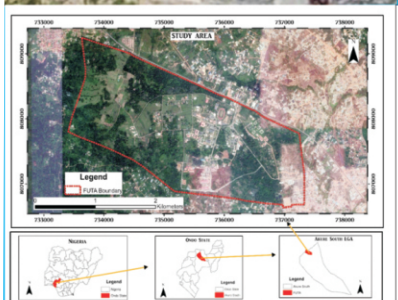




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Aim and Scope

The Journal of Environmental Technology (SetJet) is published by the School of Environmental Technology (SET), The Federal University of Technology, (FUTA) Akure, Nigeria is a multi-disciplinary, double blind, peer-reviewed journal committed to the advancement of the frontiers of knowledge through the publication of basic and applied research in the field of Environmental Science, Technology and Management. SetJet is published twice in a year (June and November), and its scope includes Architecture, Building, Civil Engineering, Estate Management, Environmental Conservation and Management, Fine Art, Industrial Design, Project Management, Quantity Surveying, Surveying and Geoinformatics, Urban and Regional Planning as well as other allied disciplines.

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Editorial

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The Journal of Environmental Technology (SetJet) is published by the School of Environmental Technology of the Federal University of Technology, Akure, Nigeria. It is a multi-disciplinary journal committed to the advancement of the frontiers of knowledge through the publication of basic and applied research. The journal offers a vehicle for effective communication and intellectual exchange among academics and intelligentsia in general.

SetJet was first published in 2002 to provide an outlet for scholars and professionals in the built environment to disseminate their research findings. It publishes well-researched and synthesized manuscripts in all fields of environmental studies. It is published twice in a year (June and November), and its scope includes the following disciplines: Architecture, Building, Estate Management, Fine Art, Industrial Design, Land Surveying, Urban and Regional Planning, Geography, Economics, Quantity Surveying, Surveying and Geoinformatics, Transportation Planning and Management.

The Journal of Environment Technology is a fully refereed journal that provides an international forum for research and critical reviews in the broad field of environmental studies. The central focus of the journal is on the integrated planning, design and management of the built environment. It encompasses applied research, application of new

paradigms, and the evaluation of policies in all the principal disciplines in the built environment.

The Journal therefore deals with environmental issues such as: Urban design; property development and management; infrastructure and facility provision management; housing and residential development; it also includes the functional and aesthetics relevance of Arts and Industrial Design to built environment. Cost and quantification in the built environment; urban regeneration and city centre revitalization; gender and urban development; transportation; and all such-like issues.

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Olufemi F. Kayode
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A Holistic Approach for Developing a Multi-Purpose Land Administration System for Akure Metropolis

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Key Words

Multipurpose, Land Administration System, Land Management, Spatial, Database, Data Integration.

Abstract

The administration of land records by multiple departments causes inefficiency in referring or comparing the land records from different land related departments because there is no effective link between them. A Multipurpose Land Administration System (MLAS) encourages data integration from several agencies. The objective of this study is to demonstrate a GIS approach that incorporates spatial database with datasets from various land related departments into a MLAS. Different spatial datasets such as Land parcel boundaries, building locations, road network, crime map, flood risk map, etc., were acquired from the study area. These acquired data were further processed using spatial data conversion tools into interoperable formats that were useful for the MLAS. ArcGIS was used to perform map overlay operations for the spatial data integration of the various spatial databases to demonstrate a MLAS. Spatial queries were also performed in ArcGIS to demonstrate the functionality of the MLAS. The result demonstrated the need for data integration across organizations in promoting effective land management, planning, and sustainable development.

Introduction

A land administration system is built for a variety of purposes. However, the primary purpose why most countries build a land administration system is to support the processes of recording and disseminating information about the ownership, value and use of land and its associated resources. The common process found in many countries include; dividing up land, allocating it for identifiable and secured uses, distributing land parcels,

tracking changes, etc.. Nigeria's and most of the world's land administration systems (LAS) tend to fulfil this primary purpose and common processes. However, with the introduction of GIS, land administration systems have become an important tool for land management as well as an instrument for the implementation of land policies that contribute to a nation's sustainable development.

If, besides its primary purpose, LAS also efficiently supports land management, it becomes a Multipurpose Land Administration System (MLAS). Land Administration Systems should, among other things, ideally be able to: guarantee ownership and secure tenure; support the land and property tax system; constitute security for credit systems; develop and monitor land markets; protect state lands; reduce land disputes; facilitate land reform; improve urban planning and infrastructure development; support land management based on consideration for the environment and produce statistical data. Therefore, besides its primary purpose, a Land Administration System can also serve as a basis for land management which is an important instrument for the implementation of land policy and contribute to comprehensive land governance (Opaluwa et al., 2014). The core idea is to move beyond mapping, cadastral surveying, and land registration to use land administration as a means of achieving sustainable development (Tumare et al., 2015). The difference between the basic purpose of land administration and its additional purpose of land management is a set of processes ensuring that land is used in an efficient and sustainable manner (Williamson, 2002; Williamson et al., 2006).

Land information plays a central role in many administrative and economic activities. It is used by many public administration bodies and private sectors in their everyday task. The Ministry of Justice, lawyers and public administrators may be more

concerned about the tenure of land parcels and develop a database with Land Tenure being its primary purpose. The Ministry of Finance, financial experts, and bankers may be more concerned about the value of a land parcel and develop a database with Land Values being the chief purpose. Furthermore, the Ministry of Environment, lands, agriculture, forestry, and planners may be more interested in the use of a land parcel and create a database centred on the Use of Land. These various professionals, agencies and parastatals have different purposes for creating a spatial database and different forms and methods with which they acquire, store, and analyse their spatial data. The incorporation of the spatial data or land information needs of multiple organisations into a Land Information System (LIS), makes that system a Multipurpose Land Administration System (Williamson et al., 2001).

The administration of land records by multiple departments causes inefficiency in referring or comparing the land records from other land related departments. Most land related departments would want to build a Geographic information system for themselves without making provision for other departments to be able to use their digitized record. For example, a staff in the department of Urban and Regional Planning may find it difficult to access land ownership records from the land registry or utility records from the Ministry of Works because of the un-harmonized nature of varying storage formats of these land records. Most times even when these land records are already digitized, it is not still easily accessible to other departments. Such system of managing land records creates

inefficiency in land administration for sustainable development. Because there is no effective link between these various land-related departments, even when one department digitizes its records, it is not beneficial to the other departments, in that the land records only timely serves that unit. For example, the Ministry of Work tend to do the same field work that the Ministry of Lands have already done because they do not have effective access to the spatial records of that agency. This tends to cause wastage of resources and delay in the pursuit of attaining sustainable development.

A Multipurpose Land Administration System (MLAS) encourages data integration from various sources. Therefore, it is a solution towards sound management of land and its resources. A MLAS incorporates data from different agencies on land ownership, land use, land valuation, land taxation, land statistics and management. Such a system would be easy to update, secure and facilitates quick retrieval of information. It ensures the use of the system for varying purposes and ensures adequate planning for sustainable development. The goal of this work is to demonstrate a multipurpose land administration system that incorporates spatial datasets from various land- related departments for effective land management and planning within AkureMetropolis, the capital of Ondo State, Nigeria. The city is situated in the tropic rainforest zone in Nigeria and lies between latitudes $7^{\circ} 15'$ and $7^{\circ} 17'$ north of the equator and between longitudes $5^{\circ} 14'$ and $5^{\circ} 15'$ east of the Meridian. The map description of the study area is shown in figure 1.

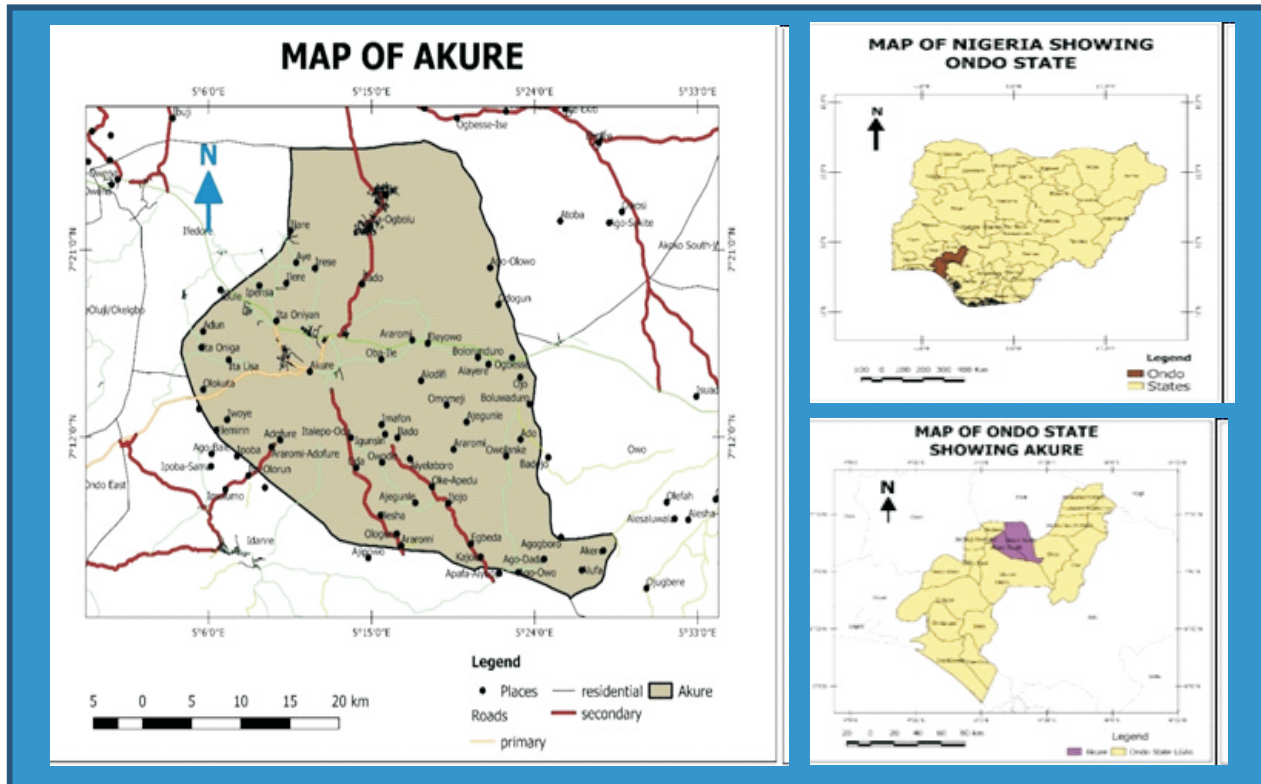


Figure 1 map of the study area (Author, 2020)

Material And Methods

This study made use of a personal computer (Intel Dual Core, 4 GB RAM memory, 500 GB Hard Disk space). *Google Earth Image Downloader* was used to acquire imagery of the study area. *ArcGIS 10.3* was used to digitize paper records, georeference the imagery, visualize multiple database, create spatial database. The GIS software was also used to fill in the attribute of spatial features, make spatial queries and analysis. Furthermore *Google Chrome* web browser was used to access websites for data downloading such as *Open Street Map*, *EarthExplorer*; and also to host spatial data online using *google drive*. *QGIS* was used to convert Spatial database formats.

Dataset Acquired

The data acquired for this project included secondary data.

- i. Imagery of the study area
- ii. Digital representation of land parcel boundaries in the study area
- iii. Digital representation of buildings in the study area
- iv. Map of the road network of the study area
- v. Topographic map of the study area
- vi. Map of flood risk zones in the study area (Oatona et al 2018).
- vii. Map showing geospatial analysis of level of crime in the study area (Bayode et al 2016).
- viii. Parcel attribute data such as land use, ownership, parcel area, parcel location

Data Processing

To ensure ease in spatial data integration, the raw data acquired were put in raster and vector formats such as .TIFF, .GDB, .SHP, etc., that could be easily accessible and updatable by different GIS applications. This further involved the evolution of spatial database into interoperable formats useful for the Multipurpose Land Administration System.

Parcel boundaries and buildings were acquired from Google Earth following a fit for purpose approach using the polygon tool in Google Earth software. The parcel boundaries and buildings were acquired in .KMZ format and were edited and converted to (.gdb) for further editing in ArcGIS.

The road network dataset was acquired from the Open Street Map website (www.osm.org) in .OSM format. The acquired dataset converted to a spatial database and edited in QGIS.

Topographic data (SRTM) acquired from Earth Explorer website (www.earthexplorer.usgs.gov) as a raster file in .BIL format which is compatible with most GIS software. However, the SRTM data downloaded from EarthExplorer website covers an area larger than the study area therefore it was clipped to the study area using ArcMap.

The flood risk map was acquired from the result of the research conducted by Olajire Olabanji Olatona, O.A. Obiora-Okeke and J.R. Adewumi on Mapping of Flood Risk Zones in Ala River Basin Akure, Nigeria. The data obtained was in a Georeferenced .TIFF format. The Image did not require further processing as it was already in the right format for data integration into GIS.

Map showing geospatial analysis of level of crime in Akure was acquired from the result of the research conducted by Olajuyigbe, A.; Omole, K.; Bayode, T. and Adenigba, A. on Crime Mapping and Analysis in the Core Area of Akure, Nigeria. The data was acquired was in .Jpeg format and needed further processing to be interoperable for this research. Therefore, the maps were georeferenced using the ArcGIS software.

Spatial Data Integration for a MLAS

ArcGIS was used for map overlay operations that integrated the different geospatial datasets that had been acquired and processed. Spatial data integration was used to facilitate the visualization, querying, and analysis of the integrated spatial data that formed the MLAS. A basic land administration system will be able to perform spatial queries that will enable the GIS user to find basic information about a land such as its ownership, value and use. However, overlaying the processed datasets from different land related departments in ArcGIS, provides the functionality of a Multipurpose Land Administration System (MLAS) that can be used for management and planning for sustainable development.

Results And Discussions

A Basic Land Administrative System (LAS) With The Parcel Database

The Parcel database is the basic dataset for a Land Administrative System that can be integrated into GIS. The parcel database fulfils the basic purpose of a Land Administrative System which is to disseminate information about the Ownership, value and use of land. Several queries were performed on the Parcel database such as identification of Parcel information; searches based on Parcel ID, Owner ID, etc. Figure 2 shows the 'Select by Attribute' window in ArcGIS used to select a parcel based on its Parcel ID.

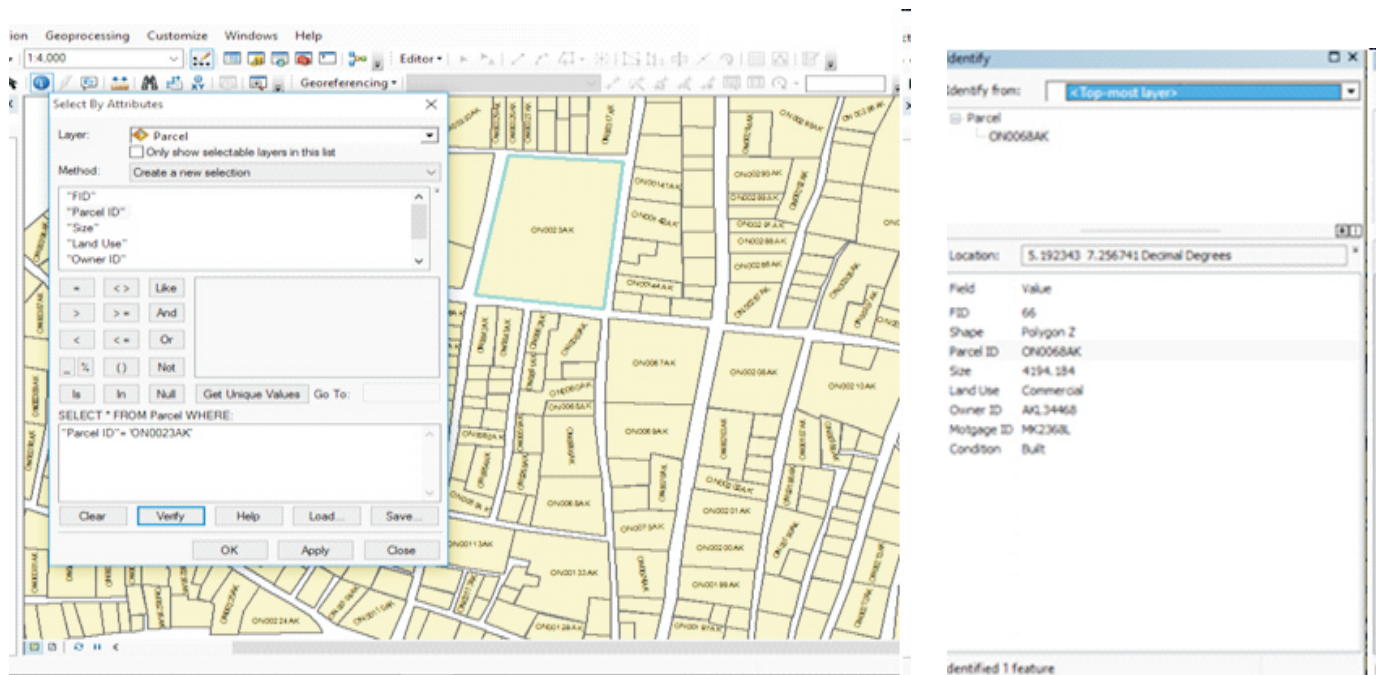


Figure 2: Selecting a Parcel based on known Parcel ID (Author, 2020)

Searching and selecting a feature from a spatial database based on its attribute is one of the advantages of using GIS to manage spatial records. For example; a query for parcels in the study area used for residential purposes and whose value is less than 10 million was performed in ArcGIS using the following:

'Land Use' = 'Residential' AND 'Land Value' < 10000000

result of the query shown in Figure 3.

The ability to use GIS to perform such queries on a land parcel database brings about efficiency and timeliness in referring to land records. The type of queries that can be performed using GIS is determined by the robustness of the database.

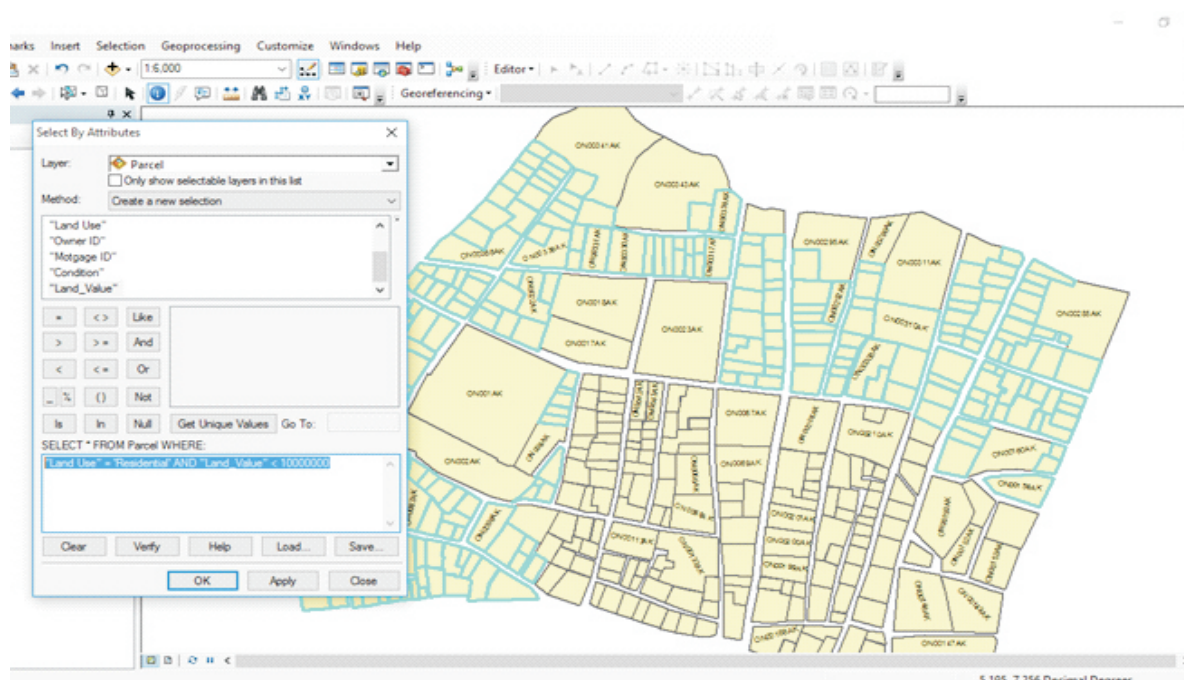


Figure 3: Query result for residential Parcels less than 10 million(Author, 2020)

Therefore, it is important for the land registry and other land-related agencies to be abreast with the current trends in spatial database design and creation. Especially considering the advocacy for the use of the Land Administration Domain Model (LADM) in ensuring the usefulness and efficiency of a land parcel database.

Integrating different database into GIS to Model the MLAS

The power of the MLAS is in its ability to make spatial analysis that will ensure proper planning and sustainable development by integrating spatial data from various sources. Figure 4 shows an overlay of the building database and the parcel database. Overlaying the Building database with the parcel boundaries

database enables the MLAS users identify a parcel and determine how many buildings within that parcel. Also, by using a Building ID, the user could determine which parcel the building is located and what other buildings are in the same parcel. Furthermore, with such integration, the staff of Ministry of Housing or that of Urban Planning can effectively monitor the start and completion of buildings. The bank staff using the building database from the MLAS can determine the building a customer claims to be residing. The mortgage staff can predetermine building with encumbrance using the building database. The search and selection of buildings based on their attributes can also be performed using the building database

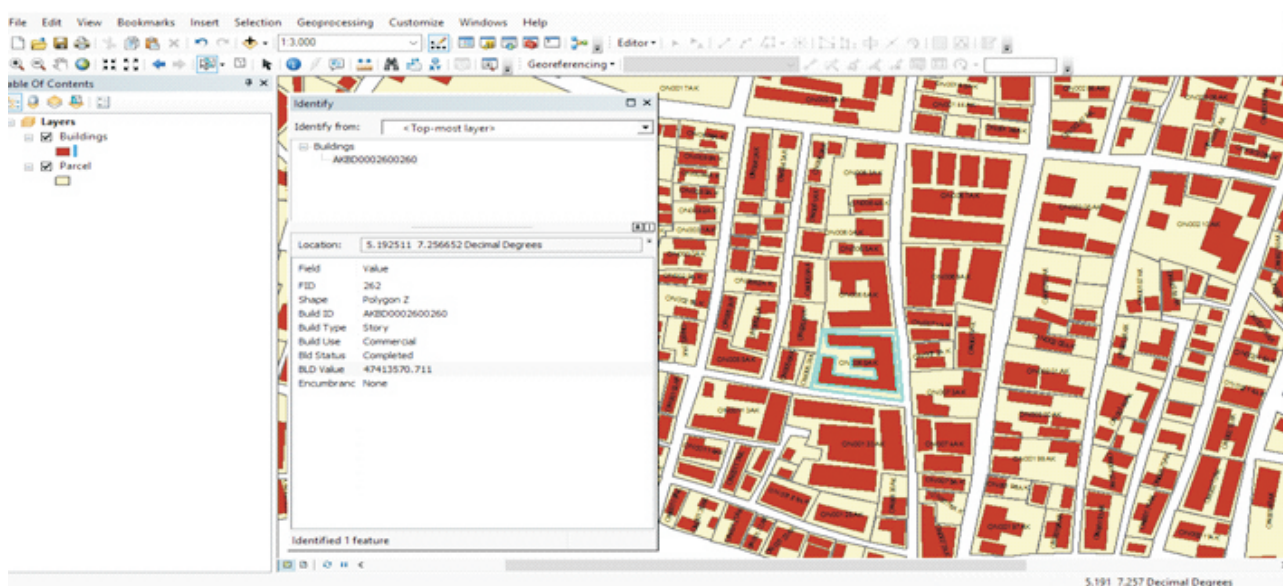


Figure 4: Building Database added to MLAS (Author, 2020)

Figure 5 shows an overlay of the road database into the GIS in ArcGIS. The result helps the GIS user identify what the effect of expanding a road would be on the land parcels and buildings in that area. Some examples of queries that can be performed using the road database in the MLAS include; determining

parcels that are along an unpaved road; determining buildings that are encroaching on road network, proximity of a land a parcel to major road, etc. The access to such datasets gives the GIS user the opportunity to think and visualize the consequences of decisions made.

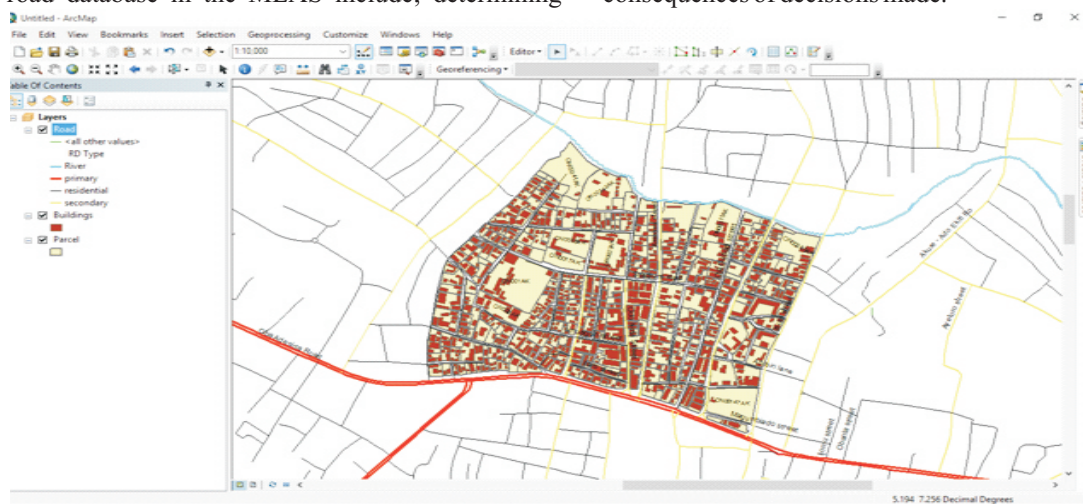


Figure 5: Integrating the road database to the MLAS (Author, 2020)

Figure 6 shows the addition of topographic data to the MLAS. The red areas are areas of high elevation while the blue areas are areas of low elevation. This kind of administration of data is more advanced from a basic LAS whereby the owner, use

and value of the land is identified. The user is still able to determine the relative elevation of that parcel. Such information definitely promotes effective planning and sustainable development.

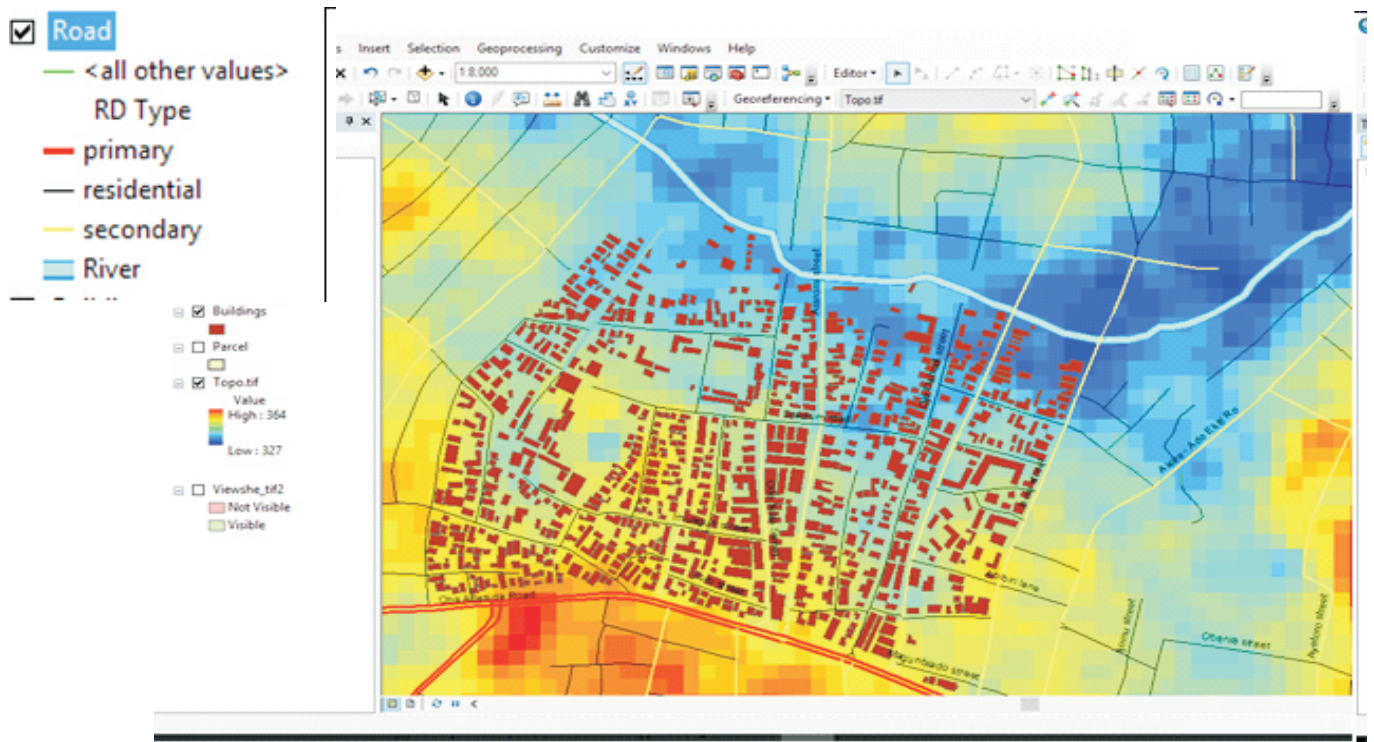


Figure 6: Integrating the Topographic dataset to the MLAS (Author, 2020)

Having a parcel ID, a user of a MLAS can check the parcel if it is an area of high or low elevation. Such integration is particularly useful for Architects and city planners know where to position a building or monument in an area of high elevation so that it will stand out in the city.

Figure 7 shows an integration of the acquired flood risk data into the MLAS and identifies the position of a land with Parcel ID

'ON00276AK' in relation to the flood data. It gives a similar visualization with the topographic data and it's also very useful for planning and land management. For instance if the land with Parcel ID 'ON00276AK' is being insured for flooding. As shown in Figure 7, its liability to flooding is considerably higher compared to its surrounding parcels. Insurance companies having access to this data set would be able to make better decisions when it comes to determining premiums.

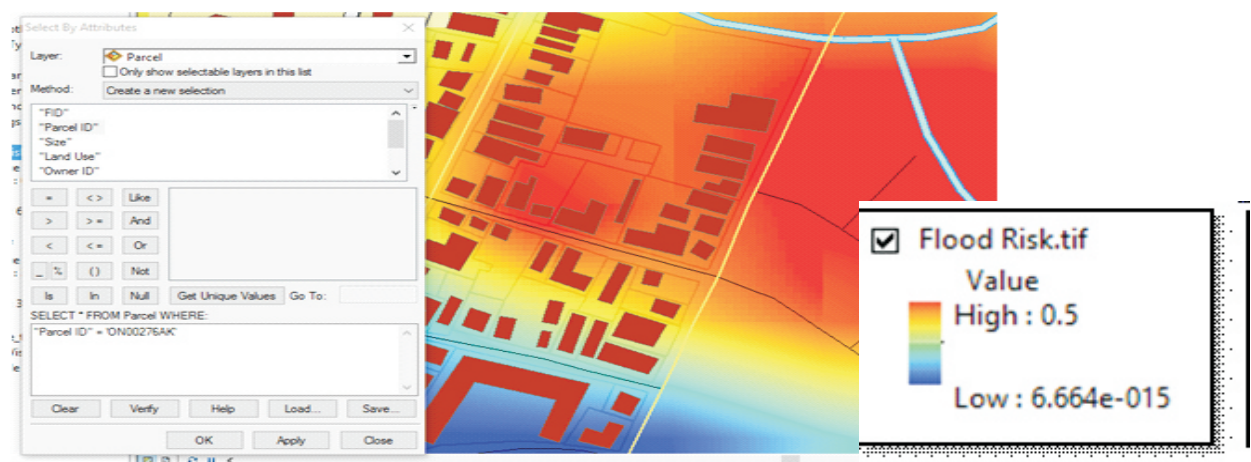


Figure 7: Identifying flood risk of Parcel ID 'ON00276AK' (Author, 2020)

The values of land in the land market can be affected by the knowledge of the use of the flood risk data. If a prospective buyer goes to the land registry to check on a property; he or she does not just get the basic information of land owner, use and value as provided by a basic LAS, but he/she is able to get more useful information about the land such as – how liable is this land to flooding. This and many other analyses are the unique usefulness of a Multipurpose Land Administrative System.

the study area. A basic land administration system will have no need for this integration but a MLAS will find this spatial data integration very useful for planning and land management. City planners can therefore determine areas to situate police stations or checkpoints, estate agents can furthermore determine relative prices for rents when considering crime levels. Also insurance companies can regulate premium price relating to the crime levels of the area of residence of their customers.

Figure 8 and 9 shows the overlay of land parcel data and building data on maps showing crime level and gang activities in

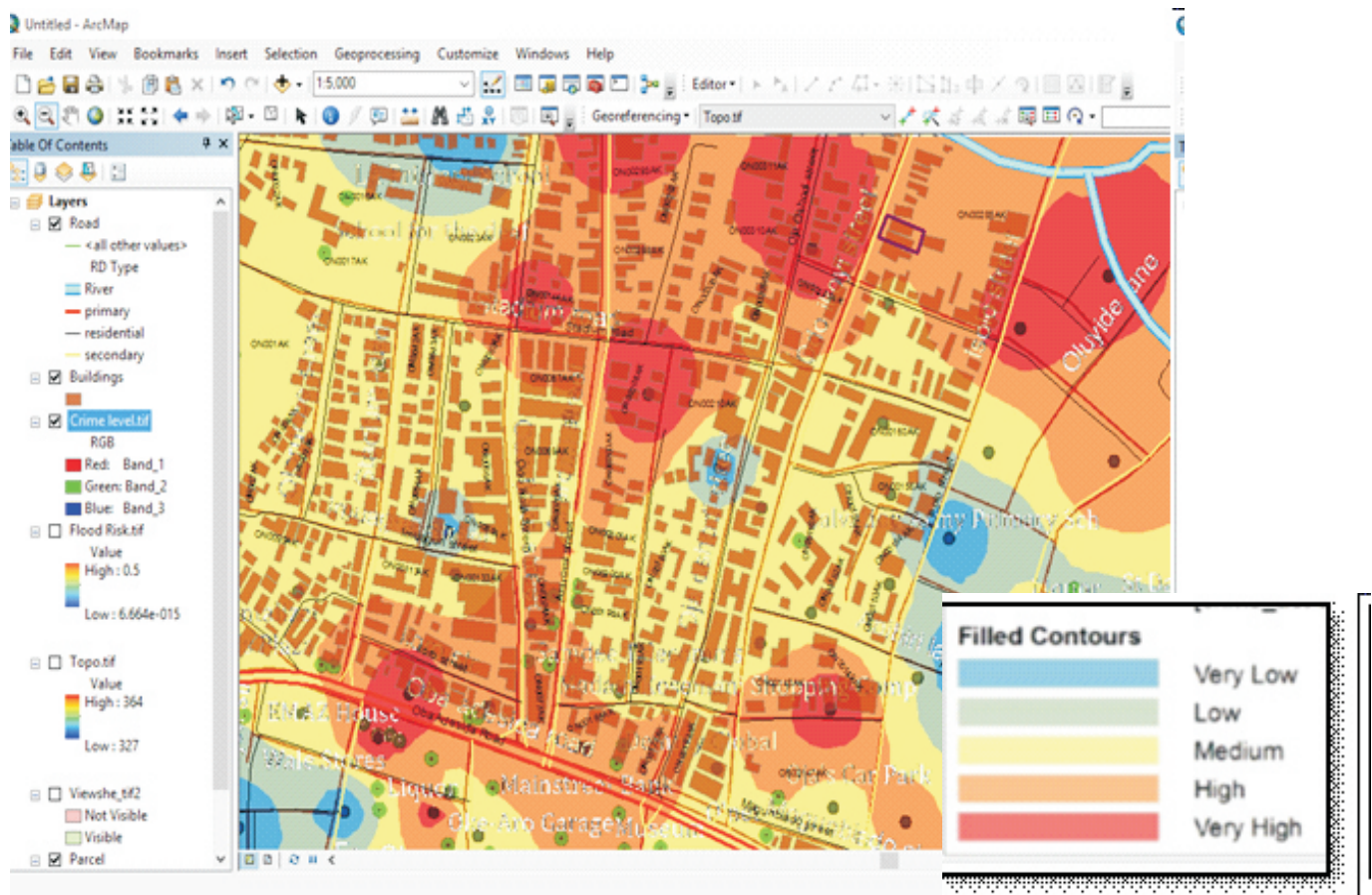


Figure 8: Integration of Crime Level map to MLAS (Author, 2020)

A Multipurpose Land Administrative System promotes data sharing among agencies. Security agencies might develop a GIS to make their work more efficient and prepare maps that help them visually identify areas of high crime incidence in an area so they can curtail it. Most times, the result of their data collection and analyses remain only useful to the security agency that produces the data or information. However, the result of this study is showing the integration of such map created by security agencies and other land related agencies.

The result of the integration is useful for identifying areas of crime risk in a Multipurpose Land Administrative System. Furthermore, the Estate manager will find the crime map useful in searching for properties to rent, as much as the security agencies will also find the building database useful in tracking down criminals.

