

# **DIGITAL SURVEYING - THE SOLUTION TO BOUNDARY SURVEYING AND LAND REGISTRATION ISSUES IN GHANA.**

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**Keywords:** Continuously Operating Reference Station (CORS), Geogenie Technology, Global Navigation Satellite System (GNSS), Land Registration, Precise Point Positioning

## **Abstract**

In Ghana, there are so many land disputes in the country but when each is studied critically it will be realized that it eventually goes down to the boundaries between the major land-owning groups. The history of the original acquisition of land has not been well documented. They are passed on by generations through oral transmission. The transmission of information is highly dependent on the human factor. Since memory fades and people die vital information such as the boundaries of the land was lost because there wasn't a way to determine the exact line that shows where the land begins and ends. They used relief features such as trees, water bodies, and other natural land features as indicators showing the boundaries of a piece of land. Since water bodies such as rivers can dry up and trees can be cut down, determining where the land boundaries are, is becoming difficult because the indicators that were used to show the boundaries are no more and the people who could determine the land stretch are also no more. Also, some boundaries were shown through paper sketches but since there wasn't any grid system, sketches did not show the actual ground boundaries.

This paper looks at a future where the boundary surveying and land Registration system of Ghana will have no problem showing the exact boundaries of a piece of land and help reduce, if not completely eradicate land disputes in Ghana with the introduction and use of Digital Mapping (Using the Geogenie Technology and Continuously Operating Reference Station (CORS) Network) to create a digital cloud-based database which gives real-time ground coordinates where a surveyor can upload coordinates unto to tablets and with the use of Geogenie on the field, The surveyor can determine if the coordinates match the ground location and will also know of any development that has been done on the land since Ground information will be stored and updated frequently on the Cloud database.

## **Introduction**

According to United Nations Economic Commission for Europe (1996), land administration refers to the process of recording and disseminating information about the ownership, value, and use of land and its associated resources. It includes the determination (sometimes known as the adjudication) of rights and other attributes of the land, the survey and description of these, their detailed documentation,

and the provision of relevant information in support of land markets. In Ghana) inefficiencies in the land administration and management system land dispute cases are on the rise. Early arguments on land disputes and conflict are mainly attributed to improper documentation of the original land arrangements. Plan of lands were not annexed, boundaries were not properly surveyed, unclear demarcation and lack of accurate documentation in most cases. The original boundaries of lands tend to be unclear with various internal and external developments including new settlements. Land ownership over the years have been threatened by the lack of reliable information on land in the past, leaving room for boundary and ownership conflicts among families, kinsmen, and chiefs (Boafo-Anang *et al.*, 2021). Land disputes have become a major problem in the management of lands in Ghana. Land cases constitute about 59% of total cases in court. Meanwhile, the average increase of land cases per year is about 25% whereas the rate of settlement is as low as 10%. This has created a lot of fear and panic in the land enterprise and its allied industries (Gyamera, 2016). Land disputes over the years have had detrimental effects on individuals and the economy at large. Huge sums of money are being wasted in settling land disputes. Projects that could create several employments and boost the economy are left handicapped due to the strenuous nature of land disputes. Most land disputes boil down to the fact that, the exact coordinates enclosing a piece of land or separating one land from another are not accurately ascertained. Hence, people end up using other people's lands while others end up registering portions of other people's lands as a part of theirs. Land boundary demarcation is increasingly becoming one of the major sources of land disputes in Ghana.

## Research Problem

The Land Title Registration Act, 1986 P.N.D.C.L 152 Section 23 to 26, clearly shows how important it is to know the demarcation or boundaries that surround a parcel of land before you can be granted any form of ownership title on a parcel of land in Ghana. One major challenge faced by the land Registration system in Ghana, is the inability to accurately determine the exact boundaries or demarcations that enclose a parcel of land. This has resulted in a lot of land dispute cases in Ghana. The difficulty in determining (accurately) the exact coordinates which enclose a piece of land dates way back to the 1900s, when chiefs and Family heads were the major custodians of Lands in Ghana. During that time, the idea of surveying was not well known. Relief features such as trees and river bodies were used as references to show the demarcations of a parcel of land. With time, the previous custodians die along with some referenes. Trees get chopped down and rivers dry up. Owners of these lands find it difficult to know the boundaries or demarcations that surround their lands. This development makes registration of their lands problematic. In an attempt to get a pictorial bird's eye view of a parcel of land, draft men decided to sketch on a piece of paper. However, the problem with this was, since there were no grid lines during those times, sketches didn't correctly depict the actual situation on the ground. Currently, the land registration system is faced with finding means and ways to determine the exact boundaries in order to drastically reduce land disputes in Ghana.

## Research Objectives

This paper demonstrates a digital solution to selected boundary demarcation issues with the use of GNSS CORS Network, and Geogenie software to know the exact coordinates that form the boundary of every parcel of land using Precise Point Positioning (Real Time Kinematic) method.

## Geogenie Software

GeoGenie is cloud-based and browser-based platform that connects field survey collection and the office complementary activities. All collection and drawing of maps is been done directly in on the field, creating real time and complete database.

Every user/organization receives an integrated tailored application with workflows adjusted to his direct needs,survey data collection and the corresponding database attribution.

Imports and exports CAD and GIS data into the system works natively with AutoCAD and ESRI datatypes.

GeoGenie works with all classic surveying equipment like GNSS, total stations and scanners. GeoGenie is capable of centrally showing/monitoring all field data collectors to office stockholders. The software can be altered by the users by writing short scripts that change workflows to suit field and office forms and creates smart forms and queries in order to tailor organization activity.

GeoGenie has an extensive adjustable/programmable querying and reporting module enabling organizations to analyze automatically all collected data. It's full flexible user hierarchy model enable users to set roles and rules to different users.

GeoGenie is the combination between professional surveying application, tailored information system and Enterprise Resource Planning (ERP) capable to support any local language and customisable to the workflow requirement of the client. Figure 1.1 shows the interface of the Geogenie Software platform with google earth basemaps for mapping.

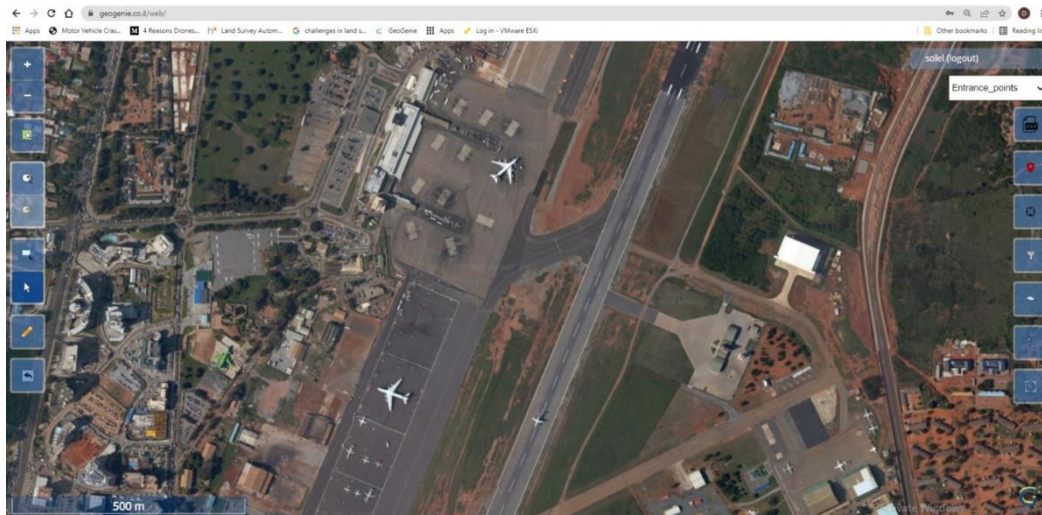


Fig 1.1: Geogenie platform with Google Earth Basemap and editable interface

## Overview of Boundary/Cadastral Information in Ghana

Boundary information in Ghana is obtained through cadastral surveys and regulated by the Survey Act 127 of 1962. The Act mandates official and Licensed surveyors to undertake boundary and other surveys. The Act also requires that all survey conform to the technical instruction published by the Survey Department and enacted by Legislative Instruments (LI) 1444 of 1989. This legal document requires an official or licensed surveyor to submit all field records, method of observation and computations to the Director of Surveys for checking and approval for use in land registration.

Issues of boundary demarcation between customary land owners primarily account for land disputes in Ghana. These issues requires the need to systematically identify, demarcate, survey and register boundaries of land owners. The activity will minimize disputes from indeterminate boundaries, establish certainty of land ownership and interest in land tenure, and enhance the registration of land. It also promotes quality land administration, spatial data infrastructure development, and enhances the overall information systems development.

## Traditional Surveying Methodology

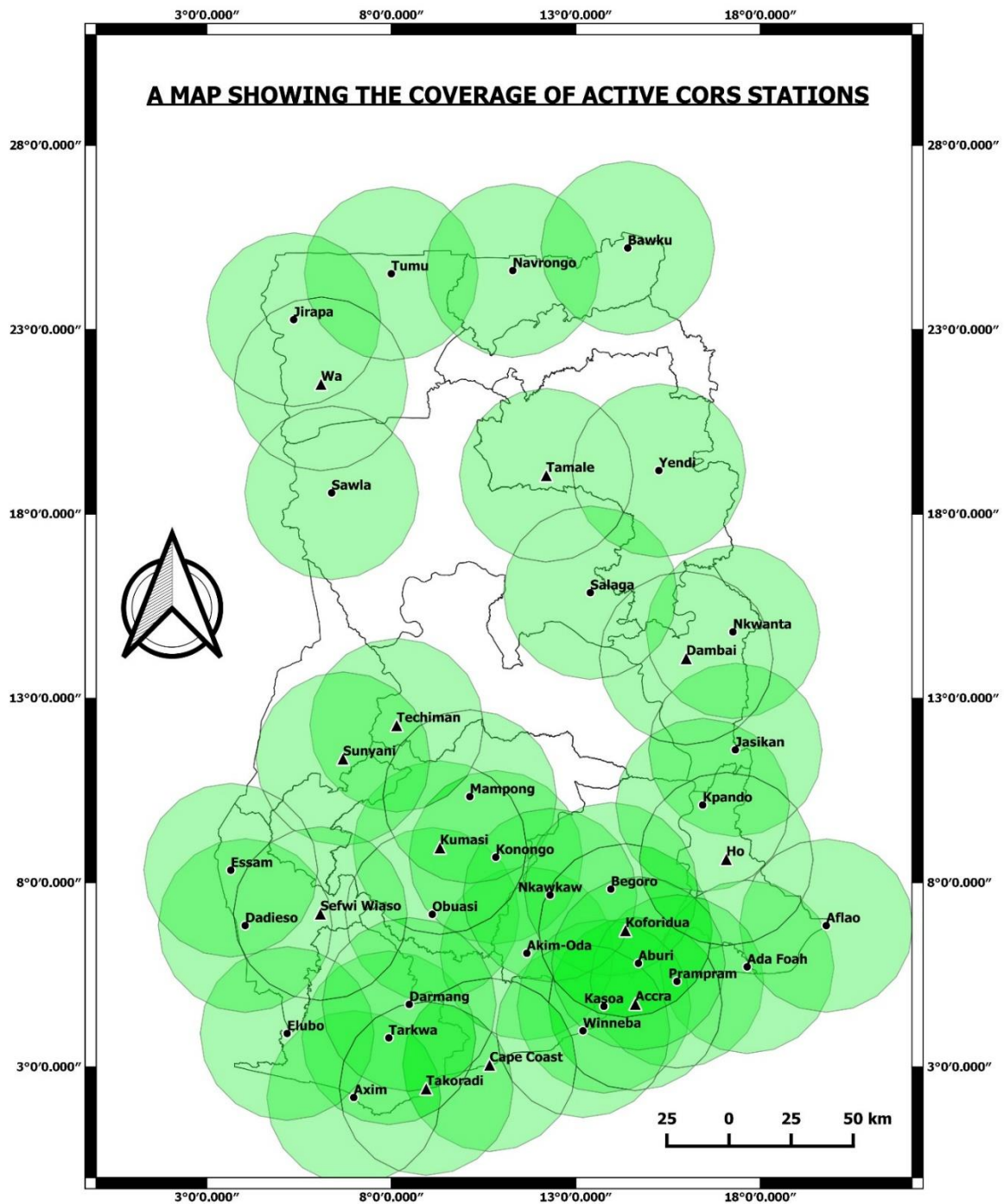
The principle of traditional boundary demarcation requires the use of a set of GNSS instruments and survey pillars with already determined coordinates. The base station is set up and the corners of the boundary observed with the other instruments/rovers. The survey is closed on another known survey pillar and the

data downloaded for post processing. This method notwithstanding the wide use is associated with some challenges such as, inability of base and rover(s) to establish connection, risk of base theft and GNSS data loss and costly operational logistics relating to labour and equipment.

## GNSS CORS Network

Spatial data infrastructure in Ghana has witnessed advancement over the years. The establishment of GNSS COR Network in the country strengthens the conduct of geospatial activities and reduces the risk presented by conventional GNSS based approach. GMX Systems Limited in collaboration with Geo-tech Systems have established the largest operational network of COR Network in the country. The network has real time capabilities, employs Virtual Reference System (VRS) technology and supports static data in RINEX formats for post processing applications. The network is fully operational with coverages across all the regions and serving agencies and institutions such as Ghana Water Company Limited, National and Regional Survey Department, private entities and other individuals in the engineering disciplines. In addition to the realization of quality SDI, the network promotes simplified operational approach and a cost effective method in terms of cost and labour. Figure 1.1 shows coverage of active CORS within the country established by the collaboration between GMX Systems and Geotech Systems Limited.

# GHANA NATIONWIDE GNSS CORS NETWORK



**PROMOTED BY**

**GEO-TECH SYSTEMS LTD.** **Geo-Tech Surveys Limited** **GVX Systems Ltd.** **Etkes**

**PARTNERED BY**

**GHANA WATER COMPANY LIMITED** **LAND COMMISSION SURVEY AND MAPPING DIVISION**

**LEGEND**

- ▲ Regional Capital With CORS Stations
- Installed Locations.
- Union
- Ghana\_Shapefile\_(New)

Digital Surveying - The GNS Solution to Boundary Surveying and Land Registration Issues in Ghana (11735)  
 Stephen Djaba, Otoo Ebenezer and Owusu-Ansah Daniel (Ghana)

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# Digital Surveying Methodology

The adopted methodology for the boundary survey is conducted with GNSS COR station and cloud based Geogenie Software. The corners of the plot were surveyed with the Geogenie GNSS with the CORS as base in real time. These mapped coordinates and other geo-information were then stored in the cloud. These spatial data stored on the cloud based system can be accessed anytime the data is needed without having to go through rigorous search at the Survey and Mapping Division of Lands Commission in later years. Table 1.1 shows a field study to ascertain the horizontal and vertical precisions of some selected corners of some boundaries for checks with static processing with the survey and mapping division of Lands Commission.

Name	Northing	Easting	Solution	RMS error	X Precision	Y Precision	Horizontal error	Vertical error
1	326076.2921	1188363.506	Fix	0.0964	0.0594	0.0444	0.0741	0.1208
2	326115.5511	1188452.12	Fix	0.0856	0.0596	0.0409	0.0723	0.103
3	326117.027	1188429.116	Fix	0.07	0.0386	0.045	0.0593	0.0841
4	326052.8101	1188393.336	Fix	0.0797	0.0403	0.0477	0.0625	0.0992
6	325523.4201	1188555.298	Fix	0.0951	0.0404	0.0763	0.0863	0.11
7	334152.6519	1197061.962	Fix	0.0655	0.0369	0.0367	0.052	0.0811
8	334148.2384	1197054.842	Fix	0.06	0.0339	0.0344	0.0483	0.0739
9	334152.7837	1197061.897	Fix	0.0643	0.0367	0.0354	0.051	0.0796
10	334251.3157	1197030.433	Fix	0.063	0.0367	0.0352	0.0508	0.0775
11	334303.3027	1196994.798	Fix	0.0616	0.0335	0.0328	0.0469	0.0775
12	334356.4616	1196953.882	Fix	0.0647	0.0361	0.0346	0.05	0.0809
13	338163.1224	1199038.765	Fix	0.0881	0.0546	0.0481	0.0728	0.1072
14	338122.6647	1199056.066	Fix	0.1114	0.0737	0.0562	0.0927	0.1349
15	338083.4238	1199054.919	Fix	0.1126	0.0672	0.0568	0.088	0.1403
16	338045.6745	1199053.704	Fix	0.0952	0.0585	0.0567	0.0815	0.1137
17	338017.9977	1199053.333	Fix	0.1031	0.0601	0.0641	0.0879	0.1236
18	337935.4726	1199050.297	Fix	0.0978	0.0525	0.0776	0.0937	0.109
19	337892.1801	1199049.375	Fix	0.1029	0.0494	0.0909	0.1035	0.1103
20	337849.4136	1199042.665	Fix	0.0959	0.052	0.0705	0.0876	0.1105
21	337835.7974	1199028.814	Fix	0.0902	0.0488	0.069	0.0845	0.1023
25	337859.0032	1198813.397	Fix	0.2019	0.1025	0.0617	0.1196	0.2717
26	337891.2938	1198738.617	Fix	0.1094	0.0548	0.0489	0.0735	0.1431
27	337958.8058	1198648.897	Fix	0.1141	0.0667	0.0588	0.089	0.1422
28	338041.3177	1198581.485	Fix	0.0853	0.0509	0.0463	0.0689	0.1048
29	338162.8508	1198553.419	Fix	0.0841	0.047	0.044	0.0644	0.1056
30	338294.2397	1198600.653	Fix	0.1154	0.0608	0.0723	0.0944	0.141
31	338392.4989	1198694.771	Fix	0.1198	0.0739	0.0445	0.0862	0.1536
32	338365.259	1198757.839	Fix	0.0931	0.0533	0.0392	0.0662	0.1198
33	338307.3732	1198824.013	Fix	0.0872	0.048	0.0453	0.066	0.1099
34	338271.9409	1198863.105	Fix	0.0863	0.051	0.043	0.0667	0.108
35	338219.3163	1198926.231	Fix	0.0918	0.0592	0.0598	0.0841	0.1056
36	338185.4787	1198986.312	Fix	0.0825	0.0494	0.0473	0.0684	0.1002
37	338170.6268	1199025.98	Fix	0.0775	0.0484	0.0428	0.0646	0.0939

## Conclusions and Recommendation

GNSS CORS coupled with the Geogenie software has been studied in a Ghanaian environment for the possibility minimizing problems associated with static and post processing surveys. The infrastructure provides a relatively accurate method of obtaining data, and additional advantage of cloud storage for future reference and data loss prevention.

The horizontal precision, main parameter of interest in boundary surveys of the COR Network conformed to the standards of survey and mapping laid down by the survey and mapping division of Lands Commission

There is the need for public and private patenrship to further explore the various opportunities by introducing this concept to the local market and learn how this system can add value to business and provide innovative and cost effective methods in the survey market.