Strengthening Disease Surveillance in Ghana Through Geospatial Analytics Training and Collaboration

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Introduction

- Ghana faces climate-sensitive disease outbreaks like yellow fever and bacterial meningitis.
- Environmental factors drive disease patterns, making spatial analysis critical.
- Project uses geospatial modeling to identify and monitor risk zones.
- Partnership among U-M, JHU, UG, and GHS combines expertise and local implementation.
- GHS staff data analytics training ensures sustainability, fostering local leadership in analytics.
- Empowering GHS with risk map tools strengthens outbreak response and health equity.

Strategy meeting with Ghana Health Service leadership identifying the capacity to build risk maps as a priority

Training Program

- Recruited a data analyst from University of Ghana for local training.
- Blended Training: Combined virtual sessions for theory and skills in R, GIS, and statistics, with in-person workshops for hands-on practice and collaborative analysis.
- Duration: Conducted March 2024–December 2025, totaling approximately 240–255 contact hours.
- Curriculum: Covered data handling, statistical analysis, spatial thinking, GIS workflows, disease mapping, climate data integration, and applied modeling.
- Applied Approach: Learning included practical exercises, working with real datasets, and iterative mentorship to build lasting capacity for climate-sensitive disease analytics.

Training outcomes

- Participants: The initial plan was to identify one trainee each from the DSD and PPME GHS groups. However, there was overwhelming interest, with nine GHS staff requesting to join. Ultimately, three were selected for the data analyst pathway and six for the data technician pathway.
- Flexible scheduling: To accommodate demanding GHS work schedules, most training sessions were held on weekends, ensuring full participation.
- Advanced workshop: After developing fundamental skills in R statistical environment, data analysts participated in a one-week intensive workshop at the University of Michigan, working closely with faculty to deepen geospatial mapping skills and refine final strategies for project success.

Key Modeling Figures and Tables

Figure 1. Conceptual flow for geospatial modeling

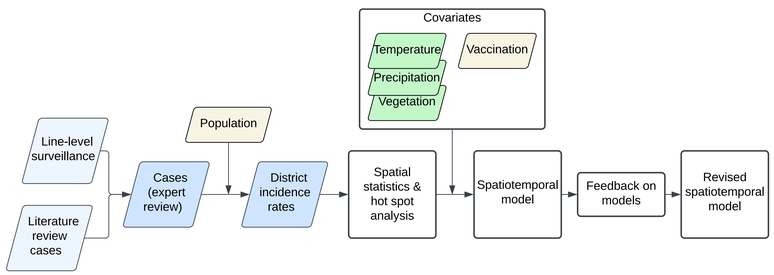


Table 1. Model variables

Outcome Variable
Yellow fever incidence
Spatial Covariates
Program factors
Routine vaccine coverage
Reactive vaccination campaigns
Preventive campaigns
Ecological factors
Precipitation
Temperature
Vegetation
Land cover
Seasonality
Non-human primate populations
Sociodemographic factors
Occupation
Sex
Age
Settlement type

Figure 2. Dependent variable (incidence) and one covariate (vaccination coverage)

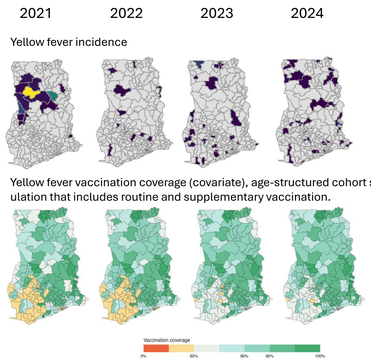


Figure 3. Local Spatial Clustering of yellow fever incidence Using Moran's I

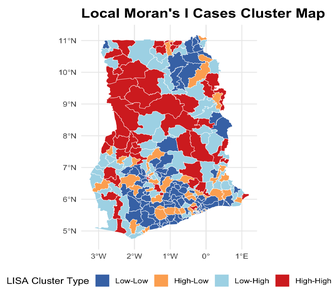
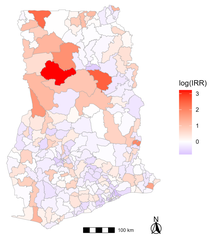


Figure 4. Bayesian spatio-temporal risk map



Generated from 2019-2024 data, including annual vaccination coverage, monthly mean temperature, monthly mean NDVI, and monthly mean precipitation.

Training session at University of Ghana

Take-aways

- Sustainable capacity: GHS staff are being directly trained in geospatial analysis and risk mapping, building a resilient, locally owned system for ongoing epidemic surveillance.
- Collaborative training: A train-the-trainer model blends hands-on workshops and online courses, enabling GHS teams to develop lasting expertise for disease monitoring.
- Local leadership: GHS personnel with deeply integrated in model building, ensuring findings are relevant and responses timely.
- Stronger partnerships: Ongoing mentorship and joint sessions with UM, UG, JHU, and GHS maximize engagement and ensure outputs meet local needs.
- Progress on risk mapping: GHS staff are developing spatial models for yellow fever and meningitis, and now expanding into measles, using advanced GIS and statistical tools to inform outbreak prevention and response.

	2024	2025	2/26	3/26	4/26	5/26	6/26	7/26
Completed								
Publicize and receive trainee applications								
Finalize trainee selections								
Hire data analyst trainer (from Univ Ghana)								
Kick-off and weekly training (virtual)								
In-person training workshops in Ghana								
Health Service data collection (events, vaccinations)								
Initial environmental covariate collection								
Data cleaning and intergration								
Initial risk-map models								
In-person workshop at UM with trainees and faculty								
NCE timeline								
Project goals								
Further covariate data collection								
Generate clean GIS Patient/Facility lists								
District-level Model development								
Patient-level Model development								
Validation of risk maps								
Updates/Dissemination								
Initial presentation to Ghana Health Service								
Presentation to GHS leadership for proposed applications								

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