GeoAI for Maternal Healthcare Accessibility: A Spatial Analysis Challenge for Muslim-Majority Regions

MusIML @ ICML 2026 — Track 3 Competition Proposal

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1. Problem Statement

Maternal mortality remains one of the most severe health equity crises in Muslim-majority regions globally. Nigeria's Northwestern states — among the most heavily Muslim-populated in Sub-Saharan Africa — record maternal mortality ratios (MMRs) exceeding 1,000 per 100,000 live births, more than double the national average. A primary driver of these outcomes is geographic inaccessibility: large proportions of women of reproductive age reside far beyond the safe access threshold of 5 km from the nearest health facility.

Despite the availability of high-quality open geospatial datasets (GRID3 health facility data, WorldPop population grids, DHS health indicators), these resources remain underutilized by the ML community for maternal health intervention planning in low-resource settings. There is no established benchmark or competition framework that challenges ML researchers to develop accessible, reproducible, and fairness-aware geospatial models for maternal health prioritization in Muslim-majority regions.

This competition proposes to fill that gap by challenging participants to build GeoAI models that identify underserved maternal health zones, rank Local Government Areas by intervention priority, and propose evidence-based deployment strategies — using only publicly available datasets.

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2. Competition Tasks

Task A: Spatial Accessibility Modeling

Participants build models to estimate healthcare facility accessibility for women of reproductive age across a target state or region, using GRID3 facility locations and WorldPop population grids. Models are evaluated on accuracy of accessibility classification against a held-out ground truth derived from network travel-time estimates.

Task B: Underserved Zone Identification

Participants apply spatial clustering or similar ML methods to identify contiguous underserved population zones suitable for mobile healthcare intervention. Evaluated on clustering quality (silhouette score), spatial coherence, and coverage of high-risk populations.

Task C: Composite Risk Ranking

Participants construct a composite maternal health risk ranking across administrative units using multi-source indicators. Evaluated against expert-validated priority rankings derived from ground-truth DHS and facility data.

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3. Dataset Considerations

Primary Datasets (All Publicly Available)

Dataset	Source	Description
GRID3 Health Facilities	grid3.org	Georeferenced health facility locations across Nigeria and other African countries
WorldPop Population Grid	worldpop.org	100m resolution gridded female population estimates
Nigeria DHS 2018	dhsprogram.com	LGA-level maternal health indicators including MMR proxies, skilled birth attendance, ANC coverage
OpenStreetMap Road Networks	openstreetmap.org	Road network data for travel-time estimation
GADM Administrative Boundaries	gadm.org	LGA and state-level boundary shapefiles

Ethical Sourcing

All datasets are open-access, non-identifiable, and aggregated at administrative unit or grid level. No individual patient data is used. All data providers (GRID3, WorldPop, DHS Program) explicitly authorize research use. The competition will include clear data use guidelines prohibiting any attempt to re-identify individuals.

Pilot Dataset

The proposers have completed a pilot analysis on Kebbi State, Nigeria, which serves as the example dataset and baseline for the competition. This includes 1,207 GRID3 facilities, 1,510 populated grid cells, and LGA-level risk indicators across 21 administrative units.

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4. Evaluation Criteria

Technical Metrics

- **Task A:** F1 score and AUC for accessibility zone classification; Mean Absolute Error against travel-time ground truth
- **Task B:** Silhouette score; spatial coverage ratio of high-risk population zones; false negative rate on critically underserved areas
- **Task C:** Spearman rank correlation with expert-validated LGA priority rankings; robustness under ±10% indicator weight variation

Fairness Metrics

Submissions are additionally evaluated on:

- Equity coverage: proportion of the highest-burden population captured in top-ranked intervention zones
- Bias audit: performance disaggregated by population density quintile to ensure models do not systematically underserve the most isolated communities

Reproducibility

All submissions must include code and full documentation sufficient for independent reproduction. Non-reproducible submissions are disqualified.

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5. Potential Positive Impact

Direct Health Impact: Models developed through this competition can directly inform mobile clinic deployment, health resource allocation, and emergency routing decisions in Kebbi State and analogous regions. The pilot analysis alone identified 310,000 women in critically underserved zones across three priority LGAs.

Broader ML Community Impact: This competition establishes the first open benchmark for GeoAI-based maternal health accessibility modeling in Muslim-majority African regions, enabling reproducible comparison of methods and fostering a research community around this underserved problem domain.

Capacity Building: By using only open datasets and requiring code reproducibility, the competition is fully accessible to researchers in low-resource institutions — including those in Muslim-majority countries — without requiring proprietary data access or expensive compute infrastructure.

Policy Pathway: Competition outputs are designed to be directly usable by state ministries of health and NGOs working on maternal health programs in Northwestern Nigeria and similar regions globally.

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6. Implementation Plan

Phase 1: Data Preparation (Pre-Competition)

- Finalize pilot dataset and baseline code for Kebbi State
- Establish held-out ground truth for evaluation
- Publish data documentation and ethical use guidelines
- Set up competition platform (Kaggle or CodaLab)

Phase 2: Competition (3 Months)

- Month 1: Starter kit release, data access, baseline code
- Month 2: Leaderboard open, forum support active
- Month 3: Final submissions, reproducibility review

Phase 3: Post-Competition

- Top solutions presented at MusIML workshop or subsequent NeurIPS event
- Aggregated findings submitted as a community benchmark paper
- Dataset and evaluation framework released as permanent open resource

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7. Connection to Muslim Communities

Kebbi State and the broader Northwestern Nigeria region is one of the most densely Muslim-populated areas in Sub-Saharan Africa, with over 95% Muslim population. The maternal health crisis in this region is directly tied to systemic underinvestment in healthcare infrastructure in Muslim-majority communities. This competition directly addresses MusIML's core mission of using ML to improve outcomes for Muslim communities while building research capacity among Muslim-majority institutions.

The competition is designed to be accessible to researchers from Muslim-majority countries, with no proprietary data requirements and full open-source tooling.

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8. Organizer Background

The proposing team has completed a pilot GeoAI analysis of Kebbi State maternal health accessibility using GRID3, WorldPop, and DHS data, including DBSCAN spatial clustering (silhouette score: 0.83) and composite risk scoring across all 21 Kebbi LGAs. This work has been submitted to MusIML @ ICML 2026 Track 1. The pilot analysis serves as the baseline and example dataset for the proposed competition.

Keywords

GeoAI, Maternal Healthcare, Spatial Clustering, Healthcare Accessibility, Muslim Communities, Northern Nigeria, Fairness in ML, ML for Social Good