Varying Geometry Area Determination of Selected Sites in Rivers State University, Port Harcourt, Nigeria.

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PRESENTATION OUTLINE

- Introduction
- Materials and Methods
- Results and Analyses
- Conclusion and Recommendations

INTRODUCTION

- The extent of a land can be measured in square meters (m^2) or hectares (ha). The area of any landed property is the quantity that expresses the extent of a two-dimensional (2D) figure or shape.
- In plane surveying, area refers to the orthographic projection of a tract of land on a horizontal plane (as such the curvature of the earth is negligible).
- Area computation is indeed an important part of the office work involved in surveying (Chandra, 2006).
- In southeastern and Southern Nigeria, land division of 50×100ft (15.24m x 30.48m) is the widely used size for a plot of land, but this dimension differs according to the location of that landed property within Nigeria but due to the variations in geometry, a plot can range from 450sqm to 1200sqm.

INTRODUCTION cont.

- For this study a closed traverse was carried out on 18 parcels of different geometry. The variation is made such that the perimeter is held constant but the angles were be altered by 5° for each parcel.
- The non-adherence to the principles of geometry is the contributing factor to variations in extent, and the resultant effect is that people have less than the value they have paid for.

Aim and Objectives

The aim of this study is to determine the area of a parcels of land by varying the geometry.

The objectives are as follows;

- To carry out traverse on different geometry of a land with the same perimeter and produce boundary coordinates.
- To determine the adjusted coordinates using least squares and the area of each parcel.
- To produce the plans of the different parcels overlaid on each other and to present both tabular and graphical form, the change in area as a result of the variations in angles.

STUDY AREA

- The location of this study is at the right wing of the entrance to the Faculty of Environmental Sciences in Rivers State University
- It is bounded by geographical coordinates: latitude 40 47’ 30”N to latitude 40 48’ 20”N and longitude 60 58’ 35”E to longitude 60 59’ 05”E
- The study area is an open greenery and relatively has less human movement.

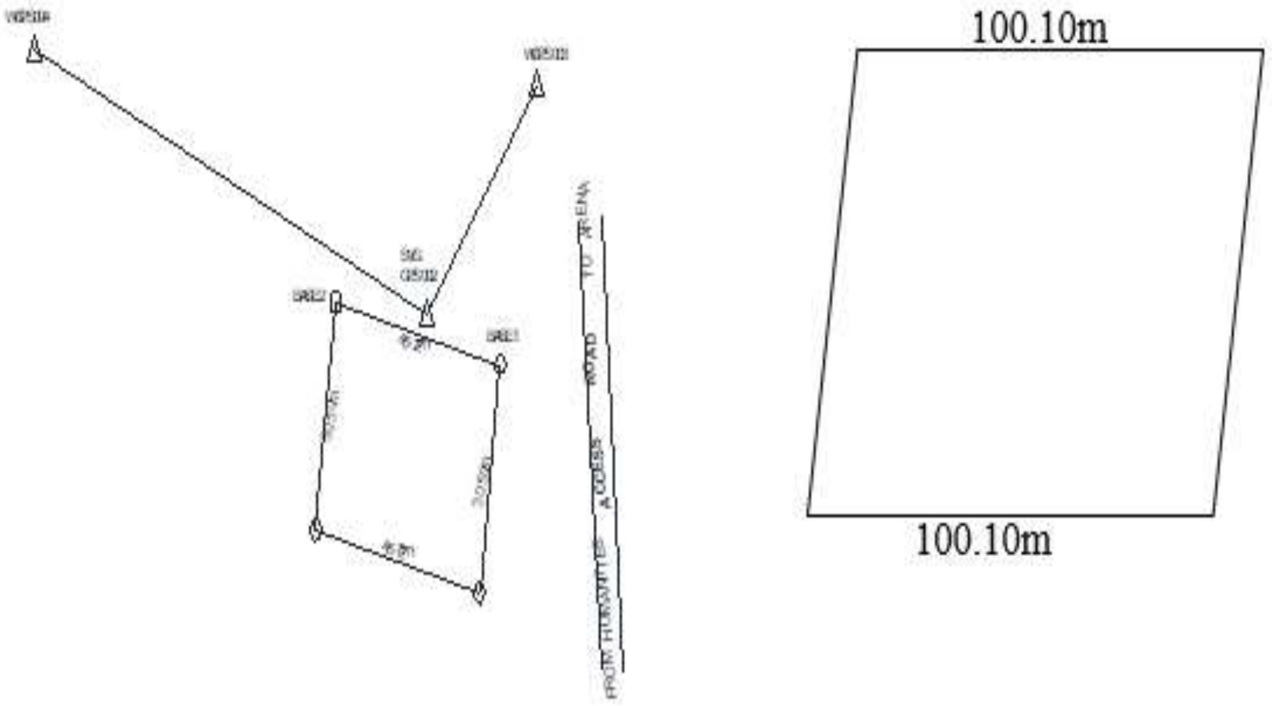

Figure 1: Shows reconnaissance flow chart of the study

INTRODUCTION

Types of Surveying

On the basis of whether the curvature of the earth is taken into account or not, Ejiobih (2008) identified that surveying can be divided into two categories:

Plane Surveying

This is the type of surveying where the mean surface of the earth is considered as a plane. All angles are considered to be plane angles (Dashe,1987). For areas less than 250km² plane surveying can safely be used for which the distances of this study are less than 1km (Ejiobih, 2008).

Geodetic surveying

This is that branch of surveying, which takes into account the true shape of the earth (spheroid).

Area Determination in Surveying

Area can be obtained directly from field measurements or from maps as such area gotten from field measurement can be divided into two categories: area consisting of regular boundary and area consisting of irregular boundary (Dashe,1987; Chandra, 2006).

Area Consisting of Regular Boundary

This can be determined either by dividing the parcel into triangles, trapezoid, calculated from coordinates of the traverse stations and double meridian distances (Dashe,1987).

Area consisting of irregular boundary

If the boundary of a parcel is irregular the area is computed using the offsets taken at a regular interval the area between the traverse line and irregular boundary may be determined by either of the following methods: Mid-Ordinate, Average Ordinate, Trapezoidal and Simpson's Rules.

METHODS

Kirshenblatt-Gimblett, (2006) defined research design as the strategy that is chosen to integrate the various components of the study in a coherent and logical manner, thereby ensuring effective approach to address the research problem. As such for a study of this nature research design brings out the conceptual structure of the research, the blueprint of data collection, measurement and analysis.

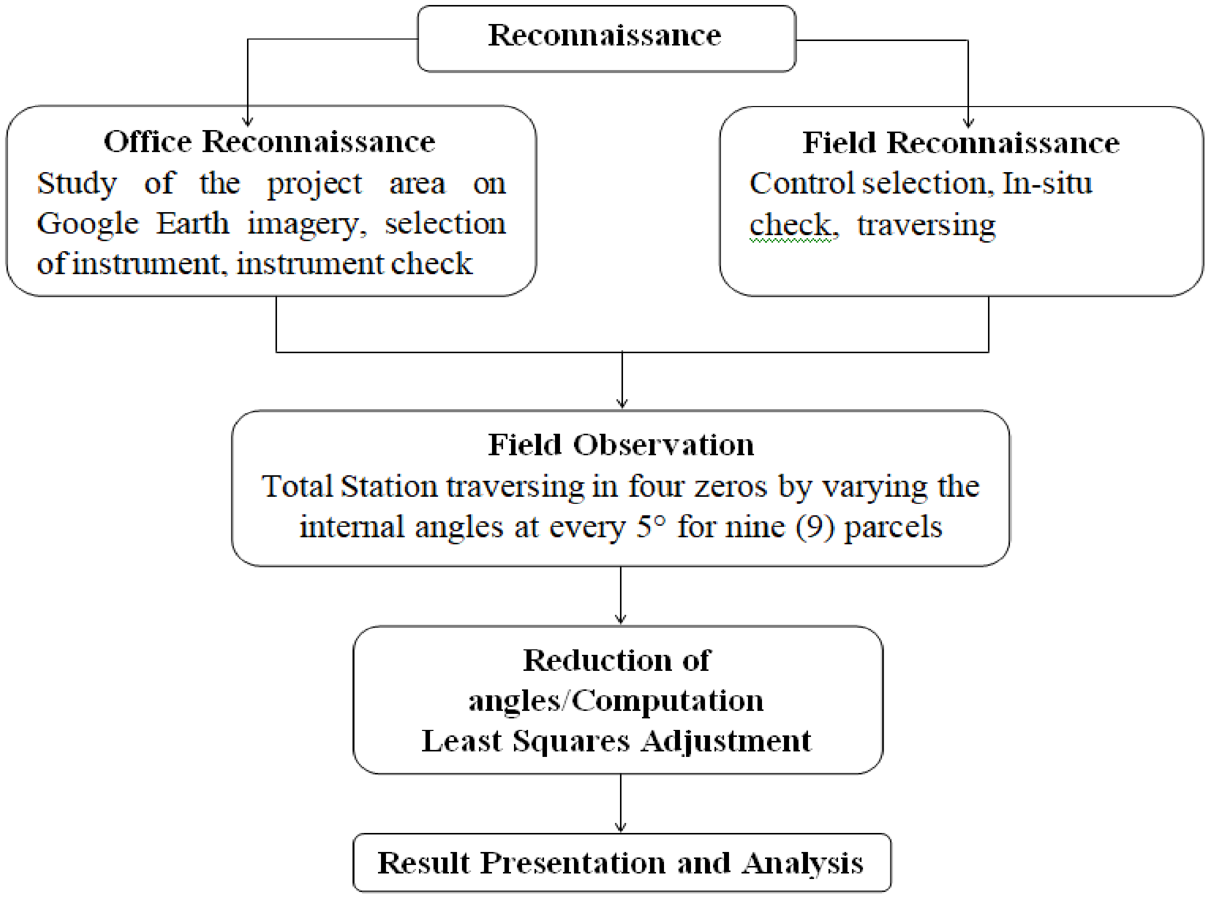

Figure 2: Shows flow chart of the study

INTRODUCTION

Least Squares Adjustment

Wolf and Ghilani (1997) identified that the least squares method is used in the adjustment of measured quantities containing random errors. It is assumed that all systematic errors have been removed from the observed values and that only random error and blunders which have escaped detection remain. Least squares adjustment technique makes use of redundant observation in the mathematical modeling of a given problem to minimize the sum of squares of discrepancies between the observation and the most probable value (Wolf and Ghilani, 1997)

Method of Observation Equation

The functional relationship of the observation and the adjusted parameters is given as:

$$L^a = F(X^a) = L^b + V \quad (1)$$

$$V = AX - L^b \quad (2)$$

Where: L^a = adjusted observation
V = Residual vector
A = Design matrix
L^b = Original observation
X = Adjusted parameter

Solution of the unknown parameters or the estimate of the correction of approximate parameter vector, X, in a non-linear model is given as:

$$L^a = f(x^a) = f(x^o + x) \quad (3)$$

$$x^a = x^o + x \quad (4)$$

Where: x^0 = Approximate value of adjusted parameters
X = Correction to approximate value

$$X = -(A^T PA)^{-1} A^T PL \quad (5)$$

Where: $(A^T PA)$ = normal equation coefficient matrix, $A^T PL$ = normal equation constant and P = unit weight

$\sum_x = \sigma_0^2 (A^T PA)^{-1}$ = variance – covariance matrix of adjusted parameters (6)

Where: $\sigma_0^2 = V^T PV/n\text{-}m$ = aposteriori of unit weight (7)

RESULTS AND ANALYSES

Computation of the Final Coordinates using Least Squares

Least squares method is used in the adjustment of measured quantities containing random errors. It is assumed that all systematic errors have been removed from the observed values and that only random error and blunders which have escaped detection remain (Wolf and Ghilani, 1997; Charles, 2010). Having obtained the variance-covariance matrix of X, the standard error of the adjusted parameters (coordinates), was determined by taking the square roots of the diagonal elements of the variance-covariance matrix. The following equations were used to generate the 'A' Matrix which was used to compute the corrections to the approximate coordinates.

A =

0.948	-0.319	0	0	0	0	0	0
0.348	0.937	-0.348	-0.937	0	0	0	0
0	0	0.984	-0.18	-0.984	0.18	0	0
0	0	0	0	-0.348	-0.937	0.348	0.937
0	0	0	0	0	0	-0.888	-0.459
-9341.937	-3147.115	0	0	0	0	0	0
9487.255	6988.333	-6340.14	2353.604	0	0	0	0
-6340.14	2353.604	5671.429	-6791.277	812.402	4437.673	0	0
0	0	812.402	4437.673	-7151.905	-2083.336	6339.503	-2354.337
0	0	0	0	6339.503	-2354.337	-7863.642	5301.119
0	0	0	0	0	0	1524.139	-2946.782

L =

0
0
0.001
0.001
0.001
0.004027
0.007361
-0.007361
0.000166
-0.000833
-0.003888

X =

0.00000183139
-0.00000415676
0.00026183781
0.00070717139
0.00081845281
0.0006042458
0.00073375883
0.00037819636

RESULTS AND ANALYSES Contd.

The area of each parcel was computed and the results for the 18 varying parcels are displayed on the table below in Universal Transverse Mercator (UTM) zone 32N projection system.

Table 1: Table Showing Results from Parcel 1 (100 x 100m)

Parcel ID	Back Comp. Coordinates N (m)	Back Comp. Coordinates E (m)	Back Comp. Area (m^2)	Adjusted Coordinates N (m)	Adjusted Coordinates E (m)	Adj. Comp. Area (m^2)	Standard Error ΔE(m), ΔN(m)	Difference in Area (m^2)
BASE 1	530931.730	275875.422		530931.729	275875.425		±0.000, ±0.001	
1A	531030.734	275890.214		531030.730	275890.217		±0.029, ±0.079	
1B	531015.940	275989.222		531015.937	275989.221		±0.074, ±0.076	
BASE 2	530916.937	275974.428	10,020.879	530916.936	275974.427	10,020.229	±0.008, ±0.004	0.650

Table 2: Table Showing Results from Parcel 9 (100 x 100m)

Parcel ID	Back Comp. Coordinates N (m)	Back Comp. Coordinates E (m)	Back Comp. Area (m^2)	Adjusted Coordinates N (m)	Adjusted Coordinates E (m)	Adj. Comp. Area (m^2)	Standard Error ΔE(m), ΔN(m)	Difference in Area (m^2)
BASE 1	530931.731	275875.418		530931.729	275875.425		±0.000, ±0.001	
9A	531017.082	275823.111		531017.084	275823.110		±0.000, ±0.001	
9B	531002.288	275922.117		531002.290	275922.116		±0.000, ±0.001	
BASE 2	530916.936	275974.423	7,676.419	530916.936	275974.427	7,676.545	±0.008, ±0.004	-0.126

Table 3: Shows the varying misclosures and geometry for nine 100 x 100m parcels

Parcel	Angle Variation	Angular Misclosure	Perimeter (m)	Linear Accuracy	Area (m^2)	Difference in Area (m^2)	Number of 50 x 100 plot	Number of 50 x 100 plot lost
1	90°	-1"	400.40	1: 227,878	10,020.010	0.000	21.571	0.000
2	85°	58.38"	400.40	1:108,733	9,981.881	38.129	21.489	0.082
3	80°	00"	400.40	1:45,938	9,867.784	152.226	21.243	0.328
4	75°	-1.5"	400.40	1:41,728	9,678.586	341.424	20.836	0.735
5	70°	-4"	400.40	1:229,579	9,415.729	604.281	20.270	1.301
6	65°	-6"	400.40	1:9,111	9,081.213	938.797	19.550	2.021
7	60°	-3"	400.40	1:114,823	8,677.583	1,342.427	18.681	2.890
8	55°	32.7"	400.40	1:448,190	8,207.912	1,812.098	17.670	3.901
9	50°	-6"	400.40	1:229,591	7,675.773	2,344.237	16.524	5.047

Table 4: Table Showing Results from Parcel 1 (30 x 45m)

Parcel ID	Back Comp. Coordinates N (m)	Back Comp. Coordinates E (m)	Back Comp. Area (m^2)	Adjusted Coordinates N (m)	Adjusted Coordinates E (m)	Adj. Comp. Area (m^2)	Standard Error ΔE(m), ΔN(m)	Difference in Area (m^2)
BASE 1	530896.520	275982.590		530896.520	275982.589		±0.001, ±0.000	
1A	530866.519	275977.098		530866.519	275977.097		±0.000, ±0.001	
1B	530874.752	275932.126		530874.752	275932.125		±0.000, ±0.001	
BASE 2	530904.752	275937.618	1,394.421	530904.752	275937.617	1,394.395	±0.001, ±0.000	0.026

RESULT AND ANALYSIS cont.

Table 5: Table Showing Results from Parcel 9 (30 x 45m)

Parcel ID	Back Comp. Coordinates N (m)	Back Comp. Coordinates E (m)	Back Comp. Area (m²)	Adjusted Coordinates N (m)	Adjusted Coordinates E (m)	Adj. Comp. Area (m²)	Standard Error ΔE(m), ΔN(m)	Difference in Area (m²)
BASE 1	530896.533	275982.597		530896.520	275982.589		±0.001, ±0.000	
9A	530877.031	275959.147		530877.034	275959.150		±0.002, ±0.002	
9B	530885.276	275914.173		530885.279	275914.176		±0.002, ±0.002	
BASE 2	530904.743	275937.647	1,069.096	530904.752	275937.617	1,069.162	±0.001, ±0.000	0.066

Table 6: Shows the varying misclosures and geometry for nine 30 x 45m Parcels.

Parcel	Angle Variation	Angular Misclosure	Perimeter (m)	Linear Accuracy	Area (m²)	Difference in Area (m²)	Number of 50 x 100 plot	Number of 50 x 100 plot lost
1	90°	0.3"	152.44		1,394.421	0.000	3.00	0.000
2	85°	2"	152.44	1:232,148	1,389.082	5.339	2.99	0.011
3	80°	-2"	152.44	1:232,164	1,373.156	21.185	2.96	0.046
4	75°	-1"	152.44	1:77,434	1,346.885	47.515	2.90	0.102
5	70°	2.5"	152.44	1:114,754	1,310.404	84.096	2.82	0.181
6	65°	39.6"	152.44	1:46,025	1,263.670	130.649	2.72	0.281
7	60°	39"	152.44	1:17,392	1,206.441	186.820	2.60	0.402
8	55°	16"	152.44	1:8,006	1,141.996	252.182	2.46	0.543
9	50°	9"	152.44	1:13,618	1,069.096	326.238	2.30	0.702

Tables 1 and 2 shows the results for the 100 × 100m parcels while tables 4 to 5 shows the results for 30 x 45m parcels comparing the products of the unadjusted coordinates of each parcel and that of the least square adjustment coordinates with their standard errors and difference in areas.

RESULT AND ANALYSIS: cont.

Tables 3 and 6 shows the angular variation for the varying geometry is 5º ranging from 90º to 50º with a total of 9 parcels each for the 100 x 100m and 30 x 45m respectively.

Hence, the misclosure in every angle variation to both the tables 3 and 6 changed. Although one of the angular variations in the table 3 without misclosure having 00". As the angle variation decreases in degree's so the area and the number of plot decreases. As such the decrease of both number of plots and areas is the increase of number of plots lost.

Table 3 have angular misclosures ranging from -6'' to 58.38'' with a constant perimeter of 400.40m, linear accuracy ranging from 1:9,111 to 1:448,190, area ranging from 10,020.010m² (1.002ha) to 7,675.773m² with a difference in area ranging from 38.129m² to 2,344.237m² that is an equivalent of 0.082 to 5.047 plots lost using 464.515m² an equivalent of 15.24m (50ft) by 30.48m (100ft) as a standard plot in South East (Abia, Anambra, Ebonyi, Enugu and Imo) and South South (Akwa Ibom, Bayelsa, Cross River, Delta, Edo and Rivers) states of Nigeria.

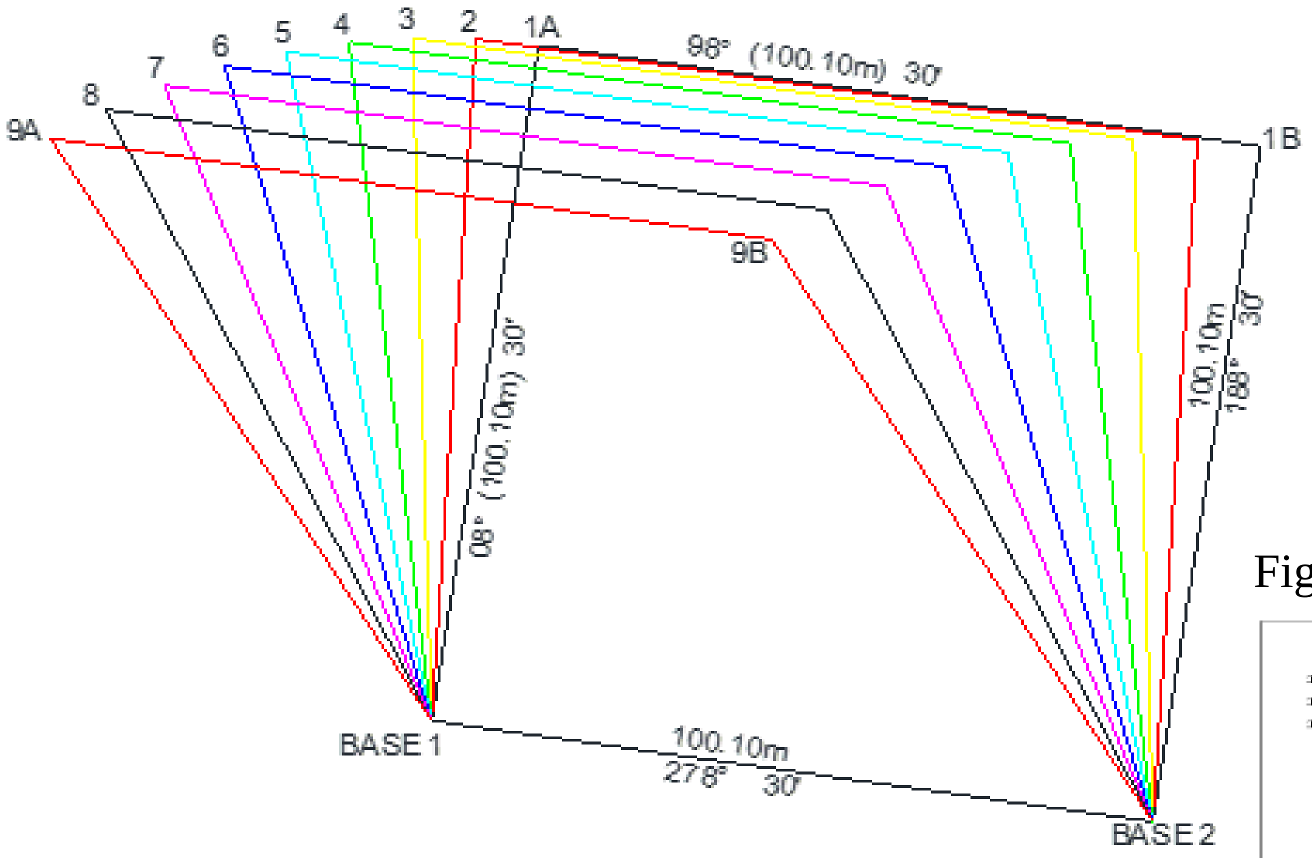

Figure 3: Superimposed 100x100m plots of the different parcels

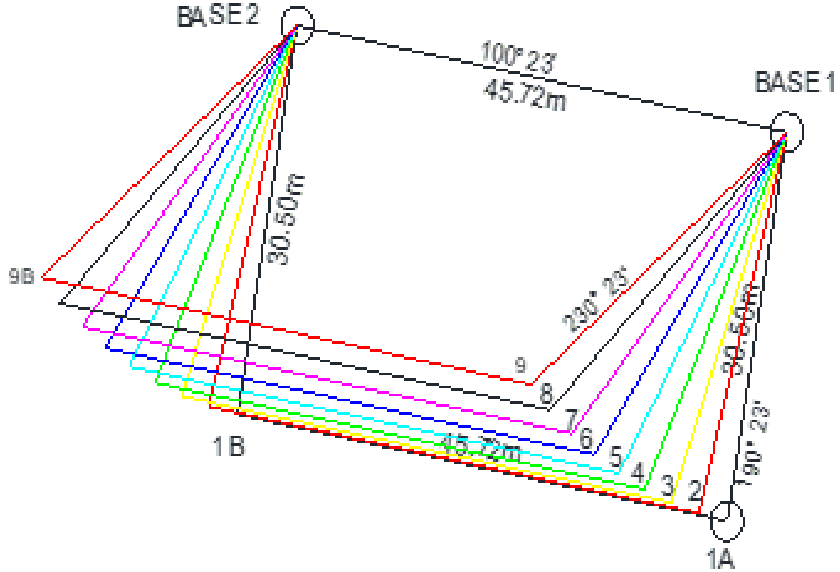

Figure 4: Superimposed 30x45m plots of the different parcels

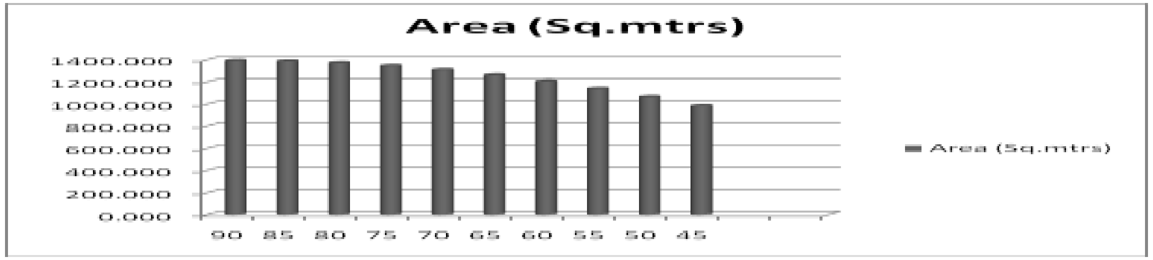

Figure 5: Statistical model of variations in area

CONCLUSION

It is important to restart the overall objectives of this study are as follows;

Firstly, to carry out traverse on different geometry of a land with the same perimeter and produce boundary coordinates.

Secondly, to determine the adjusted coordinates using least squares and the area of each parcel.

Thirdly, to produce the plans of the different parcels superimposed on each other and to present both tabular and graphical form, the change in area as a result of the variations in angles.

Therefore, it is important to state that this study has added more value to researchers by enlightening the land professionals on the necessity of taking into consideration, the geometry of any parcel of land in other to maximize the use of such landed property. From the results of this study, it is obvious that the more inclined the shapes are lesser in size.

RECOMMENDATION

The research has revealed salient points regarding the effect of varying the geometry of lands. The comparison of smaller and a fairly large parcels should not be overlooked as it solves the problems of doubt from the result of computed parcels.

The results of the work should be readily accessed by built professionals as a contribution into best practices for countries that sell or leases of properties in plots rather than square meters.

It will benefit the professionals by helping to facilitate swift survey for effective land registration and management, easier and faster than it is possible in the existing practice. The Government will also benefit by the possible drastic reduction of land dispute and tenure related challenges in terms of paying so much for lesser coverage of land.

It should be recommended that the surveyors and other land professionals adopt a maximum angular deviation during subdivision, lease and sale of landed property. If possible, a law should be passed through the appropriate professional bodies on the maximum angular deviation on properties of smaller dimensions.

Thank you!

for your apt attention