



FIG Working Week 2024

19-24 May

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Presented at the FIG Working Week 2024,
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GEOSPATIAL ASSESSMENT OF PLANNING SCHEMES USING GIS & REMOTE SENSING TECHNIQUES : A CASE STUDY

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Presentation Outline

- ❖ **PROBLEM STATEMENT**
- ❖ **OBJECTIVES**
- ❖ **MATERIALS AND METHODS**
- ❖ **RESULTS AND DISCUSSIONS**
- ❖ **CONCLUSIONS AND RECOMMENDATIONS**

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Problem Definition

- ❖ alternative patterns of urban settlement, the rational use of resources to alleviate urban problems, and the provision of city's physical and social infrastructure;
- ❖ The spatial structure of activities (or land uses) is put together as a document called the Planning Scheme (PS) (Local Plan or Town Layout) for a particular area;
- ❖ The most common uses of land are for recreational, transport, agricultural, residential and commercial purposes;
- ❖ In Ghana, the Metropolitan/Municipal/District Assemblies (MMDAs) with a special unit called the Spatial Planning Unit
- ❖ and if not properly done bring errors in the final PS or the various parcels for various land uses on ground;

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Problem Definition (Cont'd)

- ❖ These errors have negative influence on the growth of human settlements leading to chaotic and grossly irregular growth;
- ❖ Most urban areas with the inclusion of the Tarkwa Area (TA) are dominated by problems of;
- ❖ unauthorised developments, lack of infrastructure, poor sanitation, flooding, health hazards, fire hazard, crime and squatter settlements
- ❖ due to ineffective planning, wrong and unapproved methods of urban planning, poor implementation, and non-revision of PS
- ❖ Due to the errors associated with PS during preparation, implementation and revision;

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Problem Definition (Cont'd)

- ❖ there is the need for the various MMDAs to have a geodatabase of PS;
- ❖ assess the accuracy of the PS geospatially from time to time to aid in an accurate and effective revision of PS to meet the current needs of the community.
- ❖ Hence, this research seeks to create a geodatabase for various land uses from the PS of the Tarkwa Area (TA);
- ❖ This research further seeks to geospatially assess the PS of the TA by taking into consideration the standards for the preparation of PS
- ❖ the results of which can be used to revise the PS of the TA by the planning agencies

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Research Objectives

The objectives of this research are to:

- ❖ develop a geodatabase for parcels of land in the TA; and
- ❖ geospatially assess the planning schemes of the TA; and

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Materials Used

Table 1 Spatial Data for Research

No.	Data Type	Source of Data	Format
1	Planning Schemes of Tarkwa	TCPD, Tarkwa	JPG
2	Maps of roads, rivers, dams, fault and tectonic zones,	Professionals in Geology and Surveying	Shapefiles (.shp)
3	Maps of telecommunication, radio and television masts locations	Field Survey	Excel(.CSV)
4	(X,Y & Z) coordinates of selected points on ground for validation	Ground surveys using GNSS South Receivers	Excel(.CSV)
5	Maps of pipelines, high tension power distribution lines, and telecommunication lines in Tarkwa	Utility Companies	Shapefiles (.shp)
6	Digital Terrain Mode (DTM) of TA	Online	.dtm
7	Wind Rose or Wind Heading Data	UMaT Meteorological Department PLATINUM SPONSORS THE SCIENCE OF WHERE®	Excel(.CSV) GEOISA Geospatial Information Authority for Surveying and Geospatial Information



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Materials Used Cont'd Table 2 Non-Spatial Data for Research

No.	Data Type	Essence	Source of Data
1	Details of the size of the parcels of land, UPN of parcels of land and other details from the PS	To obtain the UPN of the parcel of land to check at the various land agencies for more details to obtain details of the size and locations of the various parcels of land	TCPD
2	Cadastral Plan Registration details	To obtain details of ownership of land and to check whether the approved cadastral plan conforms with the PS	SMD
3	Information on indenture and deed registration of parcels of land at the LC	To obtain details of ownership and to check whether the registered land conforms to the PS of TA	LC
4	Permit information on the various parcels of land	To know if the parcel of land for building does conform to the PS of TA and whether the TCPD did grant a permit for the parcels of land in context	TCPD

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Materials Used Cont'd

Software

- ❖ Excel;
- ❖ GNSS South Processor;
- ❖ Spectrum Survey;
- ❖ ESRI ArcGIS 10 Software; and
- ❖ AutoCAD 2018.

Instrument

South GNSS Receivers



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Methods Used

Development of Geodatabase for Parcels of Land in the PS:

- ❖ In order to create the geodatabase for the TA, the digital format of the PS of the TA in JPEG format with a Cell Size of 2.100 feet (0.64 m)
- ❖ was imported in ArcGIS 10 software where the geo-referencing tool was used in geo-referencing the PS of the TA to a
- ❖ Total Root Mean Square (RMS) Error of 1.301 feet (0.040 m) using the 2nd Order Polynomial Transformation
- ❖ The error of geo-referencing of 1.301 feet which is smaller than the cell size of 2.100 feet of the raster data;

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Methods Used

Development of Geodatabase for Parcels of Land in the PS:

- ❖ indicates an accurate geo-referencing;
- ❖ The Editor Tool of ArcGIS 10 software was used for the digitisation of the various land used in the PS of the TA;
- ❖ and a digitisation error of 0.009 feet (0.003 m) was achieved.
- ❖ The digitisation took into consideration parcels of land for various purposes;
- ❖ rivers, dams, roads, high voltage electricity distribution lines, railroads and areas of ecological importance.

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Methods Used

Development of Geodatabase for Parcels of Land in the PS:

- ❖ Attribute Table of ArcGIS 10 software was used in creating columns and rows relating to various parcels of land in the TA;
- ❖ Information regarding various parcels of land in the PS the TA was taken from the MA of Tarkwa and entered in the Attribute table;
- ❖ The attribute information included ownership of parcels of land, registration status;
- ❖ structure on the land and permit number of buildings.

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Methods Used

Geospatial Assessment of PS in the TA:

- ❖ The geo-spatial assessment of the PS also took into consideration the positions of parcels on the PS and corresponding positions on ground;
- ❖ distance of a parcels of land from major roads, pipelines, high voltage electricity lines, telecommunication masts and water bodies;
- ❖ Information on all these existing features were taken from various utility companies and validated;
- ❖ some were surveyed with the South (GNSS) receivers in Real Time Kinematics (RTK) mode;

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Methods Used

Geospatial Assessment of PS in the TA:

- ❖ information was added to the geo-database of the TA;
- ❖ The Analysis Tools and Geostatistical Analysis Tool of ArcGIS 10 were used to create a buffer according to the standard reservations of;
 - ❖
 - ❖ roads and other features in order to see whether buildings and other land uses on ground are falling on road reservations and other reservations;
- ❖ A map is then created after the geospatial assessment indicating affected parcels of land and land uses to aid in revision of the PS.

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Methods Used

Table 3 Spatial Factors Considered in the Preparation

of PS No.	SPATIAL FACTOR	SYMBOL	WEIGHT (%)	Magnitude
1	Nearness to existing road	A	a(Weight=0.10)	30 m
2	Nearness to (dams)	B	b(Weight=0.15)	60 m
3	Nearness to drainage channels	C	c(Weight=0.10)	15 m
4	Nearness to rivers	D	d(Weight=0.10)	use 50 m
5	Nearness to flood zones	E	e(Weight=0.20)	60 m
6	Nearness to power	F	f(Weight=0.15)	50 m

Transmission lines

Nearness to masts for





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Methods Used

Proposed Revisions to the PS of the TA:

- ❖ The existing PS were assessed to determine inconsistencies such as settlements implemented on roads, water ways, rivers etc in TA;
- ❖ The revision process involves re-planning the area based on the results of the assessment where unsuitable areas are erased;

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Results and Discussions: Geodatabase for the PS of TA

Table

Parcels_of_Land

OBJECTID	Shape *	Parcel_ID	Name	Shape_Length	Shape_Area	Locality	District	Registration_Status	Development_Status
1	Polygon	172	Abanga, Shirley	135.308871	1072.057879	TAMSO	TARKWA NS	CADASTRAL APPROVED	BUILDING COMPLETE
2	Polygon	174	Abare, Diana Talata	131.580134	1011.919241	TAMSO	TARKWA NS	CADASTRAL APPROVED	NO BUILDING
3	Polygon	176	Abayateye, Agnes Oger	132.517438	1043.952256	AKYEMPIM	TARKWA NS	REGISTERED AT LC	NO BUILDING
4	Polygon	17	Abban, Randy Joe	138.593463	1108.900245	AKYEMPIM	TARKWA NS	REGISTERED AT LC	NO BUILDING
5	Polygon	175	Abbey, Regimmanuel Jaakwei	139.121755	1105.267543	NEW ATUABO	TARKWA NS	CADASTRAL APPROVED	FOUNDATION STAGE
6	Polygon	173	Aboagye, Kofi Bray	144.874169	1215.952634	NEW ATUABO	TARKWA NS	REGISTERED AT LC	FLOWING STAGE
7	Polygon	Open Space	Acheampong, Appiah	275.770624	4565.751783	EFUANTA	TARKWA NS	NO CADASTRAL	BUILDG COMPLETE
8	Polygon	178	Acheampong, Delphina Owusu	129.605981	997.392974	EFUANTA	TARKWA NS	NO CADASTRAL	NO BUILDING
9	Polygon	179	Acheampong, Kofi Charles	135.916279	1093.609509	BANKYIM	TARKWA NS	NO CADASTRAL	NO BUILDING
10	Polygon	181	Ackwonu, Christine Aba	130.837645	1002.443085	TAMSO	TARKWA NS	CADASTRAL APPROVED	NO BUILDING

Figure 1 Geodatabase of Planning Scheme of Tarkwa Area



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Results and Discussions Cont'd: Geodatabase for the PS of TA

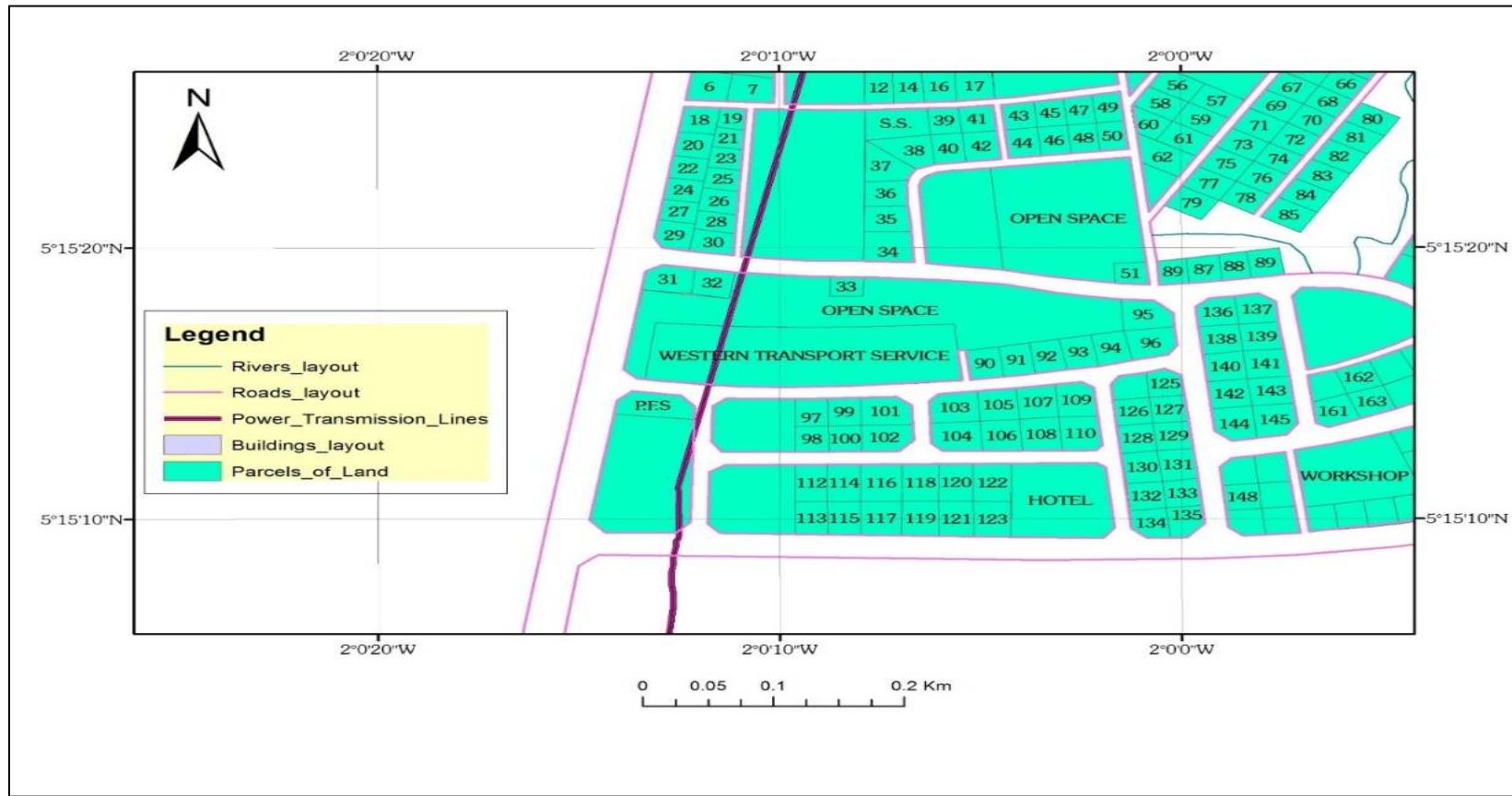


Figure 2 Section of Digitized Planning Scheme

of TA



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Results and Discussions Cont'd

Geodatabase for the PS of TA

:

- ❖ The geodatabase consists of 7 546 parcels of land and their UPN, roads, rivers, dams, electric lines, open spaces, existing buildings,
- ❖ ownership of parcels, locality of parcels, size of parcels,
- ❖ registration status of parcels,
- ❖ development status of parcels,
- ❖ permit status parcels;

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Results and Discussions Cont'd: Geospatial Assessment of PS

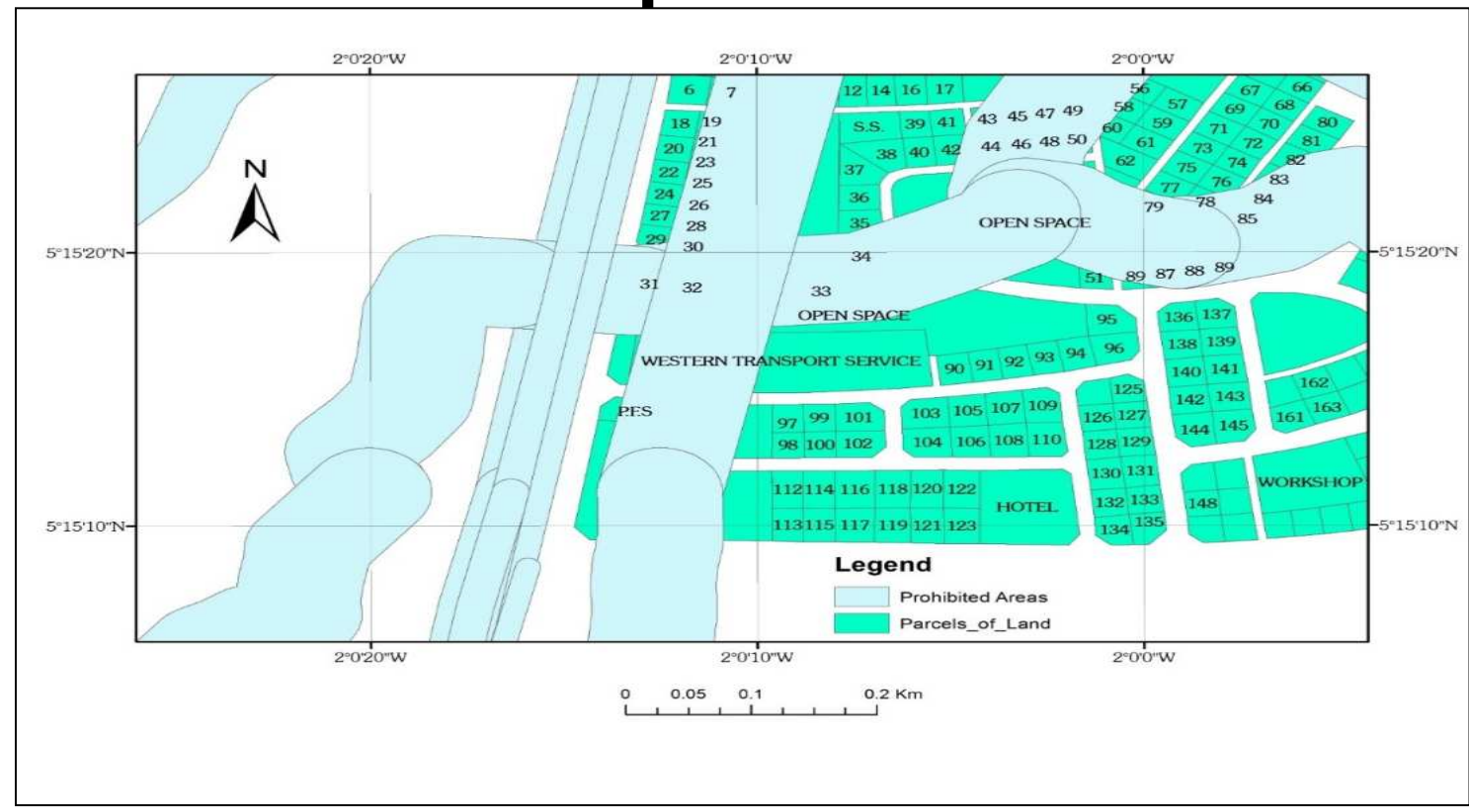


Figure 3 Sectional Map of Prohibited Areas Based on all Spatial Factors Combined



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Results and Discussions Cont'd:



Figure 4 Sectional Map of Prohibited Areas Based on all Spatial Factors Co



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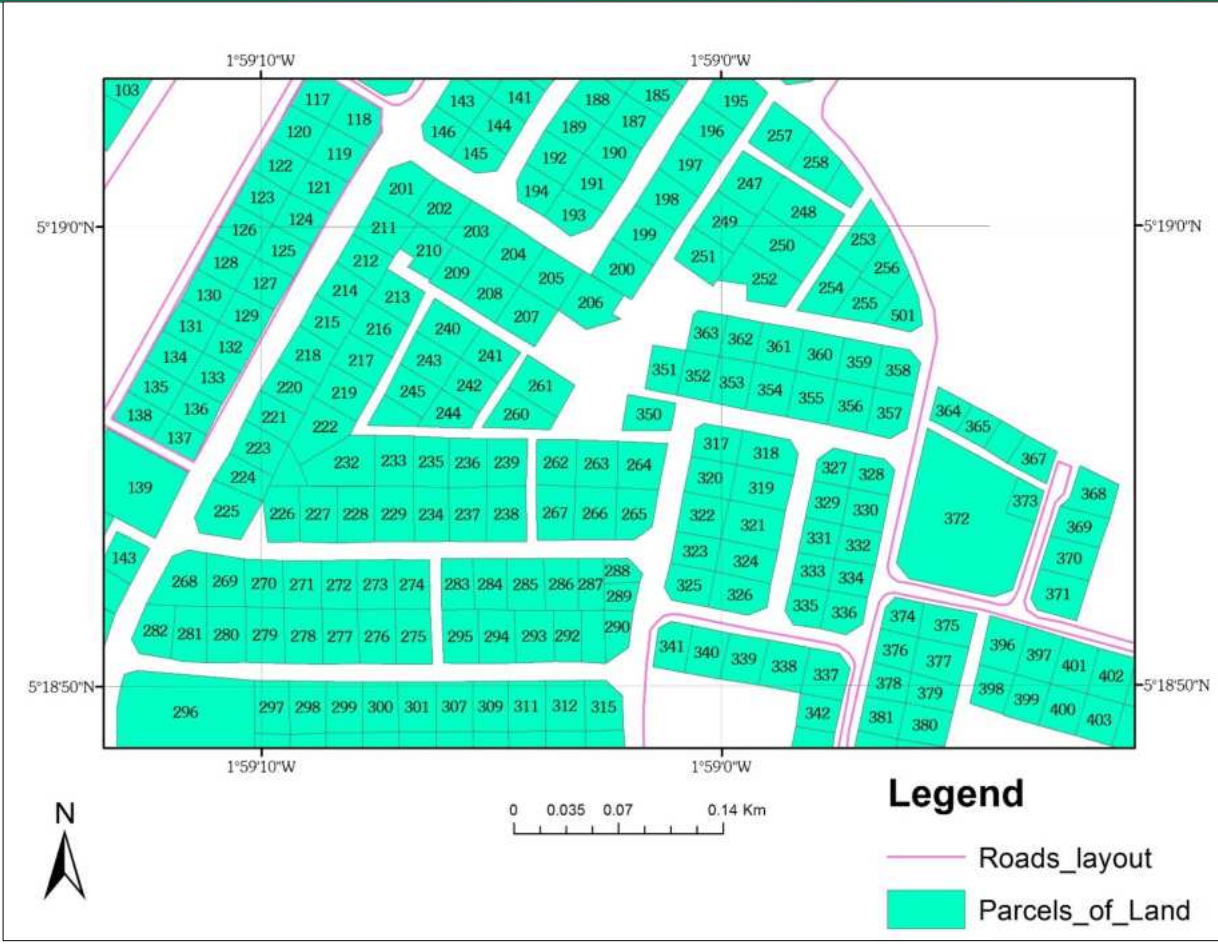


Figure 5 Cyanide Area from PS



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Results and Discussions Cont'd:



Figure 6 Map Cyanide with Pond falling in the PS



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Results and Discussions Cont'd:

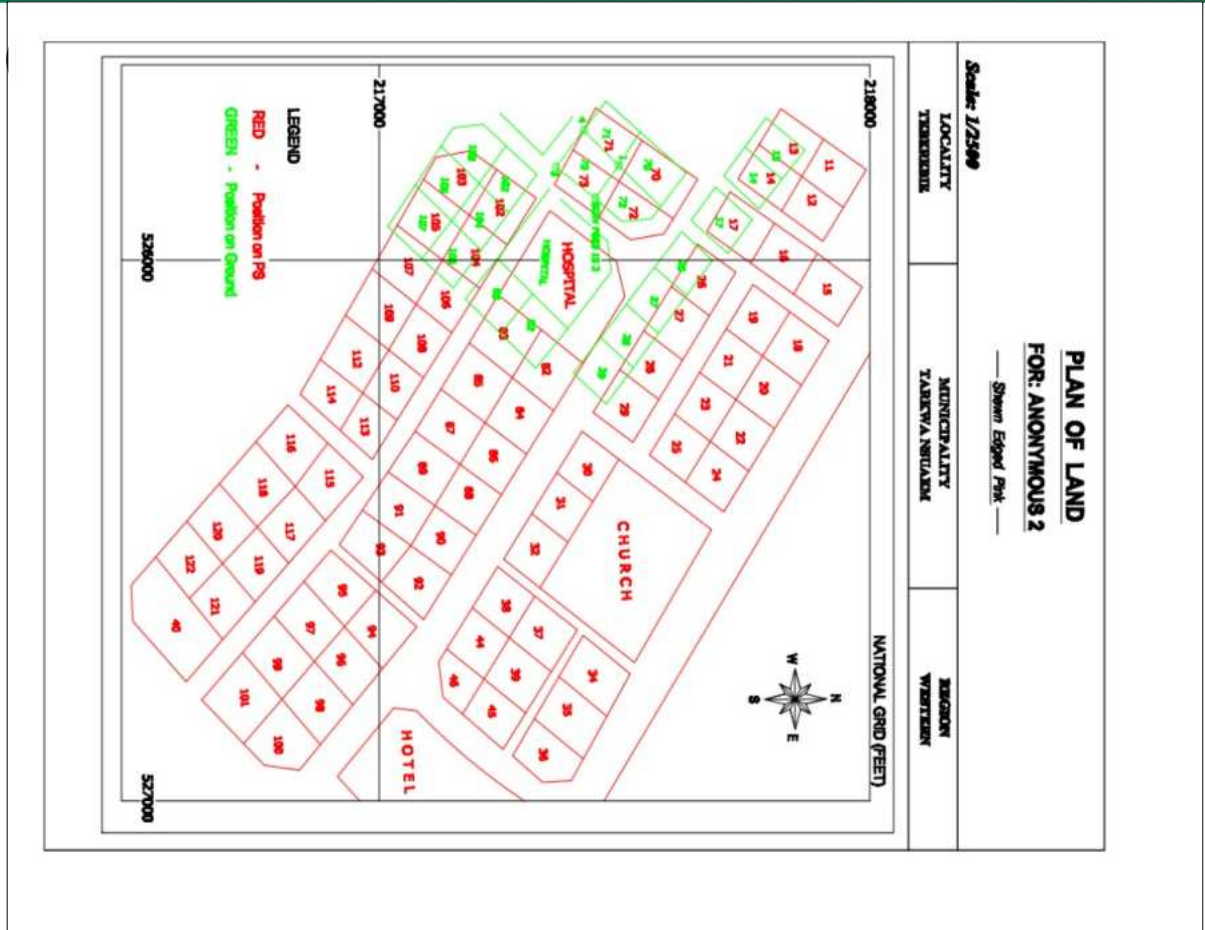


Figure 7 Map showing positional discrepancy at Teberebie



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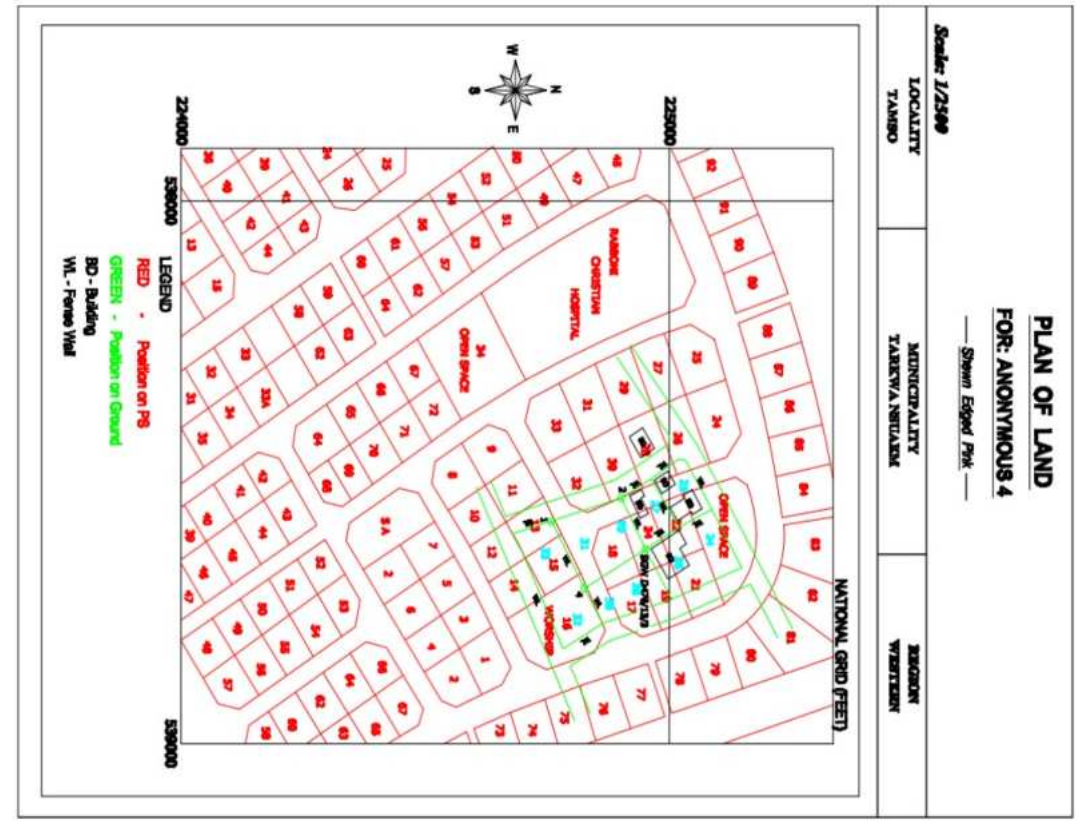


Figure 8 Map showing positional discrepancy at Tamso



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Results and Discussions Cont'd

Geospatial assessment (Positional Accuracy) of PS:

- ❖ To ascertain the positional accuracy of the implemented PS of Tarkwa, residuals, standard deviation and variance analysis were employed on the coordinates of the parcels of land implemented on ground;
- ❖ The rationale is to check the inconsistencies in the parcels of land which are been implemented on ground with wrong positions yet are approved during the registration process;
- ❖ For convenience in the analysis it is assumed that the data is devoid of mistakes and systematic errors. It is assumed that the errors in the PS are random errors;

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Results and Discussions Cont'd: Geospatial Assessment of PS

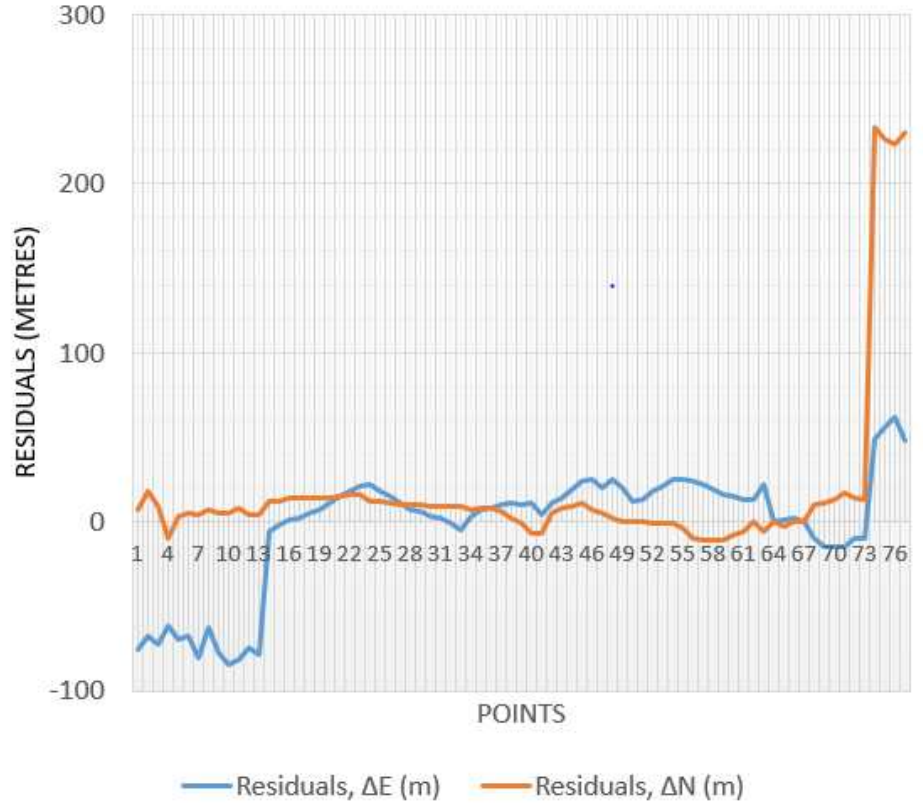


Figure 9 A Graph Showing Residuals in the implementation of PS

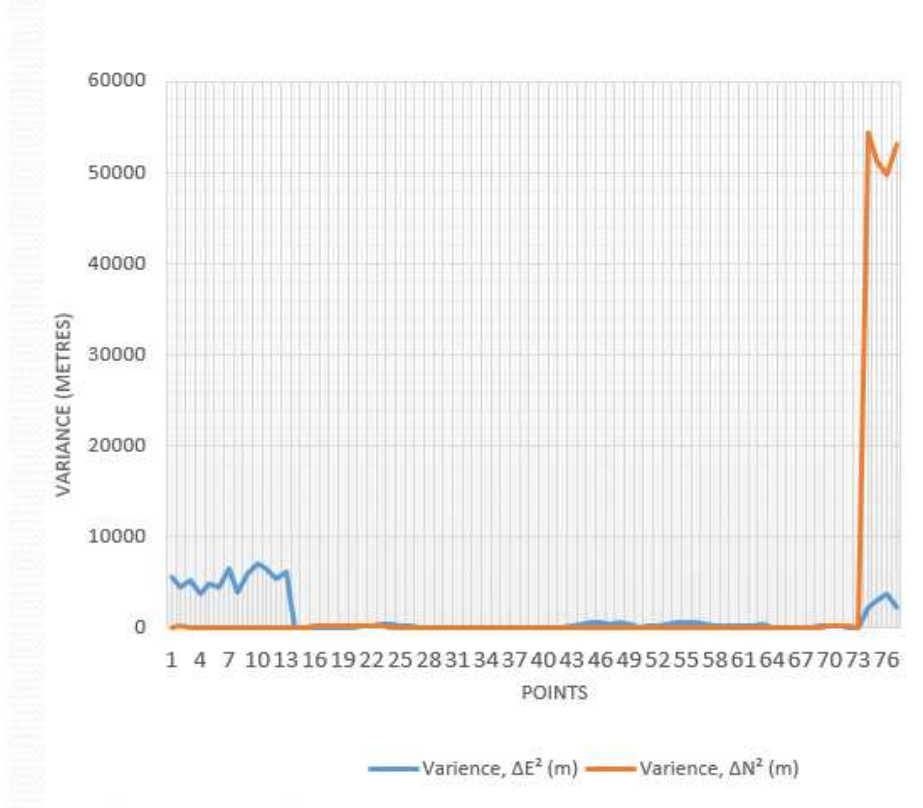


Figure 10 A Graph Showing Variances in the implementation of PS



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Results and Discussions Cont'd

Geospatial assessment (Positional Accuracy) of PS:

- ❖ The results reveals that average residuals of -2.272 m and 16.911 m for Eastings (E) and Northings (N) respectively;
- ❖ and standard deviations of ± 35.240 m and ± 53.152 m for E and N respectively affected the positions of parcels of land in the PS of the TA;

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Geomatics Society of Ghana
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Results and Discussions Cont'd: Proposed Revision to PS

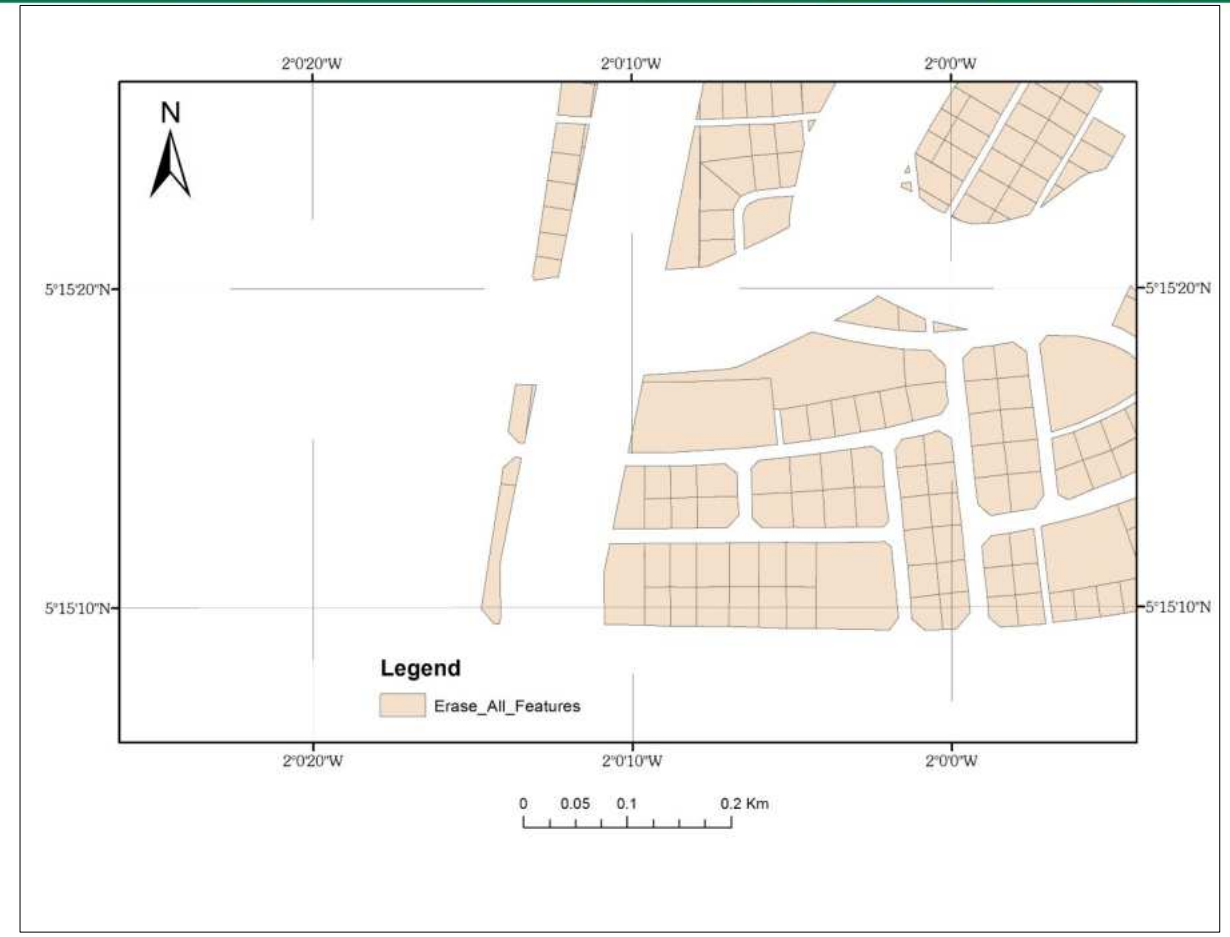


Figure 11 Map of Suitable Area to be used as basis for Revision Planning



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Results and Discussions Cont'd

The Proposed Revision to PS

- ❖ The map of suitable areas could be used as basis for revision of the PS;
- ❖ It ensures that the buffers for roads, rivers, power transmission lines, masts, telecommunication lines etc. are;
- ❖ adhered to bring sanity in the development of the area.

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Conclusions

It is concluded that:

- ❖ It is concluded that a geodatabase has been developed for 7 546 parcels of land and provides vital information on these parcels of land for the TA;
- ❖ It is also concluded that the PS of the TA has been geo-spatially assessed and standard deviations of ± 35.240 m and ± 53.152 m for E and N respectively;
- ❖ It is concluded that the geospatially assessed map could be used as basis for revision of the PS.

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Recommendations

It is recommended that:

- ❖ Spatial Planning Units of the various MMDAs should convert all PS to digital format;
- ❖ After Planning the Surveyor must implement the PS, collect data on the implemented PS, Plot it and submit back to the Planners to the come out with the final PS;
- ❖ Revisions be made on PS every 5 years;

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Commission

Commission's name

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