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GEOSPATIAL INFORMATION FOR LAND USE PLANNING AND SUSTAINABLE MANAGEMENT

Barnabas O. Morakinyo

Department of Surveying & Geoinformatics, Faculty of Environmental Sciences, BAZE University, Abuja, Nigeria

*Corresponding authors' email: barnabas.ojo@bazeuniversity.edu.ng

ABSTRACT

Land-use planning is the systematic assessment of land and water potential, alternatives for land-use, and economic and social conditions in order to select and adapt the best land-use options. The aim of this study is to examine how geospatial information is the bedrock for land use planning and management with a focus on estate housing development. The project site is located at Eleko, Lagos State, Nigeria. The three (3) survey controls used for the connection of the project are ZTT 37/17, ZTT 37/18 and ZTT 37/19. Digital Survey instruments (Leica TCR 307, Level) were used for the acquisition of geospatial data of the site. Tacheometric survey method for spot heighting and ray method for detailing of features within and around the site. Grid levelling was carried out at 10 m intervals with staking at 10 m. The results obtained show that the total perimeter of the traverse is 839.805 m; total area of the site is 3.132 Hectares; and the linear accuracy of the traverse is 1/15,000. Grid levelling was carried out at 10 m intervals with staking at 10 m. This provides the elevation for each point which was used to provide contours for the terrain; and finally the production of topographic map and Digital Terrain Model (DTM) of the site which are used as tools for land use planning and its management. Therefore, it can be concluded that geospatial information such as topographic map and DTM are the bedrock for land use planning and management.

Keywords: Geospatial data, Land use, Mapping, Planning, Topographic map, Digital Terrain Model (DTM)

INTRODUCTION

Land is required for various uses in all society; and it is an important element in the socio-economic development of any society (FMH & UD, 2006). As population grows and rural areas become urban centres and urban centres become large metropolitan areas, there is always increased competition and demand for land for different uses (Aribigbola, 2008). Furthermore, as the population of the society becomes more urbanized and cities grow, land use planning becomes more critical (Davidson and Gareth, 1986; Nimisha et al., 2015) in tackling growing land use problems such as overcrowding and congestion, slum formation, rising costs of land, incompatible use, flooding among others for the purpose of achieving sustainable city development and ensure the safety and health of the people (Aribigbola, 2008, Musa et al., 2024).

Land-use planning is the systematic assessment of land and water potential, alternatives for land-use, and economic and social conditions in order to select and adapt the best land-use options (FAO/UN, 1993). This definition embraces the systematic approach of possibilities for different land-uses in the future, and also the (felt) need for changes and the willingness to execute the plan (Masoudi et al., 2017). All present land-use planning is caught up between two seemingly contradictory dimensions: ecological conservation and economic existence (Masoudi et al., 2017) in which both dimensions are related to sustainability in land-use planning. The conflicting problem of economic development and ecological conservation is often mentioned as the environment cannot be saved without development and that development cannot continue anywhere unless the environment is saved (Van Lier, 1998).

In this regard, land use planning is a kind of long-term planning that considers the land as a determined factor in supplying development goals. Land use planning based on regulations with permanent and suitable return view, according to the qualitative and quantitative capabilities and talents for different use of human from the land shall render type of utilization (Masoudi et al., 2017).

Appropriate land use planning concept (Laroche, 2017) for urban development and growth is needed in order to meet up with the rapid population growth of the area (Nimisha et al., 2015). However, the concept of sustained land use basis should be taken into account in order to ensure long-term and sustainable enhancement and management of the land infrastructure and development in the area/ on the land (Altiery, 2015; Nimisha et al., 2015; Laroche, 2017).

Geospatial Technology (GT) for the production of geospatial information/ data for land use planning purpose includes Global Positioning System (GPS) (Amelia et al., 2023); Geographic Information System (GIS) (Taryadi et al., 2019);Remote Sensing (Abdel Rahman, et al., 2016, Wahyutomo et al., 2016; Ramteke et al., 2018; Taryadi et al., 2019; Dombrovska et al., 2022); Unmanned Airborne Vehicle (UAV) (Dombrovska et al., 2022); and Cartography (Ramteke et al., 2018). GT collected spatial information about features at a place or in space, collected in real time (Ramteke et al., 2018). GT is found the best over the conventional methods of data collection (Saxena et al. 2000; Taryadi et al., 2019); and it provide accurate terrain analysis by capturing real time data output through the analysis (Ramteke et al., 2018). GT capture, store, manipulate and analyze geospatial data to understand complex situations of the environment and solve the problems for sustainable development (Abdel Rahman, et al., 2016).

The basic data that provide land use planning information include topographical maps (Ramteke et al., 2018); digital terrain model (DTM) (Guth et al., 2021) which represents land surface of the Earth especially for topographic that can generate slope information (Smith and Sandwell, 2003). It is essential to know that this information on land use (LU) be available in the form of maps and statistical data because they are very vital for spatial planning, management and utilization of land (Kumar & Khan, 2020). Geospatial data is primarily grouped into two forms namely vector data and raster data (Silva-Coira et al., 2020). All data that define points, lines and polygons etc. are vector data; and they are used to represent objects like buildings, roads, waters bodies, etc. (Feng and

Koch, 2024). Raster data are acquired inform of row and column for example satellite data, airborne data from aircraft, photographs etc. (Gong et al., 2017).

Geospatial information are used for land use planning (Guth et al., 2021); land evaluation, assessment and spatial analysis (Davidson and Gareth, 1986, Davinson, 1992); production of spatial information, geospatial analysis, and mapping process (Dibs, 2013; Wahyutomo et al., 2016; Abdel Rahman, et al., 2016; Taryadi et al., 2019); description/ presentation of Earth surface geomorphology involving plains, valleys, hills, mountains, rivers, streams (Seif, 2014); presentation of built up environmental/ developmental structures such as buildings, roads, terracing, water storage or drainage structures(FAO/UNEP, 1997) etc. Geospatial information for land use planning can be used as basic data for the environmental management sustainability (Amelia et al., 2023). The nature of land use usage affects almost all spheres of social and economic development of the people (Koshkalda et al., 2023); the condition and quality of agricultural lands, determines the nature of anthropogenic impact on the environment (Koshkalda et al., 2023).

There is need to obtain reliable data about land use for planning, management, conservation and optimum use for further development in sustainable manner (Shaw et al. 2015; Akike and Samanta 2016). With increasing population pressure and associated need for increased infrastructure production, there is great need for improved management of the land resources specially the soils and water (Koshkalda et al., 2023).

Terrain mapping is a classification system that describes the characteristics and spatial distribution of surface materials, and land uses (Ramteke et al., 2018). Digital elevation model (DEM) can be used for number of purposes like land use planning, hydrologic modelling, sediment transport, soil erosion estimation, drainage basin morphology, vegetation, and ecology etc. (Reddy et al., 2012).The generation of accurate DEM fully depend on the terrain parameters, like drainage network and watershed boundaries from collateral data and remotely sensed data (Reddy et al. 2012).

Proper land use planning and management would ultimately result in improvement in infrastructure development, economic and industrial growth (Kumar & Khan, 2020). Planning and development of urban areas with well-developed infrastructure, utilities, and services has its legitimate importance (Kumar & Khan, 2020).

Advent of technology has transformed the acquisition of geospatial data and its applications; therefore, geospatial data have been widely acknowledged as vital to land use planning and its management (Ramteke et al., 2018; Amelia et al., 2023; Koshkalda et al., 2023). The significance of this study is that it shows that geospatial information is the basis for land use planning and management. Three research questions for this study are: (1). What is geospatial information? (2) What are the essential geospatial information required for land use planning and management? (3) What are the applications of topographic map and digital terrain model (DTM) for land use planning and management? The aim of this study is to examine how geospatial information is the bedrock for land use planning and management with a focus on estate housing development. The objectives considered for this study are: (1) Identification of geospatial data require for land use planning and management; (2) Determination of the study site land boundary; (3) Mapping of the entire site; (4) Production of topographical map of the site; (5) Production of Digital Terrain Model (DTM) of the site.

MATERIALS AND METHODS

Study Site

The site is located along Eleko Road, Eleko, off Lekki-Epe Expressway, Ibeju-Lekki Local Government Area (LGA), Lagos State, Nigeria. It is located between Latitude 06° 28' 20.40" to 06° 28' 52" N and Longitude 03° 50' 49.18" to 03° 50' 59.26" E. The Northern part of the site is built up and the Eastern portion is made up of swampy that is yet to be developed. A flowing canal bounded the Southern part from the East to the West; and the West is defined by the Eleko Road. Figure 1 show the location of the site.

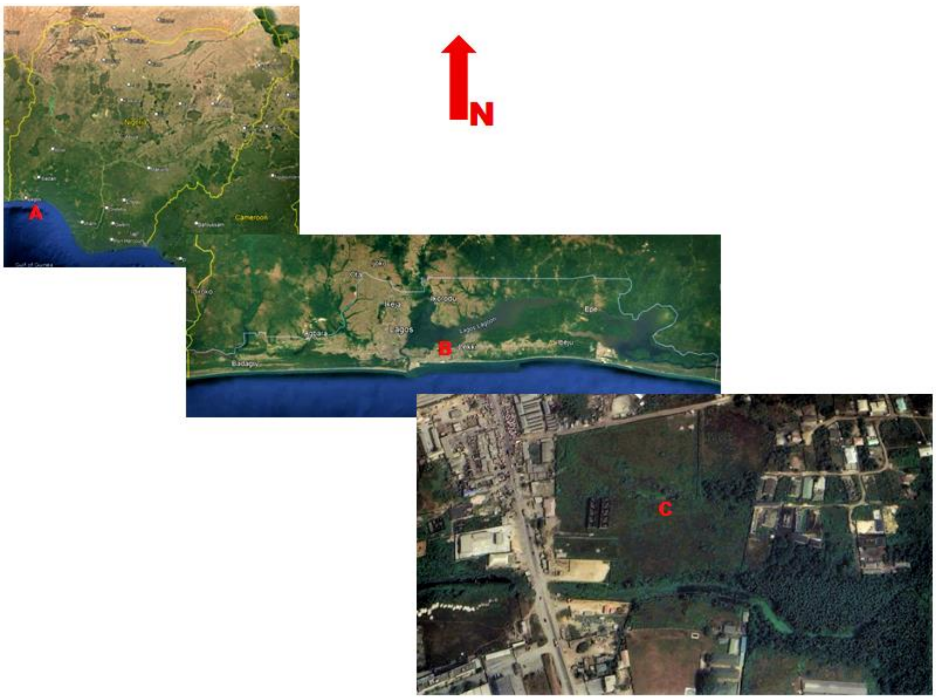

Figure 1: A) Location of Lagos State in Nigeria; B) Location of Ibeju-Lekki LGA, Lagos State; C) Location of the site (Google Earth, 2025)

Reconnaissance (Recce)
This is the first stage of any survey work after the purpose and accuracy of such work had been decided upon. It involves paying visit to the project site to have a physical view of the area. During reconnaissance (recce), the most suitable way of carrying out the project was decided. Other significance of recce includes helps in determining the most suitable station points and methodology to be employed for data acquisition; in the choice of survey instruments to be used; the number of personnel to be involved; the choice of the actual date for the commencement of fieldwork; identification of possible obstacles and how they could be avoided etc. The recce was concluded with a search for controls around the site area which is to provide the framework for the survey. The controls found around the area and very close to the site are ZTT 37/17, ZTT 37/18 and ZTT 37/19.

Equipment used
This consists of instruments used in the acquisition of data for this project. They are: Total Station (LEICA, 307) with accessories; prisms; tribrach with spindle; steel tape (100 meters); ranging poles (8 Nos.); Leica Automatic level with full accessories; Leveling staff (4 Nos.); cutlass (4 Nos.) and Hammer (2 Nos.)

Instrument test
Horizontal and vertical collimation error test for Total Station (Leica 307)
For the horizontal collimation error test for Total Station (Leica 307) used for the study. From instrument station A, a target at station B was bisected on both face left and right; and the horizontal and vertical angle readings were recorded for each face (Table 1).

Table 1: Horizontal and vertical collimation error test

From station	Instrument face	Horizontal reading	Difference	Vertical reading	Sum	To station
A	Face left	000°50’ 02”	180° 00’ 04”	087°47’ 38”	360° 00’ 06”	B
A	Face right	180° 50’ 06”		272° 12’ 28”		B

The difference between the two horizontal angle readings was computed. The result obtained is presented in Table 1. Theoretically, for any instrument to be free of horizontal collimation error, the difference should be 180^o. The result obtained from Table 1 show that the Total Station has a collimation error of 2 seconds i.e.

$$\frac{180^o - 180^o00'04''}{2} = 00^o00'02''$$

This can be considered good for the project.
Also, the vertical collimation test for Total Station (Leica 307) was carried out to ensure that the horizontal axis of the instrument is truly horizontal. With the same instrument at station A, and a target at B was bisected, vertical circle readings (VCR) were taken on both faces and recorded accordingly as shown in the Table 1. The sum of the two vertical angle reading was computed (Table 1). The half of the difference between the sum of the two reading and complete circle of 360° is the vertical collimation error for the instrument i.e.00° 00’ 06” / 2 = 00° 00’ 03”. Hence, the vertical collimation error recorded for Total Station (Leica 307) used for this study is 00° 00’ 03”.
The results of the two tests conducted for Total Station (Leica 307) used show that the two errors obtained were minimal, and that the collimations of the instrument were in order.

Level instrument test (Two-peg test method)
Essentially, when level instrument is properly leveled, the instrument component called Compensator will create horizontal line of sight, which enable a reading to be taken on a graduated staff, from which height difference between points can be determined. The Two-peg test method was used to determine if the line of sight of the level instrument is truly horizontal. Two points A and B of 40m apart were selected on a level ground, with a levelling staff vertically held at each point. Level instrument was set-up midway between the two staffs position, back sight and fore sight reading were made to them respectively as shown in Figure 2 and the difference between them was computed.

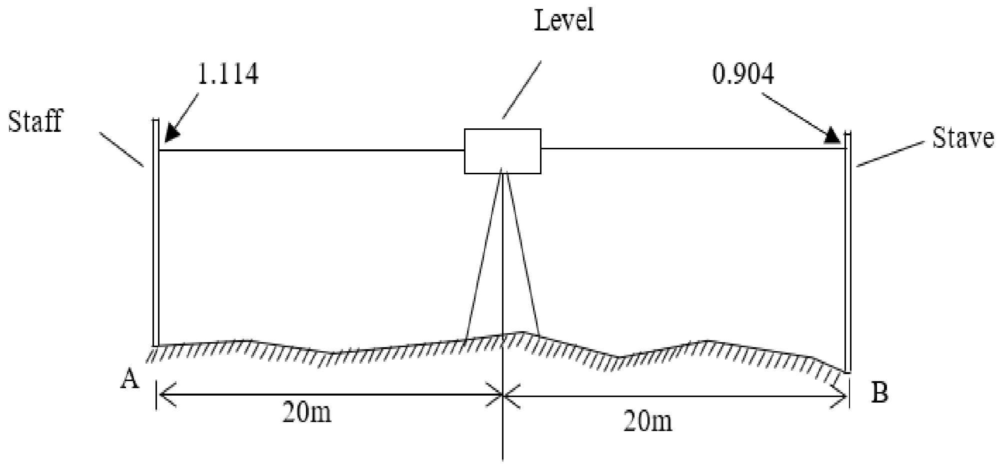

Figure 2: Test of Level Instrument

The instrument was taken to a point X, which is 10m away from B and 50m from A. The readings were again taken to the staves still held vertically at point A and B as shown in Figure 3.Table 2 shows the readings obtained.

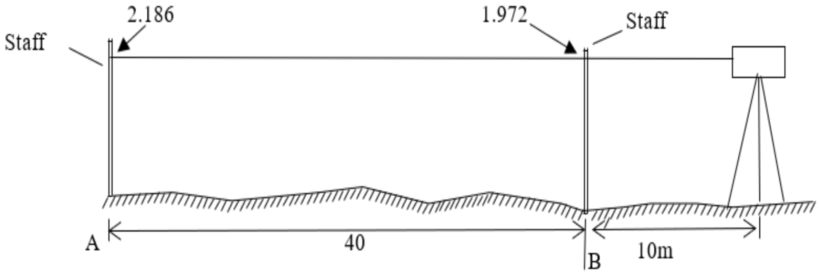

Figure 3: Test of Level Instrument with a change in instrument position

Table 2: Result of Two-peg test

Sight	Back sight (m)	Fore sight (m)	Diff. in height (m)	Distance (m)
A	1.114			20
B		0.904	A-B = 0.210	20
A	2.186			50
B		1.972	A-B = 0.214	10

The difference between the two set of readings i.e.0.214 – 0.210 = 0.004m is negligible. Hence, the level is in good working condition.

Control check

The check on ZTT 37/17, ZTT 37/18 and ZTT 37/19 controls found along the Eleko Road, around the project area was carried out. These three controls established by the Office of Surveyor General, Lagos State (OSGLS) with Minna Datum and the Universal Transverse Mercator's (UTM) origin are grouped under Zone 31.The coordinates of the three controls obtained from the OSGLS are shown in Table 3. The stability and reliability of these set of controls was confirmed. The Total Station (Leica 307) was set-up on ZTT 37/18 and two targets each on ZTT 37/19 and ZTT 37/17 as back and fore sight respectively. The instrument was then centered, leveled and focused, and directed the telescope to bisect the target at back station ZTT 37/19 on face left, horizontal and vertical circle readings were taken and recorded. The instrument telescope was turned and directed to bisect the fore station target at ZTT 37/17, the same set of observation were made and recorded to complete first zero.

The instrument telescope was transited through 180 degrees to make the instrument turn face right; then the reading taken to the fore station, and lastly to the back station on the face right. The distance between them were also measured and recorded. Table 4 show the results obtained. The mean observed angle and measured distance were compared with the computed angle and distance obtained from the given coordinate (Table 5).

Table 3: Coordinates of control points

Points	Northings (m)	Eastings (m)	Height (m)
ZTT 37/17	714688.229	593814.656	
ZTT 37/18	715347.039	593519.097	10.000 (Assumed)
ZTT 37/19	715684.955	593418.223	

Table 4: Angular control check

Mean observed angle	Computed angle	Difference
172º 27'29"	172º 27' 33"	00º 00' 04"

Table 5: Distance control check

Station	Sight	Measured distance (m)	Computed distance (m)	Difference(m)
ZTT 37/18	ZTT 37/19	352.649	352.651	0.002
ZTT 37/18	ZTT 37/17	722.073	722.070	0.003

From Tables 4 and 5 the difference obtained from the observed angle and the computed angle (00º 00' 04"), and the difference between the measured and the computed distances (0.002 and 0.003) were minimal and within the allowable error of the Survey Law. Therefore, these controls were in good position.

Linear calibration of Total Station (Leica TCR 307)

The Total Station (Leica TCR 307) has an inbuilt electronic distance-measuring device (EDM) that has the ability to measure both horizontal and slope distance in either metric or imperial units. This eliminates the need to manually reduce slope distances to horizontal when computing traverses. In average atmospheric conditions, the EDM has a range of three kilometers (3 km) with 1 prism and up to five kilometers (5km) with three (3) prisms.

For the purpose of this project, calibration of the Total Station instrument was carried out using controls ZTT 37/17, ZTT37/18 and ZTT37/19, located along Eleko road, established by the Lagos State Survey Department as the baseline. The horizontal distances from ZTT 37/17 to ZTT 37/18 and from ZTT 37/18 to ZTT 37/19 were measured with the Total Station ten times (Table 6). The difference between the measured and the computed distances give negligible difference. Hence, it was confirmed that the total station was in good working condition. The difference between the mean of the measured distances and the computed distances is +0.002. The measured distance between ZTT 37/17 and ZTT 37/19 is shown in the Table 6.

Table 6: Linear calibration result for Total Station (Leica TCR 307)

S/N	Measured distance (m)	Computed distance (m)	Difference (m)
1.	352.649	352.651	0.002
2.	352.648	352.651	0.003
3.	352.647	352.651	0.004
4.	352.650	352.651	0.001
5.	352.649	352.651	0.002
6.	352.650	352.651	0.001
7.	352.649	352.651	0.002
8.	352.648	352.651	0.003
9.	352.648	352.651	0.003
10.	352.650	352.651	0.001
	Sum =		0.022
	Mean =		0.002

Traversing and detailing

This method was adopted to obtain the planimetric position i.e. Northing and Easting of all the station points and this was achieved by measuring angular differences and distances between the successive stations with the use of Total Station TCR 307.

Angular observation/Distance measurement

Having confirmed that the ZTT(s) controls were in order. The traverse started by setting the Total Station on ZTT 37/18 and the targets set on ZTT 37/19 and CP1 respectively. The instrument was set up properly and well leveled. The Total Station was back sighted to the target mounted on ZTT 37/19 on face left, the angle and distances were measured and recorded; the Total Station was turned to the target set on CP1 on the same face left, also the angle and distance were measured and recorded. By this, the first zero was completed. The instrument was later transited to the face right with the instrument still facing the target set on CP1, the angle and distance were measured again and recorded. The instrument still on face right turned again to face the target set on ZTT 37/19, to measure the angle and distance, in order to complete the second zero.

The same observational procedure as explained above was repeated for all stations until the traverse closes back on control point ZTT 37/18. However, the vertical angle and distance measurement were made only to the fore stations. Observations were made in two faces (left and right) to eliminate instrumental error and possible observations errors. While traversing, precautions were taken to make sure that the targets were accurately bisected, and movement around the instrument was adequately controlled. Also, the instrument was carefully transported to avoid being thrown out of order. The reduction of both horizontal and vertical angles were instantly done and checked to avoid any possible gross error.

Detailing

This detail survey is for the purpose of topographical survey. The prominent features around the project site were fixed by ray method using the Total Station. The details picked were road, culvert and canal.

Mapping of the site: Topographical information

These are natural and artificial features present within and around a specific portion of land. This information shows the physical structure and depicts the terrain of the land. Topographical survey is required for the acquisition of topographic data which will finally produce topographic map (Olorunfemi, 1992). The topographical information for this study was obtained under the following survey activities:

Heighting of the boundary beacons

The boundary pillars were heighted using the spirit levelling method to height the pillars. This is necessary because the boundary pillars could serve as a control during the grid line levelling. This was achieved using the Leica Automatic Level instrument by placing the levelling staff on the ZTT 37/18 control with the assumed level of 10.000 m. The level was then set in between the control and CP1. The staff was read and the reading recorded. The instrument position was changed with the staff still on CP1; the back-sight reading was read and booked also. The staff was later placed on boundary pillar CP2, the reading was read also recorded. This same process was carried out round the boundary and finally closes back on the ZTT 37/18 Control.

Grid Heighting

The Southern portion of the boundary line was adopted as the base line. Each of the gridline was pegged out in order to assist in the tracking of each of the grid lines. All gridlines were set out in a South-North direction from the peg positions on the baselines. That is, gridlines were set out at bearing of 348° 44’ from the base line. They ran across the entire width of the boundary lines. Each line was pegged at an interval of 10 m. The coordinate for each of the points to be tracked were pre-determined and uploaded into the Total Station. Each of the gridline position was given a unique identification number. Twenty-eight gridlines were set out altogether for this project. Figure 4 show examples of grid lines of 10 × 10 m adopted for this project.

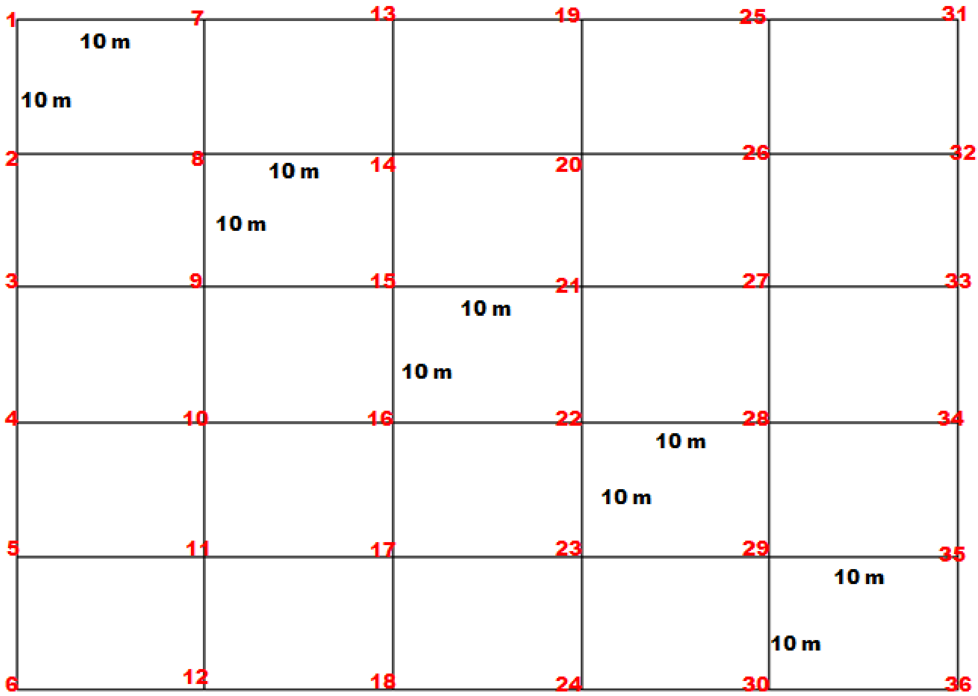

Figure 4: Grid leveling at 10m intervals with 10m staking

The gridlines levelling were achieved using tacheometry survey method. Tacheometry Survey is the process of determining the differences of elevations of stations from observed vertical angles and known distances (Ramsay, 1988). Total Station was used for the tacheometry survey in which the instrument was mounted on CP7 and it's (X, Y, Z) coordinate were uploaded into the instrument. The height of instrument and tracking rod were measured and stored into the total station. The referenced stations CP1coordinate were as well uploaded. Then, the tracking was done all through the entire length and breadth of the parcel through the grid lines. The tracking was done in 2loops, to provide check on the acquired data. After the whole exercise, the data were down loaded and processed for the topographic drawing. This involves the processing and manipulating various data obtained from the field, using various basic surveying principle and mathematical formulae in order to obtain the desire topographical data. The information obtained was later used for the preparation of topographical plan. It should be noted that the main field data were obtained from traversing and levelling operations.

Computations

Traverse computation

This consists of reduction of traverse angles, correction to the measured distances, bearing deduction, provisional co-ordinates and linear accuracy.

Reduction of angles

This was done simultaneously with angular observation in order to ensure that correct angles were obtained before leaving the observation point. The horizontal angles were reduced by subtracting the face left (FL) reading for the back station from that of forestation and face right (FR) for back station from forestation. The mean of the two angles gives the observed horizontal angle (OA). For the vertical angle, the face left reading was subtracted from 90° and 270°was subtracted from the face right, and the average of the two results gives the slope angle. However, the slope angle is not necessary for this project because the Total Station measured the true horizontal distances direct (Table 7).

Table 7: Reduction of horizontal and vertical angles of the first Traverse Leg

Station	Sights	Face	HCR ° ' "	H angle ° ' "	VCR	V angle
	ZTT 37/19	L	100 05 01			
ZTT 37/18	CP1	L	111 34 54	011 29 53	901435	000 14 35
	CP1	R	164 36 05	0112957	269 45 20	000 14 40
	ZTT 37/19	R	153 06 18	Mean = 011 29 55		Mean =000 14 38

Bearing deduction

The initial bearing and distance from the given coordinates of the initial control points ZTT 37/18, and ZTT 37/19 were computed using the formulae;

Bearing $(\theta) = \tan^{-1}(\Delta E/\Delta N)$ (1)

Distance $(L) = \sqrt{(\Delta E^2 + \Delta N^2)}$ (2)

Where;

ΔE = Difference in the Eastings of initial controls;

ΔN = Difference in Northings of initial controls.

The initial forward bearing was reduced, 180^0 was subtracted from it to give backward bearing (BB). The observed horizontal angle (OA) was added to the BB to give the forward bearing (FB) of the first traverse line. That is;

FB = BB + OA (3)

Where the angular result is more than 360^0, 360 is subtracted from it to give the forward bearing of such line. This same computation procedure was repeated until the bearing of the last point was obtained.

Check on bearing misclosure
The traverse started from and closed on known bearing line, the deduced closing bearing must be equal to the computed initial bearing. However, due to some unavoidable errors the angular misclosure of −00º 00' 02" was recorded.
This was checked to ensure its permissible limit using the formula;
Permissible error (PE) = 30" $\sqrt{n}$ (4)
Where;
n = Number of station
i.e. PE = 30" $\sqrt{9}$ = 30" × 3 = 00º 01' 30"
This signifies that the error obtained fall within the permissible error.

Bearing misclosure distribution
The error obtained was divided by the number of traverse points (9), which yield a correction of 00º 00' 0.2" i.e. −00º 00' 2" / 9 = 00º 00' 0.2" per traverse station. This correction, which accumulates was obtained and applied in succession to each of the forward bearing in order to give corrected bearing.

Partial coordinates
These are referred to as change in Northings (ΔN) and change in Eastings (ΔE), they are obtained by using the corrected bearing (θ) and the horizontal distance (L) in the mathematical relations;

$$\varDelta N = LCos\theta \quad (5)$$

$$\varDelta E = LSin\theta \quad (6)$$

i.e. for line ZTT37/18 − CP1;
$\varDelta N$ =121.415×Cos 354°52'38" =120.930
$\varDelta E$ =121.415×Sin 354°52'38"= −10.841

Provisional coordinates
Provisional coordinates are equally referred to as uncorrected coordinate (N_i) and (E_i), they are obtained by applying partial coordinates ΔN and $\varDelta E$ to the initial or previous station Northings N_o and Easting E_o respectively.

$$N_1 = N_o \pm \varDelta N_1 \quad (7)$$

$$E_1 = E_o \pm \varDelta E_1 \quad (8)$$

For instance,
N_{CP1}=715347.039$_{ZTT37/18}$+120.930=715467.969mN;
E_{CP1}=593519.097$_{ZTT37/18}$ −10.841=593508.256mE.
However, the computed provisional coordinate of the last traverse leg that supposed to be equal to the given coordinate was not. The misclosure of 0.052m and 0.012m were found for both Northings and Easting respectively.

Linear accuracy
The difference between the computed coordinate and the coordinate of the control station gives a closing error called linear misclosure. These misclosures were subjected to linear accuracy test to check for its permissibility.
This is given by;
Linear Accuracy

$$= \frac{\sqrt{((Error\ in\ Northings)2 + (Error\ in\ Eastings)2)}}{Total\ Distance} \quad (9)$$

$$= \frac{\sqrt{((0.052)2+\ (0.012)2)}}{849.805\ \text{m}}$$

=1:15,945
which shows that the error recorded from the survey for linear measurement is permissible, and can be distributed since the result is not less than 1:3,000.

Transit rule
This was adopted in distributing the linear misclosure in order to obtain the final corrected coordinate.
Transit Rule is given as;
For Northing;
Correction =

$$\frac{\text{Total error in Northing} \times \text{individual line arithmetic sum}}{\text{Total arithmetic sum of Northing}} \quad (10)$$

For Eastings;
Correction =

$$\frac{\text{Total error in Easting} \times \text{individual arithmetic sum}}{\text{Total arithmetic sum of Easting}} \quad (11)$$

Backward computation
This involves the computation of final bearing and distance for each traverse line by making use of the final corrected coordinates. This was computed by making ΔN and $\varDelta E$ in equation (7) and (8) the subject of the formula i.e.

$$\varDelta N = N_1 - N_0 \quad (12)$$

$$\varDelta E = E_1 - E_0 \quad (13)$$

These ΔN and $\varDelta E$ are then substituted in equation (1) and (2) to give final bearing and distances.

Area computation
The size of the project site was computed using Double Latitude method, which is based on the principle that
"Half of the product of the total Departure (ΔE) of any point and the sum of Latitude ($\varDelta N$) of the lines meeting at that point"
The total area computed =31218.239m^2, which is equivalent to 3.122Hectares.

Levelling computation
The level readings were reduced using Height of Instrument method i.e. the vertical distance from the datum to the instrument line of sight. The formulae used in these methods are as follows:
H.I = R.L + BS (14)
RL = H.I − I.S (15)
RL = H.I − F.S (16)
Where
H.I = Height of Instrument;
B.S = Backsight;
I.S = Intermediate sight;
F.S = Foresight.
For perimeter leveling, the computation commenced from station point ZTT37/18 with height 10.00m while for grid leveling, computations take their reference from heighted perimeter beacons and base line points and closed on another perimeter points.
Misclosures in every loop were checked for conformity with the accepted limit before they were being distributed proportionally to the number of foresights or change-points. This was achieved using the formula;

$$24\text{mm}\sqrt{K} \quad (17)$$

Where;
K = Total distance leveled in Kilometer.

Production of maps
AutoCAD is a Computer Aided Design. The AutoCAD drawing was achieved by linking the Excel format to the AutoCAD environment with the aid of "Script file" (i.e. file name. scr). The X, Y data obtained was typed into the MS-Excel. This was converted into script file, and ran in AutoCAD environment for easy drawing of the acquired data

to achieve a suitable drawing with aid of the drawing tools. Details were joined with the aid of the annotation ascribed to each detail.

The traverse lines, bearing and distances for the boundary were all shown with red colour; details were shown with black colour and connections with blue colour. The plan was plotted to a scale of 1:1,000.

Digital Terrain Model (DTM)/ Production of contour with Surfer software

Surfer is software used to obtain Digital Terrain Model (DTM) of geodetic surface (Ufauh, 1997). The software is used to display the contour on the spot heights with the aid of the X, Y and Z data exported into the environment through the MS-Excel format. The X, Y and Z data were imported into the Excel of the surfer environment, which was saved as "filename.dat". The "dat" file was processed using kriging method as grid method for contour generation, thickness of contour line, contour interval, colour and font size were all set. With these setting, contour lines were generated and exported into AutoCAD.

The methodology adopted in this study for the acquisition of geospatial data; and it's processing for land use planning and management is presented in Figure 5.

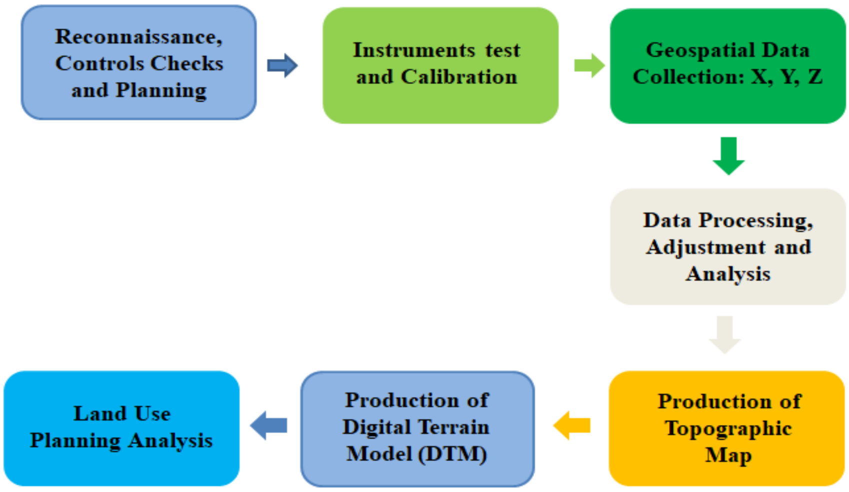

Figure 5: Methodology for acquisition of geospatial data and processing for land use planning

RESULTS AND DISCUSSION

The results obtained from the various computations are presented in this section. Table 8 is for forward traverse computation, Table 9 for backward traverse computation, Table 10 is for coordinates of site boundary controls, Table 11 is for levelling data for the boundary lines, and Table 12 show the portion of details and gridding data downloaded from Total Station.

Traverse computation

Table 8: Forward traverse computation

From station	Horizontal distance (m)	Adjusted bearing (° ' ")	Corrected Northing (m)	Corrected Easting (m)	To station
ZTT 37/18	121.415	354 52 38	715467.951	593508.255	CP1
CP1	22.578	79 38 16	715472.011	593530.465	CP2
CP2	30.451	358 03 21	715502.440	593529.432	CP3
CP3	273.557	95 15 11	715477.391	593801.834	CP4
CP4	113.635	193 55 06	715367.076	593774.500	CP5
CP5	242.095	273 30 35	715381.894	593532.854	CP6
CP6	8.385	286 39 17	715384.296	593524.821	CP7
CP7	37.680	188 44 07	715347.039	593519.097	ZTT 37/18
ZTT 37/18	0.000	343 22 43			

The total distance = 849.805 m; and linear misclosure = 1:15,945.

Table 9: Backward traverse computation

From station	Horizontal distance (m)	Adjusted bearing (° ' ")	Corrected Northing (m)	Corrected Easting (m)	To station
			715467.961	593508.255	CP1
CP1	22.578	79 38 26	715472.011	593530.465	CP2
CP2	30.451	358 03 20	715502.440	593529.432	CP3
CP3	273.557	95 15 14	715477.391	593801.834	CP4
CP4	113.635	193 55 00	715367.076	593774.500	CP5
CP5	242.095	273 30 33	715381.894	593532.854	CP6
CP6	8.385	286 38 51	715384.296	593524.821	CP7
CP7	85.279	348 47 56	715467.951	593508.255	CP1

Determination of the boundary of the site

The boundary of the site was defined by seven control points named CP1 to CP7. The coordinate of each control point is presented in Table 10.

Table 10: Coordinates of site boundary controls

Point	Northing(m)	Easting(m)	Height(m)
CP1	715467.951	593508.255	9.461
CP2	715472.011	593530.465	8.221
CP3	715502.440	593529.432	9.901
CP4	715477.391	593801.834	9.379
CP5	715367.076	593774.500	8.209
CP6	715381.894	593532.854	8.299
CP7	715384.296	593524.821	8.509

Area of the site

The total area of the project site is 31,224.355 m^2 which is approximately equal to 3.122 Hectares.

Levelling Computation

Table 11: Levelling data for boundary lines

Station	Back sight	Fore sight	Uncorrected elevation	Correction	Adjusted elevation
ZTT 37/18	0.537				10.000
CP1	1.539	1.076	9.461	0.000	9.461
CP2	2.912	2.779	8.221	0.000	8.221
CP3	1.214	1.232	9.901	0.000	9.901
TP1	1.421	1.766	9.349	0.001	9.348
TP2	1.356	1.510	9.260	0.001	9.259
CP4	1.079	1.236	9.380	0.001	9.379
CP5	1.565	2.323	8.211	0.002	8.209
AL5	1.761	1.640	8.136	0.002	8.134
CP 6	1.562	1.596	8.301	0.002	8.299
CP 7	1.694	1.352	8.511	0.002	8.509
ZTT 37/18		0.182	10.003	0.003	10.000

Data for details and gridding

Table 12: Portion of details and gridding data downloaded from Total Station

Points	Point ID	Northing (m)	Easting (m)	Elevation (m)
700005	1	715571.743	593468.704	10.162
700006	2	715522.393	593471.491	10.162
700007	3	715523.101	593474.986	10.181
700008	4	715523.996	593478.277	10.144
700009	5	715534.736	593481.138	10.163
700010	6	715512.126	593474.618	10.082
700011	7	715509.508	593474.756	10.122
700012	8	715510.905	593478.482	10.152
700013	9	715497.034	593478.171	10.122
700014	10	715497.854	593481.786	10.151
700015	11	715498.658	593485.241	10.061
700016	12	715491.076	593487.325	10.042
700017	13	715490.053	593483.964	10.131
700018	14	715488.660	593480.294	10.123
700019	15	715480.618	593482.444	10.103

Analysis of results

The accuracy obtained for traverse and all level loops were compared with the allowable accuracy as it was contained in the specification for the Third Order Traverse. The results obtained are presented in Table 13 for traversing; and Table 14 for levelling.

Table 13: Analysis of traversing results

Observation Type	Accuracy		Remark
	Allowable	**Obtainable**	
Angular accuracy	00° 01’ 15”	00° 00’ 02”	Satisfactory
Linear accuracy	1: 3000	1: 15,945	Satisfactory

Table 14: Analysis of levelling results

Observation Type	Distance(m)	Accuracy		Remarks
		Allowable	**Obtainable**	
Primary loop	850	0.022	−0.003	Satisfactory

Where,
Angular accuracy was computed using equation (4);
Linear accuracy was computed using equation (9); and
Level accuracy was computed using equation (17).
Based on the results of this analysis, it can be concluded that the survey was fell within the permissible limit and that the survey was carried out according to the Survey Rules and Regulations of Nigeria.

Topographical Map

The topographical map of the site was produced at a scale 1:1,000 with the contour interval of 0.2 m. The height of each point (spot height) and elevation of points obtained for the site are presented as numeric values and contour lines respectively. The map shows both the horizontal distances between the features and their elevation above the Minna Datum i.e. the relative positions of features on the ground and their elevations. The result obtained from the spot height was used in obtaining the land topography. Figure 6 show the boundary line of the project site, Figure 7 presented the height of every selected point at the interval of 10 m by 10 m. Figure 8 show the contours of the terrain, and Figure 9 is the complete topographical map of the site.

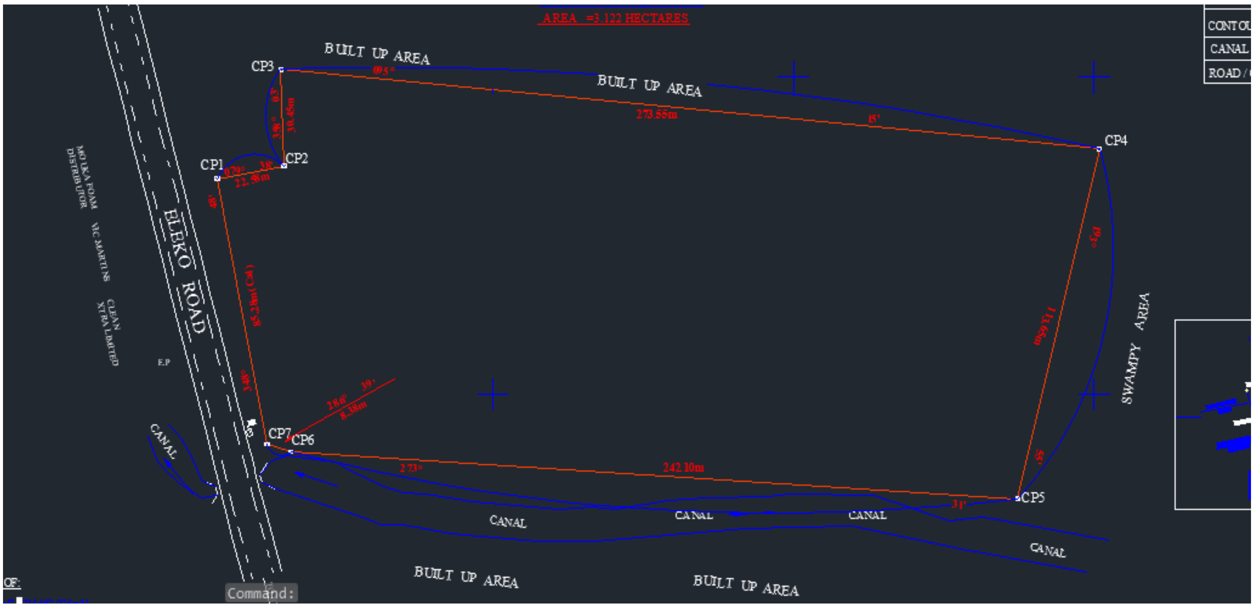

Figure 6: Map of the site showing the boundary lines

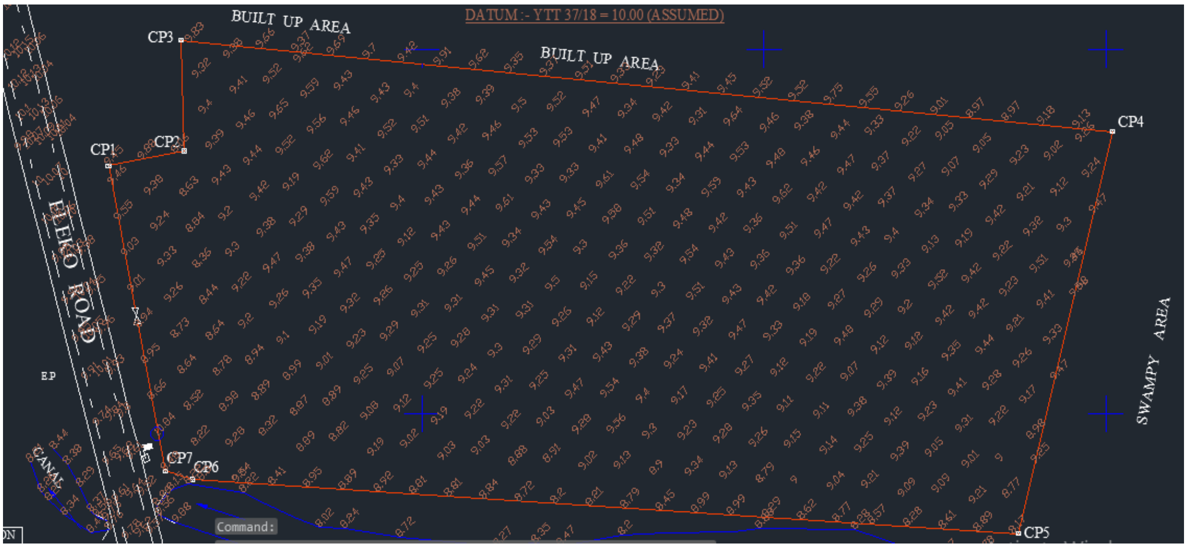

Figure 7: Map of the site showing the spot heights

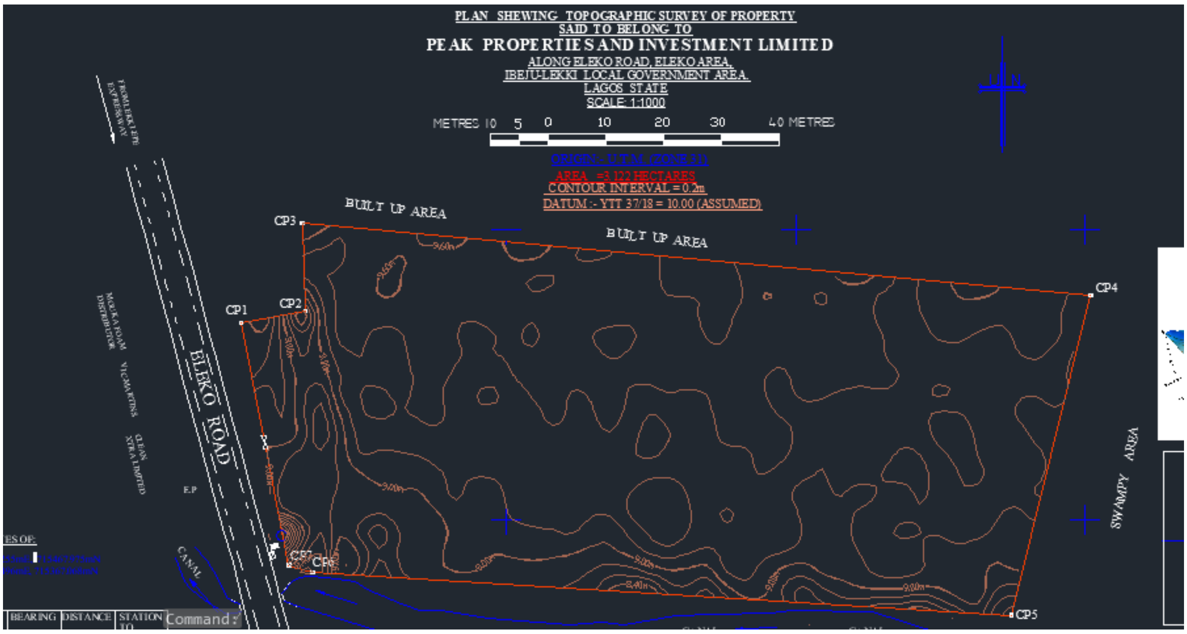

Figure 8: Map of the site showing the contours of the terrain

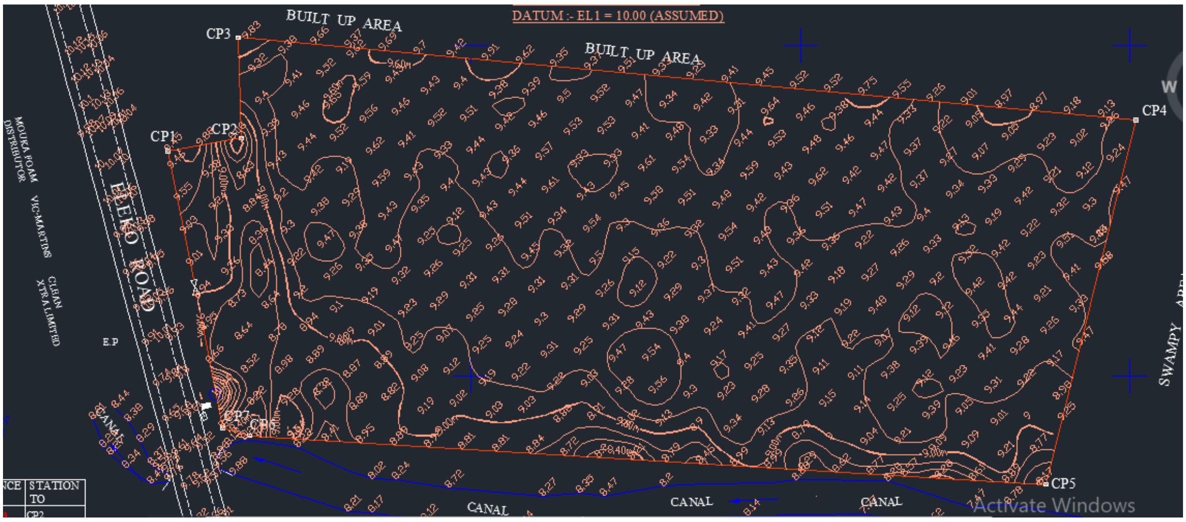

Figure 9: Topographic map of the site

Digital Terrain Model (DTM)

The DTM presented the site in three (3) dimensional forms (Figure 10). Figure 11 divided the entire site into six (6) different portions A to D. The black arrow at the terrain B pointed at the deepest part of the site, the black arrows at C with the next deeper location, and followed by the arrow at A in that order. Section E shows the most flat terrain, followed by D and F. With this information, the accurate land use planning of sustained management of the site could be achieved. This will inform the type and nature of buildings, and infrastructures suitable for each of the section of the site in relation to the environment (Figure 11). This is supported by Morakinyo & Sunmonu (2020) who used DTM for the successful assessment of the creek floor in the Niger Delta, Nigeria.

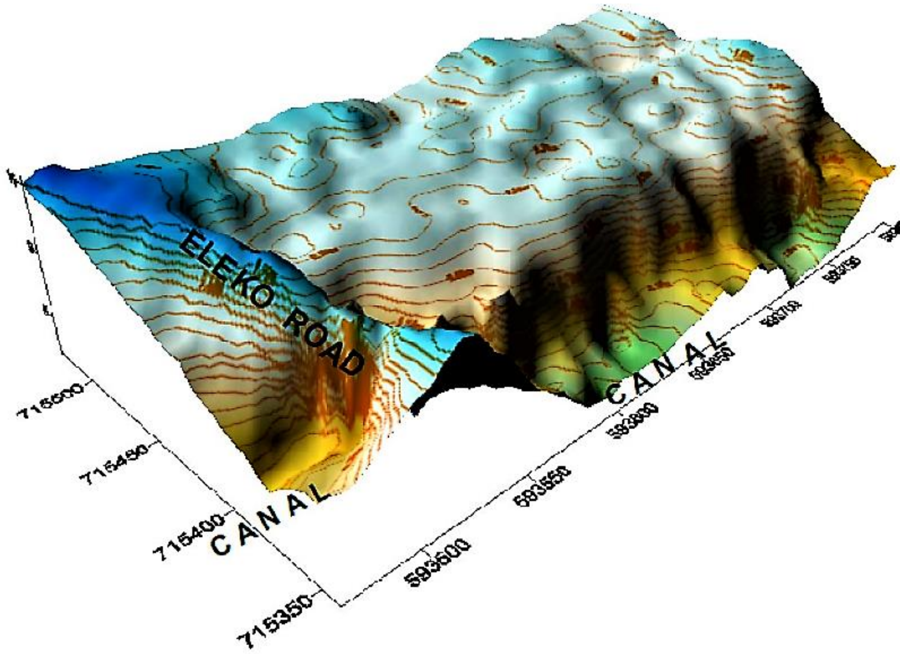

Figure 10: Digital Terrain Model of the site

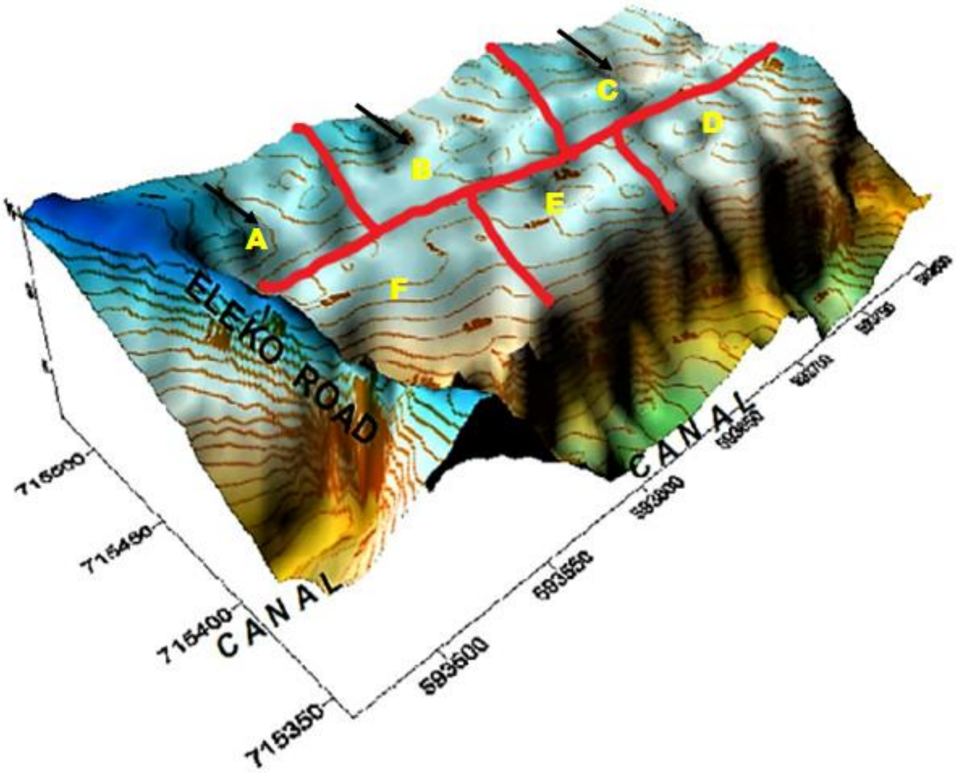

Figure 11: Six portions of site land topography obtained from DTM

The relevance of the topographic map and DTM produced cannot be overemphasized. Generally, they help to examine the nature of the terrain and to make decisions i.e. geospatial decision. Also, they are used for monitoring; analysis of the unused land within the site; enhances housing policy; crime prevention and control; environmental management; planning of social amenities e.g. the number of required fire station, shopping mall and other social amenities required in that area.

CONCLUSION

The results obtained from this project show that the total perimeter of the traverse is 839.805 m; total area of the site is 3.132 Hectares; and the linear accuracy of the traverse is 1/15,000. Grid levelling was carried out at 10 m intervals with staking at 10 m. This provides the elevation for each point which leads to the provision of contours for the terrain; and finally the production of topographic map and DTM which are used as tools for land use planning and its management. Therefore, it can be concluded that geospatial information such as topographic map and DTM are the bedrock for land use planning and management. Non availability of survey control points closer to the project site is a major challenge to this project. Hence, the following recommendations are made: Densification of survey controls to cover the entire Lagos State in order to reduce the problems of finding the already existing useable controls for the new survey job since every meaningful environmental development is based on them. Also, Nigerian Government should ensure that topographical survey plan should be among the documents needed for registration of land that is more than one hectare. This is to enhance proper and adequate planning of the land terrain; and to assist the Architects and Engineers in like manners.

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