Kakamega ENSO & VBD Pilot Project: Malaria and Mosquitoes

PI	Githeko A. K.	KEMRI
Grant number	US, Dept, Commerce, NOAA, OGP, PDO# NA98AANAG0396).	
Duration:	February 1999-Feb 2000	
Amount	US $ 15,400.00	

The project was a collaborative study between the Kenya Medical Research Institute and the International Centre for Insect Physiology and Ecology.
Under NOAA's ENSO Experiment project a pilot project was funded to study the impact of the 1997/98 El Nino Southern Oscillation Event on malaria in western Kenya. The project was located in Kakamega District western Kenya, at a highland site (altitude, 1500m) where malaria epidemics have previously occurred. The study entailed collecting entomological data from village houses, parasitologic data from school children at Iguhu village, malaria hospital-admissions at Mukumu Hospital and meteorological data at Kakamega town. A short transect design (4KM) was used for mosquito and parasite sampling. The hospital and meteorological station were within a radius of 12km of the study site.

Study I Predicting malaria epidemics using climate data

Field studies were carried out from February 1999 to February 2000. In addition hospital historical malaria admission data and meteorological data were obtained for the period 1997 to 2000. Analysis of this data indicated that malaria epidemics such as the one that occurred during the 1997/98 El Niño event were preceded by a large anomaly in the mean monthly maximum temperature. The minimum temperature did not show any specific relationship to malaria transmission. Using this data a model that uses mean monthly maximum temperature anomalies and mean monthly rainfall threshold data as co- factors in the initiation of malaria epidemics was developed (Fig 1).

Figure 1. Relationship between malaria epidemics and mean monthly maximum temperature anomaly in Kakamega district

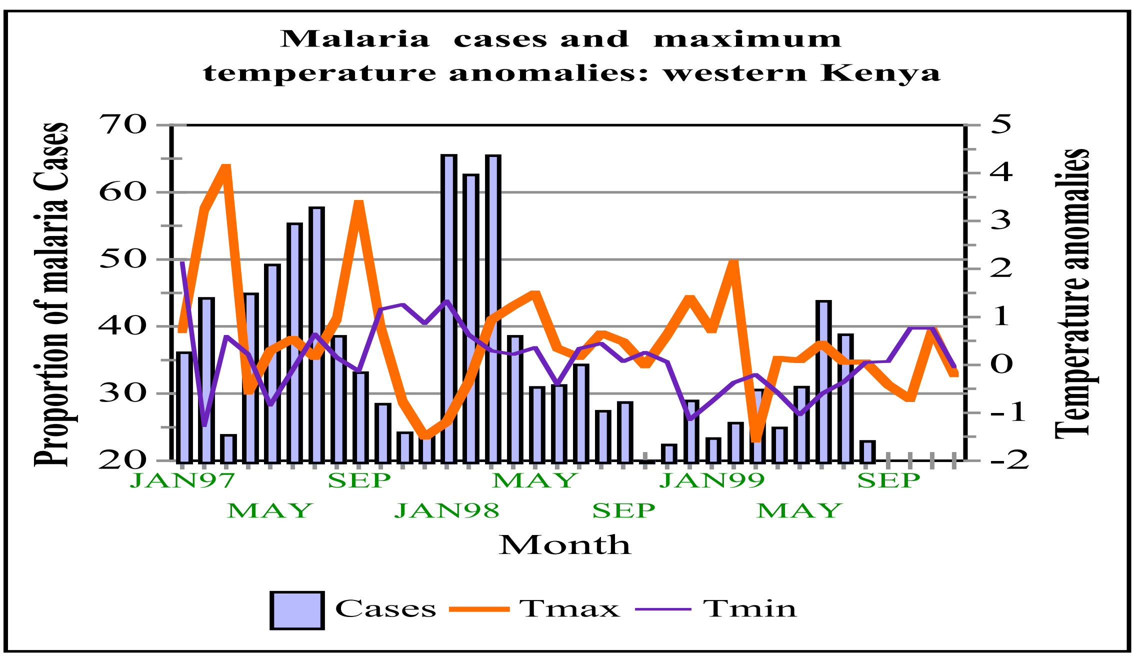


Figure 2. Children at Iguhu primary school who took part in the study
Two thirds (66%) of them had malaria parasites in their blood and many missed school because of malaria

Figure 3 The malaria epidemic prediction model

Epidemic prediction model equation

$$ER = \frac{T^{i} + R^{i}}{T^{m} + R^{m}} x\, 100$$

Where ER is the epidemic risk

$\mathbf{T^{i}}$ is the mean monthly maximum temperature anomaly

$\mathbf{R^{i}}$ is the mean monthly rainfall above 150 mm threshold for *An. gambiae*

$\mathbf{T^{m}}$ is the maximum intensity index for monthly mean temperature anomaly

$\mathbf{R^{m}}$ is the maximum intensity index for monthly mean rainfall anomaly

Rainfall above 300 mm per month takes on negative index values as such rainfall causes flashing of larvae thus reducing transmission.

ER above 50% indicates a high risk of an epidemic

Figure 4 An automatic weather station installed at the study site. Scientists from Kenya, Tanzania and Uganda visiting the sites during a training program

The output of the model, epidemic risk, showed a significant correlation, with a lag of three months to the proportion of malaria cases out of the total hospital inpatient admissions. This model is able to detect an epidemic 3-4 months before the event. The model has been validated at another site. Besides the ability to predict malaria epidemics, it also has potential to estimate the size of the outbreak. Furthermore, it can be used to simulate the effects of climate anomalies on the numbers of people infected with malaria.

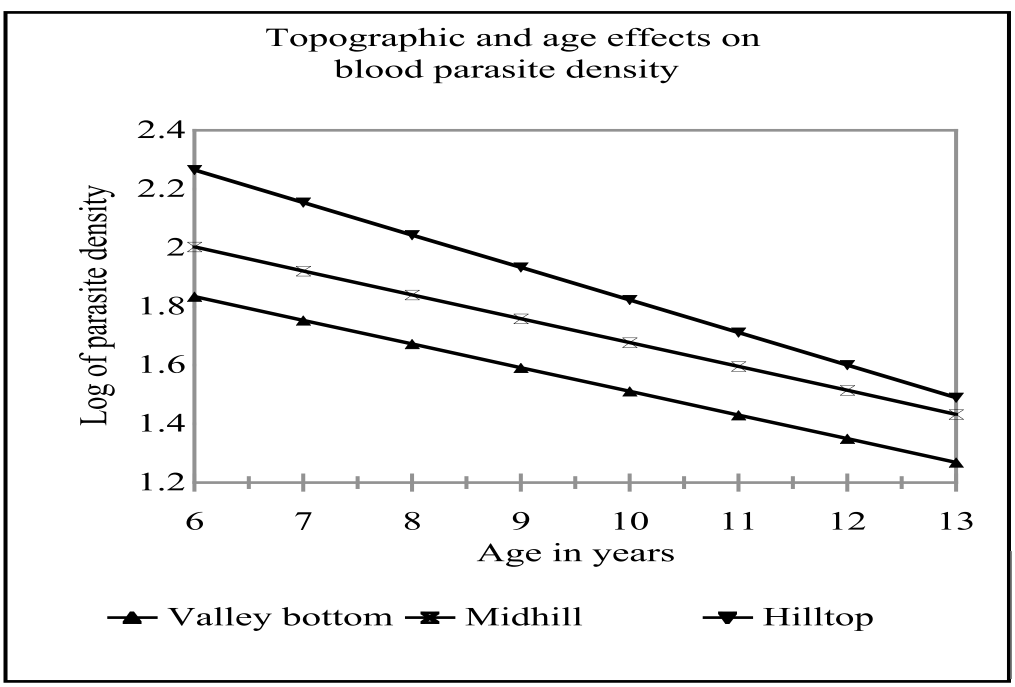
Publication

Githeko AK, and Ndegwa W. (2001). Predicting malaria epidemics using climate data in Kenyan highlands: a tool for decision makers, *Global Change and Human Health. 2: 54-63*

Study II Topography and malaria transmission

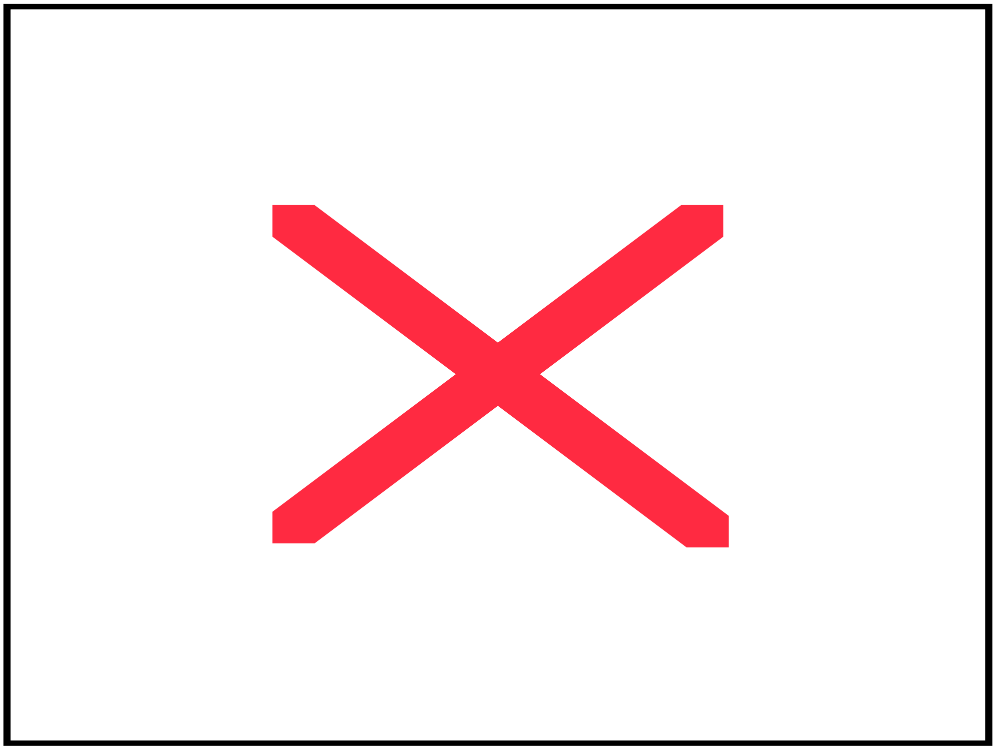
Parasitologic results indicated that malaria immunity is a function of topography in the highlands and that immunity can vary tremendously over very short distances e.g. 2km. Within a distance of 4 Km the prevalence of malaria varied from 22-66 % resulting in two human populations where one is a reservoir of parasites and the other a highly susceptible group. These results indicated which populations are likely to suffer chronic (anemia) and the severe form of the disease (cerebral malaria) due variation in immunity.

Figure 5 The mean density of parasites in blood in each age group in the general population is an indication of the level of immunity



Children living at the top of the hill had the least immunity while those at the bottom of the valley were most immune.

Figure 6 Children at the top of the hill developed most parasites during the main malaria transmission. The more parasites in the blood the more likely the infection will develop into serious disease

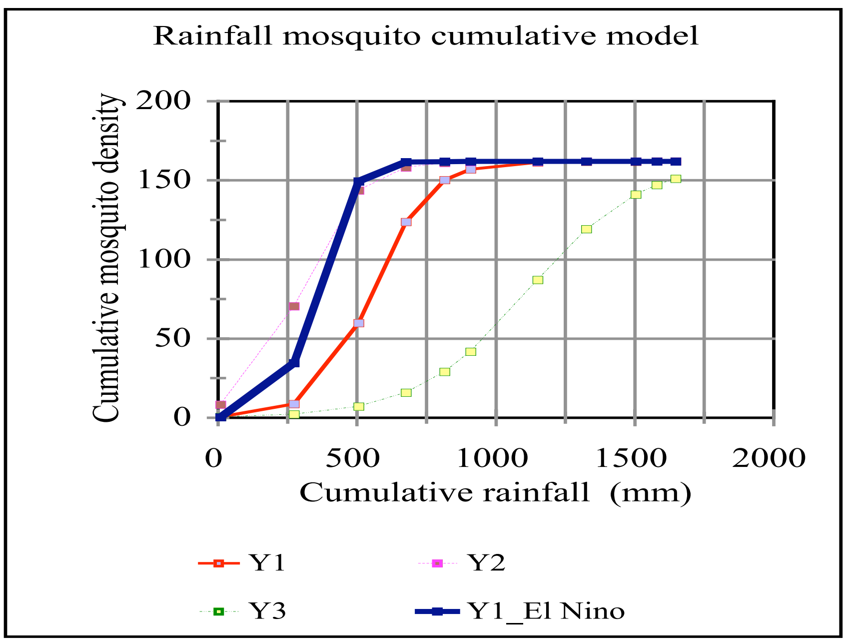


Publication

Githeko et al (2003). Topography and malaria transmission heterogeneity in western Kenya Highlands: prospects for vector control. *Journal of Tropical Medicine and International Health (submitted September 2003*)

Study III Modeling rainfall and indoor mosquito abundance

Previous to our study the mathematical relationship between the amount of rainfall and the numbers of mosquitoes biting and resting in houses was unknown. During this study we found a non-linear relationship between the cumulative mosquito densities in house and cumulative monthly rainfall. The relationship is a sigmoid curve, which we speculate is also a function of temperature. This awaits confirmation. Relationships between mosquito populations, temperature and rainfall could be linked to malaria incidence in a human population and this would enable the prediction of the effects of climate change and variability on malaria. The model developed has the potential to forecast trends in mosquito population dynamics and malaria transmission in different habitats using rainfall and temperature data.



.

Publication

Githeko *et al* (2003). Simulating indoor resting densities of *An. gambiae* using a climate-ecological model (In preparation)

NOAA OFFICE OF GLOBAL PROGRAMS
FILE INFORMATION FOR GRANT GC98-993
Title: Kakamega ENSO & VBD Pilot Project: Malaria and Mosquitoes

Principal Investigator	Andrew K. Githeko
Co PI(s)	Dr. John Githure International Centre for Insect Physiology and Ecology jgithure@icipe.org
Funding period	FY98
Institution	Kenya Medical Research Institute
Address	Centre for Vector Biology and Control Research, Climate and Human Health Research Unit P. O. Box 1578 Kisumu 40100
Phone 1	254 57 22923
Phone 2	245 722 849382
Fax	254 57 22981
e-mail	AGitheko@kisian.mimcom.net
Other partner Institutions	International Centre for Insect Physiology and Ecology
Publications	**Githeko AK,** and Ndegwa W. (2001). Predicting malaria epidemics using climate data in Kenyan highlands: a tool for decision makers, *Global Change and Human Health. 2: 54-63* Githeko et al (2003). Topography and malaria transmission heterogeneity in western Kenya Highlands: prospects for vector control. *Journal of Tropical Medicine and International Health (submitted September 2003*) Githeko *et al* (2003). Simulating indoor resting densities of *An. gambiae* using a climate-ecological model (In preparation)
Conference presentations	**1 Kenya Meteorological Society Conference (2000)** **2 Eighth Climate Outlook Forum for the Great Horn of Africa, Jinja, Uganda August 2001** **3 Ministry of Health, Facilitation workshop on Malaria Epidemics In Kenya, September 2001** **4 Climate and Health course, May 15-18, ACMAD, Niamey, Niger** **5 Capacity Building training workshop on reducing the health impacts of ENSO, Drought Monitoring Centre Feb 2002** **6 Ministry of Health, National Malaria Stakeholders Meeting September 2002** **7 The 51st American Society of Tropical Medicine and Hygiene Symposium on epidemic malaria, Denver Colorado USA November 10-14th 2002** **8 The 16th International Congress on Biometeorology,**

	Kansas City, USA, 28th October – 1st November 2002 9 **The Twelfth Climate Outlook Forum for the Great Horn of Africa August 2003**