

The Need for an Open Geospatial Data Platform for Smart City Development in Lagos, Nigeria

Mberede Benedict Obinna, Nigeria

Key words: Geospatial Data, Smart city, Open Data, urban planning

Abstract

The emergence of smart cities is drastically changing urban environments all over the world by utilizing technology to improve urban service efficiency and quality of life. In the context of Lagos, Nigeria, a burgeoning megacity, the implementation of smart city initiatives is critical to addressing its unique urban challenges. Central to this transformation is the availability and accessibility of geospatial data. This paper argues for the establishment of an open geospatial data platform in Lagos, highlighting its potential to foster innovation, improve urban planning, enhance public services, promote transparency, and engage citizens. The study reviews current urban challenges in Lagos, examines the role of open geospatial data in smart city development, and proposes a framework for the implementation of an open geospatial data platform using Esri ArcGIS Web Mapping Application incorporating transport & mobility data, wetlands, flood, housing data and control network data.

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1. Introduction

Lagos, one of the fastest-growing cities in the world, faces significant urban challenges, including traffic congestion, waste management, housing crisis, real estate challenges and population challenges. The smart city concept offers a promising avenue to tackle these issues through the integration of information and communication technology (ICT) in urban management.

A smart city is an urban area that uses information and communication technology (ICT) to enhance performance, well-being, and reduce costs and resource consumption. The goal of a smart city is to improve the quality of life for its residents by integrating various technologies and data-driven solutions into different aspects of urban infrastructure and services.

A core component of this approach is geospatial data, which is crucial for urban planning, transportation management, environmental monitoring, and emergency response. However, Lagos currently lacks an open, comprehensive geospatial data platform, limiting the potential for effective smart city solutions.

In the context of smart cities, open data initiatives aim to improve citizen engagement and participation, strengthen city governance, increase transparency, analysis, and planning, foster co-creation and collective intelligence, support innovative products and services, and support a variety of socioeconomic and environmental issues. (Fátima et al., 2020)

Information with a geographic component, or one that is connected to a particular place on Earth's surface, is referred to as geospatial data. Coordinates, which are commonly employed to describe this data and are related to latitude, longitude, and occasionally altitude, can be used to analyze, display, and comprehend patterns and relationships pertaining to the characteristics and phenomena of Earth.

This study highlights the potential of a near real-time web-based geographic information systems (GIS) in city planning by examining the idea of smart cities and the related technology.

1.1. Area of Study

Lagos is one of the most populous cities in Africa. As of 2023, its estimated population was over 15 million, making it the largest city in Nigeria. When considering the entire metropolitan area, that number swells to around 21 million, according to the United Nations. Lagos is the economic powerhouse of Nigeria. It contributes a significant portion of the country's GDP, with

estimates ranging from 25% to 30%. The city is a major financial center and is the hub of Nigeria's oil and gas industry.

Lagos, which is made up of several islands including Lagos Island and Victoria Island that are connected to the mainland by bridges, is situated in the southwest of Nigeria. With a wet season from April to October and a dry season from November to March, the city experiences the weather of a tropical savanna.



Figure 1: Area of Study

2. Literature Review

2.1. Urban Challenges in Lagos

Lagos is a metropolis that faces many obstacles, and because of its enormous size and quick growth, these challenges are significant. Physical geography also matters because Lagos's growth has been restricted to the east due to its original location adjacent to a lagoon with rivers and lakes.

Lagos had just 200,000 inhabitants in 1960, but it is rapidly growing to rank among the world's major cities today. Nigeria has one of the highest birthrates in the world, and as a result of poverty and violence, people from surrounding countries and rural areas are fleeing to Lagos, the country's economic hub.

One challenge the city badly needs to address is its transportation system, these issues are being addressed by the current government by providing alternative means of transportations through the blue and red line rail as well as setting up new road infrastructures.

Another major challenge Lagos is facing is housing. Rapid urbanization, lack of housing and poverty have forced millions of Lagosian to settle in informal settlements. While plenty of luxurious houses and apartments are being built for Nigeria's rich, most people share crowded rooms because that's all they can afford. Informal settlements are found all over Lagos where residents lack legal rights and basic services like water and sanitation. Many are built on reclaimed wetlands that face challenges with sinking buildings and rising sea levels. One of the more unique and famous informal settlements of Lagos is Makoko, a floating community of stilt houses built on the water on the edge of Lagos Lagoon.

The demolition of homes in the affluent Lekki neighborhood has been the subject of intense controversy and discussion since the Lagos State government started this project in recent months. This move has sparked debate, rumors, and inquiries over the reasons for this significant urban change.

In Lagos, Nigeria, breaking building setback restrictions is a serious problem that is frequently used as justification for demolishing homes. Legal regulations known as "building setbacks" specify the minimum amount of space that a building must have between it and the edge of its land or public infrastructure, such as roadways and drainage systems. The purpose of these setbacks is to guarantee environmental sustainability, safety, and planned urban growth. Buildings that break these rules may face demolition as a final resort in addition to other issues.

Due to not available open information of these environmental and safety setbacks, citizens and prospecting investors of Lagos tend to make the wrong decisions as sometimes they do not know where to source for the exact information, this therefore necessitate the need for an open geospatial data portal as according to Ugoada Orji, 70 percent of the investment in Nigeria's real estate comes from Nigerians in the diaspora while 30 percent is accrued from Nigerians at home.

2.2. Smart City Concepts and Geospatial Data

More than 90% of the world's population will reside in cities by the end of this century. Whether or not they reside in cities themselves, most people's lives will be greatly impacted by the nature of future cities. (Glenn Kong, 2023)

The idea of "smart cities" has become well-known throughout the world as the most innovative approach to urban planning in the future. In this regard, one of the most important tools for smarter city development is the integration of web-based Geographic Information Systems (GIS) with real-time capabilities.

Smart cities utilize data and technology to enhance urban living. Geospatial data, which includes information about geographical locations and features, is vital for urban planning and management. Studies have shown that open access to geospatial data promotes innovation and collaboration among government, private sector, and citizens.

A smart city is an urban setting that maximizes the use of available resources to improve the standard of living for its citizens. This is typically achieved using cutting-edge technology that allow for the optimization of city operations and the resolution of numerous issues related to urban living. To do this, these cities make use of ICTs (information and communication technologies) to gather and process data, enabling well-informed choices that enhance productivity, sustainability, and general well-being. Additionally, smart cities provide an intelligent and integrated urban ecosystem by providing digital solutions in several areas, including public services, energy, healthcare, transportation, and government. (Daniel et. al, 2024)

It is estimated that location information makes up 80% of the data in the globe (Franklin and Hane, 1992, Williams, 1987). Hence and an increase in demand for the use and need of Geospatial data.

The urban landscape is changing, and effective data management is becoming more and more crucial as cities grow and face more difficult problems. Utilizing cutting-edge geospatial data analysis methods, geospatial datasets are crucial in this context as they enhance our comprehension and management of urban environments. (Darwish et. al, 2022)

There's no doubt that future smart cities will look very different from cities today. Making significant judgments and tackling diverse urban difficulties will heavily rely on spatial orientation. It will be essential in this situation to gather and analyze large volumes of data, especially geographic data. As a result, one of the most important tools for building future smart cities will be the use of real-time web-based Geographic Information Systems (GIS). Smart cities can improve services to residents and communities by utilizing real-time web-based GIS in two main ways: data visualization and crowdsourcing. This strategy will make urban management more effective and efficient.

Datasets covering a wide range of topics, including parks, financial transactions, refugee camps, the distribution of natural resources, and socioeconomic statistics, contain geospatial elements. Being "mapped," or connected to fundamental geographic framework data is necessary for many applications of open data. For instance, administrative boundaries may be overlaid on top of socioeconomic indicators, like population statistics. The same soil data can be compared to geographically intersecting data on land ownership and land subsidies. Soil quality data can be added to digital elevation models to simulate erosion. Many publicly available datasets would be far less useful without their geographic component.

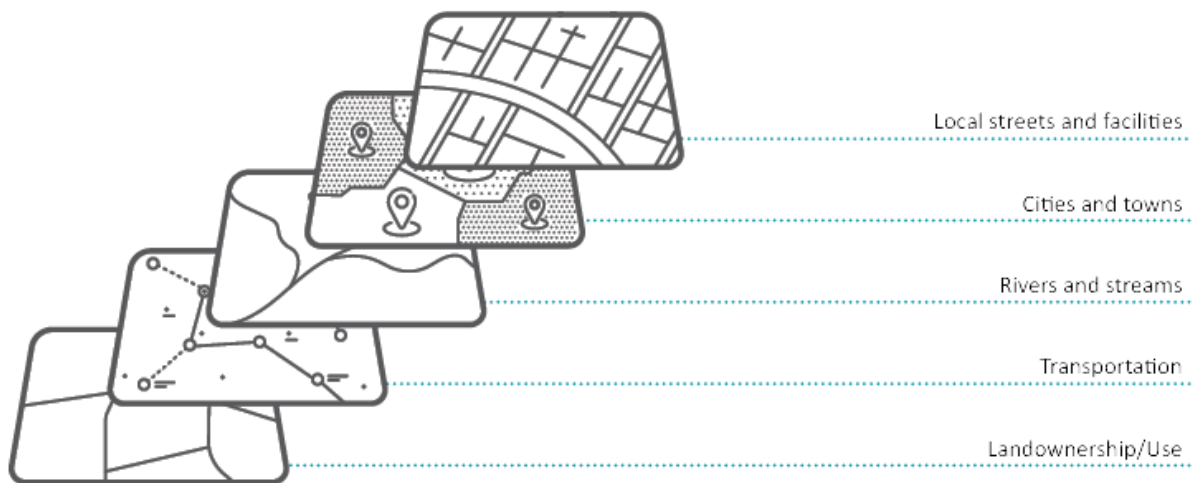


Figure 2: Different layers for Open Geospatial Data

2.3. Case Studies of Open Geospatial Platforms

According to Esri, there are eight basic open data principles, which should serve as the foundation of the open data movement. It was noted that open data should be:

- Complete: All public data is made available. Public data is data that is not subject to valid privacy, security, or privilege limitations.
- Primary: Data is as collected at the source, with the highest possible level of granularity, not in aggregate or modified forms.
- Timely: Data is made available as quickly as necessary to preserve the value of the data.
- Accessible: Data is available to the widest range of users for the widest range of purposes.
- Machine processable: Data is reasonably structured to allow automated processing.
- Non-discriminatory: Data is available to anyone, with no requirement of registration.
- Non-proprietary: Data is available in a format over which no entity has exclusive control.
- License-free: Data is not subject to any copyright, patent, trademark, or trade secret regulation. Reasonable privacy, security and privilege restrictions may be allowed.

These eight guidelines have motivated governments all around the world to make their official data available, leading to open data initiatives that have strengthened the positions of experts in almost every industry. Many people and organizations, including researchers, journalists, entrepreneurs, and health experts, have benefited from accessible data in changing the way government functions.

Nevertheless, other requirements for an open geospatial data include authoritativeness of data, spatial and attribute data accuracy through quality assurance and control, derived insights.

Significant progress has been made in opening geographic datasets over the past ten years. There is evidence to support the considerable social and economic benefits of this. For instance, in 2013 the Danish government made digital mapping data available for free under an open license as part of their Basic Data program. According to a 2017 follow-up study, this resulted in socioeconomic value of DK 3.5 billion (about USD 495 million) in the year before. (PwC, 2017).

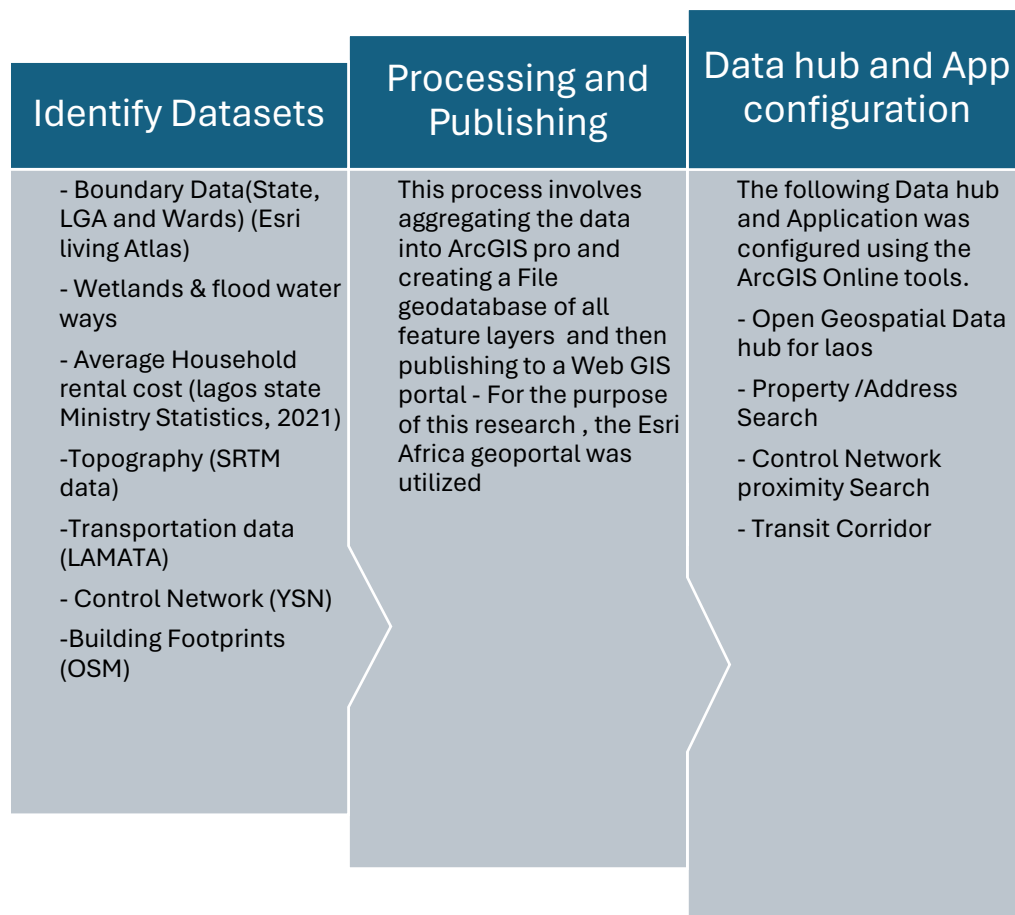
In the UK, open data policy has led to new datasets being made open from their mapping agency, the Ordnance Survey. The release of geospatial data responded to advocacy that focused on gains to the economy from a more open approach to this data. (yates et. al, 2018)

3. Methodology

This study adopts a case study approach, analyzing existing geospatial datasets in silos, gathering this dataset, and publishing to a web GIS system and configuring an open geospatial data hub of flood data, control network, topography, housing, and transportation data to enable a smart city initiative that utilize geospatial open.

3.1. Objectives

- Identify available geospatial dataset needed for open data from various sources.
- Process these datasets for publishing to a web portal.
- Configure open data hubs for various application citizens and geospatial professionals can interact with.



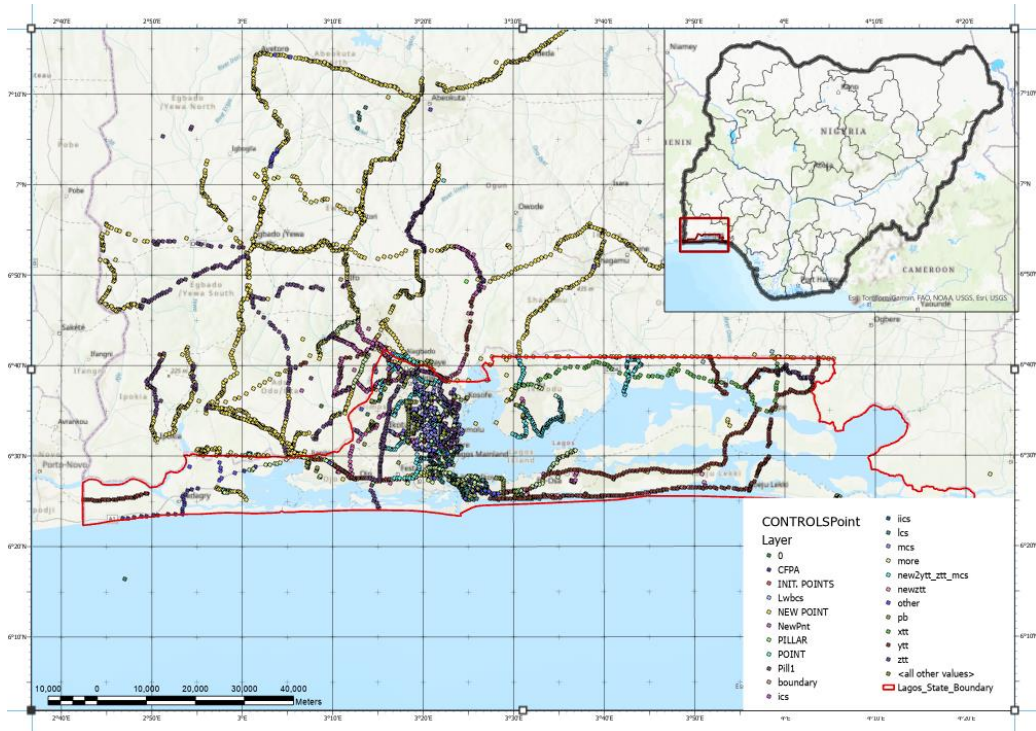


Figure 3: Control Network Distribution for Lagos State

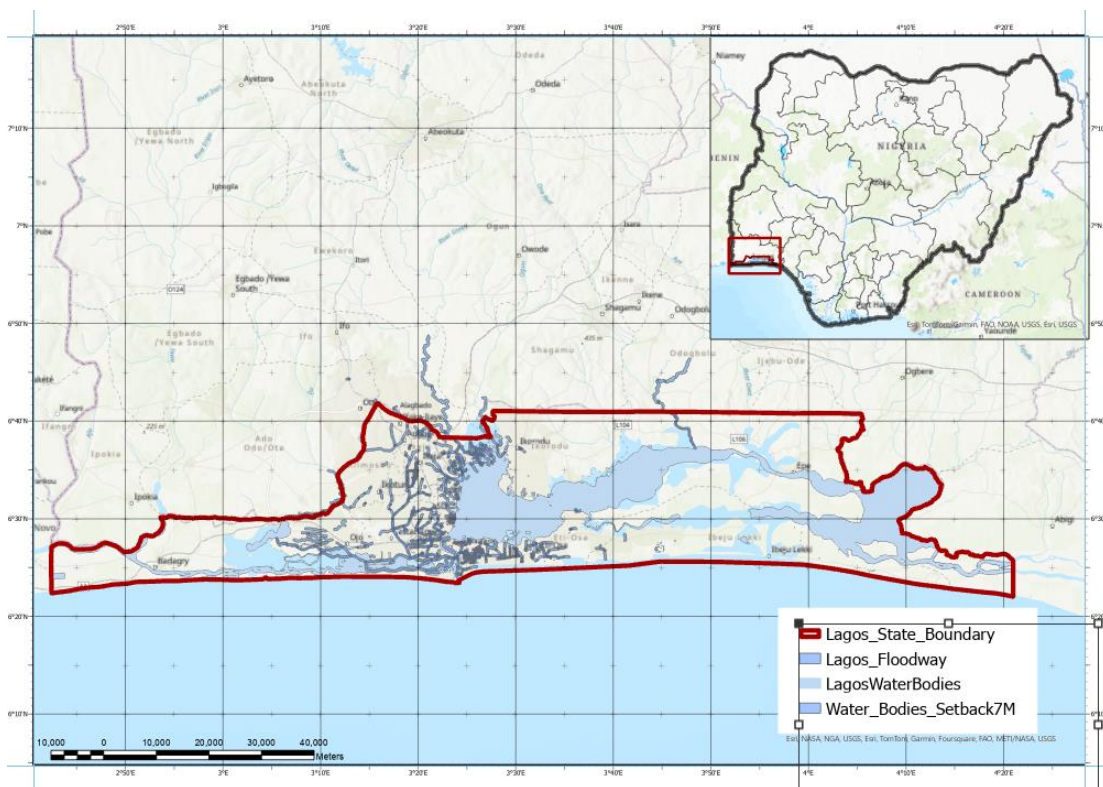


Figure 4: Wetlands and Flood way

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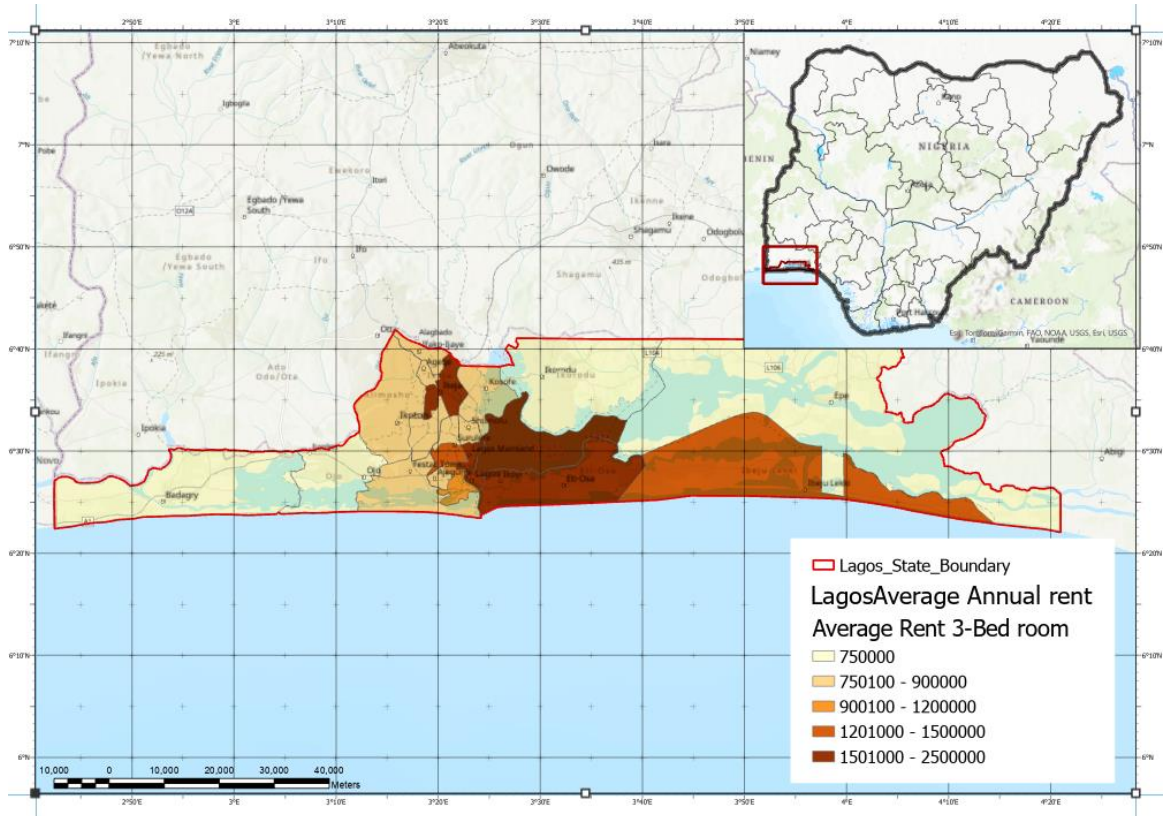


Figure 5: Average Annual Rent Cost in Lagos

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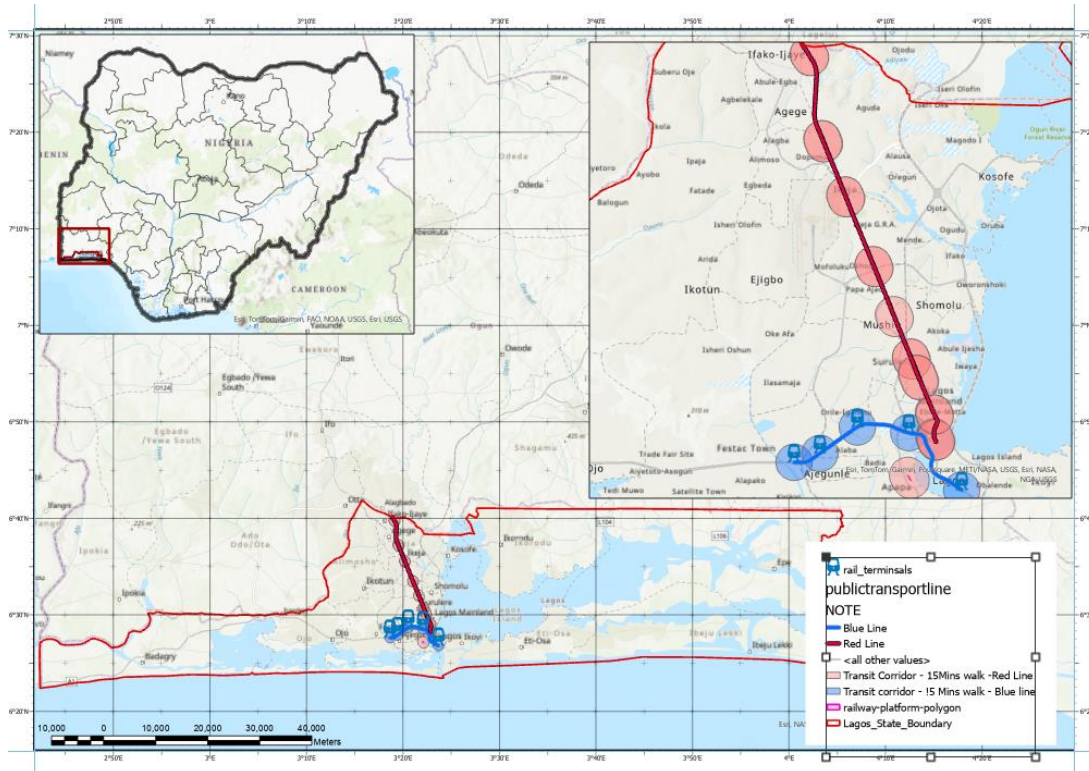


Figure 6: Transit Corridor of blue and Red Line

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4. The Need for an Open Geospatial Data Platform in Lagos

4.1. Enhancing Urban Planning and Management

An open geospatial data platform would enable more accurate and efficient urban planning in Lagos. It would facilitate better decision-making in infrastructure development, traffic management, and environmental protection.

The property search application can inform prospective investors about the environmental status of their properties if they fall on wetlands or flood zones and give details about the average annual rentage of properties within that area. Also, the transit corridor map can inform users of how close their property is to the existing transit infrastructure.

4.2. Fostering Public-Private Partnerships

Such a platform could serve as a catalyst for public-private partnerships, driving innovation and investment in urban solutions. By providing access to vital data, it would encourage private sector involvement in urban development projects.

The control network datasets can inform various stakeholders and encourage them in establishing accurate positioning of their infrastructures and ease planning. The open topography data can also give an overview and insights about necessary resources needed to be deployed for any constructions in the preliminary stages before an in-depth and accurate survey is carried out.

4.3. Engaging Citizens and Improving Services

Open data fosters transparency and citizen engagement. By empowering citizens with information, it promotes more participatory urban governance. Additionally, it can improve the delivery of public services through data-driven insights.

With the recent demolitions around Lagos on encroaching properties on standard setbacks, this open data portal serves as a preliminary base for information before in depth analysis and survey is done to pre inform investors, as research has shown that more than 70% of investors in Nigeria are Nigerians in Diaspora. This open data portal, which can be accessed anywhere in the world, will be able to guide them on when their investment falls and the environmental status of such investment.

5. Proposed Framework for Implementation

5.1. Data Collection and Standardization

The first step involves collecting comprehensive geospatial data across various sectors in Lagos. This data must be standardized to ensure interoperability and ease of use. Most of the data would have to be processed and re-analyzed to generate insights for public consumption. These data vary from tables, raster data, vector data and other resources with locational information. Most of these data resides with various ministry of the Lagos state government.

5.2. Platform Development and Management

Developing a user-friendly, scalable platform is crucial. The platform should ensure data security, privacy, and regular updates. The platform must be easy to use for both public and private consumption. It should also be easily accessible without necessarily needing to sign up. The need for constant maintenance and updates of all data should also be prioritized.

5.3. Stakeholder Engagement and Capacity Building

It is crucial to include stakeholders from the public, business, and civil society sectors. Additionally, the platform's viability depends on developing local competence in data administration and literacy.

6. Conclusion

For Lagos to develop into a smart city, an open geospatial data platform must be established. It might greatly advance public services, encourage innovation, and improve urban planning. This paper urges stakeholders to acknowledge the significance of open geospatial data in urban development and offers a strategic framework for its implementation.

The development of smart cities and environmental management can greatly benefit from the integration of flood data, topographical data, housing statistics, and other geospatial datasets into an open geospatial data platform. The case studies show how these kinds of platforms can improve urban resilience, guide development, and involve the public. To fully realize these advantages, ongoing investments in open data infrastructure and regulations are essential.

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