GEOSPATIAL MODELING OF ARBOVIRUS THREATS IN SOUTHWEST NIGERIA: A STRATEGIC RISK ASSESSMENT

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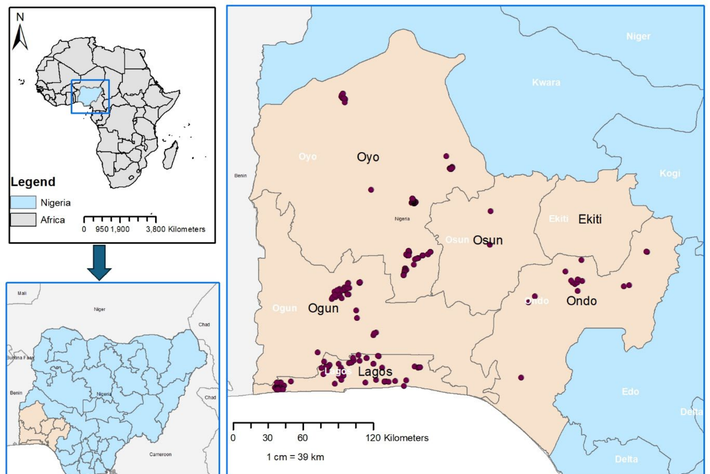
BACKGROUND

- Arboviral diseases like Dengue, Chikungunya, and Zika, transmitted by *Aedes* mosquitoes, pose a significant and growing threat to public health and global health security in sub-Saharan Africa.
- These diseases represent a considerable risk to the health and readiness of deployed personnel in regions like Southwest Nigeria.
- Effective Force health protection requires proactive, data-driven vector surveillance to identify high-risk areas, rather than relying on reactive responses to outbreaks.
- This study addresses the critical gap in spatially explicit data by mapping *Aedes* vector habitats to inform targeted control strategies.

APPROACH

Field Data Collection → Environmental Data → Random Forest Model → Risks Maps & Validation

- Study Area: Five states across Southwest Nigeria between 2022 and 2025.
- Entomological Data: 340 georeferenced survey points, incorporating both positive and negative detections for all *Aedes* spp. larvae found during the study.
- Modeling Framework: Random Forest (RF) species distribution modeling.
- Predictor Variables: Assessed key environmental drivers, including temperature-related bioclimatic variables, Landsat spectral indices, and livestock density (e.g., chicken, goat, cattle).

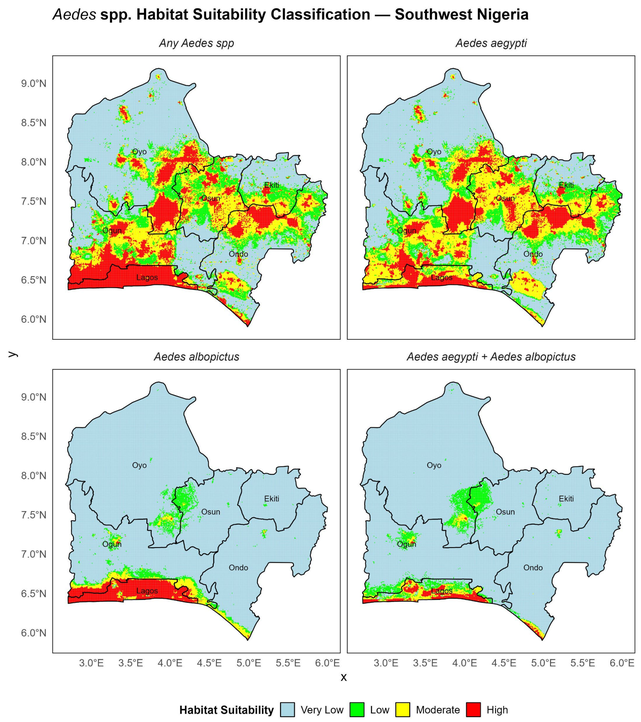


Study area map showing *Aedes* larval sampling locations across five southwestern states in Nigeria

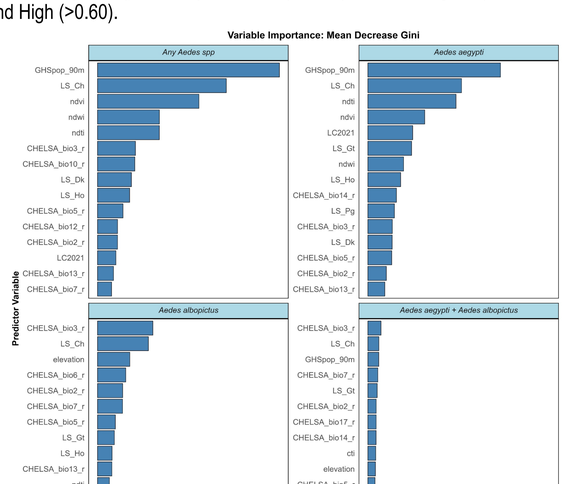
Aedes larval collection sites

RESULTS

Three *Aedes* larvae species were identified across five states in Southwest Nigeria: *Aedes aegypti, Aedes albopictus,* and *Aedes vittatus*.

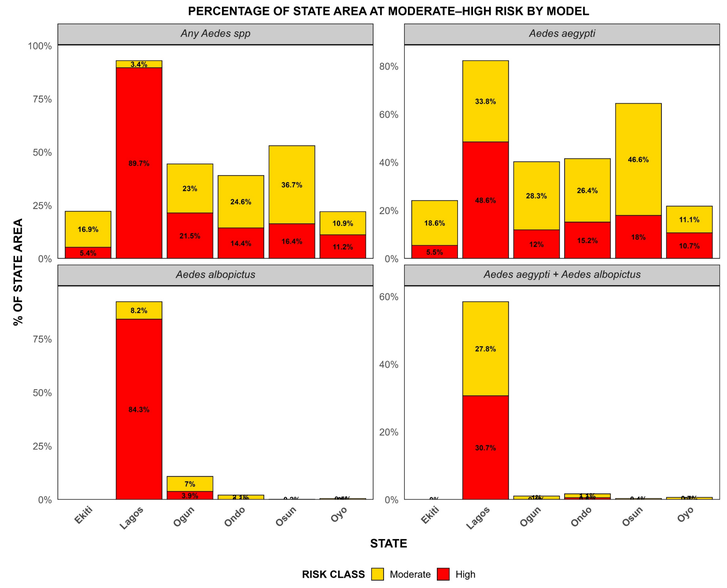


Predicted habitat suitability maps for four *Aedes* models at 1 km resolution across Southwest Nigeria. Suitability categories: Very Low (probability ≤0.2, blue), Low (>0.20–0.40, green), Moderate (>0.40–0.60, yellow), and High (>0.60).



Mean Decrease Gini for the top 15 environmental predictors. GHSPop_90m=Global Human Settlement Population density;LS_Ch=Livestock chicken density; NDVI=Normalised Difference Vegetation Index; NDWI=Normalised Difference Water Index; NDTI=Normalised Difference Turbidity Index; CHELSA_bio=CHELSA bioclimatic variable; LC2021=land cover 2021.

- High-risk hotspots for *Aedes aegypti* were widespread across all States, while *Aedes albopictus* hotspots were limited to Lagos and Ogun.
- Population density is the primary driver for *Aedes* aegypti.
- Climate variables are key drivers for *Aedes albopictus*.
- Model performance was high, with an AUC of 0.983 for any *Aedes* spp. and 0.893 for *Aedes aegypti*.



State-level stacked bar plots showing moderate (gold) and high (red) habitat suitability area (km²) per state for each *Aedes* model. States are shown on the x-axis; percentage of state area on the y-axis.

CONCLUSION/STRATEGIC IMPACT/RECOMMENDATIONS

- This study provides the first high-resolution (1 km²), validated risk maps for *Aedes* vectors in Southwest Nigeria.
- These validated risk maps provide direct intelligence for AFRICOM pre-deployment planning and operational health risk assessments.
- Prioritizing vector control and disease surveillance for personnel operating in Lagos, Ogun, and Oyo is recommended.
- Because *Aedes* species are driven by fundamentally different environmental factors, vector control operations must be species-specific.
- This modeling framework is a proven, scalable tool for proactive arbovirus surveillance in other operational areas.
- This study enables a critical shift from reactive outbreak response to proactive, data-driven vector risk mitigation.

PARTNERS/COLLABORATORS

The authors would like to acknowledge the valuable contributions of our collaborators at the Nigerian Institute of Medical Research (NIMR). We are grateful to the Country Director and staff of the Nigerian Program of the Walter Reed Army Institute Research-Africa (WRAIR-Africa) for their collaborative support and assistance in study execution.

Maps were created with Arc GIS 10.8 and R version 4.4. Photos courtesy of Adewale D. Adediran.

This work was supported by the Armed Forces Health Surveillance Division, Global Emerging Infections Surveillance (GEIS) Branch, ProMIS ID P0145_25_N3.