Relative effects of climate factors and malaria control interventions on changes of parasitaemia risk in Burkina Faso from 2014 to 2017/2018

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Background

- Malaria poses a major global health threat, particularly in sub-Saharan Africa. It is among the epidemics that the United Nation's SDG 3 aims to eliminate by 2030 [1].
- In Burkina Faso, around 8 million cases and over 16,669 deaths related to malaria were recorded in 2022, of which more than 50% were children under the age of five [2,3].
- Despite reduced prevalence following the scale-up of control measures in Burkina Faso over the two past 10 years, climatic factors still influence malaria parasite development, potentially reversing intervention success.

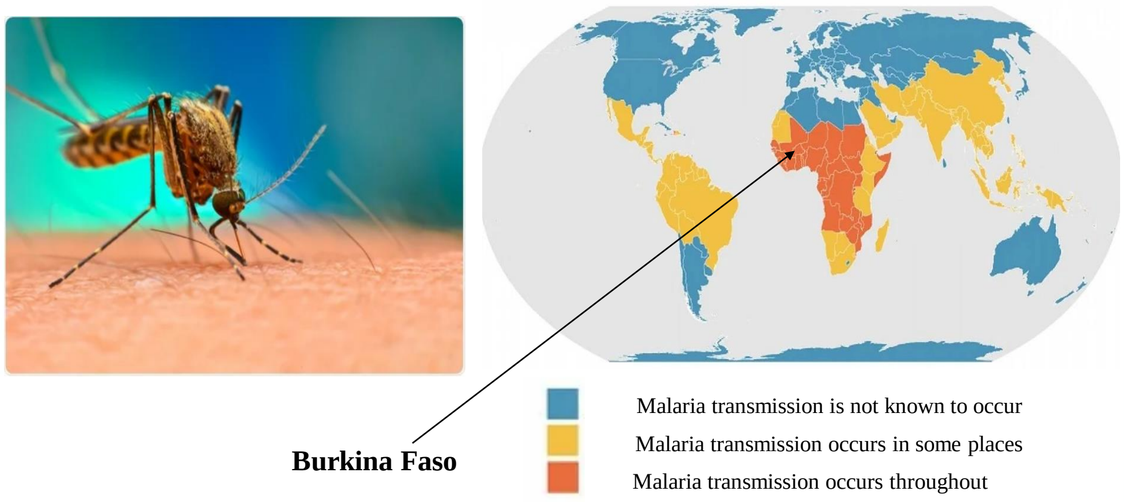

Fig: Female anopheles mosquito and the world malaria map 2023

Data and methods

Data sources:
- Malaria data: Malaria Indicator Survey data of Burkina Faso.
- Climatic data: Remote sensing data.

Outcome variable: prevalence of malaria in children under the age of five tested by microscopy.

Predictors: Insecticide treated nets (ITNs), artemisinin-based combination therapy (ACT) coverage, day and night land surface temperature (LST), altitude, night lights, and distance to water bodies.

Statistical analysis:
- Bayesian geostatistical logistic regression with mixed random effect model.
- Bayesian kriging was carried out to predict parasitaemia risk at a 2x2 km² spatial resolution grid.
- Estimation of the number of infected children at 1 km² spatial resolution.
- Spatially varying coeficients model.

Objective

To estimate the differential effect of malaria interventions and climatic factors on the temporal changes of malaria parasite prevalence ~~of~~ in children under the age of 5 years in Burkina Faso during the period of 2014 to 2017/2018.

Results

Key findings:
- Bed nets contributed more than climatic factors to the reduction of parasitaemia risk at both national and regional levels.
- ACT was only effective in the Hauts-Bassins, Boucle du Mouhoun, and Centre-Sud regions.
- The number of infected children reduced by 58.8% between the two time periods.
- Highest reduction in parasitaemia risk was observed in the Centre-Est region, while the lowest in the Southwest.

Predictor	MIS 2014 OR (95% BCI)	MIS 2017/2018 OR (95% BCI)
LST night	0.72 (0.64-0.93)[a]	0.89 (0.81-0.96)[a]
Night light	0.47 (0.38-0.59)[a]	0.49 (0.37-0.64)[a]
Distance to water bodies	0.83 (0.72-0.94)[a]	0.71 (0.57-0.85)[a]
Altitude*		
[201-307 m]	1.00	
[307-545 m]	0.72 (0.51-0.96)[a]	-
Proportion of households with at least one ITN for every two people (ITN ownership)	1.06 (0.24-1.48)	1.04 (0.86-1.20)
Proportion of children who slept under ITN (ITN use)	-	0.82 (0.70- 0.96)[a]
ACTs	-	1.22 (0.93-1.40)
Spatial parameters		
Spatial variance	0.41 (0.19-0.71)	0.32 (0.15-0.61)
Non spatial variance	0.31 (0.16- 0.49)	0.29 (0.14-0.48)
Range (km)	129.4 (57.1-367.5)	303.7 (189.2-371.1)

Table : Posterior odds ratios (ORs) and 95% Bayesian credible intervals (BCIs) estimated by multivariate geostatistical logistic regression models

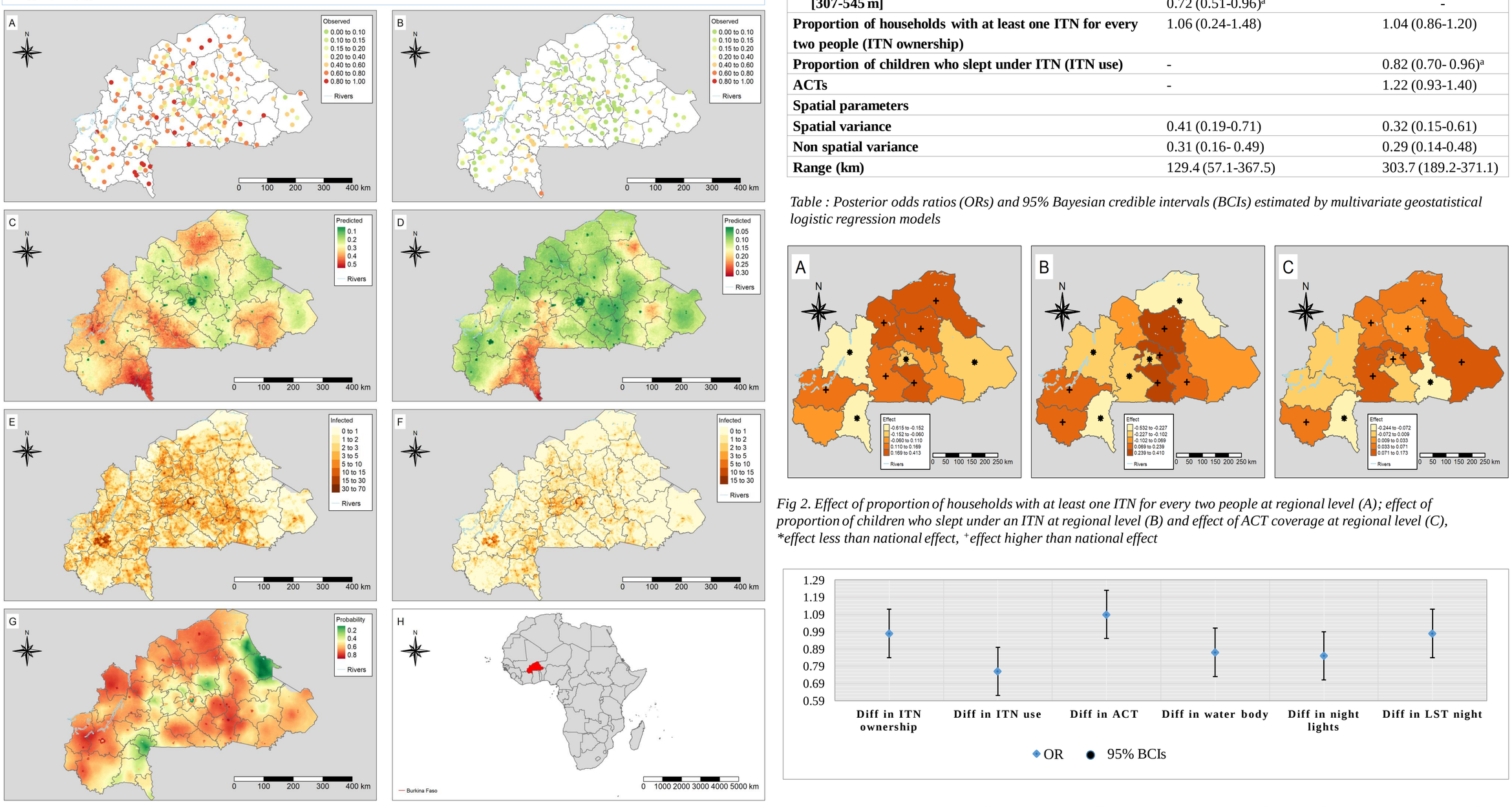

Fig 1. Observed malaria prevalence and survey locations of MIS 2014 (A) and 2017/2018 (B); predicted parasitaemia risk in 2014 (C) and 2017/2018 (D); distribution of estimated number of infected children per km² pixel in 2014 (E) and 2017/2018 (F); posterior probability of reduction in parasitaemia risk (G); location diagram of Burkina Faso (H).

*Fig 2. Effect of proportion of households with at least one ITN for every two people at regional level (A); effect of proportion of children who slept under an ITN at regional level (B) and effect of ACT coverage at regional level (C), *effect less than national effect, ⁺effect higher than national effect*

Fig 3: Posterior estimates of the effect of changes (differences) in interventions and climatic factors on parasitaemia risk decline.

Conclusion

- Malaria interventions effects varied across regions within the country.
- A notable reduction in the burden per unit area occurred in the country.
- The National Malaria Program should focus on regions identified as potential disease hotspots, where the likelihood of reducing parasitaemia risk is below 20%, such as the Southwest region.

References

[1] https://data.unicef.org/sdgs/goal-3-good-health-wellbeing/
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[3]https://www.trtafrika.com/fr/africa/burkina-faso-plus-de-4-000-deces-dus-au-paludisme-en-2022-letat-promet-de-reagir-14231179

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