Implementation and validation of Bayesian geostatistical models to estimate spatio-temporal patterns of RMNCH in Mali

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INTRODUCTION

- The Sustainable Development Goals (SDGs) prioritize improving **reproductive, maternal, newborn, and child health (RMNCH)** globally.
- Achieving equitable progress in RMNCH requires **detailed geographic data** to inform decision-making at local administrative levels.
- **Armed conflicts** pose significant challenges to RMNCH data collection and monitoring, threatening progress toward the SDGs.
- **Bayesian geostatistical modeling (BGM)** has attracted growing interest and demonstrates the potential for leveraging existing data to produce small-area health estimates. **However, their potential has not been well explored in conflict-affected settings.**

Can BGM accurately estimate key RMNCH outcomes in a conflict-affected setting at high spatial resolutions?

Can BGM assess temporal trends in the coverage of key RMNCH outcomes from pre-conflict to conflict periods?

OBJECTIVE

To implement and validate a Bayesian geostatistical modeling approach to estimate the patterns of indicators of RMNCH service uptake on an annual basis at sub-regional levels from 2000 to 2018 in Mali

METHODS

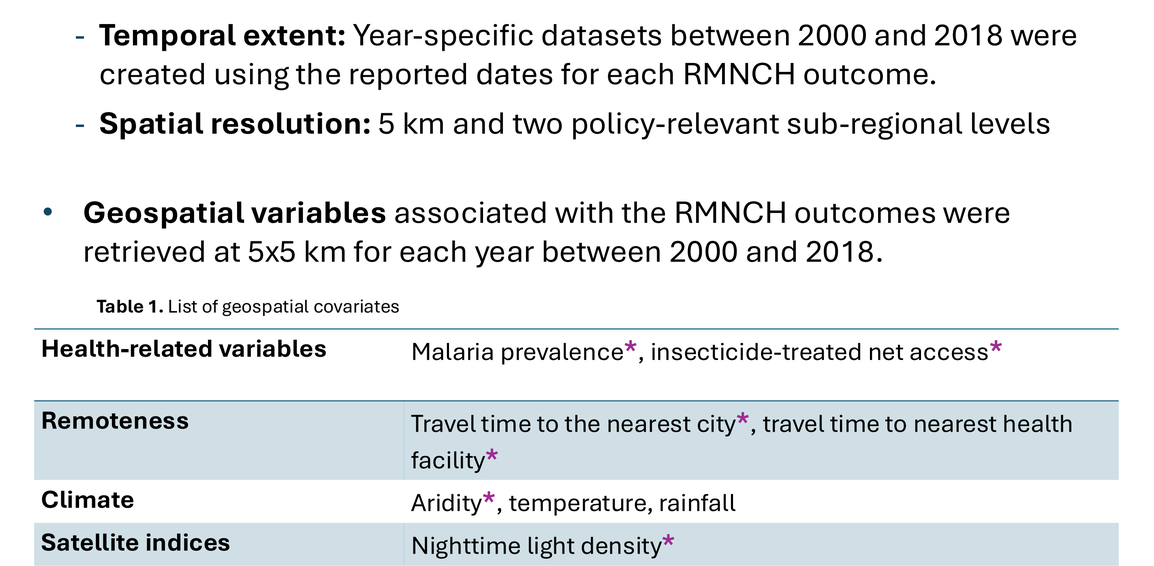
- **Main data sources:** Demographic and Health Surveys (DHS) providing georeferenced RMNCH data from women of reproductive age and under-five children in the five years preceding the survey.
- **Outcomes across the continuum of RMNCH care:** Modern contraceptive use, antenatal care, skilled birth attendance, postnatal care of mothers and babies, basic childhood immunization
  - **Temporal extent:** Year-specific datasets between 2000 and 2018 were created using the reported dates for each RMNCH outcome.
  - **Spatial resolution:** 5 km and two policy-relevant sub-regional levels
- **Geospatial variables** associated with the RMNCH outcomes were retrieved at 5x5 km for each year between 2000 and 2018.

Table 1. List of geospatial covariates

Health-related variables	Malaria prevalence*, insecticide-treated net access*
Remoteness	Travel time to the nearest city*, travel time to nearest health facility*
Climate	Aridity*, temperature, rainfall
Satellite indices	Nighttime light density*
Socio-demographics	Population density*, population counts, fertility, women of reproductive age with primary education*
Topography and land cover	Built-settlement growth*, degree of urbanization

*Covariates selected using AIC

- **Statistical approach:** Bayesian spatial and spatio-temporal models using the **integrated nested Laplace approximation (INLA)** and **stochastic partial differential equation (SPDE)** approaches.



PRELIMINARY RESULTS

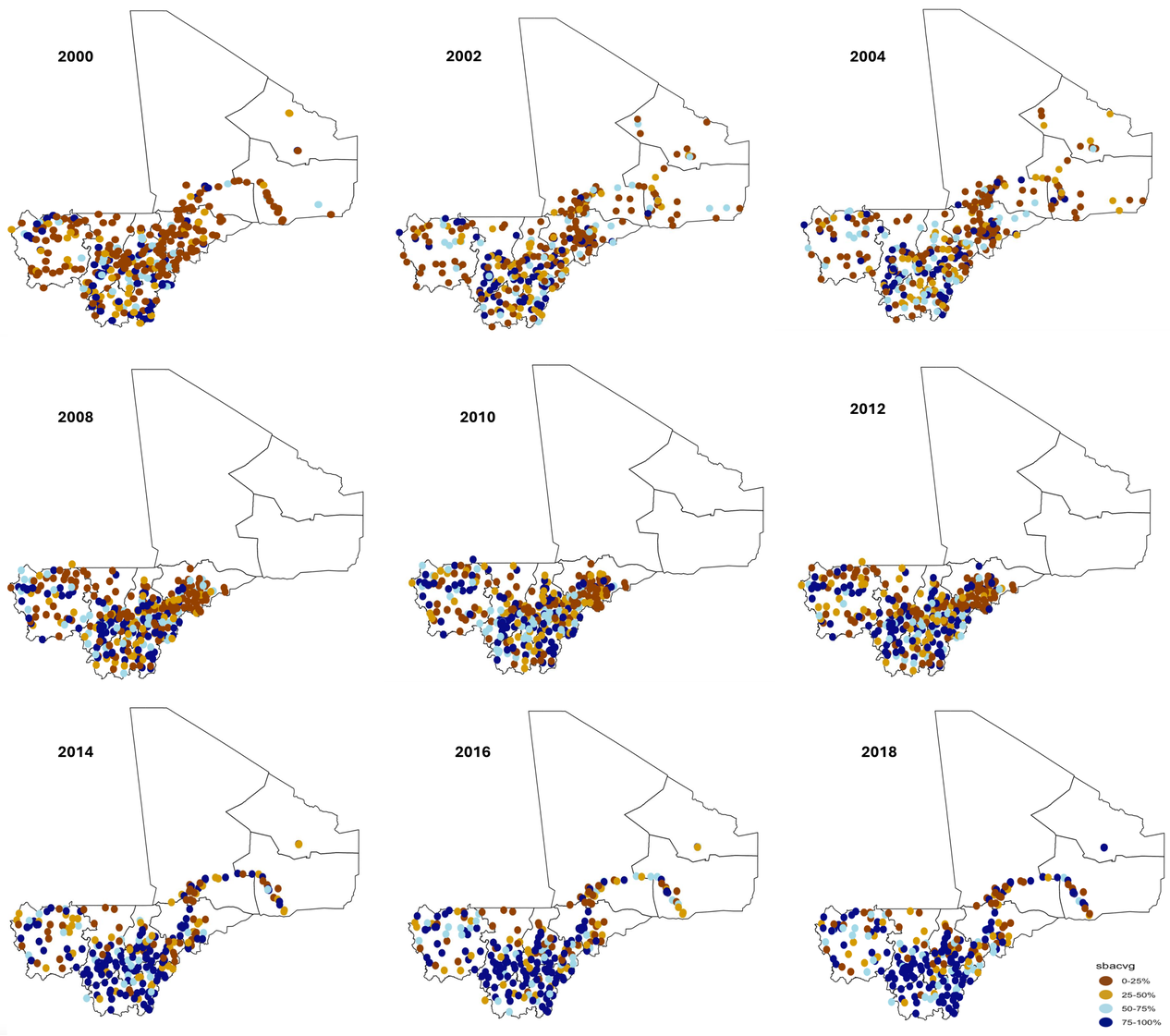


Figure 1. Maps of DHS survey clusters with the prevalence of skilled birth attendance in Mali from 2000 to 2018.

- Cluster-level RMNCH coverage values are unstable due to low cluster-level data but still indicate the **presence of spatio-temporal variability**. Due to insecurity, **no clusters were selected in the North during the 2012 survey.**

Figure 2. Zoom on Segou Region

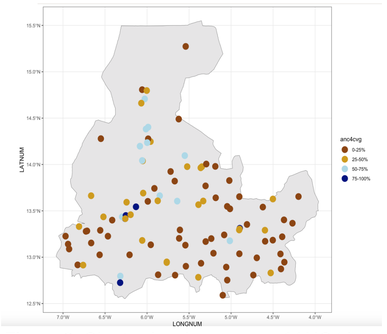


Figure 3. Cluster-level coverage of ANC4 in Segou Region between 2000 - 2003

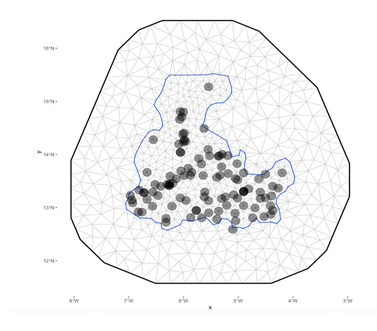


Figure 4. Segou Region overlaid on mesh

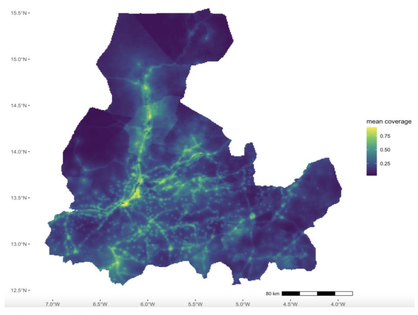


Figure 5. Predicted mean values of ANC4 coverage across Segou

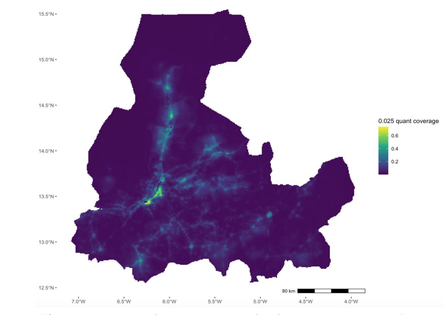


Figure 6. Predicted lower limit values of ANC4 coverage across Segou

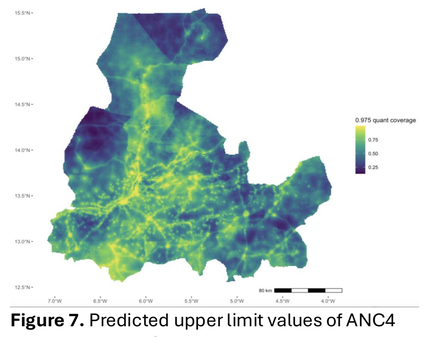


Figure 7. Predicted upper limit values of ANC4 coverage across Segou

- The models produce **continuous surface** estimates of RMNCH indicators, enabling the identification of low-coverage areas that should be prioritized, while also **quantifying the uncertainty** around these estimates.

DISCUSSION AND NEXT STEPS

- We observed **spatio-temporal variability in the coverage of RMNCH outcomes**, which we will explore in greater depth using Bayesian geostatistical models. However, data limitations in certain regions could impact the precision of our predictions and the robustness of model validation.
- The next steps include enhancing the Bayesian geostatistical models by **refining prior distributions**, **incorporating non-spatial and spatial random effects**, and **adjusting for survey design variables**, such as stratification and clustering.

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