



Climate - Malaria Link: An Introduction

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1. Introduction

- ❖ Globally in 2023 malaria cases are were around 263 million, incidence was 60.4 cases per 1000 population at risk.
- ❖ Globally in 2023 597,000 deaths were recorded, 76% of death was children under 5 years old.
- ❖ In 2023 Africa shares 94% cases and 95% of the death.

Cont...

Ethiopia



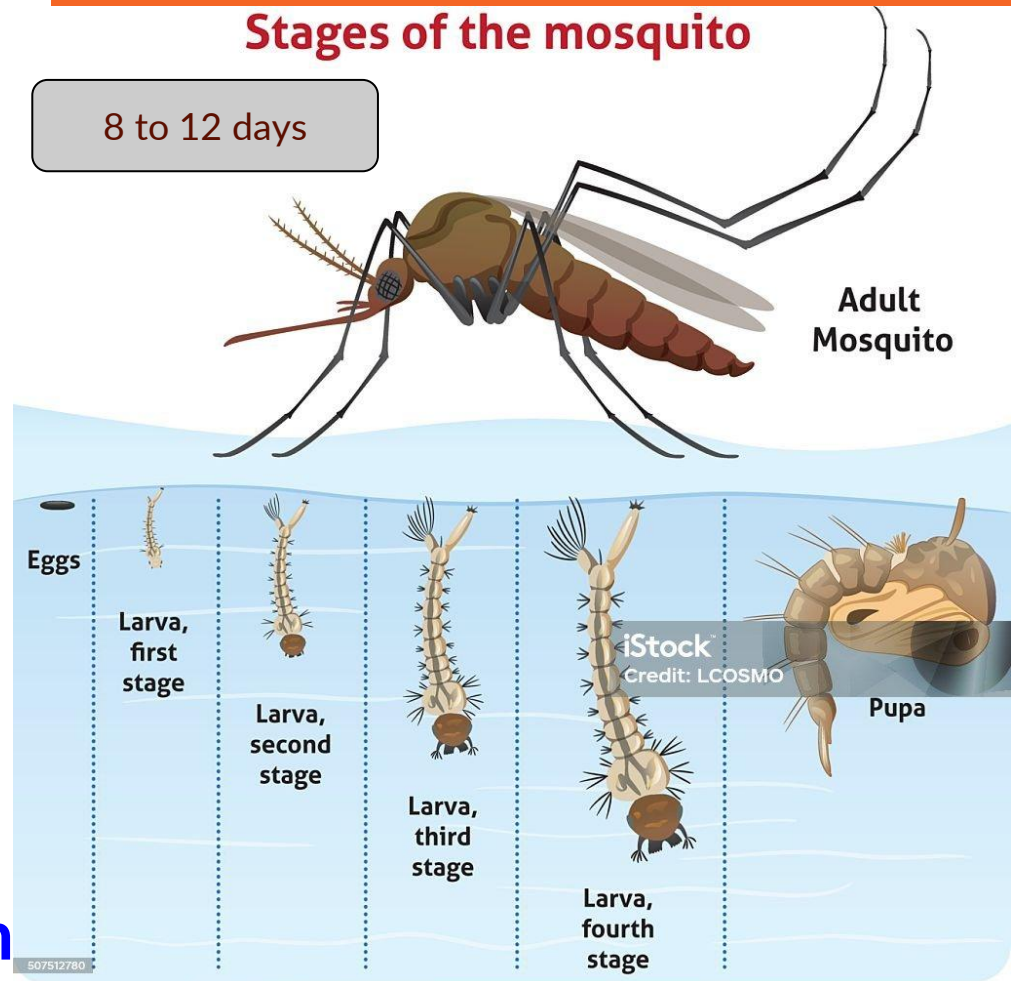
- ❖ Around 60% of the population is at risk of malaria disease
- ❖ 76 million Ethiopian are within various exposure of malaria
- ❖ 78% landmass of Ethiopia is malarious
- ❑ **Malaria is a burden on morbidity and mortality.**



2. Vector Life Cycle

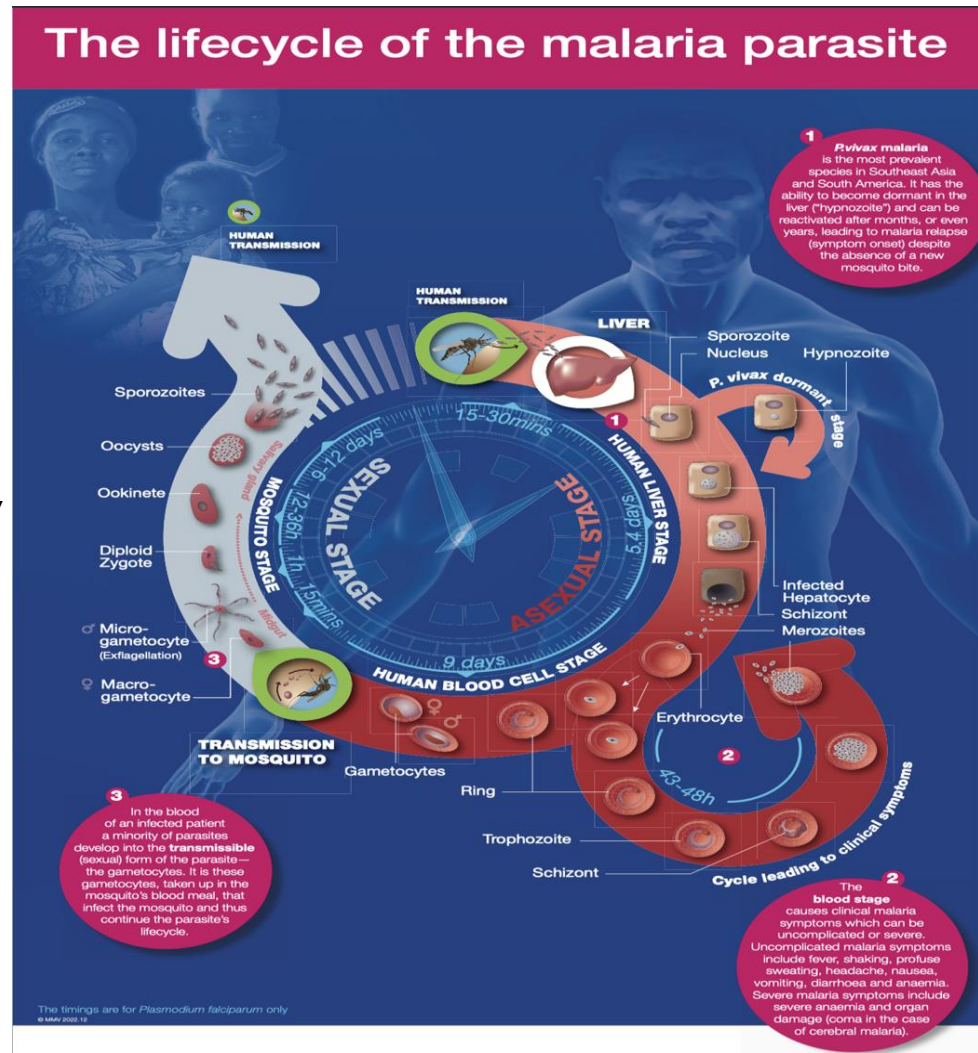
- ❑ Female Mosquito requires blood to lay eggs
- ❑ Stage (egg, larva, pupa, adult)

Growth: affected by temperature and environment



3. Parasite Development and transmission

- ❑ Anopheles mosquitoes transmit malaria
- ❑ Anopheles (*arabiensis*, *pharoensis*, *funestus*, *nili*)
- ❑ 95% of transmission is carried out by *A. arabiensis*
- ❑ Parasites: *Plasmodium* (*falciparum*, *vivax*, *malariae*, *ovale*)
- ❑ Pf (60% infection), Pv (40% infection)



1. Human Liver Stage

Mosquito bite, Virus enters in to the liver,

2. Human Blood Cell Stage

Clinical symptoms

3. Mosquito Stage

Infected person can transmit to mosquito

Temperature

- ❑ Minimum threshold: $\sim 16^{\circ}\text{C}$ for most *Anopheles* species
- ❑ Optimal range: $25\text{-}28^{\circ}\text{C}$
- ❑ Lethal threshold: $>37^{\circ}\text{C}$

Parasite Development (EIP):

- ❑ Below 16°C : parasites cannot complete development
- ❑ At 20°C : EIP ≈ 23 days
- ❑ At 30°C : EIP ≈ 9 days



Humidity (RH)

- ❑ **High** humidity: increased flight activity (60 - 80%)
- ❑ Low humidity: mosquitoes shelter, reducing biting ($<40\%$)
- ❑ **Indoor vs Outdoor**: Houses often provide more stable humidity

Hydrology

- ❑ Temporary pools
- ❑ Irrigation areas

Rainfall: creates the breeding habitat

4. Host and Environmental Factors

Environmental factors

- ☐ Favorable ecosystem for the vector to exist, breeding
- ☐ Direct: Temperature, Humidity, and Water features
- ☐ Indirect: Altitude, Vegetation, and Rainfall

Host

- ☐ Human body (liver, red blood cell)
- ☐ Human population density





5. Modeling approaches: Statistical (trend)

Table1.current and future trends of malaria

Total malaria case in 2020 (baseline)	Forecasted malaria cases	
	2024	2025
1,073,878	1,175,648	1,220,448
Rate of increase from baseline (%)	9.5	14

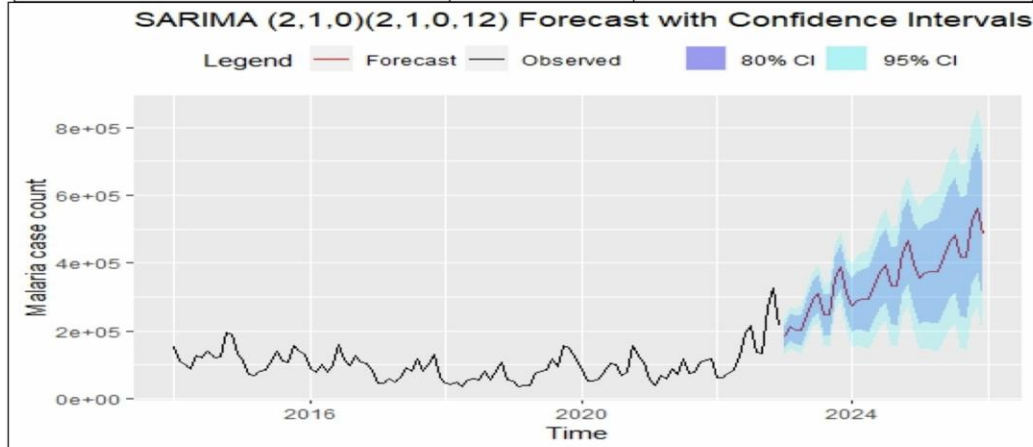


Fig3. Future malaria forecast

Modeling approaches: trend

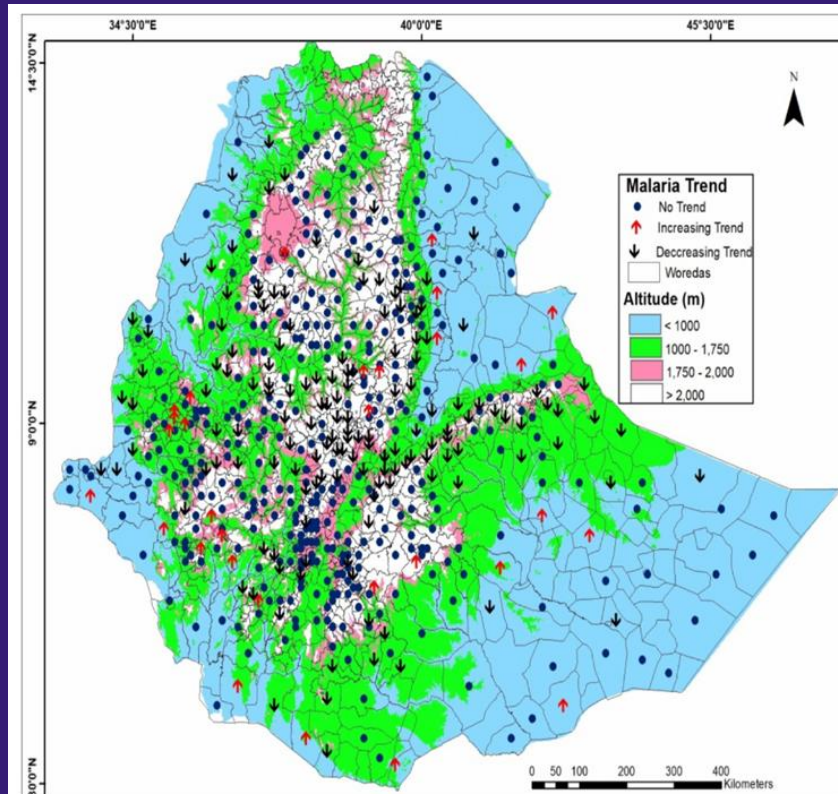


Fig.1 Malaria case incidence trend in Ethiopia

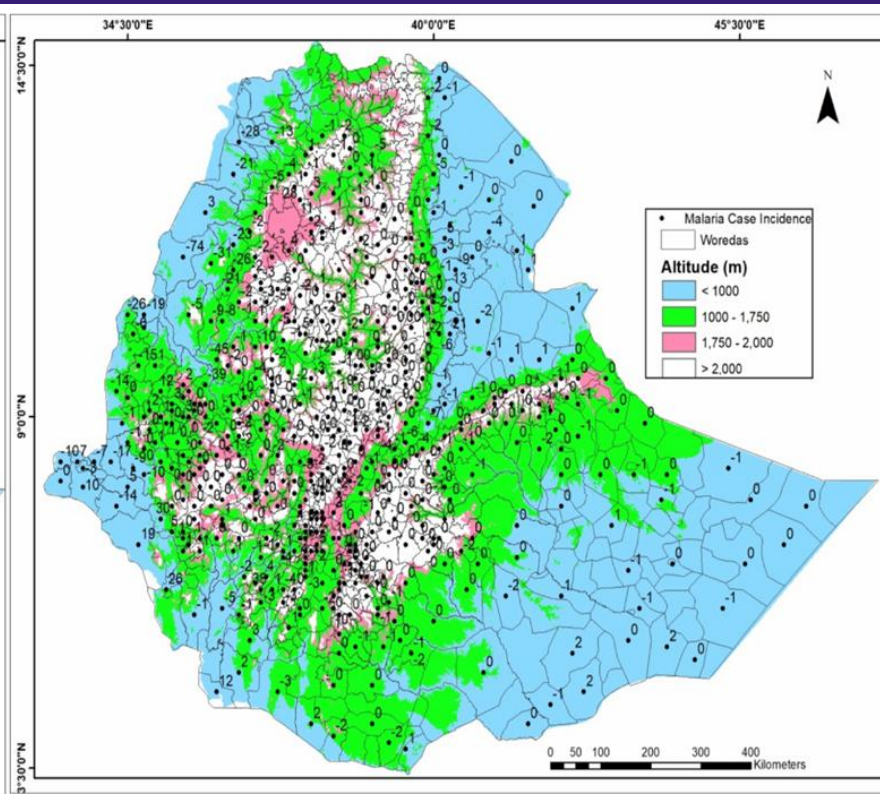


Fig.2 Malaria case incidence (cases per 1000 population at risk) in Ethiopia



Modeling approaches: Mathematical model

Human

Susceptible

Exposed

Infected

Recovered

Vector

Susceptible

Exposed

Infected

Figure 1 The flow chart for transmission of malaria disease

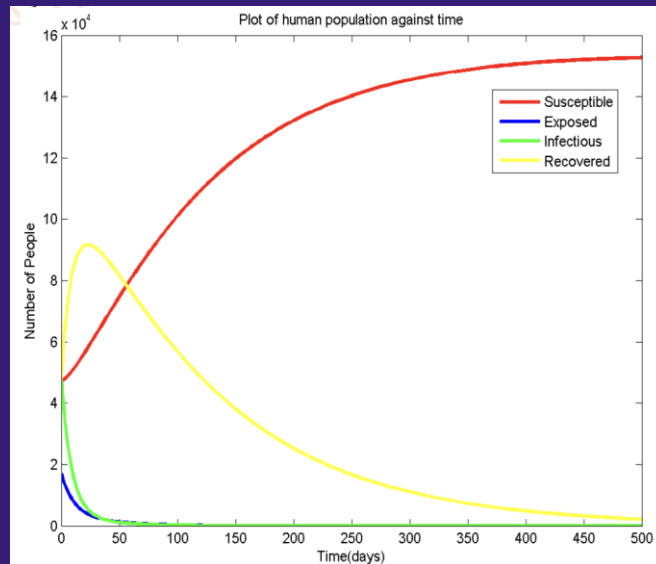
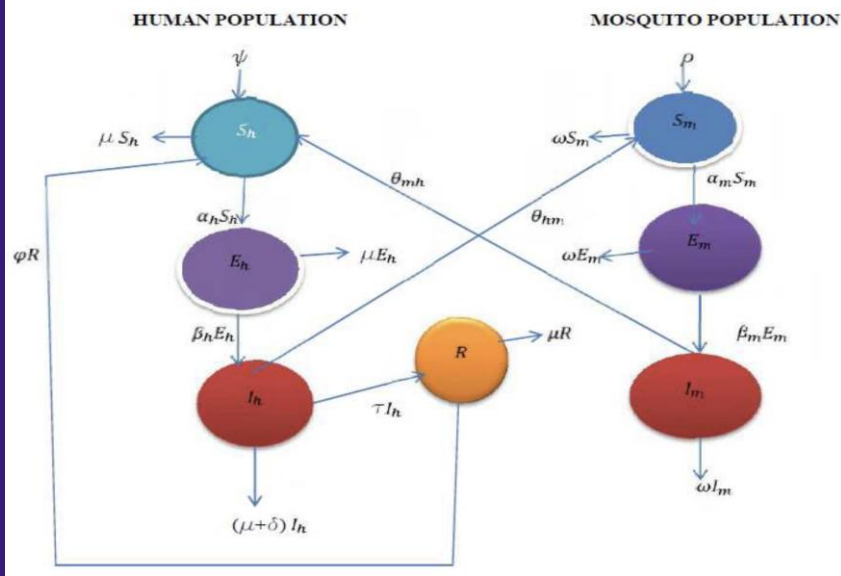
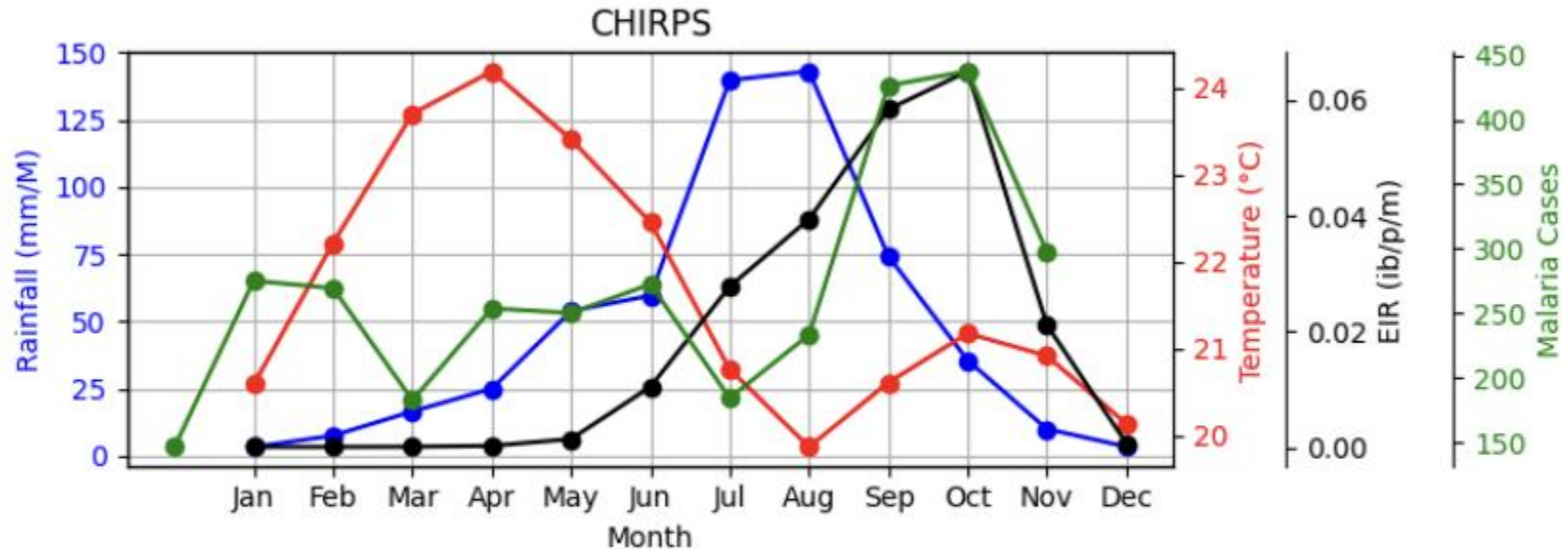


Figure 2:- A phase portrait illustrating the changes in the four state variables of the malaria model showing the system with time, of susceptible humans, exposed humans, infected humans and shows the system of recovered humans with $R_0 = 1.3874$.

Fekadu Tadege Kobe (2019). SEIR model and simulation for controlling malaria disease transmission without intervention strategies. IJTSRD, 3(6), 2456 - 6470

Modeling approaches: relationships (VECTRI)



Adapted from Hailu Fenta, 2025
(unpublished)

(a) CHIRPS

Vectri Model Results

Adapted from Hailu
Fenta, 2025
(unpublished)

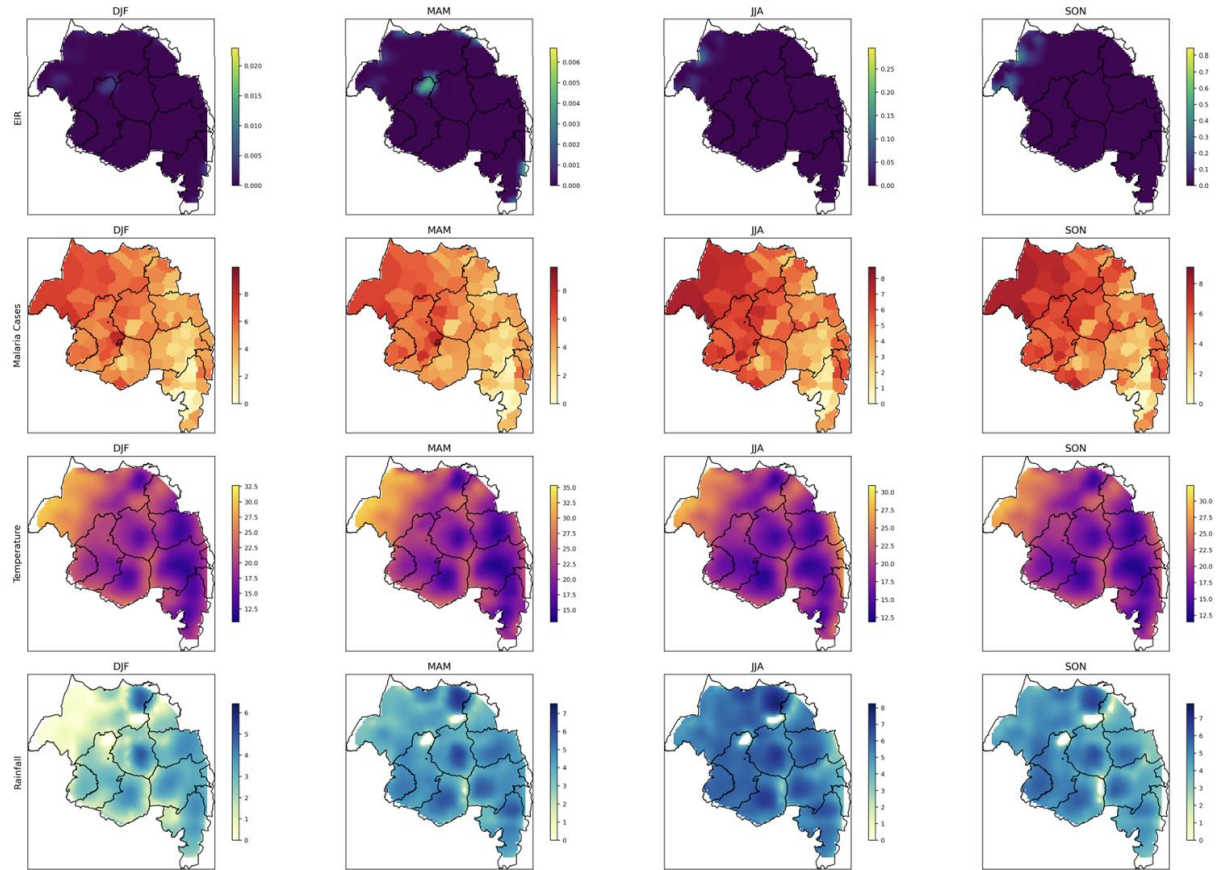


Figure 4.6: Comparison of the spatial variability between the data of the number of observed cases of malaria rain, temperature, and EIR in Amhara Region from 2013–2019:

References

- ❑ <https://www.open.edu/openlearncreate/mod/oucontent/view.php?id=88§ion=20.5.1>
- ❑ Hailu Fentaw (2025, unpublished). ASSESSMENT OF CLIMATE DRIVEN VARIATIONS IN MALARIA TRANSMISSION IN AMHARA REGION USING THE VECTRI MODEL
- ❑ WHO. (2024). World malaria report 2024: Addressing inequity in the global malaria response.
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Thank you!

Open for Questions, feedback and suggestions

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