# EVALUATING THE POTENTIAL OF THE VECTRI MODEL TO PREDICT MALARIA CASES IN ASHANTI REGION.

Alex Kwao Ablerdu [1*], Gloria Folley[1], Emmanuel Amankwaah[1], Edmund Ilimoan Yamba[1], and Kingsley Badu[2]

[1]Department of Meteorology and Climate Science, KNUST.

[2]Department of Theoretical and Applied Biology, KNUST.

*Correspondence: alexkwao100@gmail.com

COLLEGE OF SCIENCE

Kwame Nkrumah University of Science & Technology

## Abstract

In this study, we evaluated the ability of VECTRI, a climate-driven malaria model, to simulate symptomatic malaria cases across the Ashanti Region of Ghana. We drove VECTRI with daily temperature, rainfall, and population density as input data and reproduced malaria cases for the region. Using Mean Absolute Error and Mean Bias Error as statistical performance metrics we compared the simulated cases from VECTRI with the observed. We found that VECTRI successfully reproduced the observed bimodal malaria peaks and seasonal patterns, though with a one-month lag and underestimation of total cases (mean bias = –287.05). The model showed a strong correlation with observed malaria cases (R = 0.74, p = 0.006) and identified persistent hotspots in districts such as Adansi North, Obuasi, Sekyere Afram Plains, and Kumasi. Despite data limitations, results demonstrate VECTRI's potential as a climate-based early warning tool for malaria control. The study recommends refining VECTRI's parameter settings for climate-informed malaria surveillance and control.

## Introduction and Objectives

Malaria is endemic in the Ashanti Region of Ghana, with *Plasmodium falciparum* as the dominant parasite species [1]. This hyper-endemic disease is a causal factor for the country's high morbidity and mortality rates, especially among children under 5 [2].

This study aims to evaluate the capability of the VECTRI model in predicting malaria cases in Ghana's Ashanti Region. It focuses on assessing the model's accuracy at monthly timescales and its ability to represent spatial and temporal transmission patterns. The goal is to establish VECTRI as a reliability climate-based global malaria prediction tool.

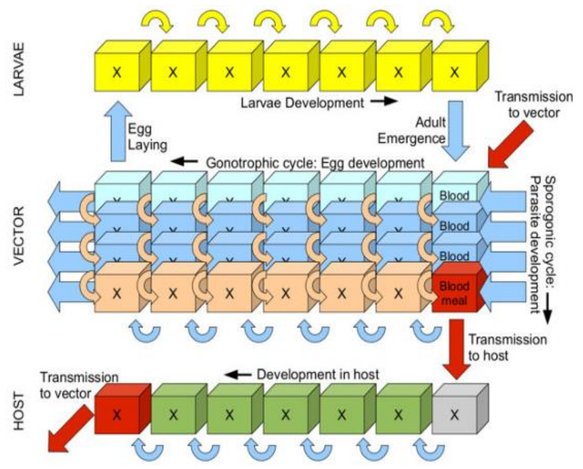


**Fig. 1: Structural layout of the VECTRI model**

## Research Significance

This research demonstrates VECTRI's potential as a climate-driven malaria early warning tool to support targeted interventions and public health policy in Ghana's Ashanti Region.

## Data and Methodology

**Table 1:** Datasets used for the study

| Dataset | Sources | Temporal Resolution | Spatial Resolution | Time span |
|---|---|---|---|---|
| **Malaria Cases (observations)** | Ghana Health Service | Monthly | Point source data | 2012-2017 |
| **Rainfall** | CHIRPS | Daily | 0.25° x 0.25° | 1990 – 2024 |
| **Temperature** | ERA5 | Daily | 0.25° x 0.25° | 1990 – 2024 |
| **Population Density** | Ghana Statistical Service | Yearly | Point source data | 1990 – 2024 |

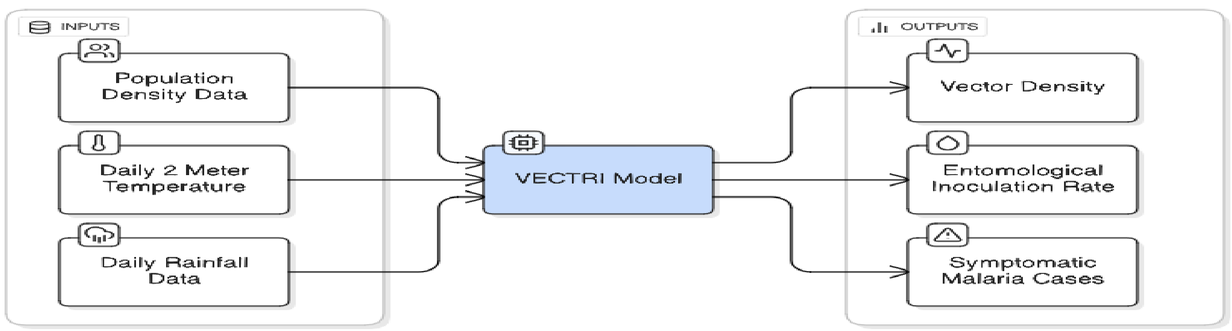


**Fig. 3: VECTRI model Workflow**

### Statistical equations

$$\mathrm{MBE} = \frac{\sum_{i=1}^{n}(P_i - O_i)}{n} \qquad \textbf{Eqn 1.}$$

$$r = \frac{\sum_{i=1}^{n}(S_i - \bar{S})(O_i - \bar{O})}{\sqrt{\sum_{i=1}^{n}(S_i - \bar{S})^2}\sqrt{\sum_{i=1}^{n}(O_i - \bar{O})^2}} \qquad \textbf{Eqn 2.}$$

## Results

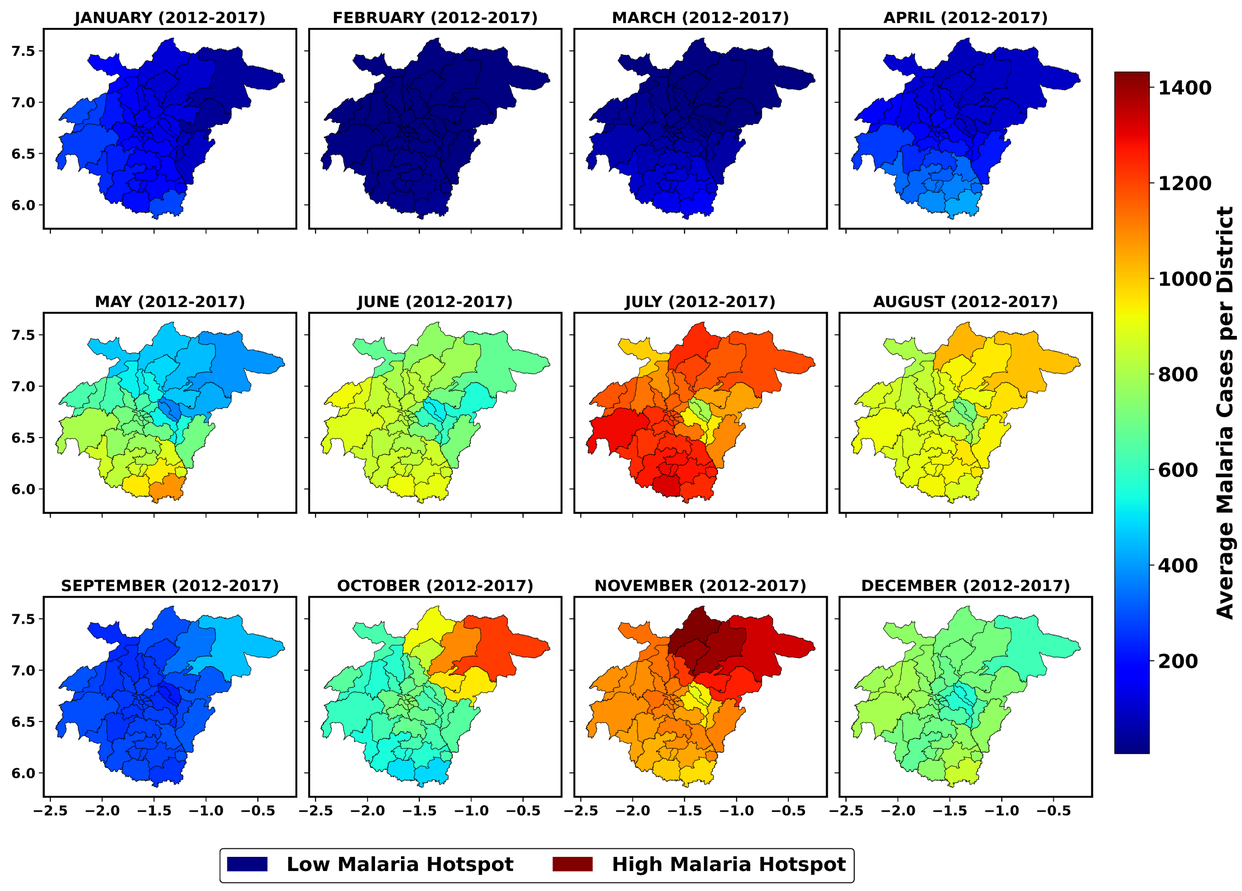


**Fig. 4: Spatial plot of VECTRI symptomatic malaria cases**

## Results

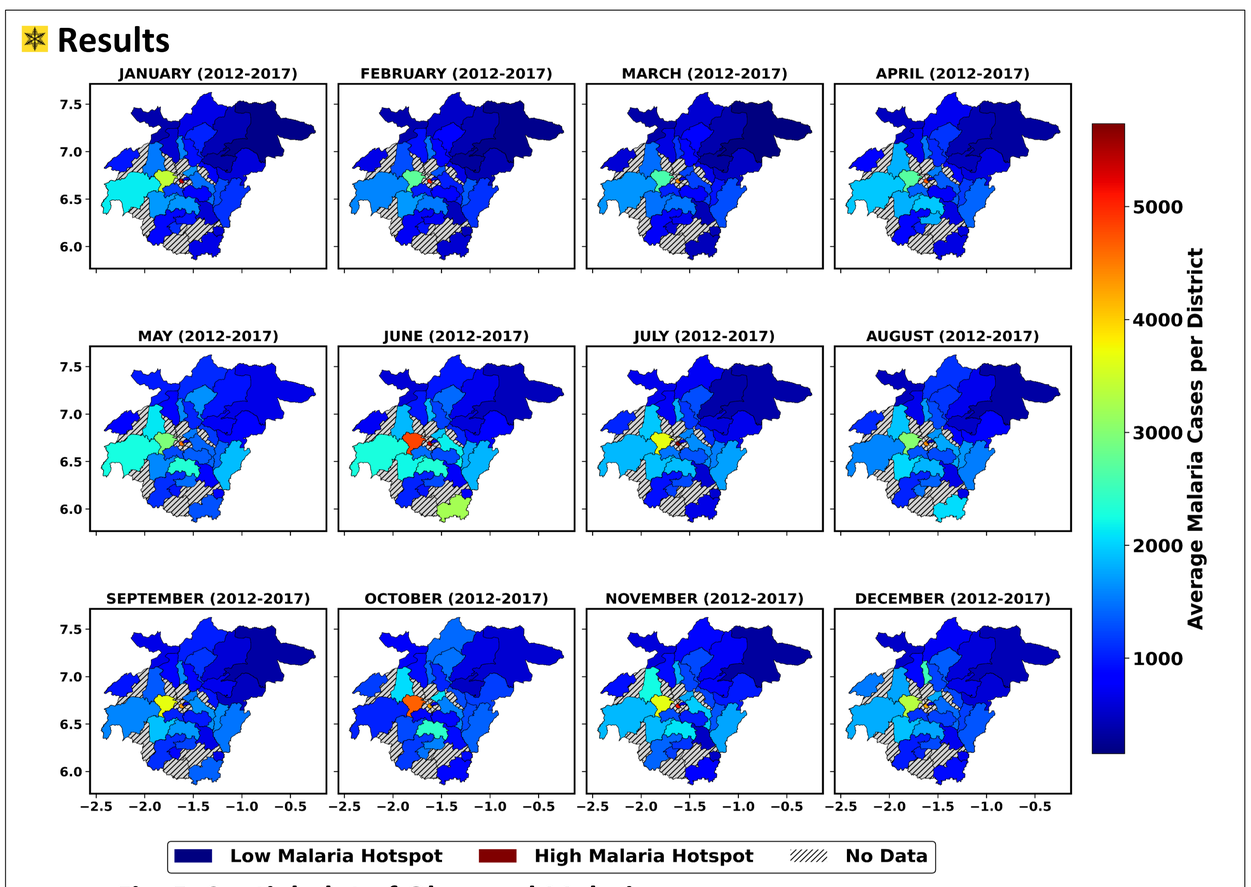


**Fig. 5: Spatial plot of Observed Malaria cases**

## Case Trends for Observed and VECTRI malaria cases Across Multiple Districts

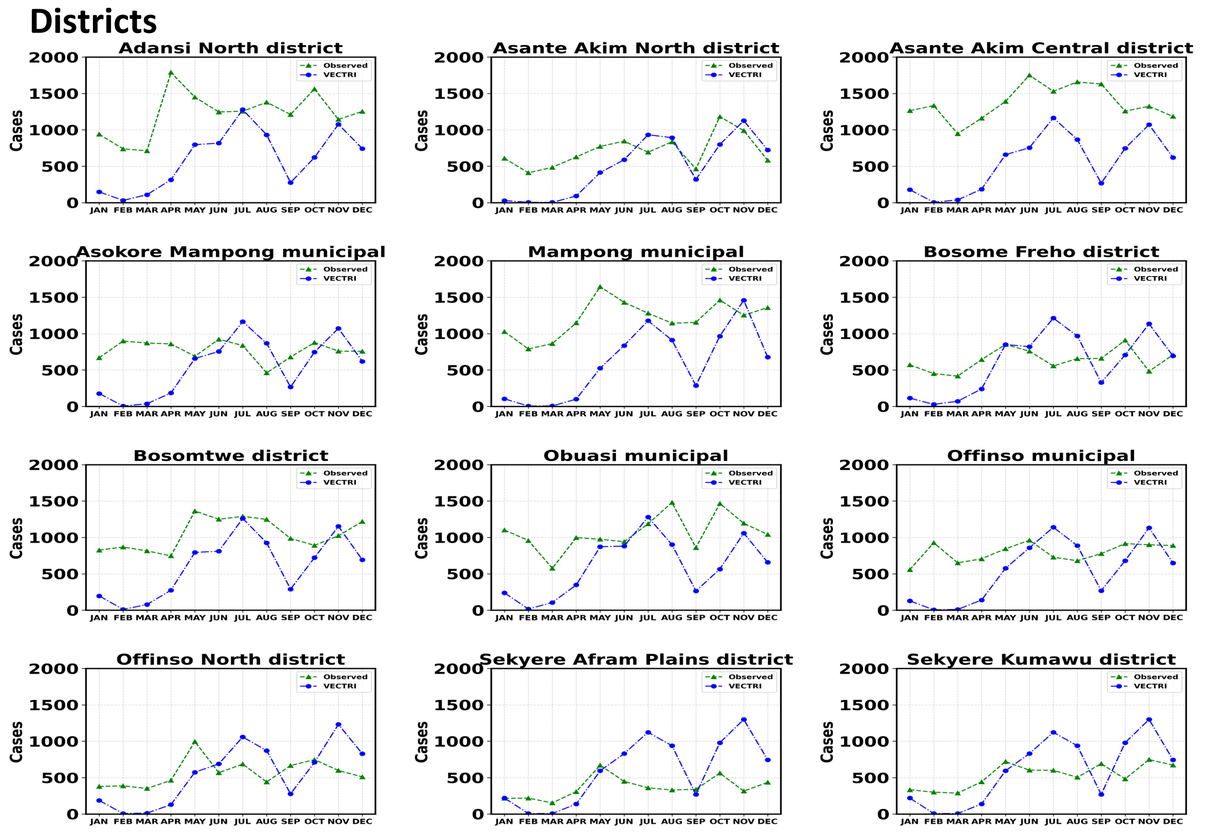


**Fig. 6: Temporal plot showing trends of VECTRI simulated cases and Observed Malaria Cases over time**

## Conclusion and Recommendations

- VECTRI effectively simulated malaria transmission in the Ashanti Region, capturing seasonal trends in vector density, EIR, and malaria cases.
- VECTRI simulated cases positively corelated strongly with observed malaria cases (R = 0.74, p = 0.006) but at a lag of 1.
- VECTRI tended to overestimate in wet seasons and underestimate in dry periods, with overall underestimation (MBE = –287.05).
- The Ghana Health Service (GHS) and the National Malaria Elimination Programme (NMEP) should intensify targeted interventions such as LLIN distribution, IRS, and climate-based surveillance in high malaria hotspots, while sustaining monitoring and education in low-risk areas.

## References

- Badu, K., Brenya, R. C., Timmann, C., Garms, R., & Kruppa, T. F. (2013). Malaria transmission intensity and dynamics of clinical malaria incidence in a mountainous forest region of Ghana. *MalariaWorld Journal*, *4*, 14.
- Asare, E. O., & Amekudzi, L. K. (2017). Assessing climate driven malaria variability in Ghana using a regional scale dynamical model. *Climate*, *5*(1), 20.

## Acknowledgement

The authors sincerely acknowledge the Ghana Health Service (GHS) and the Ghana Statistical Service (GSS) for providing the data that made this research possible.

## Contact Information

- Email: alexkwao100@gmail.com, amankwaahemma2@gmail.com, amagloria346@gmail.com, eyilimoan48@gmail.com
- Phone: 0201968461, 0503855995, 0209686581, 0200876117