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Space-Based Application for Effective Forest Analysis and Security Surveillance in the Federal Capital Territory, Nigeria

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Abstract

This study focused on employing Space Based Technology to evaluate existing forest reserves and enhance security monitoring within the Federal Capital Territory. Landsat Operational Land Imager (OLI) imagery was utilised to analyse forest habitats used as hideouts by criminals, assessing the effectiveness of Remote Sensing and GIS for security applications. ERDAS Imagine version 2014 was adopted for classification and Arc GIS 10.4 environments to process, manage and investigate the raster and thematic datasets. The parameters used in this research are: The Normalized Difference Vegetation Index (NDVI), land use/land cover (LU/LC), buffering and digital terrain model (DTM). A value of 0.5 in NDVI indicates a high forest area. Whereas a value of -0.08 represents other types of land cover. The multiple buffer analysis shows that people in the settlements that are about 5 kilometres (km) away from the forest are more likely to be more prone to serious attack than 10 km and 15 km settlements are the least attacked by any form of insecurity. Land use/land cover map provides ranges of classes for operatives. Digital terrain models and coordinate points show terrain and strategic points where security operatives can carry out needful activities. This study shows that Remote Sensing and GIS for forest analysis have proven that space technology can provide useful infor-

mation for good management of forest reserve and security surveillance. It is expected that this approach will greatly assist security personnel in determining where effort should be focused to minimise criminal activities within the Federal Capital Territory and Nigeria at large.

Subject Areas

Forest, Security

Keywords

Land Use, Land Cover, Insecurity, Forest Reserve, Remote Sensing and GIS

1. Introduction

Land use denotes how humans use the biophysical or ecological properties of land. Land use is characterized by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it [1]. Human activities are a major factor contributing to changes in ecosystems by the way we exploit them. It is well known that ecosystem provides a series of services and functions such as provision of habitat for biodiversity, but we mix place this opportunity for insecurity such as, banditry, kidnapping, cattle rustling and farmers-herders clashes and religious crises. Nigeria is being faced with rising insecurity within the country on a daily basis and the speed with which this evil is perpetrated in Nigeria leading to the loss of lives remains worrisome. Most of these evil perpetrations are carried out in the forest.

In Nigeria, there is no presence of authorities in our forests and they are either non-existent or, at best, sporadic. This has led to forest areas being poorly managed, which in turn has led to them being exploited by criminals and posing a security threat. This is one of major reasons for the invasion and use of forested landscapes for criminal activities in Nigeria. It found that the forests are used by terrorists, kidnappers, cannabis cultivators, cattle rustlers and robbers. This is because they offer shelter and have resources that can support militants like food or illegal logging to finance their activities. The phenomenon isn't new. Across the world, forests have been exploited as a source of cover from which to launch attacks and use them in defense. What makes the Nigerian situation problematic is that criminals have been able to exploit forests because of poor management. By law, forests fall under the government's mandate, but the Nigerian government has not been able to secure them because of their huge size, lack of personnel and poor surveillance technology.

All the Nigerian Forests are meant to be a government-protected area, and almost all of these forests are rich in wildlife, but it's overrun by militants. For example, in Northeast of the Country Boko Haram has invaded the forest for many years and made it into one centre of their operations. It sprawls across four states and extends into neighbouring Cameroon, Niger and Chad.

Kidnapping has become a major crime in Nigeria. Boko Haram's kidnapping

of schoolgirls, for example, is well-known. Forests are a useful hiding place for the group, particularly when the number of victims runs into the hundreds. Crime syndicates also use thick forestland between Abuja and Kaduna for their kidnapping activities. They abduct victims for ransom on highways and then hide them in forests. For a long time, forest cover has also been used by members of cults to carry out murders.

The implication is that Nigeria symbolizes unsafe place of abode and has also been included among one of the terrorist countries of the world. Therefore, investors, foreigners, expatriates and even indigenes of Nigeria are scared about investing and committing their hard-earned resources to lucrative businesses in Nigeria. Insecurity, therefore, refers to the state of fear, anxiety, restlessness and uncertainty. This is proven by the high rate of bombings and killings in Nigeria community for political and economic-related assassinations as well as the politically influenced communal wars making the job of security agents in Nigeria porous and insignificant.

Therefore, different forests within a community need to be critically examined and monitored through the use of space technology (remote sensing and GIS) as a measure to curb this act. Land cover communicates the different features on Earth's surface [2] with the composition and characteristics of Earth's surface elements [3] including natural and anthropogenic features, and thus describes the Earth's physical state in terms of the natural environment and the man-made structures [4] which can be mapped using satellite imagery with spectral signatures. Satellite data is a significant and useful tool for monitoring and management of forest resources.

1.1. Statement of the Problem

Insecurity generally disrupts development of nations and societies. That is, where there is conflict there is often underdevelopment. Insecurity is a critical issue that has hampered industrialization and sustainable development in Nigeria and particularly the Africa at large. Nigeria which is perceived as the giant of Africa has witnessed an unprecedented incidence of insecurity ranging from the activities of Insurgencies, Armed Robber Attacks, kidnapping, political/religious crises, murder, destruction of oil facilities by militants, abduction and trafficking.

These challenges have made security a pivotal issue that has culminated in the allocation of country's huge amount of resources to the protection of lives and properties. It has also made government divert resources meant for developmental purposes to security. Also, the alarming rate at which the economic, political, social and religious affairs of the nation are dwindling at present is a real symptom of insecurity [5]. Although, there are several attempts to curb the menace of terrorists in the country, such as traditionally relaying information to military that is no longer reliable in this dispensation. However, space technology has been an excellent tool for mapping, tracking and monitoring insurgency. Images from the satellites can help security operatives understand the terrain better; see its changing nature daily, and there-

fore plan and carry out their operations more efficiently.

1.2. Justification

Space Technology has been adopted in the developed world to combat the problem of insecurity, uproar and other related Crimes. One of the approaches of addressing the problem of insecurity is the use of satellite. It is important to note that the role a satellite can play is not limitless. This is because the work a satellite does depends on the payload it carries. The payload is the cargo of equipment the satellite carries into space to do the work for which it is being launched. Images from the satellites can help security operatives understand the terrain better; see its changing nature daily, and therefore plan and carry out their operations more efficiently. Access to remote sensing images from satellites for security planning like in rescuing abducted schoolgirls will, therefore, not be a big problem. A few Earth observation satellites with expensive, high-resolution imagers are commonly used in espionage as well as in intelligence gathering in the fight against terrorism. They do reconnaissance, such as communication eavesdropping, photo surveillance, and radar imaging, using synthetic aperture radar at night or through thick cloud cover to get clear pictures.

2. Research Methodology

2.1. Study Area

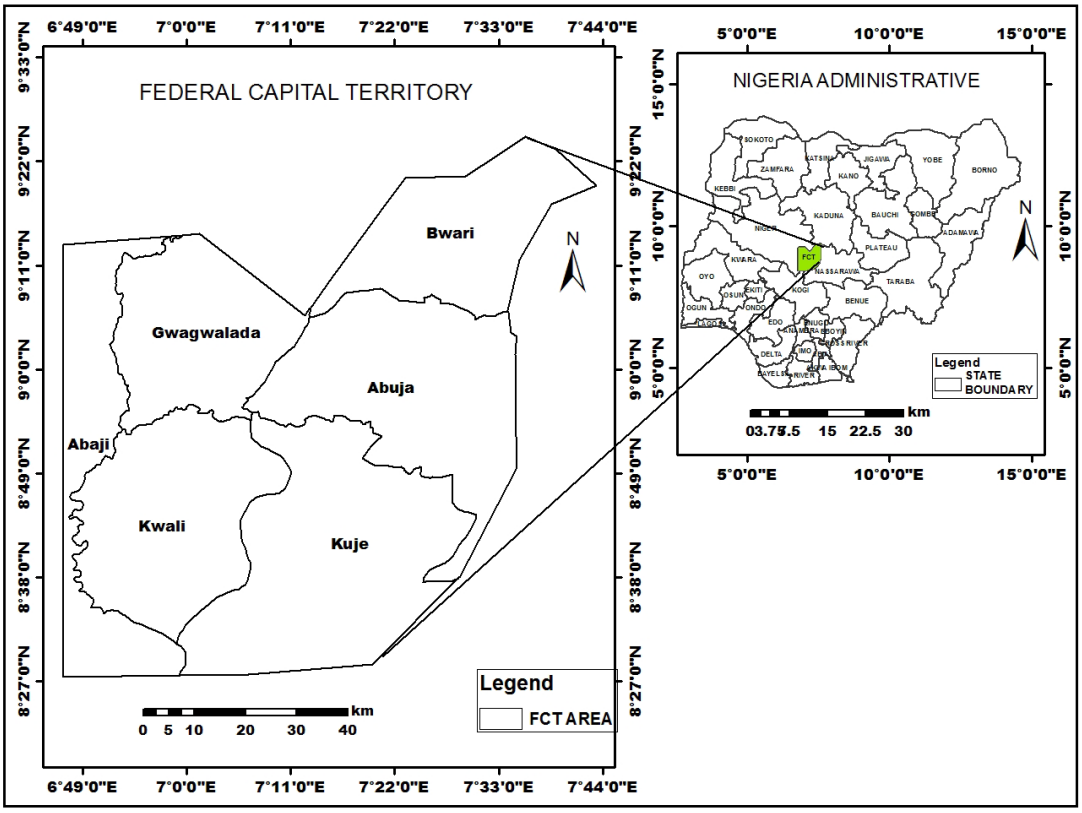


Figure 1. Study area map. [Source: Office of the Surveyor General of the Federation (OSGOF)]

Federal Capital Territory (FCT) falls within latitude 9.229˚N and 9.374˚N of the Equator and longitudes 6.736˚E and 7.618˚E and total Elevation of 536m (**Figure 1**) and a total population of 1,402,201 (2006 population census) with a land mass of 923,768 square kilometres. The Federal Capital Territory is bounded on the north by Kaduna State, on the west by Niger State, on the east and southeast by Plateau State, and on the southwest by Kogi State.

Vegetation

The Federal Capital Territory (FCT) falls within the Guinean forest-savanna mosaic zone of the West African sub-region. Patches of rainforest, however, occur in the Gwagwa plains, especially in the rugged terrain to the southeastern parts of the territory, where a landscape of gullies and rough terrain is found. The Federal Capital Territory forms one of the few surviving occurrences of mature forest vegetation in FCT of Nigeria. Urban forests are made up of trees, shrubs, and other vegetative covers that play an important role in human life. Urban forests serve important roles such as tree species diversity conservation and protection of fragile ecosystems; development of parks and event centres for relaxation and social engagements; provision of vegetables and fruits or seeds for foods and medicines; and purification of air, windbreak, and beautification of the environment [6].

2.2. Methodology

2.2.1. Data Acquisition and Source

Table 1. Data used for the work.

S/N	Data	Date	Resolution
1	LANDSAT 8 Operational Land Imager (OLI)	2021	30
2	SRTM	2021	30
3	Road shape file	2021	
4	Forest shape file	2021	

2.2.2. Remote Sensing Image

In order to study current land use and land cover (LULC) of Federal Capital Territory; 2021 image [LANDSAT 8 (Operational Land Imager)] and SRTM were obtained for the month of April from United States Geological Survey (USGS) (http://glovis.usgs.gov), Earth Science Data Interface. The Operational Land Imager (OLI) extends to band 12 with a 30-meter resolution, while SRTM has only a 30-meter resolution as seen in **Table 1**.

2.2.3. Roads Network Data

Roads shape file of Federal Capital Territory was acquired from Grid[3] in Strategic Space Applications a Department in National Space Research and Development Agency. (See **Table 2**)

Table 2. Software used.

S/N	Software	Version
1	ARC GIS	10.4
2	ERDAS IMAGINE	2014
3	Global Positioning System (GPS)	

2.2.4. Data Analysis

Image pre-processing and classification are very important in establishing a more direct affiliation between the acquired data and biophysical phenomena [7]. Due to acquisition systems and platform movements, remotely sensed data from satellites are generally geometrically distorted. The satellite data were imported into ERDAS 2014 software in an image format for geometric correction. After the images were geo-referenced, combined and subset on the basis of Area of Interest (AOI). The satellite data were studied by assigning per-pixel signatures and differentiating the land area into five classes on the basis of the specific Digital Number (DN) value of different landscape elements. The delineated classes were Built-up, Forest, Farmland, Water-body, Rock-outcrop and Bare-surface area. The order of workflow is in **Chart 1**.

2.2.5. Vegetation Analysis of Forest Reserve

The Normalized Difference Vegetation Index (NDVI). The NDVI will be performed from the ratio of band 4 and 5 in OLI images, and data will be applied to monitor vegetation in the study area in the year 2021.

Where: NIR and R are the reflectance or radiances in the near-infrared and red spectral channels, respectively.

Digital Terrain Model Analysis: The digital terrain model (DTM) analysis was carried out in ArcGIS of spatial analyst tools and data management in three-D to produce a two-D view and three-D view of digital terrain model.

Buffer: Multiple buffering was applied to validated forests in the study area in the ratio of 5, 10 and 15 kilometer (km) and 50 meters to road shape file.

2.2.6. Reconnaissance

The purpose of the survey and ground truth campaign was to verify the classified signatures of the satellite images in Federal Capital Territory (FCT) forest reserve and to monitor the rapid changing of the landscapes.

Intensive ground truth checking is necessary for an accurate impression of the landscape, its vegetation, animal life and human inhabitants.

A reconnaissance study was conducted to determine the sample points that were considered for remote sensing and geographic information system (GIS) work. This was done to help the researcher have an overview of the area under study and to assist in the feasibility and logistics plans for the fieldwork.

Field Work/Data Collection: One field trip was conducted to FCT forest reserve (see Table 4) on March 11th – 15th 2022. During the field trips, the coordinates of land use samples were collected. Some of these samples were used as training sites for the supervised classification and to interpret the clusters derived during the unsupervised classification. The second set of samples was used to conduct an accuracy assessment (User's and Producer's accuracies) to test the consistency and reliability of the supervised classification. In addition to the collection of information on the location of land use classes, the field trip provided an avenue to collect additional ancillary data on the forest sites. Some of the information collected in the field was used to estimate the forest volumes.

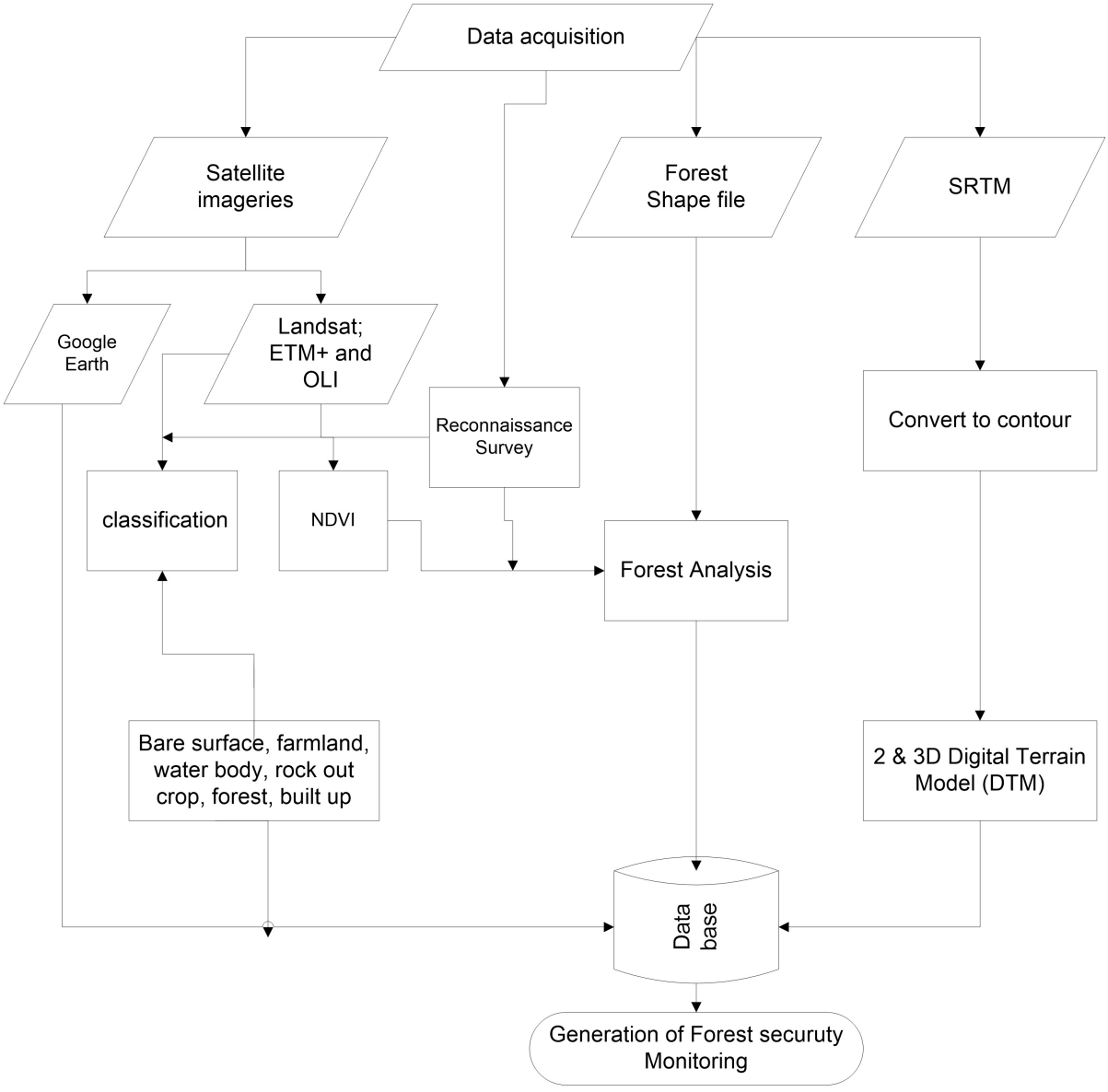


Chart 1. Methodology flowchart.

3. Results and Discussions

Knowledge about land use and land cover (LU/LC) has become important to overcome the challenges of managing the forest, loss of productive ecosystems, and deterioration of environmental quality, provision of habitat for biodiversity and monitoring of activity in the forests. The spatial analysis carried out to describe land use and land cover in this report is: Forest, Built, Water body, Rock outcrop, and Bare surface area were the major land use and land cover classes to determine how LU/LC can be utilized for effective intelligent in Federal Capital Territory (Figure 2).

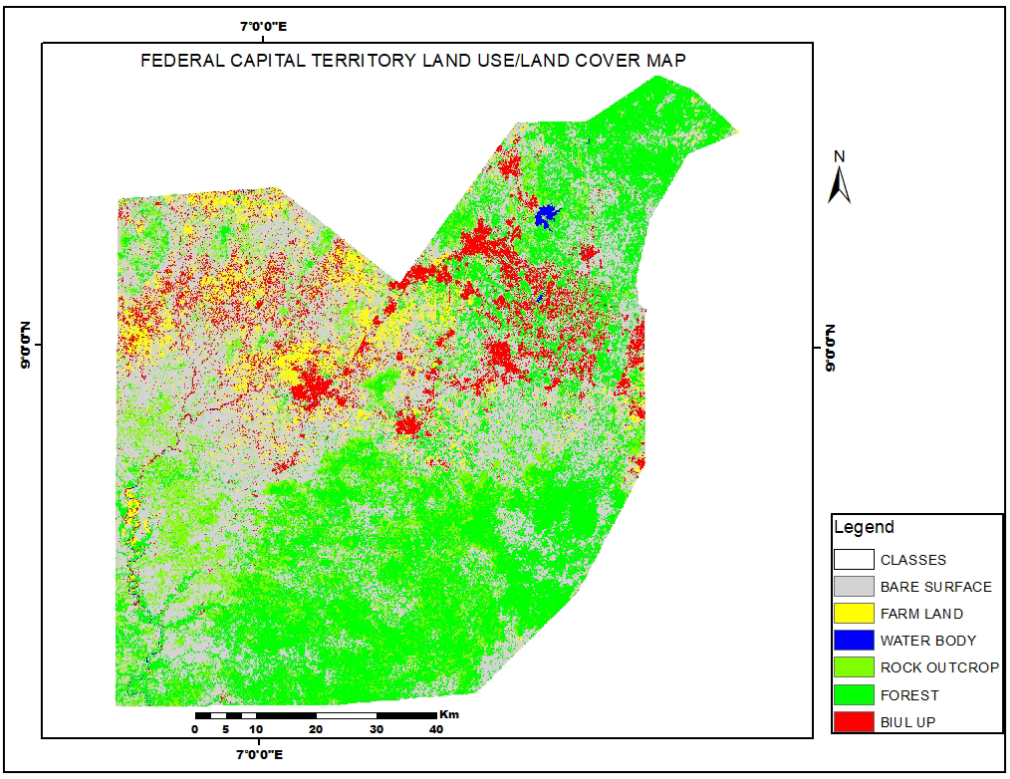


Figure 2. Land use and land cover of federal capital territory. (Source: fieldwork)

Normalized difference vegetation index (NDVI). This index defines values from −0.08 to 0.5, as shown in Figure 3, basically representing greens, yellow and red. Where negative values are mainly formed from water bodies and any class close to it, the values close to zero are primarily formed from rocks and bare soil, while positive values represent forested areas. All the values (from −1 to 1) of the NDVI function correspond to particular areas of land use and land cover. NDVI is preferable for vegetation monitoring since it helps to compensate for changes in lighting conditions, surface slope, exposure, and other external factors. For the purpose of this work, the red areas denote forest cover, which is the positive part of the NDVI and also an area of interest. The green and the yellow areas, which are negative parts was classified as other land.

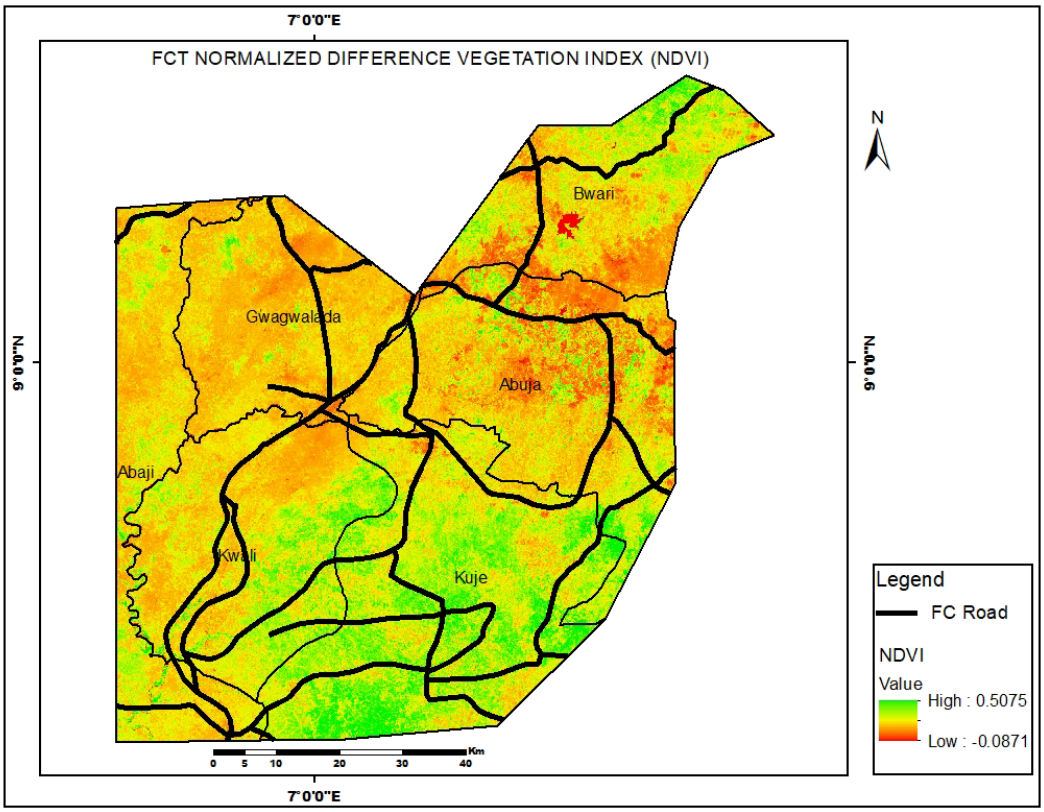


Figure 3. Normalized difference vegetation index of federal capital territory. (Source: fieldwork)

Table 3. Coordinate point of some strategic high elevation.

S/N	Latitude	Longitude
1	9.21	7.522
2	8.777	7.496
3	9.185	7.286
4	9.163	7.096
5	8.956	7.193
6	8.837	7.143
7	8.556	7.205
8	8.557	7.296
9	9.166	6.796
10	9.174	6.842

A mathematical representation model of a given area is what is termed digital terrain model (DTM). The model was carried out in this work for its important use and value as far as this work is concerned. This model shows detailed terrain of the Federal Capital Territory to determine the low-level area and the high-level area to determine appropriate locations to view and survey large areas for the purpose of surveillance. This model was produced in two forms as shown in Figure 4 and Figure 5

respectively. Figure 4 is digital terrain model in 2D form, while Figure 5 is digital terrain model in 3D form. The two models are the same; they serve the same purpose, but the only difference is the view of their usefulness. The coordinate points of the highest elevation in some areas are also recorded in Table 3 for further use.

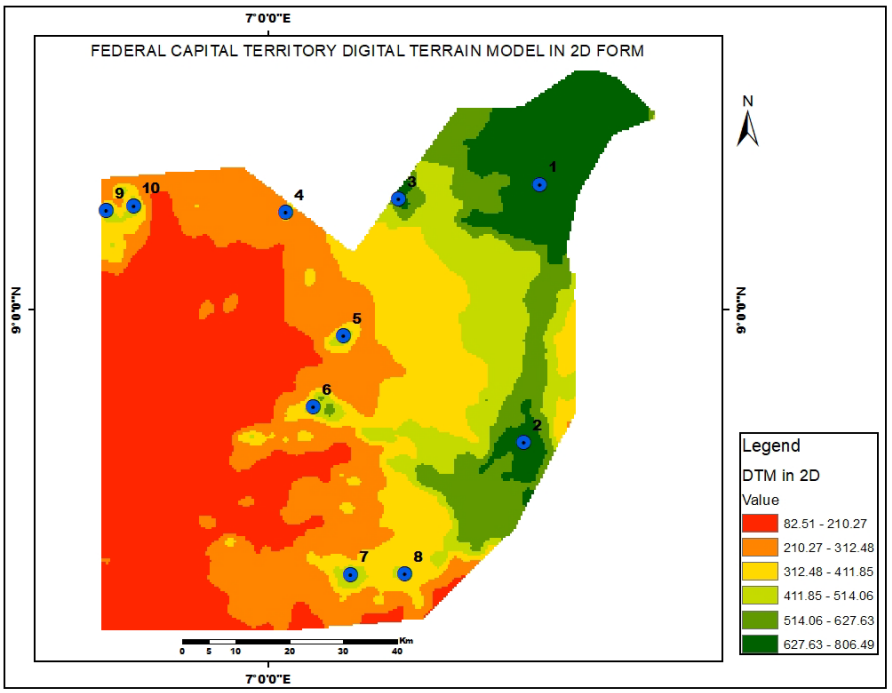


Figure 4. Federal Capital Territory of digital terrain model in 2D form. (Source: fieldwork)

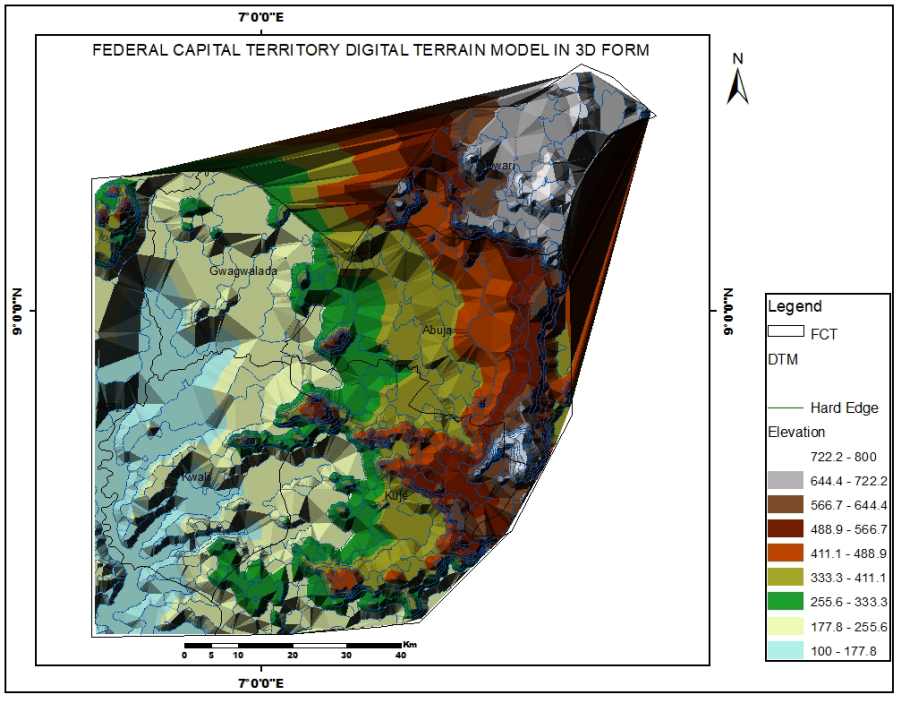


Figure 5. Federal Capital Territory digital terrain model in 3D form. (Source: fieldwork)

Figure 6 below shows an existing forest in the Federal Capital Territory, which can be a hide-out for the terrorists within the community. These forests are Buga hill forest, Gaida, Udo and Tukoki in Kuje area council. Forest in Bwari area council includes Chihurma, Chikwei, Kusoru and Shaba. Maje Abuchi forest reserve is between Gwagwalada and Niger state and also Tufa forest is located in Abaji local government area. Among all the forests, there is none without a road network, which is an ample opportunity for terrorist to perpetrate their evil.

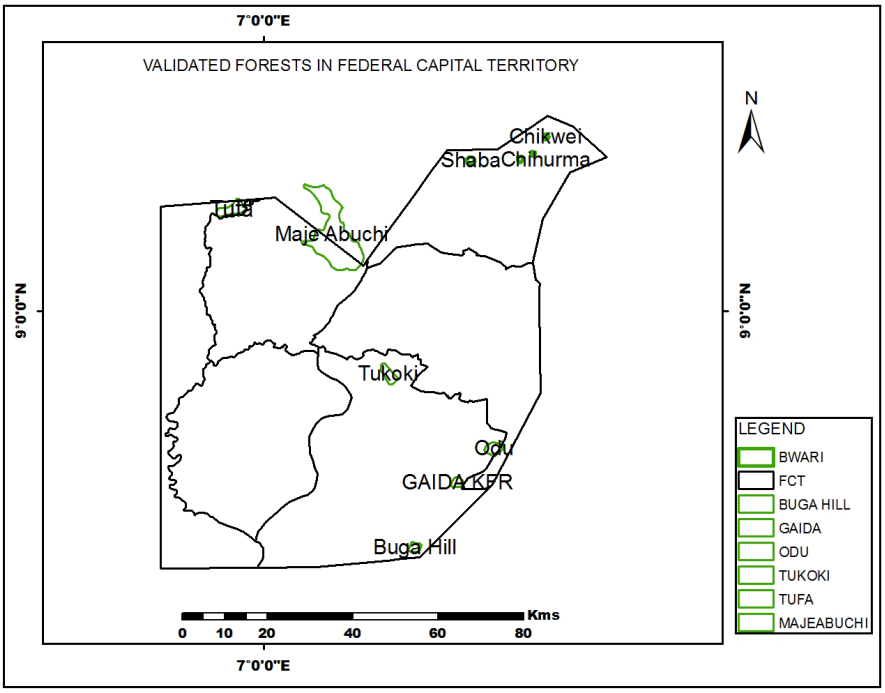
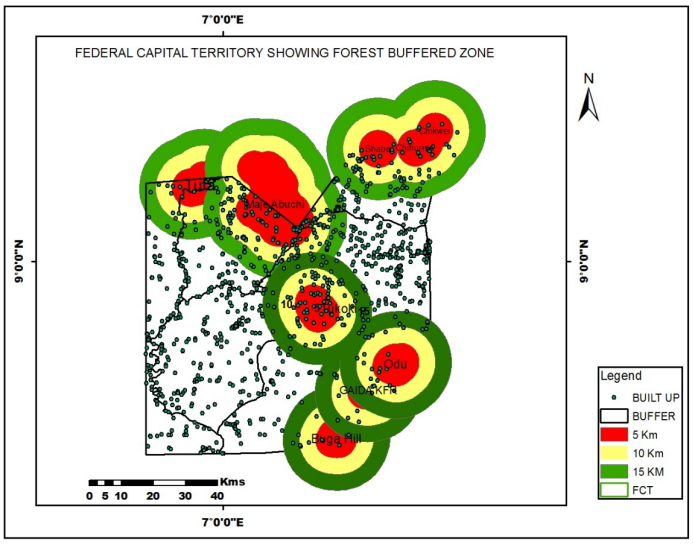
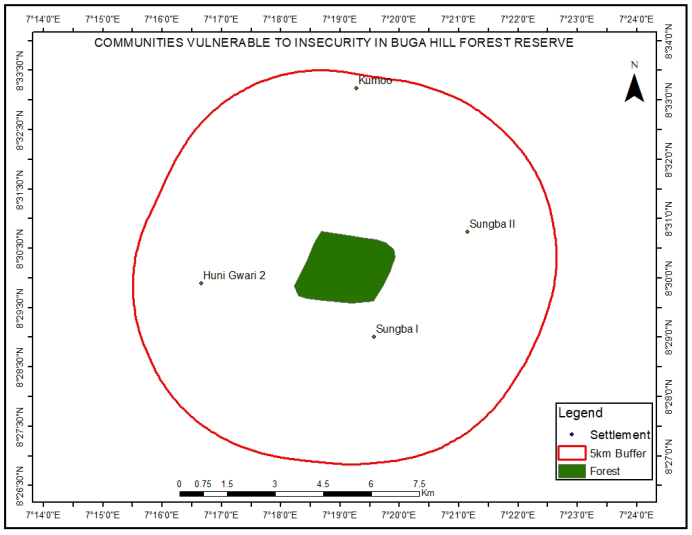


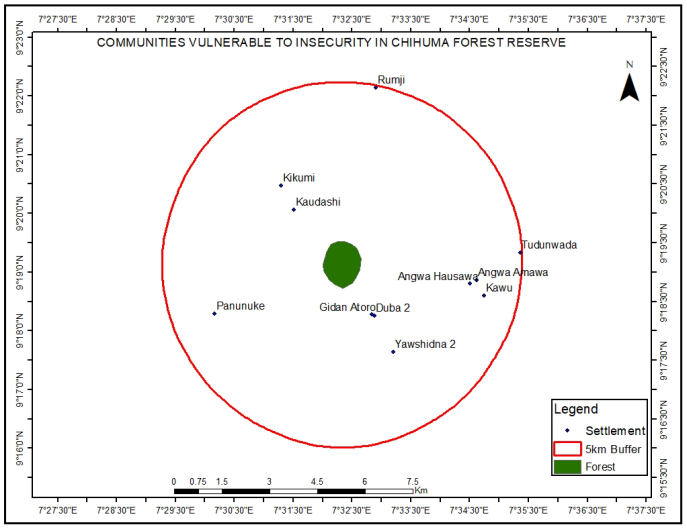
Figure 6. Validated forests reserve in Federal capital territory. (Source: fieldwork)

Figure 7 below shows different buffered zones in all validated forests in Federal Capital Territory that comprise Buga Hill, NG_61/Gaida, Udo, Tukoki, Chihurma, Chikwei, Kusora, Shaba, Maje-Abuchi and Tufa respectively. The buffer analysis was performed in three ranges, which include 5 kilometers (km) 10 km and 15 km which is in order of high risk, medium risk and low risk. The settlements around these forests are at risk for kidnapping, but it depends on the distance of settlement to the forest. From the analysis, a lot of settlements are within the 5 km buffer, which is highly vulnerable to kidnap and other criminal attack. A settlement 10 km away from the forest, on the other hand, is moderately safe, but this does not mean that they should not be vigilant and watchful. The third part of these multiple buffers is 15 km away from the forests that are considered to be least vulnerable to kidnap or other attacks. The reason these settlements are considered less susceptible to criminal attack is that the areas move further away from hotspots' vulnerability to insecurity. Travelers within any of these forests at a particular time when bandit want to carry out operation can be at risk because road networks pass through them.

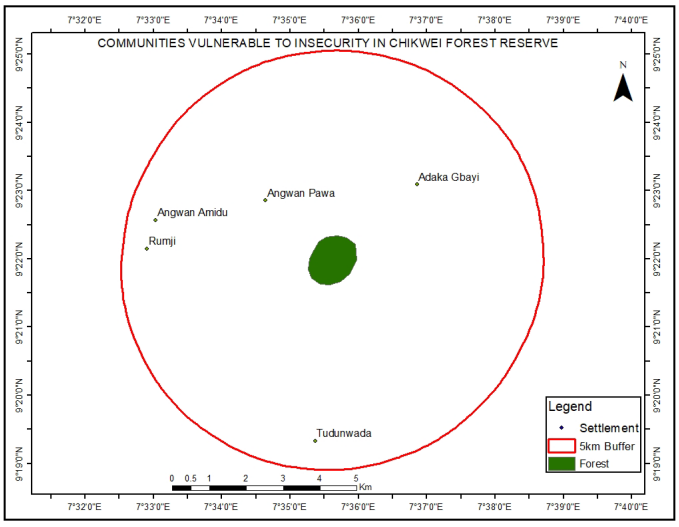

7°0'0"E
FEDERAL CAPITAL TERRITORY SHOWING FOREST BUFFERED ZONE
N
9°0'0"N
Kms
0 5 10 20 30 40
Legend
BUILT UP
BUFFER
5 Km
10 Km
15 KM
FCT


COMMUNITIES VULNERABLE TO INSECURITY IN BUGA HILL FOREST RESERVE
N
Kumbo
Sungba II
Huni Gwari 2
Sungba I
Legend
Settlement
5km Buffer
Forest
0 0.75 1.5 3 4.5 6 7.5
Km

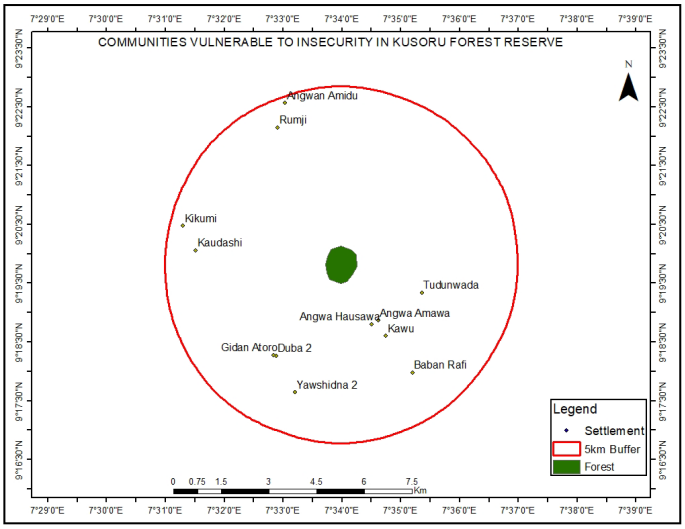
(a)


COMMUNITIES VULNERABLE TO INSECURITY IN CHIHUMA FOREST RESERVE
N
Rumji
Kikumi
Kaudashi
Tudunwada
Angwa Hausawa
Angwa Amawa
Kawu
Panunuke
Gidan AtoroDuba 2
Yawshidna 2
Legend
Settlement
5km Buffer
Forest
0 0.75 1.5 3 4.5 6 7.5
Km

(b)


COMMUNITIES VULNERABLE TO INSECURITY IN CHIKWEI FOREST RESERVE
N
Adaka Gbayi
Angwan Pawa
Angwan Amidu
Rumji
Tudunwada
Legend
Settlement
5km Buffer
Forest
0 0.5 1 2 3 4 5 Km

(c)


COMMUNITIES VULNERABLE TO INSECURITY IN KUSORU FOREST RESERVE
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Angwan Amidu
Rumji
Kikumi
Kaudashi
Tudunwada
Angwa Hausawa
Angwa Amawa
Kawu
Gidan AtoroDuba 2
Baban Rafi
Yawshidna 2
Legend
Settlement
5km Buffer
Forest
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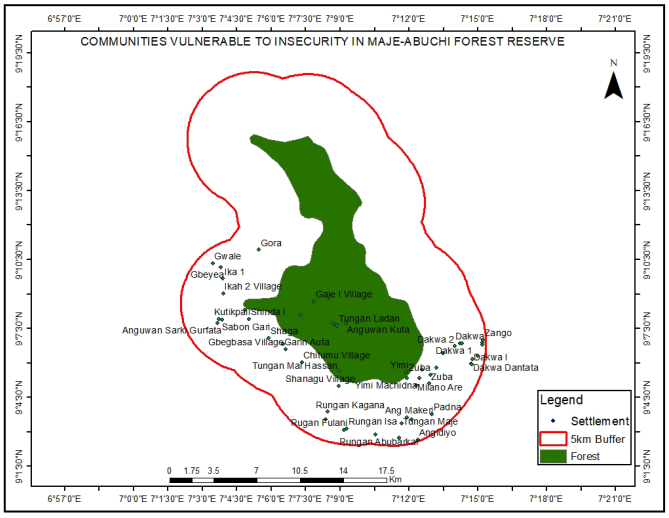
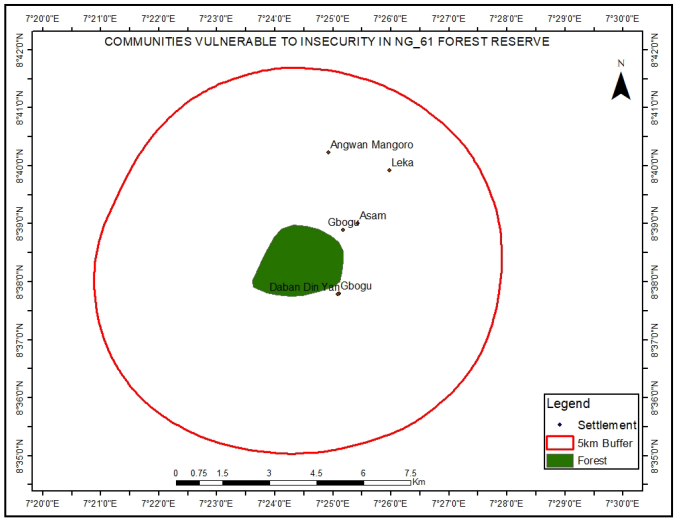
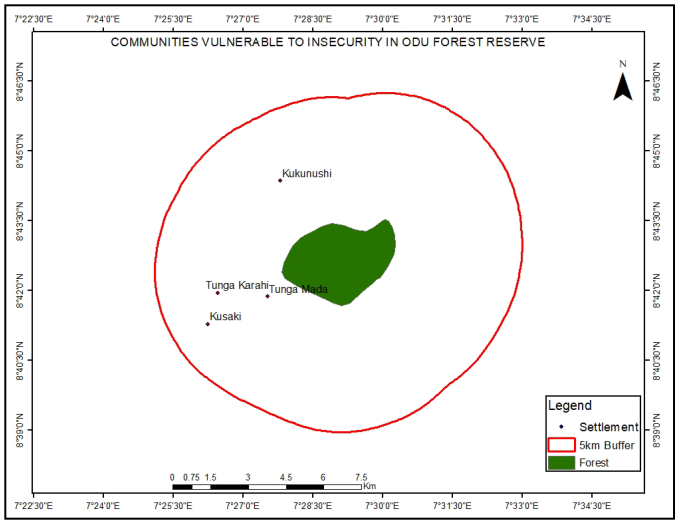
(d)


COMMUNITIES VULNERABLE TO INSECURITY IN MAJE-ABUCHI FOREST RESERVE
N
Gora
Gwale
Gbeyeki
Ika 1
Ikah 2 Village
Gaje I Village
Tungan Ladan
Anguwan Kuta
Anguwan Sarki Gurfata
Gbegbasa Village
Chitumu Village
Tungan Mai Hassan
Shanagu Village
Yimi Machindna
Dakwa 2
Dakwa Zango
Dakwa 1
Dakwa I
Dakwa Dantata
Zuba
Milano Are
Rungan Kagana
Ang Makeo
Padna
Rungan Fulani
Rungan Isa
Angan Maje
Angdiyo
Legend
Settlement
5km Buffer
Forest
0 1.75 3.5 7 10.5 14 17.5 Km

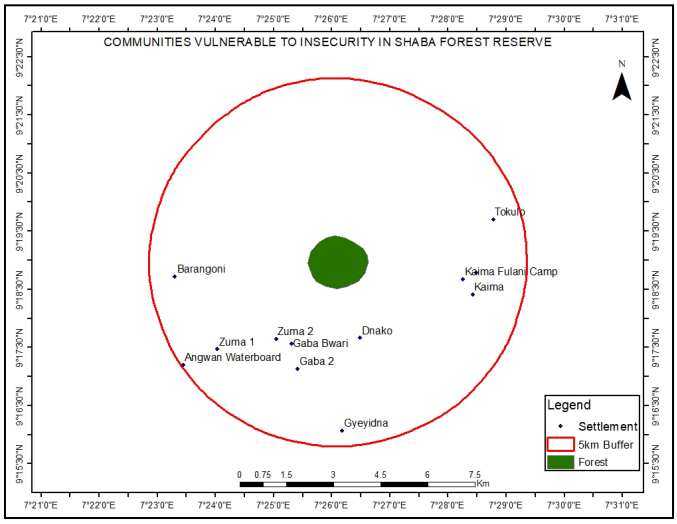
(e)


COMMUNITIES VULNERABLE TO INSECURITY IN NG_61 FOREST RESERVE
N
Angwan Mangoro
Leka
Gbogu
Asam
Dabah Dm Yan Gbogu
Legend
Settlement
5km Buffer
Forest
0 0.75 1.5 3 4.5 6 7.5
Km

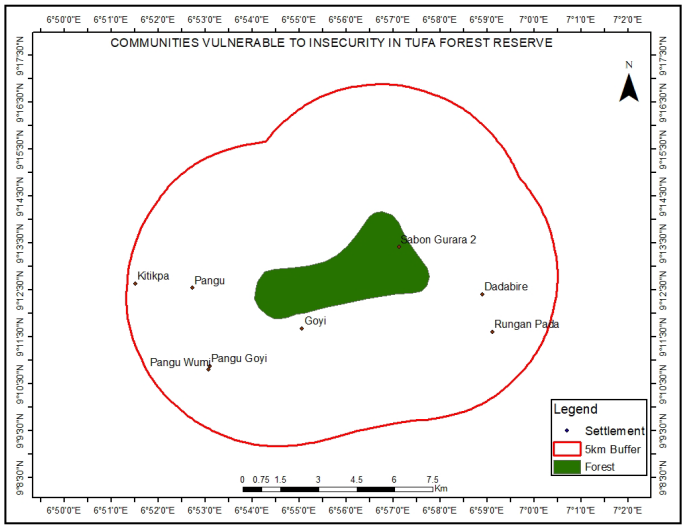
(f)


COMMUNITIES VULNERABLE TO INSECURITY IN ODU FOREST RESERVE
N
Kukunushi
Tunga Karahi
Tunga Mada
Kusaki
Legend
Settlement
5km Buffer
Forest
0 0.75 1.5 3 4.5 6 7.5
Km

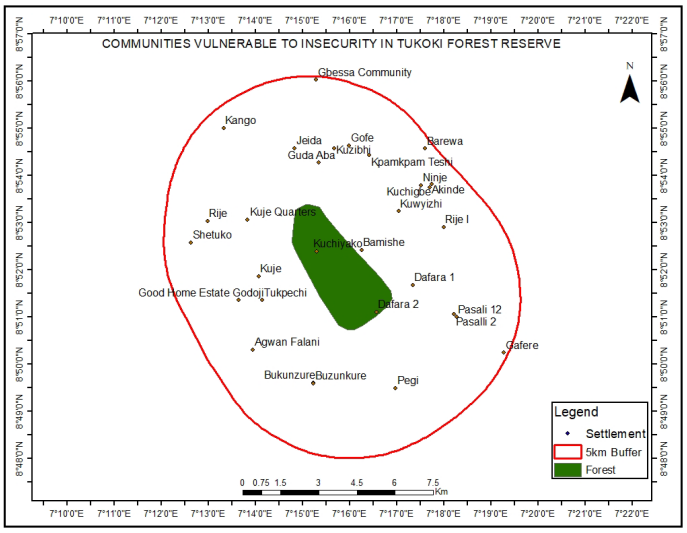
(g)


COMMUNITIES VULNERABLE TO INSECURITY IN SHABA FOREST RESERVE
N
Tokuro
Barangoni
Kaima Fulani Camp
Kaima
Zuma 2
Dnako
Zuma 1
Gaba Bwari
Angwan Waterboard
Gaba 2
Gyeyidna
Legend
Settlement
5km Buffer
Forest
0 0.75 1.5 3 4.5 6 7.5
Km

(h)



(i)



(j)

Figure 7. Forest buffered zone in the federal capital territory. (a) highly vulnerable communities in Buga hill forest reserve in Kuje Area Council; (b) highly vulnerable communities in Chihuma forest reserve in Bwari Area Council; (c) highly vulnerable communities in Chikwei forest reserve in Bwari Area Council; (d) highly vulnerable communities in Kusoru forest reserve in Bwari Area Council; (e) highly vulnerable communities in Maje-Abuchi forest reserve in Gwagwalada Area Council; (f) highly vulnerable communities in NG-61 forest reserve in Kuje Area Council; (g) highly vulnerable communities in Odu forest reserve in Kuje Area Council; (h) highly vulnerable communities in Shaba forest reserve in Bwari Area Council; (i) highly vulnerable communities in Tufa forest reserve in Abaji Area Council; (j) highly vulnerable communities in Tukoki forest reserve in Kuje Area Council. (Source: fieldwork)

Figure 8 shows the road buffering of Federal Capital Territory network of 50 meters (m) away from the road. This is important because it is one of the strategies to combat insecurity on the highway. When both sides of the road can be cleared to 50 m apart, drivers or travelers can see far distance. In case, if there is security

threat in the high way drivers can quickly maneuver and take reasonable measures to avoid attacks from kidnappers. In the same vein, when both sides of the road are clear it will be difficult for criminal people to block the high way. Some time ago when rate of kidnapping was high in Lokoja to Okene road, Governor Yahaya Bello of Kogi State adopted this same method and it addressed the situation.

Table 4. Highly vulnerable communities around FCT forest reserves.

FOREST	COMMUNITIES
Buga	Huni Gwari 2
	Sungba 1
	Sungba 11
	Kumbo
Chihuma	Kauddashi
	Gidan Atoro
	Duba 2
	Rumji
	Kikumi
	Panunuke
	Angwa Huasawa
	Angwa Amawa
	Yawshidna
	Kawu
	Tudunwada
Chikwei	Adaka Gayi
	Angwan Pawa
	Angwan Amidu
Kusoru	Angwan Amidu
	Rumji
	Kikumi
	Kaudashi
	Angwa Hausawa
	Tuduwada
	Angwa Amawa
	Kawu
	Yawshidna
	Baban Rafin
Maje-Abuchi	Jigbodo Village
	Chezoko 1
	Gora
	Ika
	Dada

Continued

	Gaje 1 Village
	Garin Auta
	Shanagu Village
	Dakwa
	Zuba
	Pungan Isa
	Panda
	Pandna
	Yimi
NG_61	Anguwa Mangoro
	Leka
	Asam
	Gbogu
	Daban Din Yangbogu
	Kujekwa
Odu	Kukunushi
	Tunga Mada
	Gidan Kaka
	Tunga Karahi
	Kusaki
	Gbo Mada
	Angwan Ma goro
	Leka
Shaba	Barangoni
	Zuma 1
	Zuma 2
	Dnako
	Angwan Waterboard
	Gaba Bwari
	Gaba 2
	Gyeyidna
	Igu
	Tokujo
	Kaima Fulani Camp
	Kaima
Tufa	Kitikpa
	Pangu
	Gbiti
	Goyi
	Pangu Wumi
	Pangu Goyi

Continued

	Sabon Gurara 2
	Dadabire
	Rungan Pada
Tukoki	Gui
	Kango
	Jeida
	Gofe
	Kuzibhi
	Guda Aba
	Ninje
	Kuchigbe
	Akinde
	Kuwyizhi
	Rije 1
	Bamishe
	Dafara 1
	Dafara 2
	Pasali 1
	Pasali 2
	Buzunkure
	Buzunkure Pegi
	Good Home Estats
	Shedadi
	Kuje
	Tukpechi

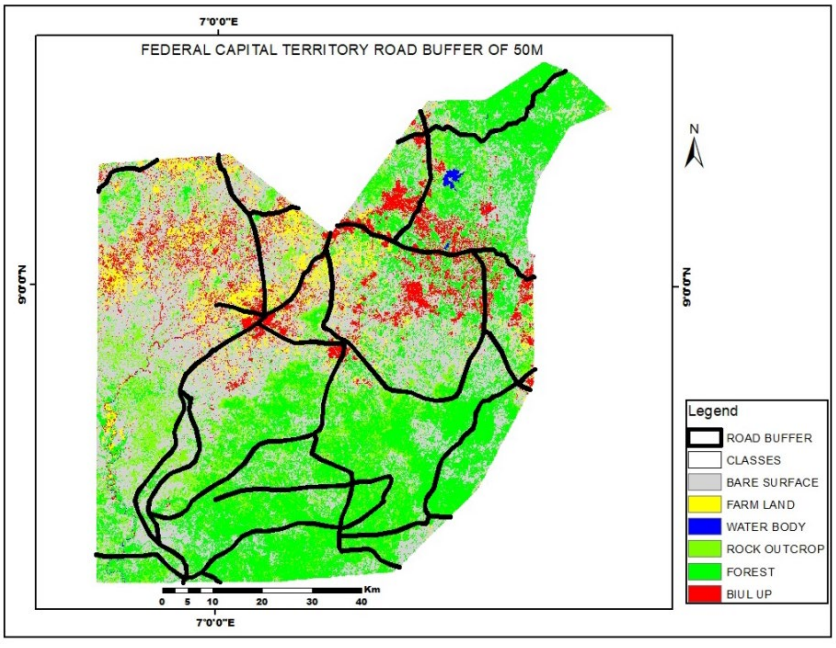


Figure 8. Federal capital territory road buffered. (Source: fieldwork)

4. Discussion

Remote sensing and geographic information systems are complementary technologies that, when combined, enable improved monitoring, mapping, and management of forest resources. Remote sensing and GIS provide detailed surveys of the forest, location, composition, and distribution of forest resources. As one of the principal sources of forest management information, these databases support a wide range of management decisions to any development plan of long-term strategies. From results in **Figure 2**, it can be seen how various distributions of land use and land cover of federal capital territory are distributed according to geographic distribution. These particular land uses and land cover include bare surface, built-up, forest, rock outcrop and water body areas. As far these areas can be identified, the major concern is forested area, which has been serving as hiding places for criminal elements.

As we all know, forests are isolated areas where nobody lives and as such can be used by those who oppose the government or societal values and carry out activities that are against the law such as theft, armed robbery, banditry, kidnapping and attack on security personnel. To be in fact, this problem is not peculiar to Nigeria alone. In Kenya, gunmen believed to be members of Al-shabab hiding in two forests in Lamu county carried out attacks that killed 60 people, and destroyed people's houses and farmlands [8]. In different parts of the world, there are examples of forests becoming security threats, as some people use forests abusively to carry out unlawful activities.

However, our forests need to be monitored with available resources. These resources still rely on remote sensing and GIS, why because they can map, measure and monitor the extent of the forest and determine any changes that might happen to the forest. Therefore, **Figure 3**, shows the extent of validated forests in the federal capital territory and possible measures to adopt and control them in case of any infiltration. Category of different heights in the particular forest with respect to their coordinate point is shown in **Figure 4**, and **Table 3** for proper intelligent monitoring so as to secure the area from habitation of criminal elements. **Figure 5**, on the other hand, is an excellent one in the domain of remote sensing and GIS for intelligent monitoring. The highest height is 800 m, which is in Bwari and AMAC forest. The next height is 644.4 m which, can be found in Abaji and Kuje forest. Gwagwalada and Kwali happen to be lowland and the highest height here is 333.3 m.

Buffering usually creates two areas: one area that is within a specified distance of selected real-world features and the other area that is beyond. The area that is within the specified distance is called the buffer zone. A buffer zone is any area that serves the purpose of keeping real-world features distant from one another. Buffer zones are often set up to protect the environment, which includes protecting people from danger, and natural disasters and possibly preventing violence. Common types of buffer zones may be green areas, residential and commercial areas and border zones between countries. Buffer zone in this work as

shown in Figure 7 is between the forest and residential where criminals can hide in the forest and attack residence near the forest and in Figure 8 where possible solution can be provided to commuters by clearing the bush around 50 m away in the two sides of road to prevent any attack to traveler and allow driver to view long distance for any attempt of attack.

The Normalised Difference Vegetation Index (NDVI), a widely used remote sensing metric, provides valuable insights into vegetation health and density. NDVI quantifies greenness and helps differentiate various habitats, including forests. However, while NDVI is effective for assessing vegetation status, it has limitations. These include sensitivity to atmospheric effects, saturation at high vegetation cover, and variations due to sensor characteristics. Understanding these limitations is crucial for accurate interpretation, especially in applications like Unmanned Aerial Systems (UAS), where users may lack remote sensing expertise. So, when observing the healthy area of the forest, which is the thickest part of the forest and assumed to be the possible hideout of the criminal element during surveillance. In summary, while NDVI offers valuable information, it should be used alongside other indices and contextual data to assess forest potential fully.

5. Conclusion

Land use and land cover information are spatial patterns readily obtainable by classifying remotely sensed data. Habitat assessment is typically geographic information system based; it involves selecting data layers likely to be of value in developing predictive models for the occurrence and distribution of individual species or species assemblages, as well as the identification of species useful as indicators of ecological condition. The use of remotely sensed data together with other spatial datasets integrated within a GIS environment has greatly enhanced the habitat assessment process. The influences of growing human activities and the attention of human population in forest zones are being felt throughout in the Federal Capital Territory. Evidence about varying designs of land use and land cover over time in forest areas is thus important, not only for the organization and development of these areas, but also for an improved understanding of the association among landscape dynamics and forest ecology responses. Satellite remote sensing permits a surveying, synoptic viewing of huge areas, thus providing the potential for a geographically and temporally detailed assessment of land use and mapping in forest areas. Images from the satellites can help security operatives understand the terrain better; see its changing nature daily, and therefore plan and carry out their operations more efficiently. This work is without any doubt a template for the Nigeria government to tap into the seemingly latent potential in space technology for mapping, monitoring and tracking systems in tackling insecurity in the Country.

Conflicts of Interest

The authors declare no conflicts of interest.

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