Executive Summary

Introduction

In Uganda, land ownership is governed by the Constitution of 1995, which recognizes four types of land tenure systems: Mailo, Freehold, Leasehold, and Customary.

Mailo Tenure: A unique system primarily found in central Uganda, Mailo tenure involves land ownership where the land is held in perpetuity. Mailo land is registered and managed through the Uganda National Land Information System (UgNLIS), ensuring that ownership and occupancy rights are well-documented.

Freehold Tenure: This system grants the landowner full ownership rights in perpetuity, allowing them to use the land for any lawful purpose and to transfer it at will. Freehold land, like Mailo, is systematically registered and managed through the UgNLIS, providing secure and clear ownership records.

Leasehold Tenure: Under leasehold tenure, the land is leased to an individual or entity for a specified period, typically 49 or 99 years. Leasehold agreements are also managed through the UgNLIS, with detailed records of lease terms and land use rights.

Customary Tenure: The most prevalent tenure, covering over 80% of Uganda's land, customary tenure is governed by traditional rules and laws specific to different regions, often based on hereditary principles. Unlike the other tenure systems, customary land has historically been measured and registered using rudimentary methods such as sketch maps or measuring by tapes and is not systematically managed through the UgNLIS. This has led to challenges in securing land tenure, as records are often incomplete or informal.

The GIS-based tool being developed for mapping customary land in Uganda seeks to address these challenges by providing a modern, accessible platform that aligns with the "Fit for Purpose" approach. This approach emphasizes simplicity, community participation, and the use of low-cost tools like QGIS to document land boundaries, enhancing tenure security and supporting the legal recognition of customary rights.

Problem Statement

Despite the vast extent of customary land in Uganda, covering over 80% of the country, there is a significant gap in systematic mapping and documentation, which has impeded the legal recognition of these lands. The existing methods for land documentation are often inaccessible due to high costs, complexity, and the exclusion of community input, leaving many customary landowners without formal recognition or protection of their rights.

The proposed GIS-based tool, developed as a QGIS plugin, addresses these challenges by providing a robust, user-friendly interface for spatial data mapping and visualization. Built on customizable open-source software, this tool ensures flexibility and adaptability to meet specific user needs. The tool serves as the backbone for data storage and management, enabling efficient handling of spatial data and ensuring that geographical information is well-organized and accessible. This system supports the mapping, demarcation, and documentation processes necessary for issuing Certificates of Customary Ownership, thereby empowering communities and enhancing land tenure security.

Methods

The tool leverages a combination of open-source technologies, including QGIS for mapping, Postgres/PostGIS for spatial and non-spatial data storage, and Python for scripting. The development process involved defining project goals and objectives, setting up the development environment, configuring the database, and implementing key functionalities such as parcel creation and deletion, checking of inconsistencies in the parcels created such as incomplete polygons, applicant details input forms, shapefile import, and generating of reports.

Architectural/Software Diagram Description

1. User Interface Layer:

QGIS Interface:

Mapping and Spatial Data Handling (QGIS Plugin): The primary user interface is within QGIS, enabled with a custom plugin developed using Python. This plugin allows users to map, edit, and analyze customary land data directly within the QGIS environment, leveraging its powerful GIS capabilities.

Web Interface:

Forms and Data Input (HTML, CSS, JavaScript): For tasks like submitting land ownership information, viewing reports, and administrative tasks, the system provides a web interface built using HTML, CSS, and JavaScript. This interface is designed to be intuitive and user-friendly, allowing users to interact with the database, manage records, and generate reports.

2. Application Logic Layer:

QGIS Plugin (Python):

The Python-based QGIS plugin handles all the GIS-specific tasks, such as digitizing land parcels, automation of checking topological constraints , and visualizing data. This plugin is the core of the mapping functionalities within QGIS.

Web Application (Java, HTML, CSS, JavaScript):

Java: Used for handling complex backend processes and server-side logic, ensuring robust and scalable interactions between the user interface and the database.

JavaScript: Enhances the interactivity of the web interface, enabling dynamic content updates and user interactions without requiring a full page reload.

CSS: Used for styling the web interface, ensuring a consistent and user-friendly experience.

3. Backend Services Layer:

Backend Services (Java and Python):

Java Services: Implement business logic, handle user requests, and manage data processing tasks.

Python Services: Particularly focused on spatial data processing, integration with QGIS, and execution of GIS-specific scripts.

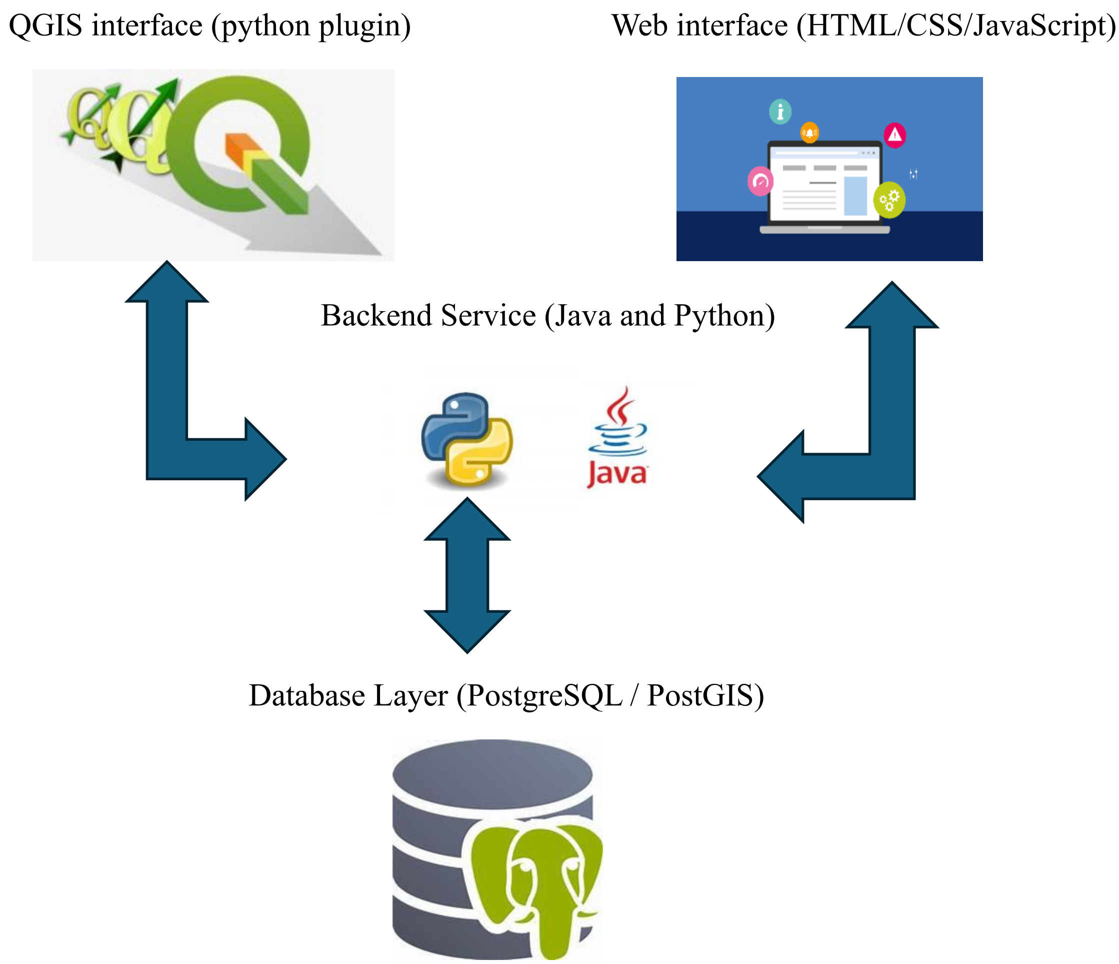
4. Database Layer:

PostgreSQL with PostGIS (SQL):

PostgreSQL: The primary database management system, which stores all land-related data, including ownership details, spatial data.

PostGIS: An extension of PostgreSQL, enabling the handling and querying of geographic objects. SQL is used extensively for database management, including creating, updating, and querying records.

Architectural / Software Diagram



Results

The GIS-based tool offers a range of features designed to meet the needs of its target audience. Key functionalities include:

Digitizing and Editing Tools: Allowing users to map and edit land boundaries, ensuring accurate representation of customary land areas.

Parcel Management: Users can create and delete parcel boundaries directly on the map interface, keeping land records current.

Applicant Details Input Forms: Facilitating the entry of ownership details, which are stored alongside spatial data for comprehensive land management.

Shapefile Import and Attribute Management: Enabling the integration and management of external data for enhanced analysis.

Reporting Tools: Users can generate detailed reports on land ownership and produce printable maps for community meetings and official documentation.

Query Tool: Provides in-depth analysis of tenure systems, owner details, and parcel sizes, supporting informed decision-making.

Use Case Scenario

An envisioned use case involves a land surveyor and a records/land officer at the Ministry of Lands, Housing, and Urban Development, who are tasked with updating land records in a village in Northern Uganda.

The officer opens the QGIS interface, where the custom plugin is already deployed. Using the digitizing tools from the QGIS layers panel, the officer begins drawing land parcels. This process involves selecting nodes that represent boundary markers (mark stones) and connecting them with edges to form closed parcels. After creating each parcel, the officer clicks on the form button in the layers panel and selects the desired parcel to input the landowner's details into a form.

Once all parcels are systematically created, the officer defines the area to be exported for further processing and storage. The data is then exported as a zipped JSON file.

Next, the officer logs into the GIS tool, imports the JSON file, and adds the parcels along with their associated forms from the field layer. After ensuring that topological constraints are met, the officer commits the updated records to the database. Finally, reports are generated, and the village's land records can be exported as a shapefile for printing or further analysis.

Conclusion

The GIS-based tool for mapping customary land in Uganda addresses land tenure security and management challenges. The project has taught valuable lessons in requirements definition, interface design, and integration testing. Future work could involve customizing QField for mobile use and expanding geographic coverage, building on this solid foundation to enhance sustainable land management in Uganda.