Evaluating Environmental Degradation from Artisanal and Large-Scale Mining in Amansie West District, Ghana.

AfricaGIS 2025

UN-GGIM: AFRICA
UNITED NATIONS
GLOBAL GEOSPATIAL
INFORMATION MANAGEMENT

Jefferson-Aaron Ayerbi Totimeh

Department of Geomatic Engineering, Kwame Nkrumah University of Science and Technology (KNUST)

AfricaGIS 2025 and
UN-GGIM: Africa XI Joint Conference

United Nations Economic Commission for Africa

EIS

FIG International Federation of Surveyors
Fédération Internationale des Géomètres
Internationale Vereinigung der Vermessungsingenieure

KNUST
KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Why This Matters1/2

Ghana's Economic Imperative

Gold mining generates 40% of Ghana's national export revenue, need for environmental oversight. (Ghana Chamber of Mines, 2024).

Amansie West: A Key Study Site

This district is a hotspot for diverse mining impacts, ideal for geospatial analysis geospatial analysis of both Artisanal (ASM) and Large-Scale Mining (LSM) (LSM) (Hilson & Adu-Gyamfi, 2023).

Quantifying Environmental Degradation

Mining causes extensive deforestation and land degradation, which using advanced remote sensing techniques (Aboagye et al., 2019).

Why This Matters 2/2

Resolving Land Use Conflicts

Mining activities create **escalating conflicts** among miners, miners, local communities, and regulatory bodies. Effective Effective resolution is crucial (Owusu et al., 2016).

Precision Monitoring with AI

We apply **deep learning and computer vision** to high-resolution remote sensing data (satellite optical, SAR imagery).

This ensures **real-time detection** and precise monitoring monitoring of illegal mining activities and environmental environmental degradation.

The Hidden Crisis

Environmental Devastation

Unregulated mining leads to extensive deforestation and land and land degradation, especially in areas like Amansie West. Amansie West.

Inefficient Monitoring

Current monitoring relies on time-consuming, labor-intensive intensive field surveys with limited spatial coverage.

Underutilized AI Solutions

Advanced AI-driven remote sensing for precise detection of illicit mining remains largely untapped.

Missing Holistic Frameworks

A critical gap exists in integrated geospatial frameworks for frameworks for comprehensive impact assessments.

What We Set Out to Do

Aim

To integrate remote sensing and computer vision models to quantify environmental degradation in Amansie West District.

Key Objectives:

Quantify Land Use/Cover Change → **Assess Socio-Economic & & Health Impacts** → **Automate Mining Detection with AI**

Study area

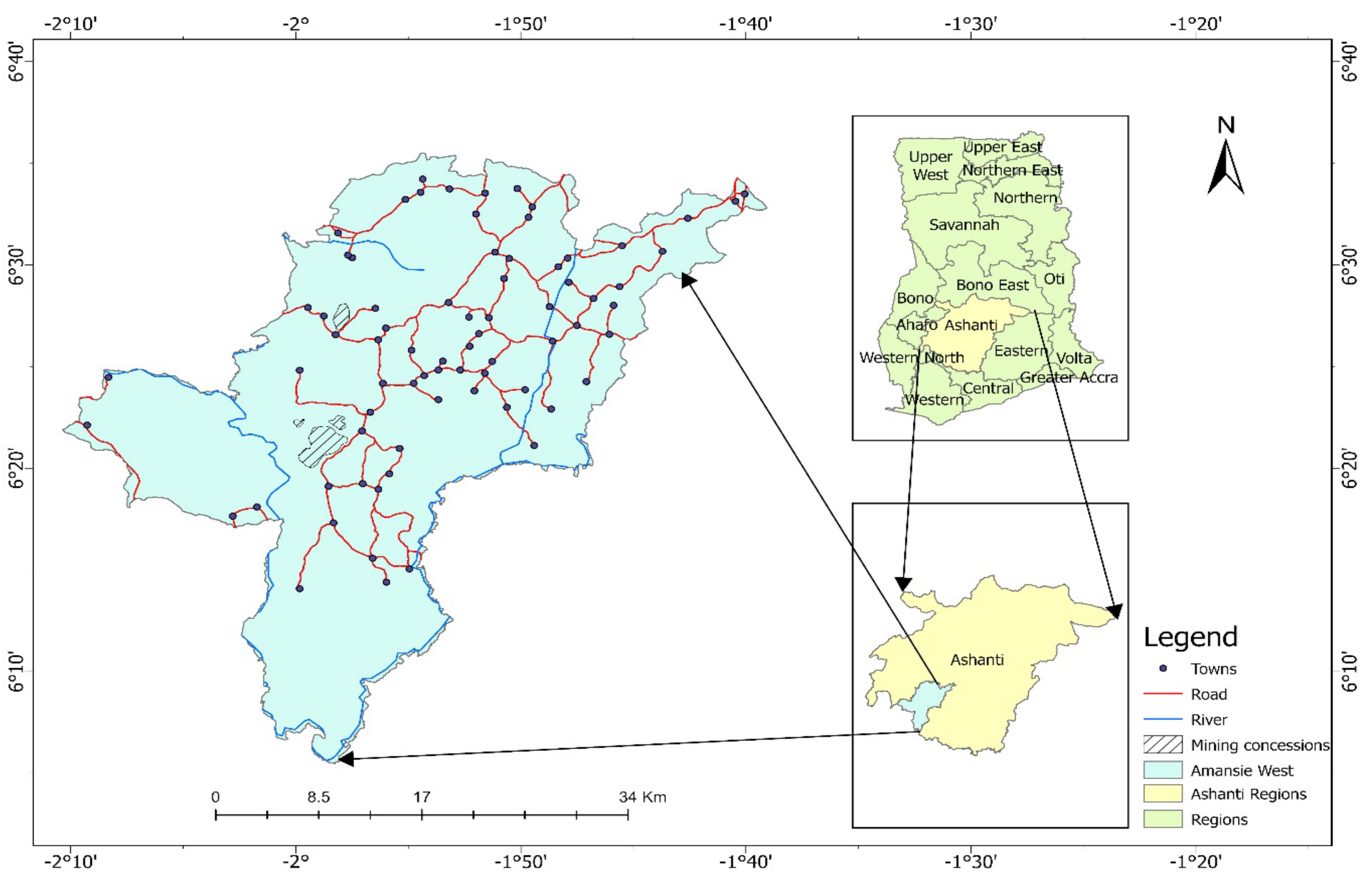
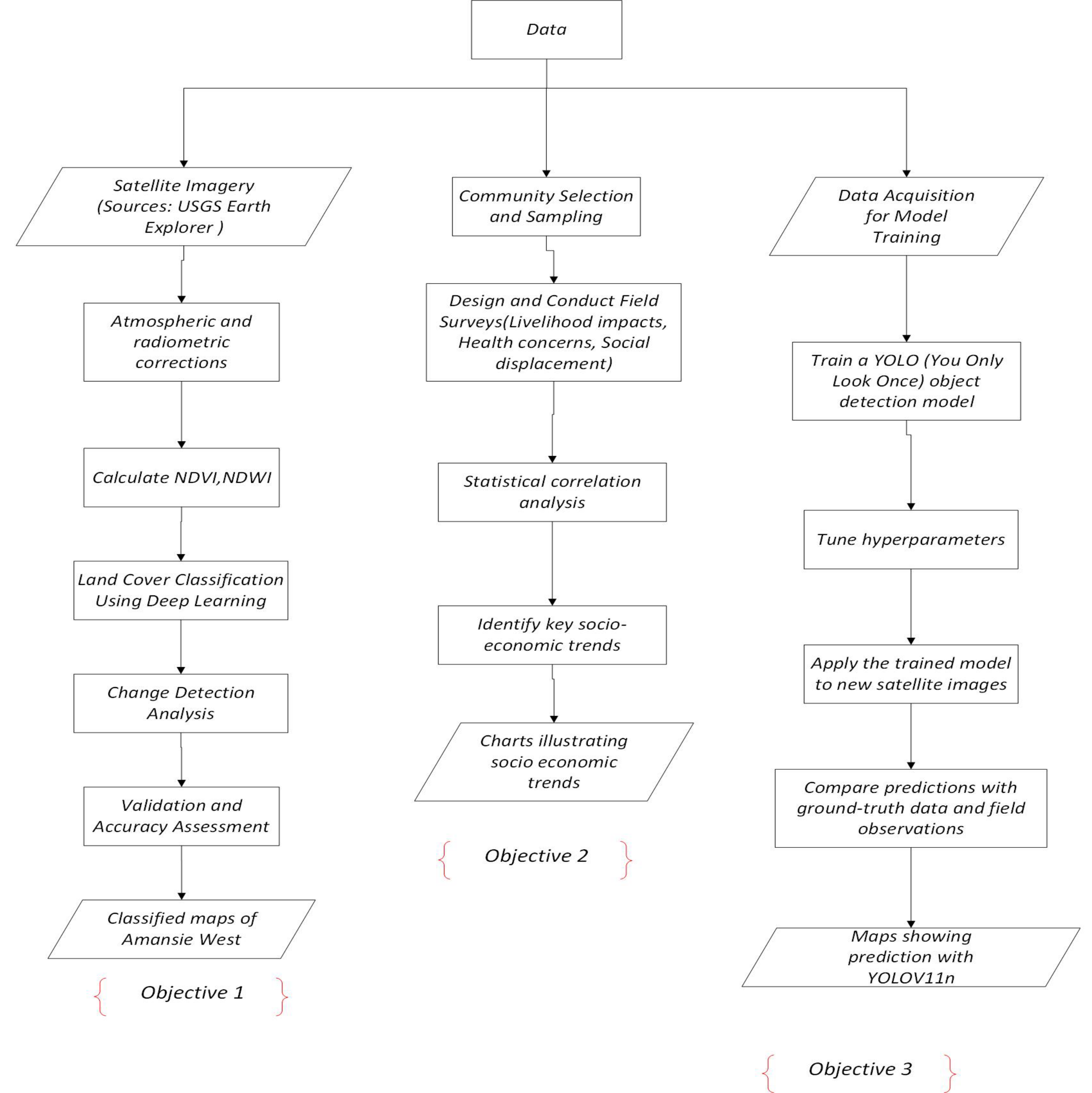


Figure 1. Study Area Map of Amansie West District, Ghana.

AfricaGIS 2025

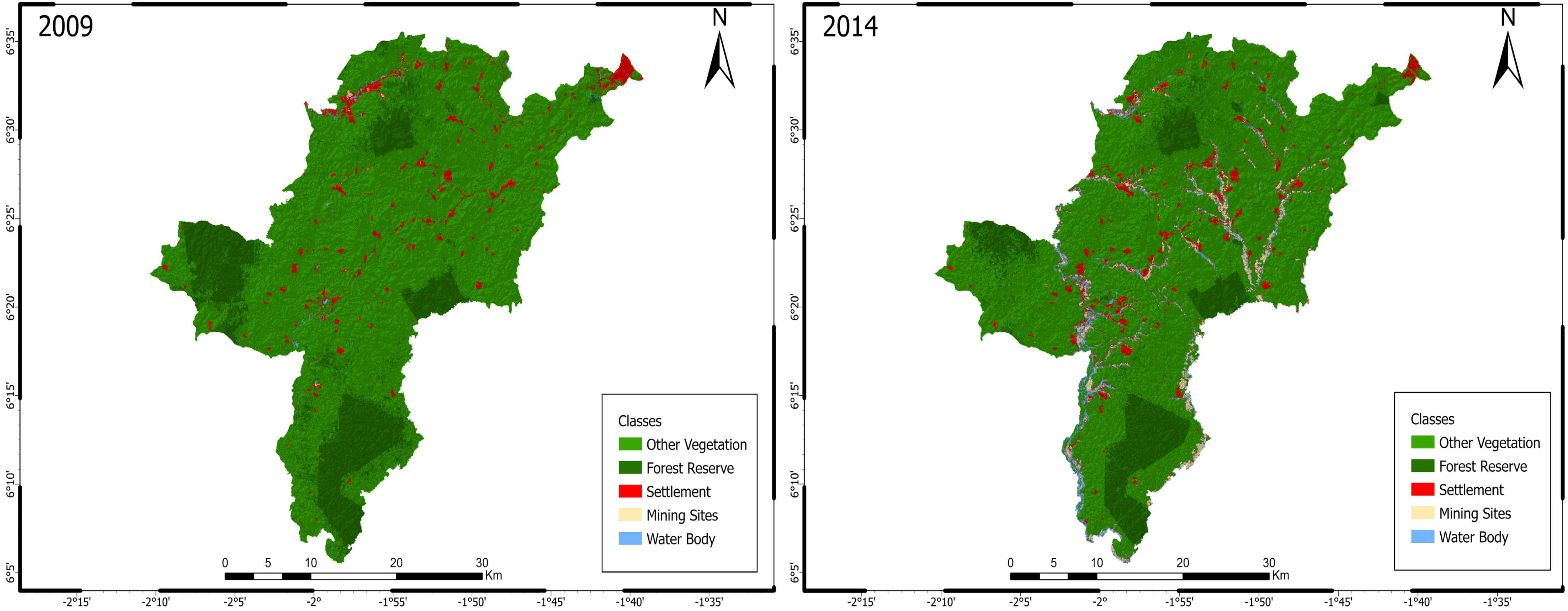
UN-GGIM: AFRICA
UNITED NATIONS GLOBAL GEOSPATIAL INFORMATION MANAGEMENT

How We Did It



- Figure 2 Flowchart showing methodology.

15 Years of Transformation

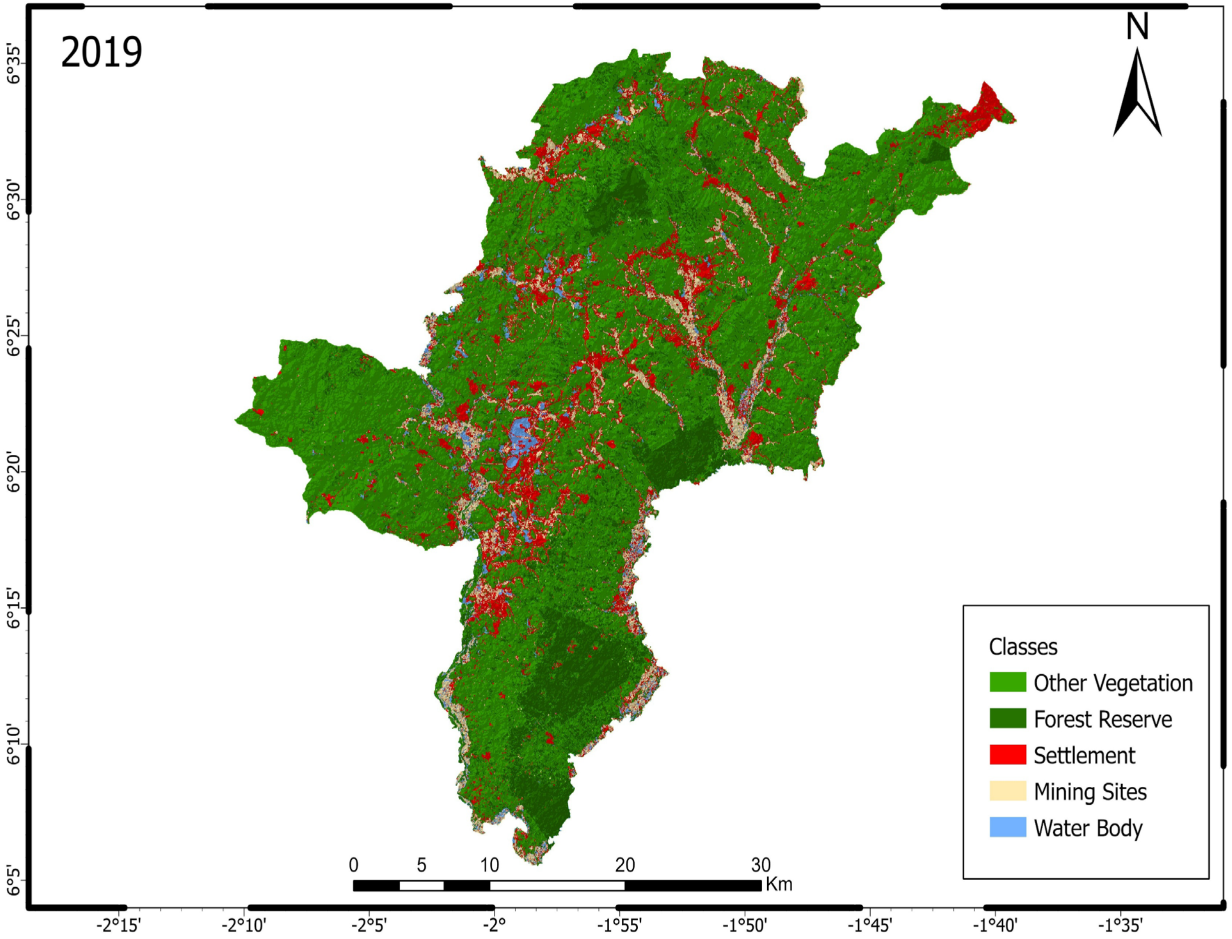


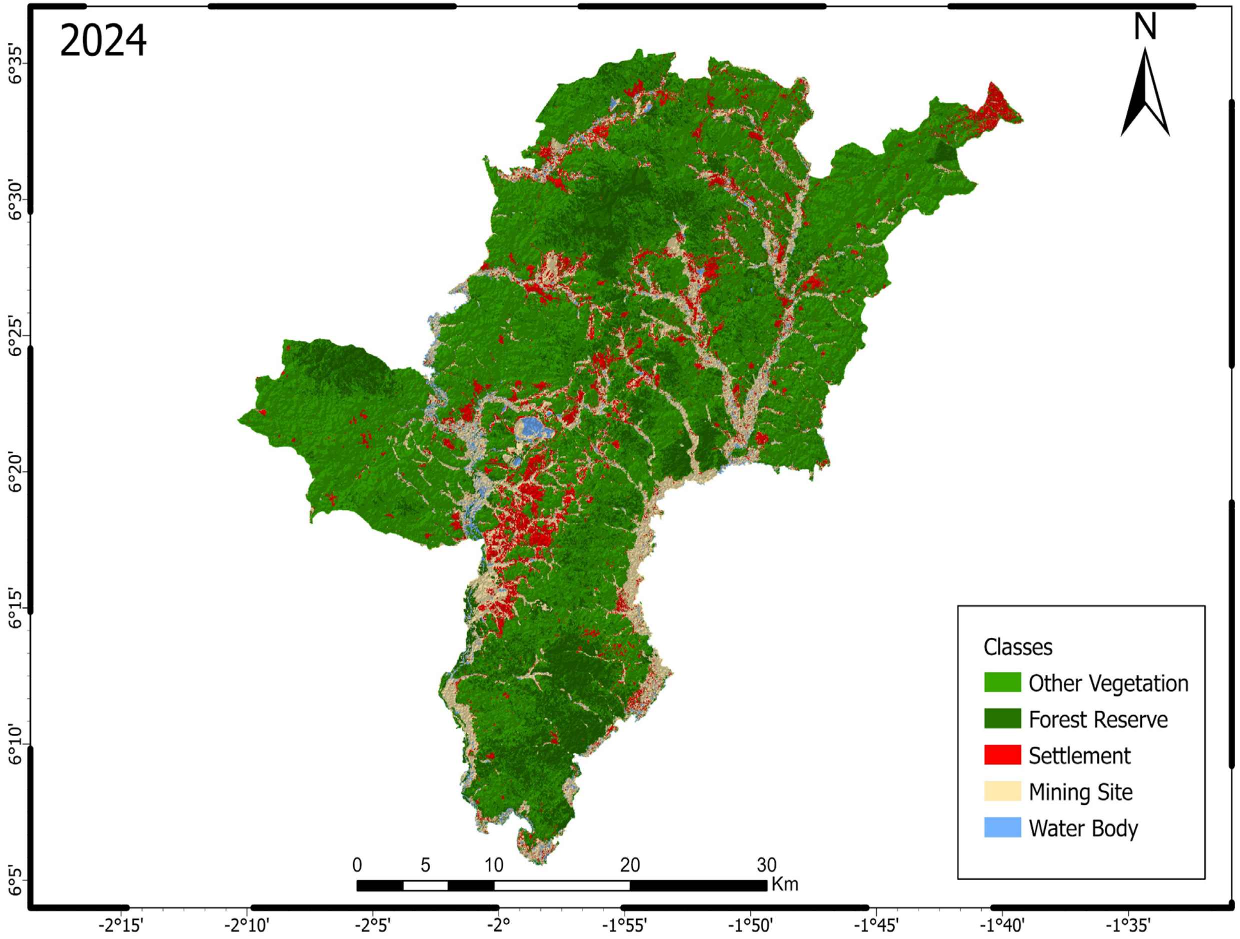
- Forest cover declined from 61% (2009) to 34% (2024) — loss of ≈19,703.64 hectares .
- Mining areas expanded from 3% to ~20%

AfricaGIS 2025

UN-GGIM: AFRICA
UNITED NATIONS GLOBAL GEOSPATIAL INFORMATION MANAGEMENT

From Forest to Mine



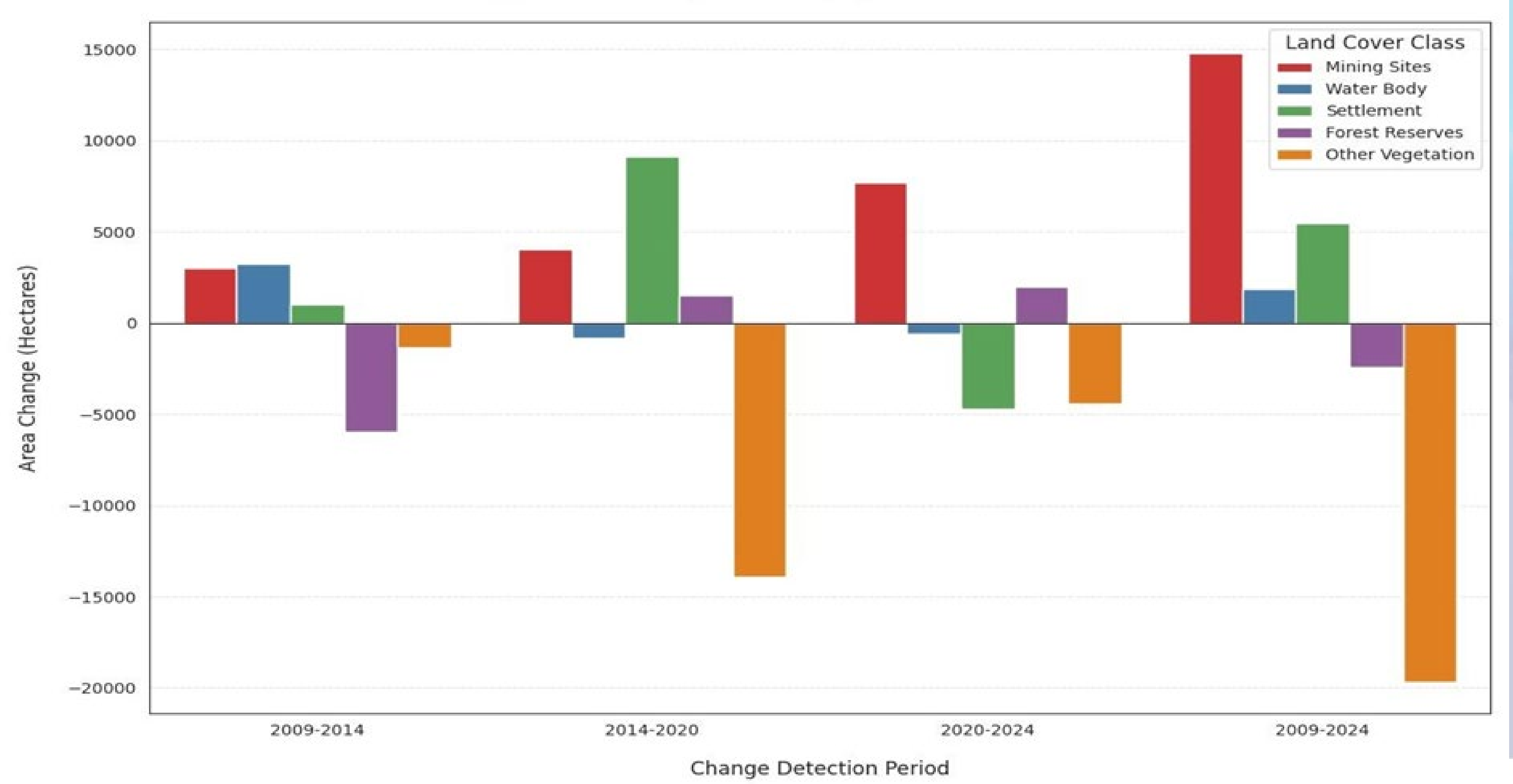


- Annual forest loss rate: 1.9% (> Ghana's national rate of 1.3%, FAO, 2023).
- Most rapid change: 2019–2024 period.

AfricaGIS 2025

UN-GGIM: AFRICA
UNITED NATIONS GLOBAL GEOSPATIAL INFORMATION MANAGEMENT

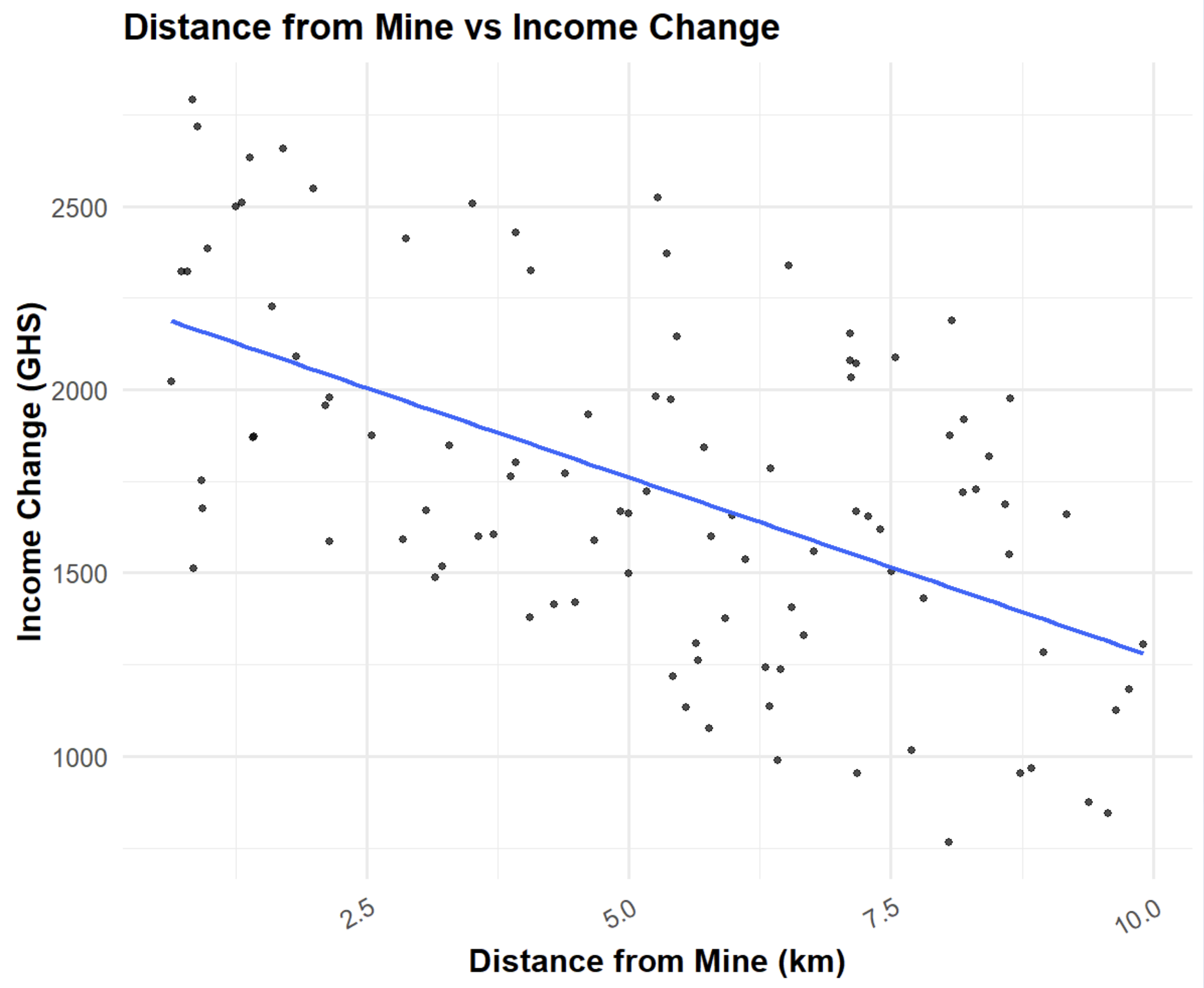
339 km² of Forest Gone

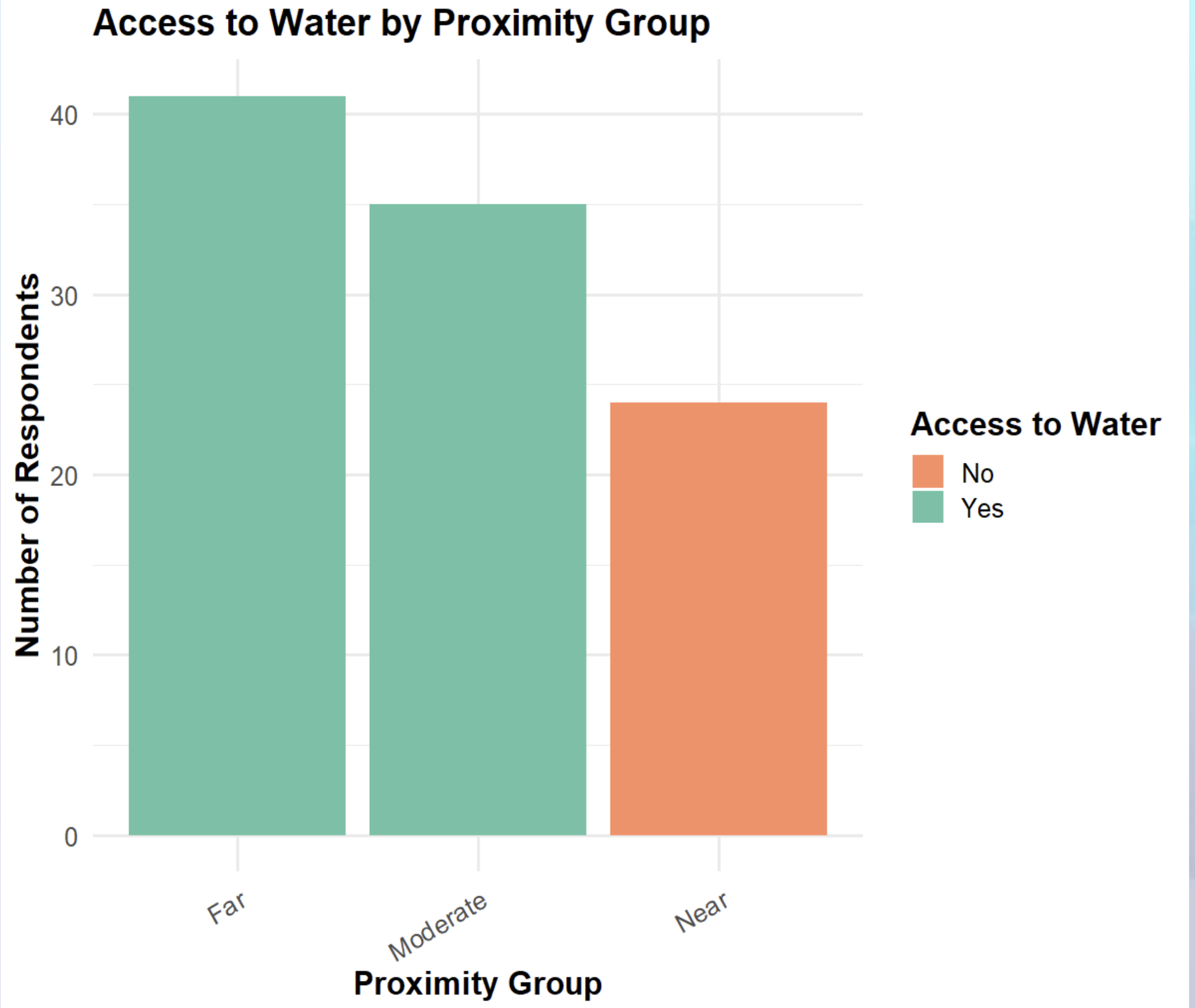


AfricaGIS 2025

UN-GGIM: AFRICA
UNITED NATIONS
GLOBAL GEOSPATIAL
INFORMATION MANAGEMENT

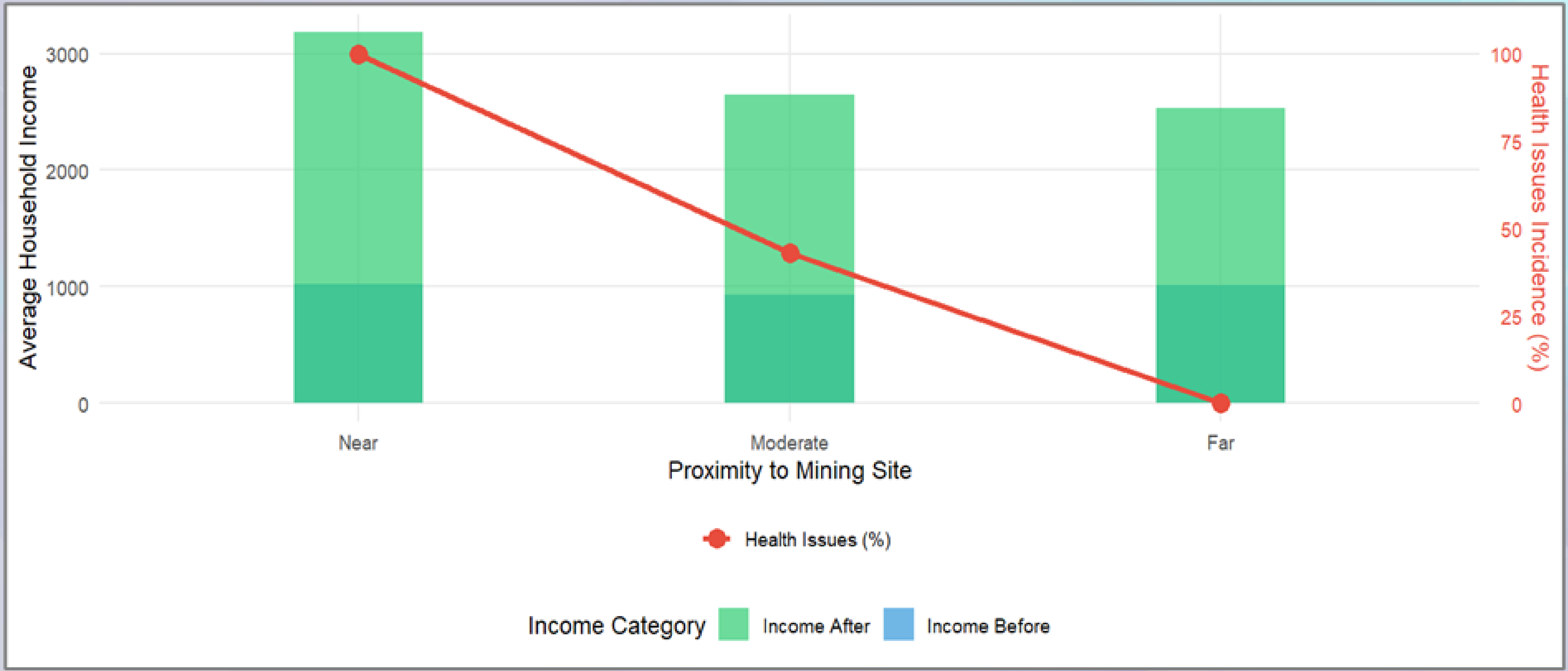
The Human Cost





- Communities within 3 km of mining sites reported lowest income (GHS 985.1).
- Income rises with distance from mining zones (ANOVA, $F = 19.23$, $p < 0.001$).
- Strong negative correlation between income and proximity ($r = –0.55$, $p < 0.01$).

Closer to Mines = Richer and Sicker

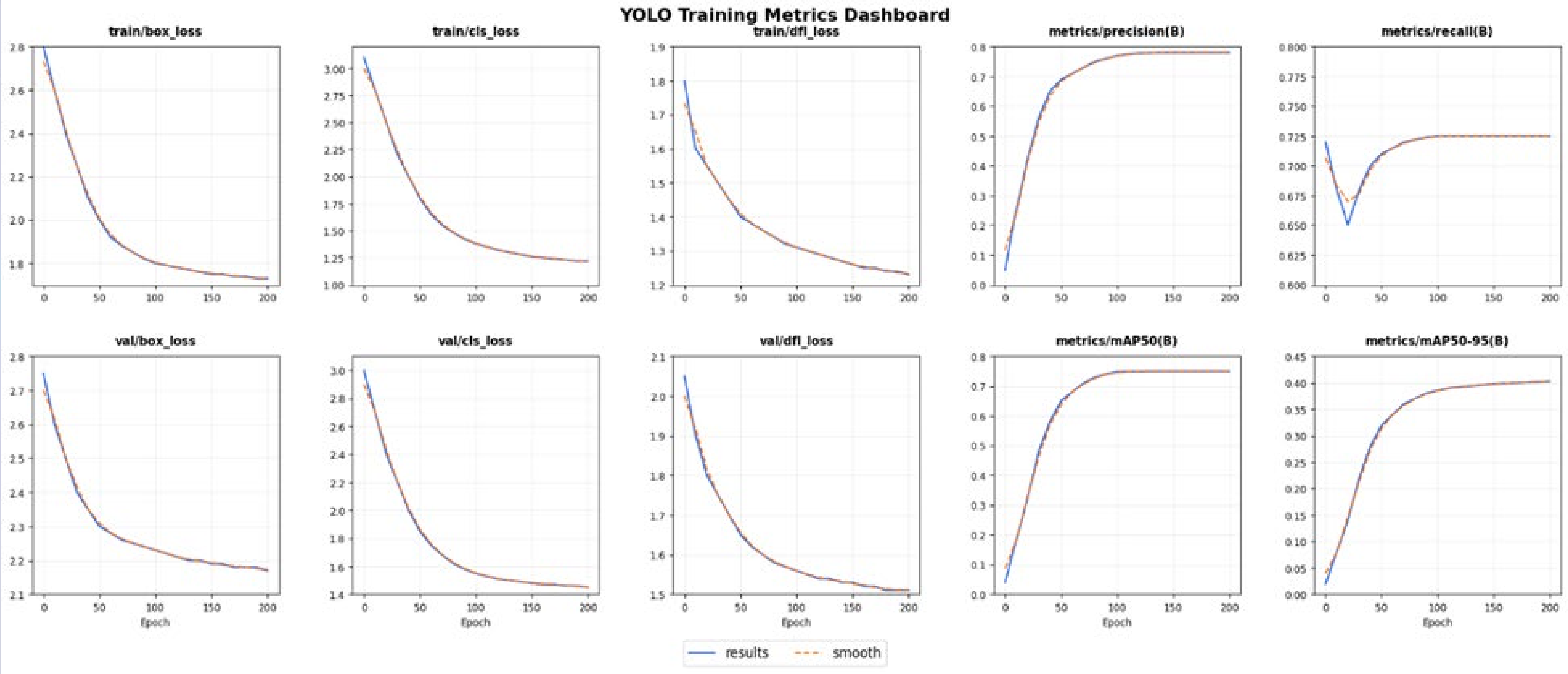


- Higher rates of respiratory (41%) and skin (27%) infections within 3 km of mines.
- Significant association between proximity and reported illness ($\chi^2 = 63.97$, $p < 0.001$).
- Distant communities report much lower incidences (GHS 2,023).

Seeing the Unseen with AI

- YOLOv11n model trained on ~7,000 annotated image tiles (Ultralytics, 2024).
- Performance: mAP@0.5 = 75.0%, mAP@[0.5:0.95] = 40.3%, Precision = 77%, Recall = 73%.

Model Performance



Key Takeaways

Forest Loss & Mining Expansion Expansion

Socio-economic Impacts

AI for Environmental Monitoring

AfricaGIS 2025

UN-GGIM: AFRICA
UNITED NATIONS GLOBAL GEOSPATIAL INFORMATION MANAGEMENT

Path Forward: Key Initiatives

Enhanced Satellite Monitoring Monitoring

Integrate VHR & SAR imagery for precise precise detection of all artisanal and small-small-scale mining (ASM) operations.

Longitudinal Socio-Economic Economic Assessments

Monitor livelihood resilience, public health, and resource access in mining-mining-affected communities over time. time.

Advanced Deep Learning for Real-time Monitoring

Develop AI models with augmented datasets for seamless GIS integration and and predictive early warning systems.

Thank you

- Contact information

Email – jefftotimeh@gmail.com

Phone - +233 555132609