**Case Study: Spatial Distribution and Safety Assessment of Educational Facilities in Ablekuma, Greater Accra Region**

**Author: Aduni Alfred Awoja**

**Date:** October 2025  
**Institution:** Ga Central Municipality, Greater Accra Region, Ghana  
**Software Used:** ArcGIS · Survey123 for ArcGIS · QGIS  
**Analysis Techniques:** Field GPS Data Collection · Kernel Density Estimation (KDE) · Spatial Visualization

**1. Introduction**

Urban growth in peri-urban settlements like **Ablekuma** has led to the rapid establishment of educational, health, and industrial facilities. Despite this expansion, the **spatial distribution** and **safety preparedness** of these facilities remain a major challenge.

This study integrates **field-collected GPS data** with **GIS-based spatial analysis** to evaluate the **distribution pattern and safety status of educational facilities** in Ablekuma. Using **Kernel Density Estimation (KDE)**, the study visualizes the spatial intensity of educational institutions to identify **clusters, underserved areas, and potential safety risks**.

**2. Objectives**

1. To map and analyze the **spatial distribution** of educational facilities in Ablekuma using GIS.
2. To assess **safety preparedness** levels in schools and related community facilities.
3. To apply **Kernel Density Analysis** to determine educational facility concentration and accessibility.
4. To generate spatial evidence for **policy, safety planning, and infrastructure improvement**.

**3. Study Area Description**

**Ablekuma** is a peri-urban community located within the **Ga Central Municipality** of the **Greater Accra Region**, approximately 15 km northwest of central Accra.  
It is characterized by mixed land uses: residential developments, commercial corridors, light industrial workshops, and public facilities.

The area is experiencing **rapid spatial transformation** but faces challenges such as **poor safety enforcement**, **limited emergency response capacity**, and **uneven service distribution**.

**Insert Figure 1:** *Map of the Study Area (Ablekuma)*

**4. Data and Methodology**

**4.1 Data Collection Tools**

* **Survey123 for ArcGIS:** Used for collecting georeferenced data, photographs, and facility information.
* **Handheld GPS Devices:** For capturing accurate coordinates of educational and other facilities.
* **Microsoft Excel:** For cleaning and exporting data into CSV format.
* **QGIS/ArcGIS:** For spatial analysis, digitization, and visualization.

**4.2 Data Collection Process**

1. Conducted reconnaissance and boundary delineation using **Google Earth**.
2. Administered structured questionnaires covering facility ownership, operation, and safety infrastructure.
3. Captured **GPS coordinates** for each facility using Survey123’s geolocation feature.
4. Integrated data into QGIS for visualization and further spatial analysis.

**4.3 Kernel Density Estimation (KDE)**

The Kernel Density tool in ArcGIS was applied to the **educational facility points** to analyze:

* **Hotspots** of school distribution,
* **Accessibility trends**, and
* **Potential service gaps** across Ablekuma.

The output produced a **density surface** highlighting areas of high educational concentration (red/yellow zones) and low concentration (green/blue zones).

**Insert Figure 2:** *Kernel Density Map of Educational Facilities in Ablekuma*

**5. Findings and Analysis**

**5.1 Facility Inventory**

| **Facility Type** | **Number Surveyed** | **Examples** |
| --- | --- | --- |
| Educational Institutions | 28 | Mercy Seat Academy, Holy Innocents Anglican Basic School, Villot Heaven’s Way School |
| Health Facilities | 19 | Jennifer Amaako Pharmacy, Samaritan Pharmacy |
| Mechanic Workshops | 14 | Erico Mental & Body Works, Boateng Auto Mechanic |
| Filling/Gas Stations | 3 | Oilfast Filling Station, Mambah Gas Station |

**5.2 Ownership Analysis**

* **Private Facilities:** 80% (generally better equipped with safety tools).
* **Public Facilities:** 20% (mostly government schools with limited equipment).

**5.3 Safety Preparedness**

* **Health Facilities:** Moderate safety compliance; many pharmacies had fire extinguishers.
* **Educational Institutions:** Low preparedness; few had extinguishers, none had alarms.
* **Mechanic Workshops:** High-risk, minimal safety tools.
* **Filling Stations:** Highest safety compliance — had extinguishers, sand buckets, and fire signage.

**5.4 Kernel Density Analysis Results**

The **Kernel Density surface** revealed:

* **High-Density Clusters:** Around the central zones of Ablekuma — mainly private schools.
* **Medium Density:** Around mixed-use areas with public schools.
* **Low Density:** In the northern and peripheral areas — indicating underserved regions.

**Insert Figure 3:** *Kernel Density Visualization of Educational Facilities*

**Interpretation:**  
Areas with a high density of schools indicate better educational access but also pose **potential safety and congestion risks**. Low-density zones suggest the **need for new educational infrastructure** to improve accessibility and balance development.

**6. Discussion**

The integration of **field-collected data** with **spatial kernel analysis** provided a clear picture of how educational facilities are distributed and how safety preparedness varies.

While private schools are densely clustered and moderately equipped with safety tools, public institutions remain **sparsely distributed and underprepared**.  
Spatial analysis revealed patterns that could guide both **urban development** and **emergency planning** in peri-urban communities.

Kernel density results confirm that **educational facilities are unevenly distributed**, highlighting the importance of **data-driven urban management** for equitable service provision.

**7. Recommendations**

1. **Policy Enforcement:** Implement municipal laws requiring fire extinguishers and safety signage in all schools.
2. **Capacity Building:** Conduct safety and first-aid training for educational staff.
3. **Infrastructure Planning:** Develop new schools in low-density areas to enhance accessibility.
4. **GIS Integration:** Create a dynamic municipal GIS dashboard for continuous facility monitoring.
5. **Community Awareness:** Educate school administrators and workshop owners on fire prevention and disaster preparedness.

**8. Conclusion**

This case study demonstrates how **GIS technology** can be applied to analyze spatial distribution and safety preparedness in a developing urban environment.  
By combining **field survey data** and **Kernel Density Estimation**, the study reveals patterns of educational clustering, accessibility, and vulnerability within Ablekuma.

The findings emphasize the need for **policy-backed safety enforcement**, **infrastructure equity**, and **continuous GIS-based monitoring** to promote safer, more organized urban growth.