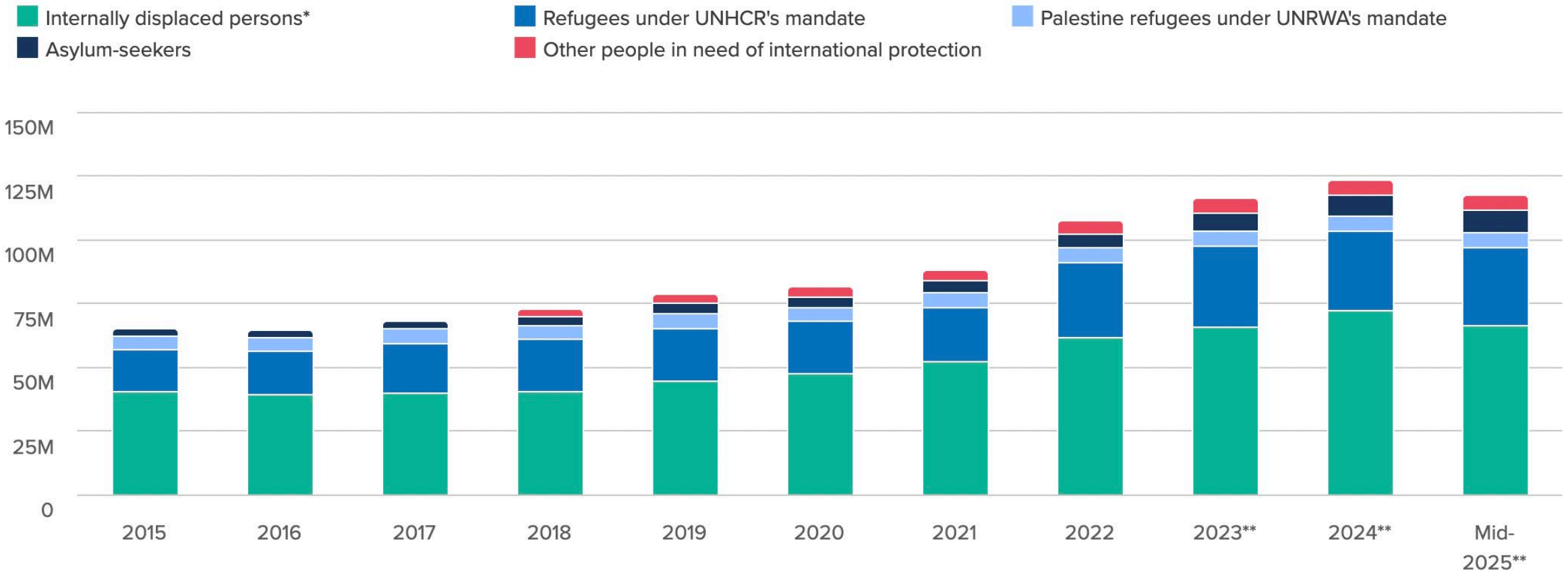
13.4 million

Sudan remains the largest displacement situation

Second

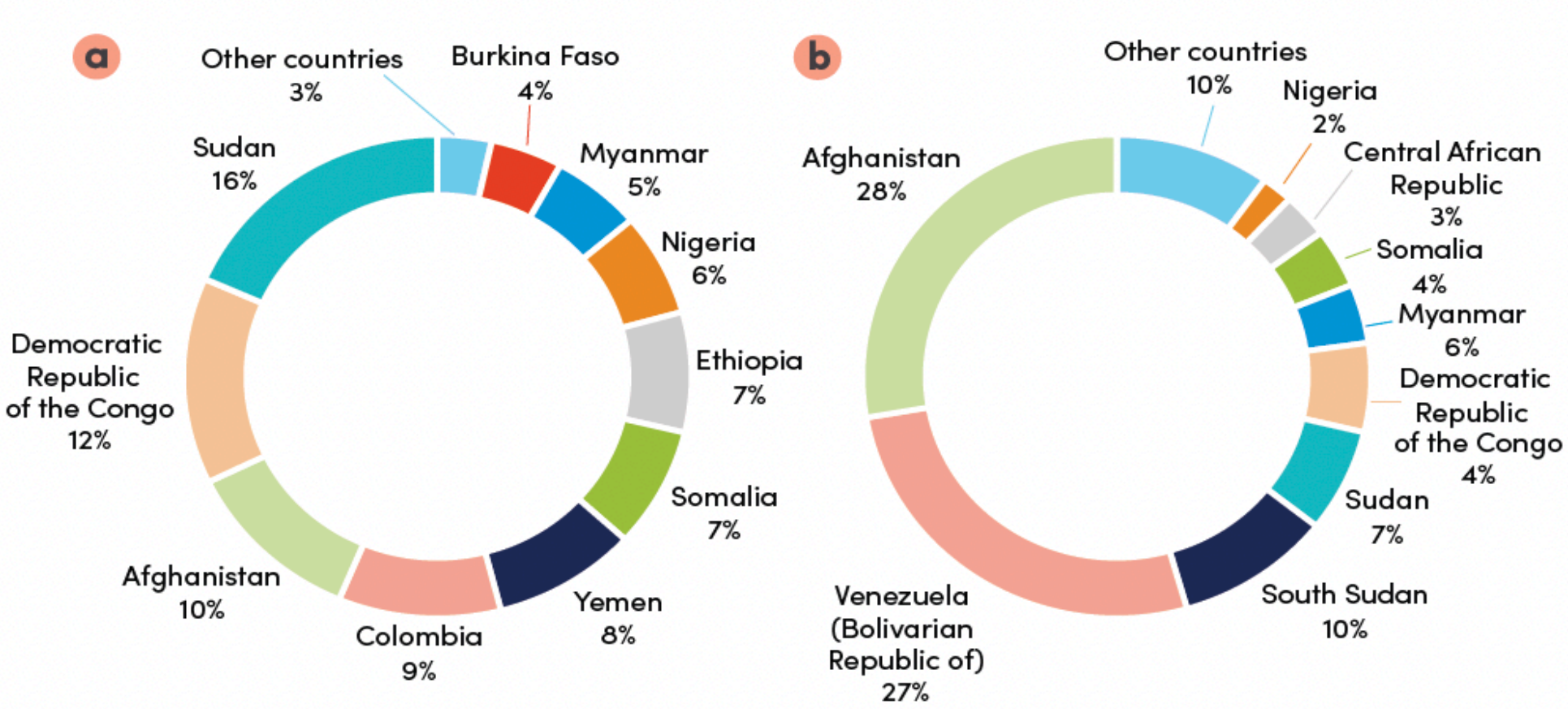
most common cause of morbidity among refugees in 20 countries is malaria.

Current Situation



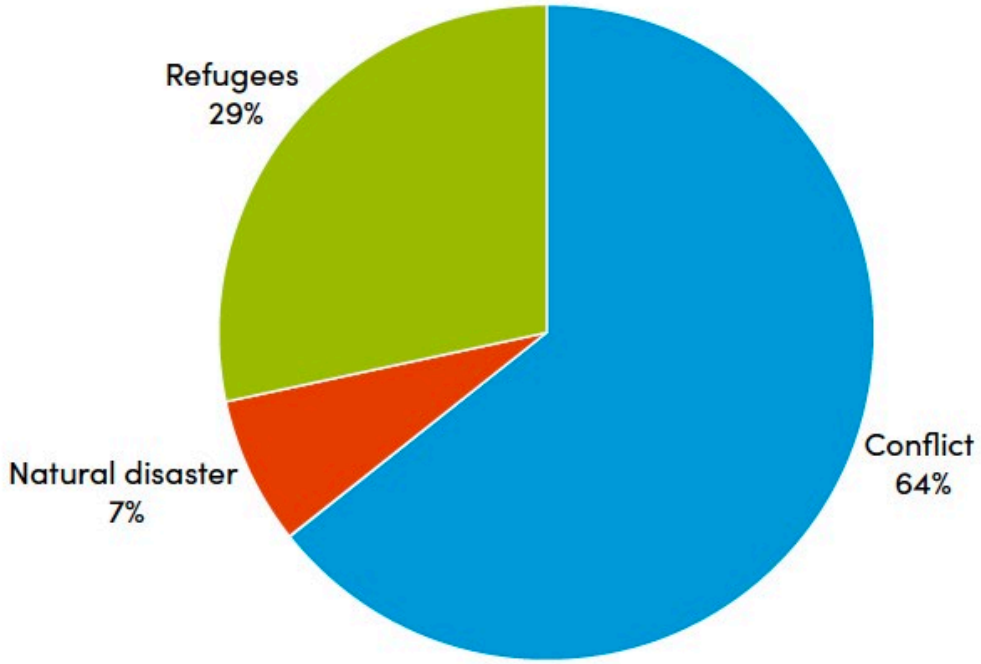
Current Situation

Proportions of a) IDPs due to humanitarian emergencies in malaria endemic countries and b) refugees from malaria endemic countries, 2023



Current Situation

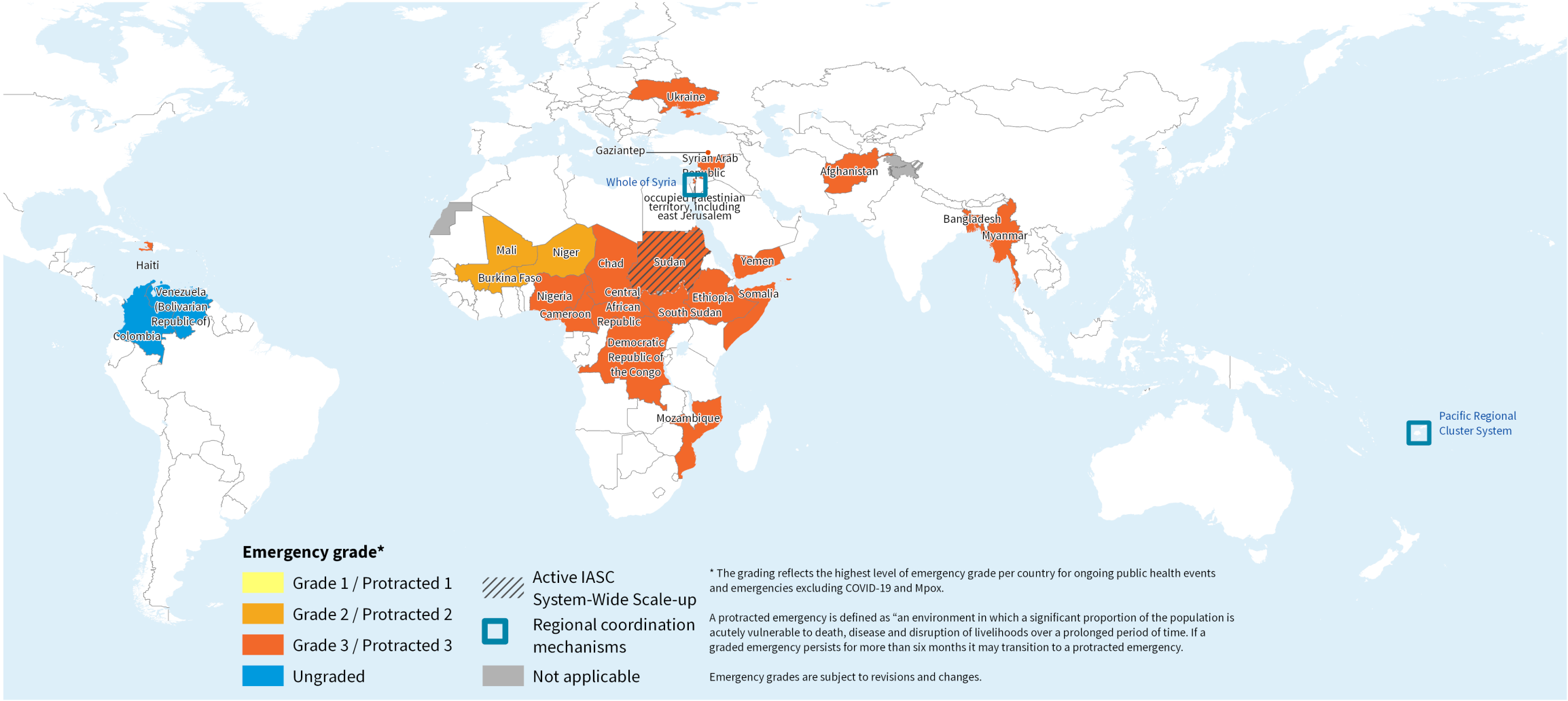
Proportion of IDPs and refugees in malaria endemic countries (79.8 M)



World malaria report 2024 (7)



Country Health Clusters, December 2025



* The grading reflects the highest level of emergency grade per country for ongoing public health events and emergencies excluding COVID-19 and Mpox.

A protracted emergency is defined as "an environment in which a significant proportion of the population is acutely vulnerable to death, disease and disruption of livelihoods over a prolonged period of time. If a graded emergency persists for more than six months it may transition to a protracted emergency.

Emergency grades are subject to revisions and changes.

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of WHO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: WHO Health Emergencies Programme
Map Date: 19 January 2026

0 1,500 3,000 Km

World Health Organization

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The Crossroads

- Funding landscape is tightening.
- Humanitarian caseload is expanding.
- Climate variability is increasing malaria shocks.
- New tools exist — but adoption pathways in emergencies are unclear.
- Countries ad hoc coordination (Sudan, South Sudan, Pakistan, Madagascar, Gaza, Sahel, etc.).



WS3 TT3: VCHE | Focus Areas

Priority 1
Expanding Use, Access, and Diversity of Vector Control Tools in Humanitarian Settings

Priority 2
Strengthening Operational Research and Evidence Generation in Emergency Settings

Priority 3
Documenting, Sharing, and Applying Best Practices Across Humanitarian Settings

Activities + Plans Moving Forward

Priority Area	**Priority 1 Expanding use, access, and diversity of vector control tools in humanitarian settings**	**Priority 2 Strengthening operational research and evidence generation**	**Priority 3 Documenting, sharing, and applying best practices**
Key Activities (2025)	• Country Experience and Operational Adaptation • Promoting Tool Diversification • Strengthening Linkages with Humanitarian Response Systems	• Hosted Applied Research on Vector Control in Humanitarian Emergencies Webinar • Co-Hosted with APMEN "Vector Control in Compromised Settings" • **WHO Malaria Control in Emergencies Field Handbook- Published July 2025**	• Organized humanitarian-focused sessions within VCWG to share operational experiences and lessons from emergency contexts • Facilitated cross-country exchange among implementers and technical partners
Next Steps (2026)	• **Practical decision-support framework** for selecting and deploying vector control tools in humanitarian settings.	• Technical webinars and document operational case studies	• Focused exchange and evidence base targeted for humanitarian relief organizations.

RBM VCWG Agenda 2026

Using Digital Tools to Enable ITN Distribution in Complex Operating Environments
Case Study: Mali *Boubacar Maiga, CRS*

Non-Mesh Impregnated Mosquito Net for Hard-to-Reach Populations : Partnership and evaluation in South Sudan
Natacha Protopopoff, Swiss TPH

ITN Campaign Implementation in Sudan: Operational Adaptations in a Humanitarian Context: Reflections on implementation and support needs
Sudan NMCP & Ida Ameda, UNICEF

Priority 1 – Expanding use and access to vector control tools

Priority 1 – Expanding the humanitarian vector control toolbox
Priority 2 – Strengthening operational research

Priority 3 – Documenting and sharing best practices

Next Steps…

What we lack is not experience….

What we lack is structured guidance, costing models, and decision pathways specific to emergencies.



RBM Partnership
To End Malaria

4 March 2026

Presentation: Using digital tools to enable ITN distribution in complex operating environments: A case study from Mali

Boubacar Maiga, Catholic Relief Services



Revue de l'utilisation de la technologie pour faciliter la distribution de moustiquaires imprégnées d'insecticide dans des environnements opérationnels complexes

Etude de cas: Renforcement des campagnes MII et de la CPS au Mali grâce à la digitalisation, lorsque le contexte sécuritaire le permet

Développé par CRS Mali, PNLP Mali, et Eau Claire Consulting

Agenda

1. Aperçu de la revue
2. Etude de Cas - Mali
3. Contexte
4. Approche adoptée
5. Composante digitalisée
6. Les résultats globaux
7. La valeur ajouter - Digitalisation
8. Défis/Leçons/Perspectives



Photo par Fatoumata Diallo /CRS

Aperçu de la Revue (1)

- Pour relever les défis uniques de la distribution des MII dans les populations déplacées, l'Alliance pour la Prévention du Paludisme (APP) a créé un Groupe de travail sur les populations humanitaires et déplacées (HARP).

- Suite à une série de tables rondes multisectorielles de HARP en 2022-23, une recommandation a été faite de *Collecter et partager des données sur la faisabilité de la digitalisation pour une prise de décision fondée sur des preuves.*

- Pour adresser cette recommandation, CRS et l'APP ont mené cette revue, qui confirme que la digitalisation est faisable, essentielle et très efficace dans les environnements complexes (COE), à condition que sa mise en œuvre soit spécifique au contexte et détenue localement.

- La revue a:
  - Mené 24 entretiens avec des informateurs clés, dont les coordinateurs des programmes nationaux de lutte contre le paludisme, les consultants d'APP en digitalisation, et des partenaires tels que l'UNICEF, le PNUD, CHAI, Against Malaria Foundation, et la Fondation eGov.
  - Développé cinq études de cas avec les programmes nationaux de lutte contre le paludisme du Burundi, Mali, Pakistan, Somalie, et Tchad.

Aperçu de la Revue (2)

- Les succès les plus significatifs identifés sont:
  - L'amélioration notable de la précision des données démographiques
  - Réduction significative des délais opérationnels (par exemple, au Burundi, le délai d'enregistrement des données de distribution a été ramené à 22 jours)
  - Forte adoption des outils numériques par les utilisateurs (94 % des bénévoles du Soudan du Sud ont exprimé une préférence pour l'outil digital).

- Principaux défis identifiés :
  - Les limitations de connectivité et de recharge des équipements
  - Niveau variable de littératie numérique du personnel de terrain pour l'utilisation des outils digitaux
  - Des risques de sécurité liés à l'utilisation de dispositifs avec GPS dans les zones de conflit.

Sources
- Key informant interviews
- Aweno, N (2025). Lessons learnt and challenges from digitalisation of long-lasting insecticidal net distribution campaigns in South Sudan. Presentation to the Alliance for Malaria Prevention Annual Meeting 2025

Etude de cas - Mali

Contexte

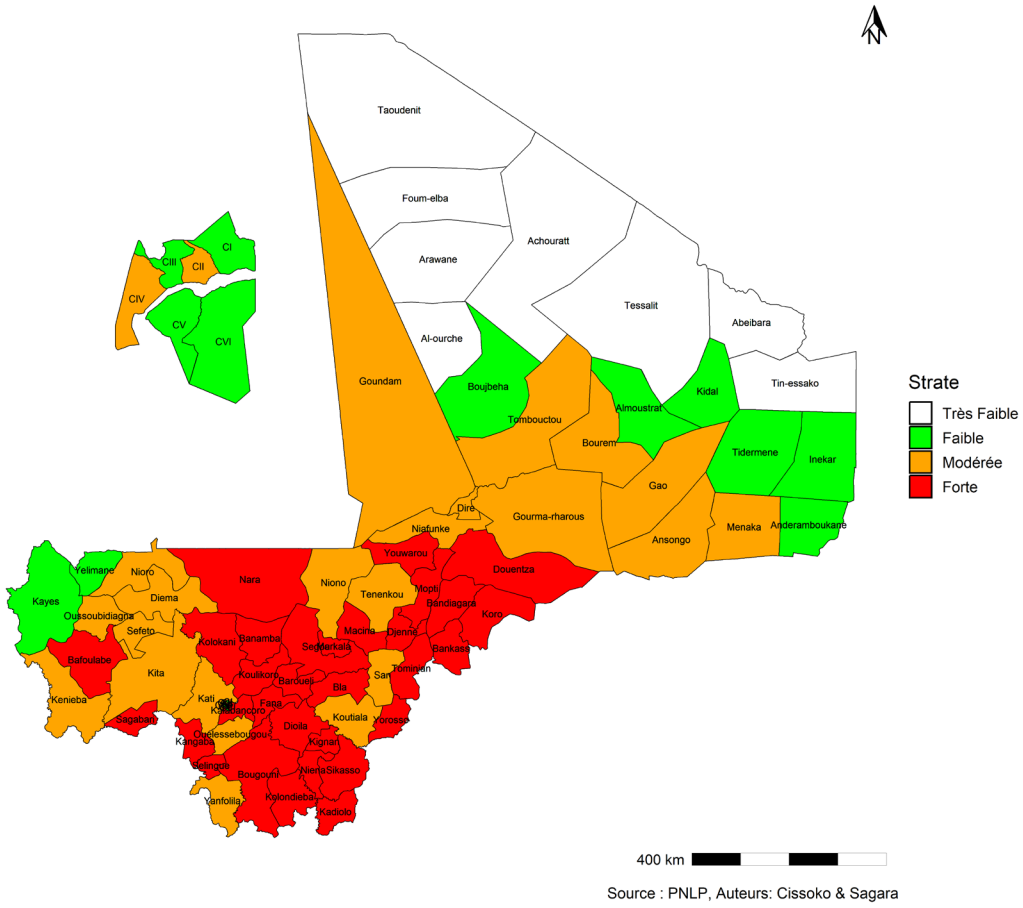
Pays à fort fardeau palustre : 34% morbidité, 27% mortalité

Contexte sécuritaire instable depuis 2012

- Déplacements de populations
- Structures sanitaires non fonctionnelles
- Accès humanitaire limité dans le nord et le centre

Défis majeurs pour les campagnes :

- Données tardives et peu fiables (papier/Excel)
- Difficultés d'accès et de supervision
- Gestion complexe des stocks

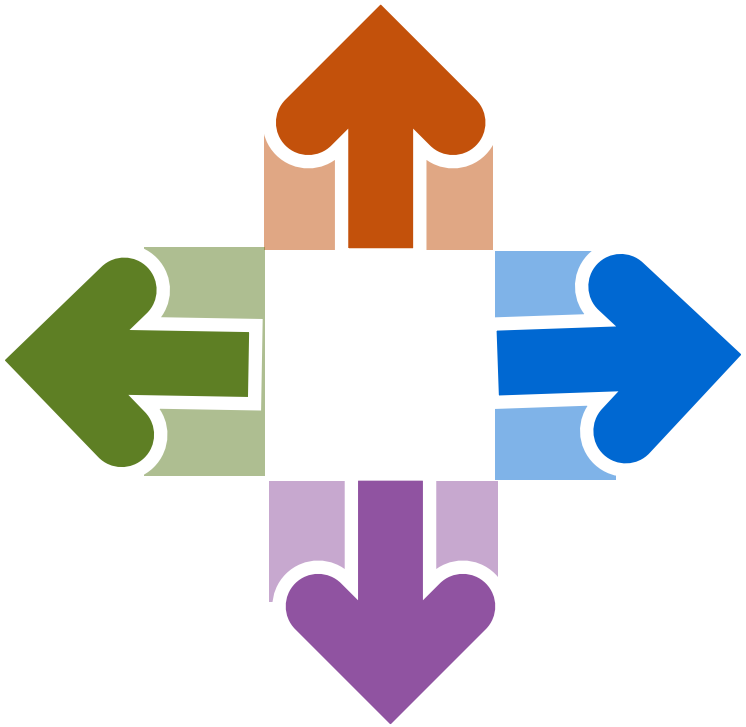


Opportunité: Digitalisation identifiée comme levier stratégique par le PNLP

Approche adoptée par le PNLP

1. Principe clé : Digitaliser là où le contexte sécuritaire le permet

4. Système d'information : Alignement progressif avec les systèmes nationaux du Ministère de la sante.



2. Plateformes utilisées :
- DHIS2 : Collecte, supervision, Monitorage, Quantification et gestion des stocks, tableaux de bord

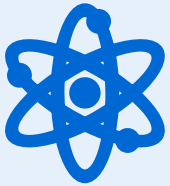
3. Approche différenciée :
Zones Stables -> digitalisation complète terrain
Zones Instables -> digitalisation logistique & supervision

Composantes digitalisées de la campagne MII



Dénombrement des ménages

Permet une quantification précise des besoins et une couverture équitable, même dans des zones difficiles d'accès



Distribution des MII

Réduit les erreurs de distribution et limite les fraudes, tout en accélérant la mise en œuvre



Supervision digitale

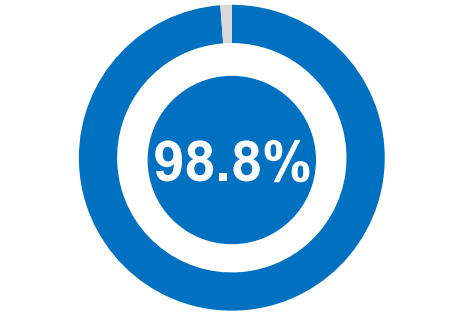
Identifie en temps réel les zones non couvertes et facilite les corrections en cours de campagne



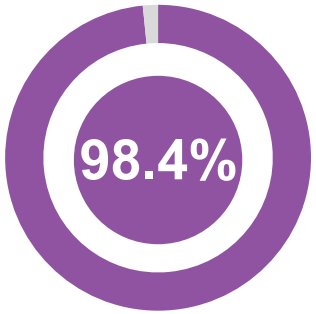
Logistique et stock

Suivi en temps réel de la réception, du transfert et de l'inventaire des stocks

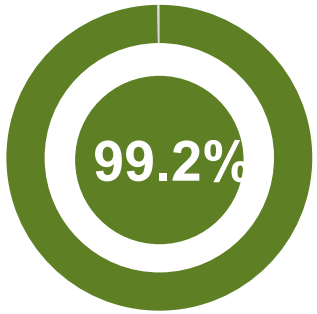
Les résultats globaux de la digitalisation MII



Taux de Couverture population



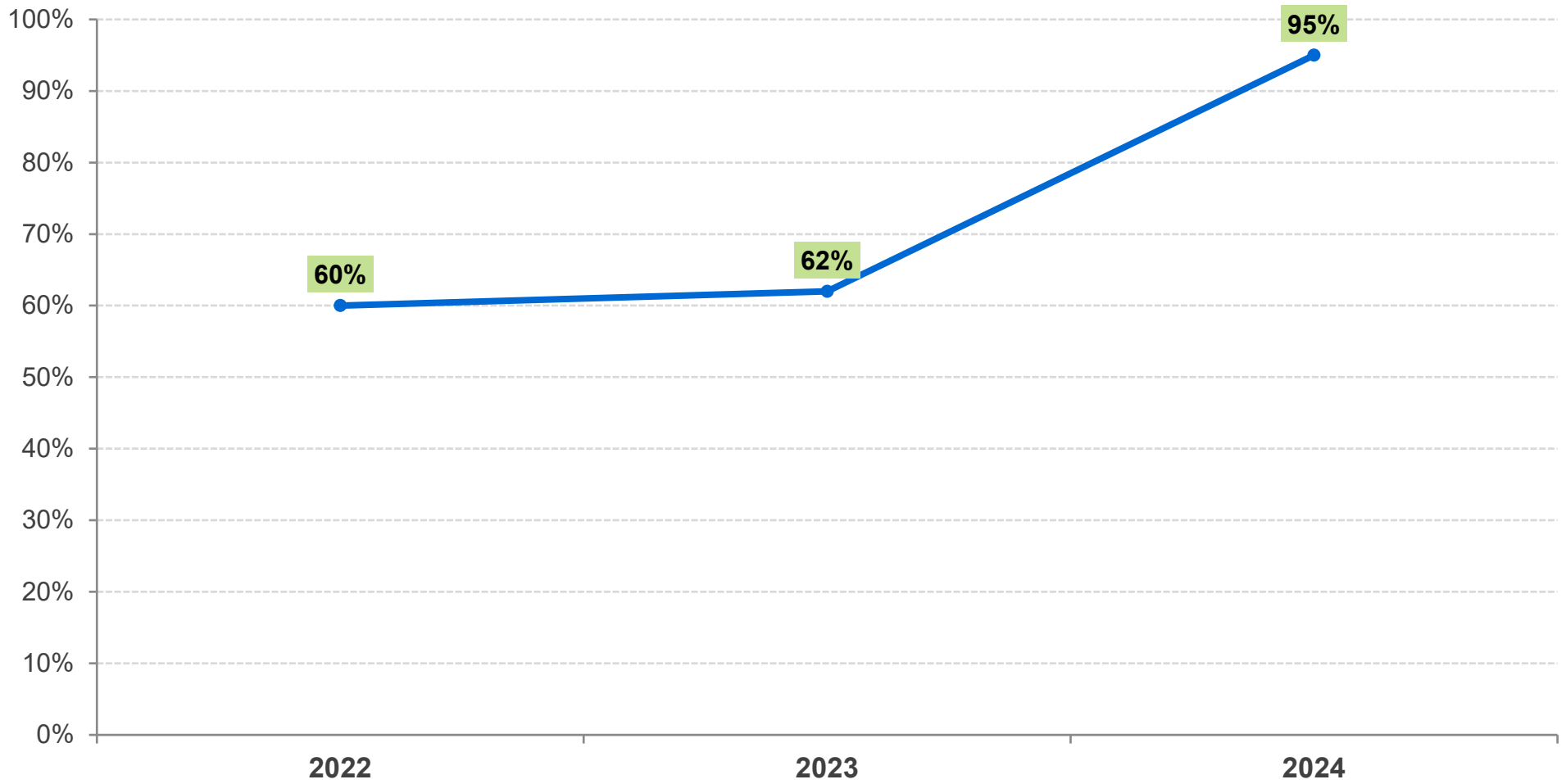
Taux de couverture Ménage



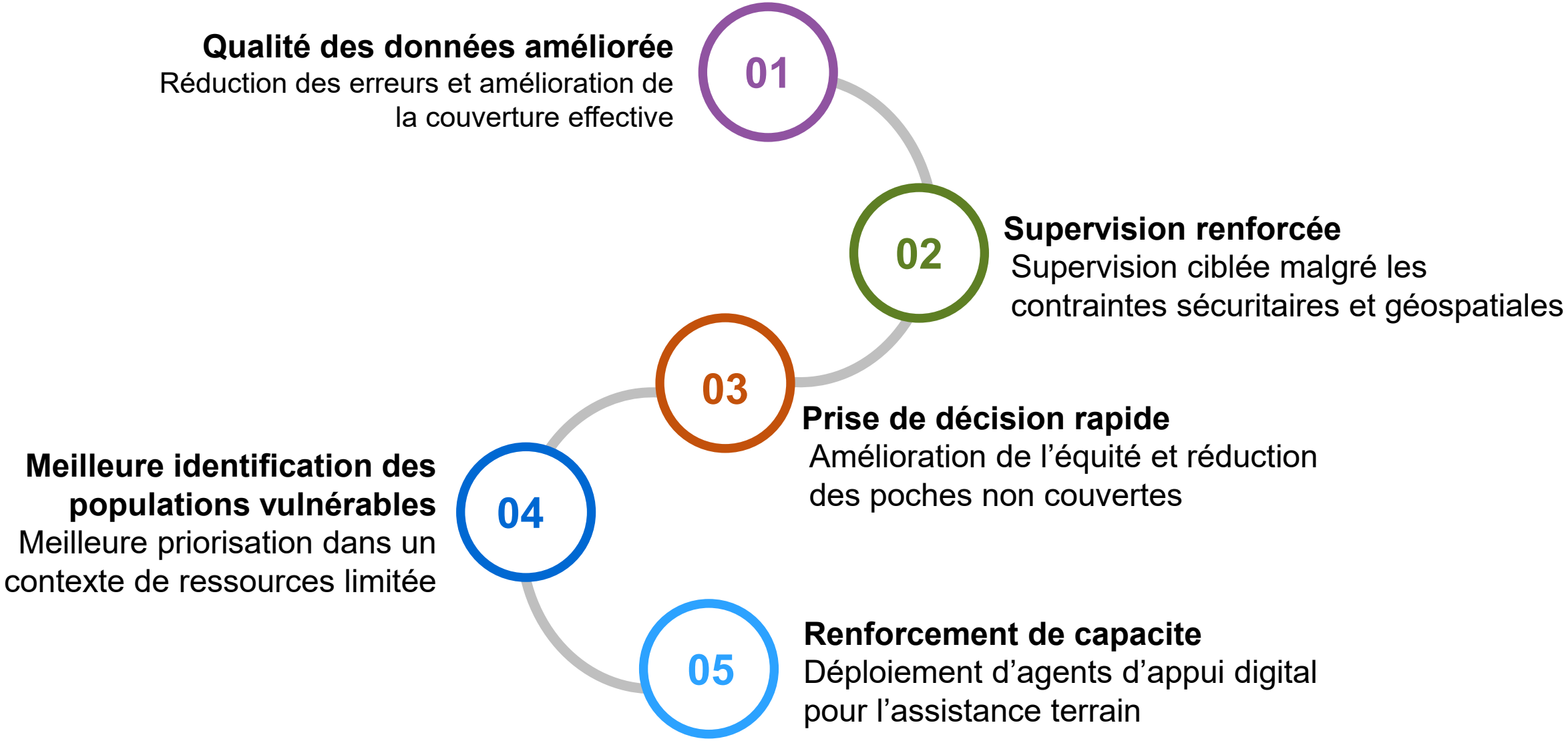
Taux de distribution MII

Gains majeurs : disponibles quasi en temps réel, Meilleure équité dans la distribution

Les résultats globaux de la digitalisation CPS



Valeur ajoutée de la digitalisation en COE



Défis, leçons et perspectives

Défis rencontrés 01

- Risques sécuritaires liés à l'usage des smartphones en zones instables
- Gestion complexe des équipements
- Faible connectivité et sabotages des infrastructures télécoms
- Facteurs humains : formation, motivation, paiements

Leçons clés 02

- La technologie est un facilitateur, pas une solution en soi
- Importance de l'acceptation communautaire
- La formation adaptative et continue est indispensable
- La supervision doit être pilotée par les données, pas seulement administrative

Perspectives 03

- Intégration des données MII–CPS pour une planification plus fine
- Campagne MII 2026 :
  - Approches communautaires renforcées dans les zones à haut risque
    - Extension de la digitalisation
    - Renforcement durable des capacités du PNLP

Thank You

Boubacar Sidiki MAIGA

boubacar.maiga@crs.org

Faith knows no bounds®

CRS®

RBM Partnership
To End Malaria

4 March 2026

Presentation: Non-Mesh Impregnated Mosquito Net for Malaria Control in Hard-to-Reach Populations: A partnership to deliver and evaluate an adapted vector control tool in South Sudan.

Natacha Protopopoff, Swiss TPH

Swiss TPH

Non-Mesh Impregnated Mosquito Net for Malaria Control in Hard-to-Reach Populations:

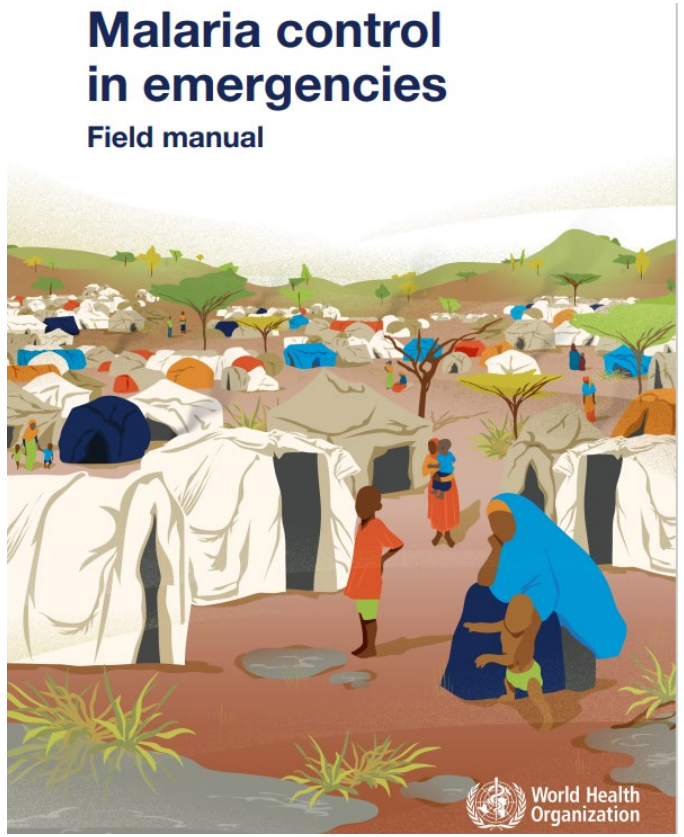
A partnership to deliver and evaluate an adapted vector control tool, South Sudan

Natacha Protopopoff

VCWG, 3-6 March 2026, Nairobi

Malaria risk and adapted tools

- 122 M forcibly displaced people in 2024
- 50M nomads/semi-nomads live in malaria-prone regions. (Gammino *PLoS Negl Trop Dis* 2020; **14**(7))
- Challenges to implement standard core interventions (ITNs and IRS): population movement and inadequate shelter.



- ➢ WHO recommends LLINs in emergencies/hard to reach, but:
  - Durability issues
  - Low retention in nomadic settings
- ➢ Urgent need to expand malaria vector control toolbox for hard-to-reach populations.

PermaNet® Dumuria

- PermaNet® Dumuria (Vestergaard) is a non-mesh insecticide-treated polyester coated with deltamethin and an UV-protectant.
- Inspired by Dhamoria, traditional opaque net used by nomads in Kenya and South Sudan



Courtesy of Corey Leclair (MSF)

PermaNet® Dumuria

- PermaNet® Dumuria (Vestergaard) is a non-mesh insecticide-treated polyester coated with deltamethin and an UV-protectant.
- Inspired by Dhamoria, traditional opaque net used by nomads in Kenya and South Sudan

- Study done in Garissa, Kenya 2011-2013
- ✓ 98% retention after 22 months
- ✓ Meets WHO bio-efficacy up to 18 months
- ✓ High cultural acceptability: already ~40–48% use Dhamoria-style net.



Am. J. Trop. Med. Hyg., 93(5), 2015, pp. 1002–1009
doi:10.4269/ajtmh.14-0458
Copyright © 2015 by The American Society of Tropical Medicine and Hygiene

Investigating a Non-Mesh Mosquito Net among Outdoor Sleeping Nomadic Communities in Kenya

Georgia R. Gore-Langton, James Mungai, Nfornuh Alenwi, Abdullahi Abagira, Owen M. Bicknell, Rebecca E. Harrison, Farah Amin Hassan, Stephen Munga, Katie Eves, Elizabeth Juma, and Richard Allan*

The MENTOR Initiative, Crawley, United Kingdom; The MENTOR Initiative, North Eastern Province, Kenya; Ministy of Health, Garissa, Kenya; The MENTOR Initiative, Maban, South Sudan; Centre for Global Health Research, Kenya Medical Research Insitute, Kisumu, Kenya; Division of Malaria Control, Ministry of Public Health, Nairobi, Kenya

Abstract. Rising reports of exophagic malaria vectors make even more pressing the need for alternatives to traditional, mesh, long-lasting insecticidal nets (LLINs) designed for indoor sleeping and often inadequate in the protection of outdoor-sleeping populations. This study tests and evaluates the retention, utilization, and durability of novel, non-mesh nets designed for outdoor use. Longitudinal, cross-sectional surveys were conducted, the physical condition of nets was assessed, and bio-efficacy and insecticide content were tested. At 22 months, retention was 98.0%; 97.1% of nets fell within the World Health Organization (WHO) category of being in "good" condition; none were in the "torn" category. At 18 months post-distribution, 100% of nets had at least WHO Pesticide Evaluation Scheme (WHOPES)-acceptable levels of insecticide, this proportion was 66.7% at 22 months. This novel mosquito net has the potential to provide a durable and context-specific tool to prevent malaria among traditionally hard-to-protect and highly vulnerable populations.



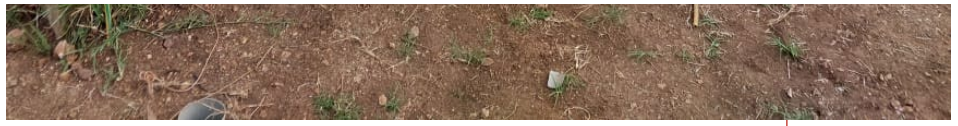
Gore-Langton *et al. Malaria Journal* (2015) 14:52
DOI 10.1186/s12936-015-0546-1

MALARIA JOURNAL

RESEARCH Open Access

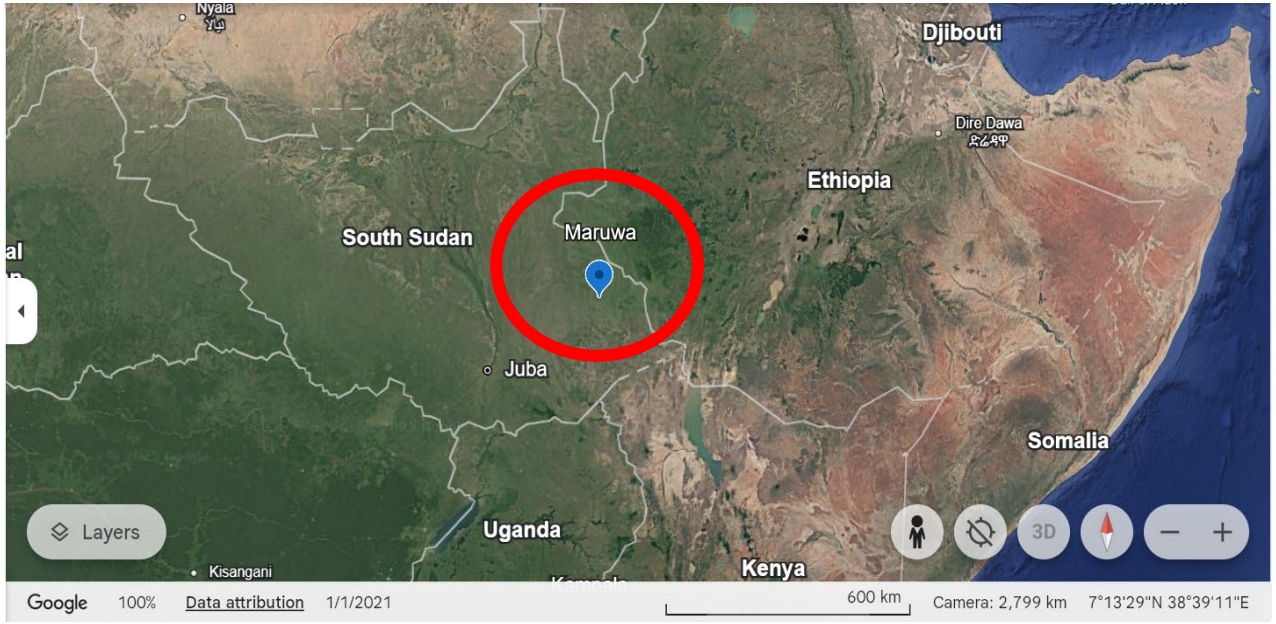
Investigating the acceptability of non-mesh, long-lasting insecticidal nets amongst nomadic communities in Garissa County, Kenya using a prospective, longitudinal study design and cross-sectional household surveys

Georgia R Gore-Langton[1*], James Mungai[2], Nfornuh Alenwi[2], Abdulla Abagira[3], Owen M Bicknell[4], Rebecca Harrison[1], Farah A Hassan[3], Stephen Munga[5], Francis Njoroge[3], Elizabeth Juma[6] and Richard Allan[1]



Area & population

- Maruwa Hills, East Pibor
- Murle Nomadic pastoralist.
- Migration during dry season December to June/July
- MSF-OCB work since 2020
- One health post and outreach activities, including integrated Community Case Management



- Species: *An.arabiensis, An.funestus*



Study design

Goal: To evaluate the effectiveness of a non-mesh insecticide impregnated mosquito net on malaria cases

Design: mixed-methods observational and implementation research study to evaluate PermaNet® Dumuria

Timeline: August 2025- April 2028

Objectives:

1. Determine whether Dumuria reduces odds of clinical malaria in children (6 months–14 years)
2. Characterize local malaria vectors.
3. Monitor net durability and insecticidal bio-efficacy.
4. Assess community acceptance, ownership, and use in Murle South Sudan
5. Assess acceptability among Maasai pastoralists in Tanzania.
6. Provider-side cost analysis.
7. Examine mobility patterns and their link to malaria risk.

Part 1: MSF

Distribution Dumuria

Prevalence and Dumuria usage/durability surveys

Passive case detection Health post and ICCM - Interrupted time series

Entomological collection and Species composition

Part 2: Swiss TPH

Cost Analysis Bridge- Swiss TPH

Qualitative, perception and acceptability Bridge-KCMUCo-SwissTPH

Durability & bioefficacy Bridge -KCMUCo

Case control in Maruwa and cattle camp Bridge-LSHTM

Mobility and malaria risk Bridge-UOttawa

Mosquito characterisations KCMUCo-LSHTM

Insecticide Resistance Bridge-LSHTM

Dumuria distribution

- 10,000 units purchased by MSF-OCB
- **July/August 2025:** Distribution of 7,020 Dumuria to 2,738 households, covering 13,678 people in Maruwa town following the census.
- **Jan/Feb 2026:** Distribution of 2000 in one community that was not previously covered.

- 97% (n=386) usage the previous night

Usage per net type	
No Protection	3%
Local untreated Dhamoria	9.6%
LLIN	29.0%
PermaNet® Dumuria	58.8%





MEDECINS SANS FRONTIERES

Net distribution challenges

- Distribution planned for August 2024, but few people returned to Maruwa.
- August 2025: Huge transport challenges





Community support:

- Communities helped transport bales to central locations.
- Communities agreed to walk several kilometers to distribution points.

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Malaria prevalence survey

- **August 2025:**
  - A total of 386 out of 493 participants in 11 out of 16 villages.
  - Overall prevalence 32%
- **Challenges:**
  - Timing of baseline surveys conducted during distribution.
  - Groups tested with RDTs not representative
    - Children under 10 had an approximate 50/50 sex ratio
    - Over 10 mainly girls and women, as most men were away with cattle during the day.

	Total RDT	Prevalence
By age group		
<5 yrs	98	41.8%
6-15 years	55	50.9%
>15 years	231	22.9%
By sex		
Female	308	27.6%
Male	76	48.7%



MEDECINS SANS FRONTIERES

Case control study

- Determine whether use or ownership of Dumuria is associated with malaria cases by comparing the odds of malaria cases in children using Dumuria to those that do not use Dumuria

- **Sample size:** 427 cases with 427 matched controls
- Data collection every six months, 2 years.
  - In the cattle camps (February-April)
  - In Maruwa villages (Sept-Nov)

- **Cases**=children 6 months - 14 years with malaria (fever & positive RDT).
- **Controls**= (health facility or/& community): children of the same age who do not have clinical malaria

- Information on
  - Dumuria ownership and usage
  - Travel history and time spent in current location
  - Housing conditions, family cattle ownership, malaria knowledge…

Entomological outcomes & Durability

- **Cross sectional surveys** every 3 months in cattle camps and Maruwa
- CDC light traps, Tent traps & Resting collection
- Species identification, Blood meal ELISA, Sporozoite Rate
- Insecticide resistance: Deltamethrin, and synergist PBO.



- **Dumuria physical durability** at 12 and 24 post distribution in cohort of nets
  - Survival
  - Holes
- **Dumuria bio-efficacy (0, 12 and 24 months)**
  - Chemical analysis and bio-assays
  - Experimental hut trial to look at killing and blood feeding inhibition



Qualitative Assessment & Cost

Knowledge, Attitudes and Practice & Focus Group Discussion

- Awareness, perception, and utilisation of PermaNet® Dumuria In Maruwa, SS
- Acceptability among Maasai pastoralists in Tanzania



Cost Analysis

- Provider-side costing: Financial expenditures for procurement and distribution
- Total costs integrated with durability and usage metrics to estimate Cost per Person-Year Protected.

Malaria risk

- Assess how environmental variability influences mobility patterns and malaria transmission dynamics over the two years

uOttawa

Team

Affiliation	Investigators Part 2
Bridge Network	Wol Athuai (Co-PI)
	Zack Wol Aluk Chol (PM, Qual)
	Chol Peter (Epi, data manager)
MOH-NMCP	Atemthii De Dau (Epi)
KCMC	Salum Azizi (Co-PI, Bio-efficacy)
	Robert Kaaya (Labo)
	Franklin Mosha (ento)
Swiss TPH	Natacha Protopopoff (PI, Entomo)
	Georg Loss (Health Economist)
LSHTM	Jackie Cook (Co-PI, Epi)
	Nancy Matowo (Ento)
	Sanni Ali (Epi)
U-Ottawa	Manisha Kulkarni (spatial epi)

Affiliation	Investigators Part 1
MSF-OCB	Corey LeClair (PI part 1, ento)
	Iro Evlampidou (Co-PI part 1, Med, Epi)
	Laura Cremonini (Co-I, Med)
	Azzurra D'Incà (Co-I, Wash)



Fundings

- Part 1 : MSF-OCB
- Part 2: Coefficient Giving (Open Philanthropy)

RBM Partnership
To End Malaria

4 March 2026

Presentation 1: ITN Campaign Implementation in Sudan: Operational Adaptations in a Humanitarian Context.

Sudan NMCP

Presentation 2: Reflections on what worked and where additional support may be most useful going forward.

Ida Ameda, UNICEF



UNICEF support to the ITN mass campaign in hard-to-reach states in Sudan

Vector Control in Humanitarian Settings Session, 4 Mar 2026

Achievements

- Over 16 million bed nets procured and delivered in Sudan.
- Over 12.5 million nets distributed in 12 States with further 1.3 million currently at localities in North Darfur.
- Nets loaded for distribution for Plan B- nets originally planned for West Kordofan & South Kordofan- relocated for IDPs.
- Over 25 millions people accessed key malaria prevention and SBC messages ensured people wanted their nets.
- No demurrage fees paid and all waivers received in good time.



UNICEF's role

- Procuring and identifying ports of entry, arranging transport routes, and importing bednets.
- In-country logistics:
  - Storage at hubs
  - Delivery to the state level in all 12 states.
  - Differentiated approach (delivery to locality level and some state hubs).
  - Coordinating & supporting with SMOH in 6 states
- Paying 8,304 Front line workers
- Ensuring local authorities were aware and supported the campaign
- Engaging partners with capacity to deliver on the ground, SRCS, Autash, PHF, Sahari.



Key factors driving success

- UNICEF worked with several manufacturers to reduce lead time and risk
- Timely provision of samples for waivers
- High Level Committee with all key Ministries
- Weekly meetings with stakeholders
- Close coordination with Humanitarian Aid Commission for approvals
- Close coordination with local authorities
- Continuous improvement process-lessons learned in Phase 1 taken forward in Phases 2 and 3



Demonstrating agility

- Continuous management of risks and risk mitigation measures
- Time lag between macro-plan and campaign, significant differences in populations
- Detailed budgeting in June/July 2024, actuals costs incurred May- Nov 2025
- Costs of in-country distribution increased
- Many FLWs do not have bank accounts, lack of cash in country
- Temporary closure of Port Sudan Port
- Early start of the rainy season
- Supporting ITN tracking survey in hard-to-reach states.



Phase 1: Actual nets distributed

States	No. of HHs registered	No. of HH Members	No. of ITNs needed based on HHR	Total number of ITNs distributed	ITN distribution allocation
White Nile	417,144	2,322,510	1,288,868	1,086,287	Round down & capping
Blue Nile	321,114	1,955,357	1,036,941	786,900	Round down
Gedarif	587,647	3,561,677	1,694,051	1,682,300	Round down
North Kordofan	156,761	879,394	472,575	415,038	Round down
South Kordofan	232,169	1,400,948	628,485	616,450	Round down
Total	1,714,835	10,119,886	5,120,920	4,586,975	

Phase 2: Actual nets distributed

State	Population from macroplan	Population from registration	%	Nets distributed
Kassala	2,079,877	3,106,661	49.4	1,211,500
Sennar	1,764,204	2,265,016	28.4	826,996
Gezira	3,587,393	6,660,564	85.7	1,681,621
South Darfur	3,746,739	4,574,235	22.1	2,081,522
West Darfur	1,856,682	2,134,928	15	1,031,059
East Darfur	1,161,300	2,049,128	76.5	645,167
Central Darfur	1,709,020	1,958,412	14.6	949,455
Total	15,905,215	22,748,944	43	8,427,320

North Darfur localities

No.	Locality	Population	HHs	ITNs
1	Dar As Salam	280,401	50982	122,867
2	Al Fashir	58,360	10611	27,956
3	At Tawisha	153,120	27840	67,094
4	Kebkabiya	342,100	62200	149,902
5	Kelemando	265,290	48235	116,245
6	Kutum	144,700	26309	63,405
7	Melit	212,450	38627	93,092
8	Saraf Omra	126,212	22948	55,304
9	Um Kadadah	105,100	19109	46,053
10	Al Lait	215,750	39227	94,538
11	Tawila	690,523	125550	302,575
12	Al Waha	59,250	10773	25,962
13	Al Koma	135524	24641	59,384
Total		2,788,780	507,051	1,224,377



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Thank you!



UNICEF support to the ITN mass campaign in hard-to-reach states in Sudan

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Thank you!

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To End Malaria

Q&A and discussion

What works, what adapts, and what is still missing for malaria and vector control in emergency control.

Moderated by Joseph Lewinski & Corey LeClair, VCWG Task Team leads



4 March 2026

Thank you for attending!

Day 3, 5th March - Workshop