# ACHIEVING UNIFIED COORDINATES SYSTEM IN OYO STATE USING CONTINUOUSLY OPERATING REFERENCE STATIONS (CORS)

**[1]LASISI, K. O., [2]ANIFOWOSE, O. I. AND [3]YUSSUFF, O. N.**
[1]Department of Urban and Regional Planning, the Polytechnic, Ibadan, Nigeria. [2]Department of Civil Engineering, the Polytechnic, Ibadan, Nigeria. [3]Department of Mechanical Engineering, the Polytechnic, Ibadan, Nigeria

**ABSTRACT**
In Nigeria, it is often difficult to achieve the same coordinates system and station adjustment during field observation and computations on the same reference Ground Control points (GCPs) using different modes of GPS. Diverse references such as National Origin, Local Origin and Universal Traverse Mercator (UTM) are adopted by different surveyors. Inability of surveyors to achieve a unified coordinates system and establish common station adjustments at different epochs introduce errors within a network of survey controls. Using two GPS receivers in differential or absolute precise point positioning is prone to various types of inconsistencies. This paper therefore focuses on comparison of coordinates using Single and Dual Frequency GPS receivers with Nignet Continuous Reference Stations (CORS) of the controls on XN07(FSS), Y1 (Koso (Hill), Y2 (Erelu Hill), Y3 (Bosero Hill), Y4 (Akube Hill), Y5 (Ikolaba Hill), Y6 (Owinni) and L11 (Agidan Hill), all in Oyo, Oyo State. CORS are established as the primary infrastructure to support user needs for real-time, centimetre level positioning accuracy requirements. The study involves office and field recconaisance, data acquisition using single and dual frequency Global Positioning System, downloading of data, transformation of data to UTM coordinates projection system and processing of the coordinates with Nignet Continuous Reference Station (CORS). The final results were presented in tables. In conclusion, this research has identified the best frequency receiver device that will give the reliable accuracy coupled with the COR Stations' consideration. The best result can then be recommended for use in any GPS observation exercise that will gradually bring about the unification of Nigeria reference system.

**Keywords**: Coordinates Systems, CORS, Global Positioning System, Epochs, Controls

## INTRODUCTION
Barry (2010) defined surveying as the art and science of taking field measurements on or near the surface of the Earth. Survey field measurements include coordinates, horizontal and vertical distances, horizontal and vertical angles to mention but just a few. In addition to measuring

distances and angles, surveyors can measure position as given by the northing, easting, and elevation of a survey station by using satellite-positioning and remote-sensing techniques. In addition to taking measurements in the field, the surveyor can derive related distances and directions through geometric and trigonometric analysis.

Surveying, which has recently also been interchangeably called geomatics/geoinformatics has traditionally been defined as the science, art, and technology of determining the relative positions of points above, on, or beneath the Earth's surface, or of establishing such points. In a more general sense, however, surveying (geomatics) can be regarded as that discipline which encompasses all methods for measuring and collecting information about the physical earth and our environment, processing that information, and disseminating a variety of resulting products to a wide range of clients. Surveying has been important since the beginning of civilization while its earliest applications were in measuring and marking boundaries of property ownership. Throughout the years its importance has steadily increased with the growing demand for a variety of maps and other spatially related types of information and the expanding need for establishing accurate line and grids to guide construction operations. Surveying has transformed over year from the use of analogue equipment to such as compass, theodolite, plane tabling among others to sophisticated equipment such as total station, scan station, smart station and GPS using online real-time applications like CORS stations.

The history of the Continuously Operating Reference Stations (CORS) system can be traced to the National Oceanic and Atmospheric Administration's (NOAA's) National Geodetic Survey (NGS). The mission of NOAA is to define, maintain and provide access to the U.S. National Spatial Reference System (NSRS) (Fuller et al, 2005). The aim of which was to enable the civilian users to determine geodetic latitude, longitude and height, plus orthometric height, geopotential, acceleration of gravity, and deflection of the vertical at any point within the United States and its territories.

Office of the Surveyor General of the Federation (OSGoF), which is the National Mapping Agency of Nigeria, initiated in 2008 a project to establish NIGNET (Nigerian GNSS Reference Network). This network is formed by state-of-the-art Continuously Operating Reference Network). This network is formed by state-of-the-art Continuously Operating Reference Station (CORS). In fact, the first motivation to implement NIGNET was to contribute to the African Reference France (AFREF) project in line with the recommendation of the United Nation Economic Commission of Africa (UNECA) through its Committee on Development, Information Science and Technology (CODIST). At national level, NIGNET is expected to serve primarily as the fiducial network that will define and materialize a new reference frame based on space-geodetic techniques and linked to AFREF. Currently, NIGNET is formed by CORS stations covering the entire country. The selection of the locations was carried out considering different theoretical and practical criteria. NIGNET will be also used for future densifications of the CORS networks in Nigeria at state level plus the Federal Capital Territory, Abuja. This is one major reason why the CORS has gained ground globally and Nigeria in particular in the last couple of years.

## STATEMENT OF THE PROBLEM

In Nigeria, it is often difficult to achieve the same coordinate system and station adjustment during field observation and computations on the same reference Ground Control Points (GCPs) using different mode of GPS. The fact is that diverse references such as National Origin, Local Origin and Universal Traverse Mercator (UTM) are adopted by different surveyors. Inability of surveyors to achieve a unified coordinate system and establish common station adjustments at different epochs introduces errors within a network of survey controls. Using two GPS receivers in differential or absolute precise point positioning is prone to various type of inconsistencies. Therefore it becomes imperative to develop and install some permanent GNSS operating stations mounted on stable platforms across a wide area, which acts as the reference or base stations for stand-alone rovers or receivers within the coverage area of the transmitted signals from the CORS and to enable accurate positioning relative to the NSRS.

The need to harmonize various reference origins by surveyors using the control stations in Oyo state becomes imperative. This study is highly necessary to establish a common coordinate system on our Ground Control Points and also to ascertain the degree and reliability of either the single or dual frequency GPS when compared side by side with existing coordinates of CORS in carrying our survey works. The use of CORS will go a long way in the improvement of the survey works as well as solving problems of non-availability of controls near the working area and or poor distributing control network. It is believed that the consistency and accuracy associated with NIGNET will be better off than the actual or existing network. In order to actualize the aim of the paper, the objectives pursued were to: take series of observations on each of the control points using the single and dual frequency GPS; capture data from NIGNET with regards to time of observation on website; download the acquired data from the GPS for processing purposes and analyze the data and compare the results.

The aim of this paper is to establish a unified coordinate system on Ground Control Points (GCPs) and test the reliability of both the single and dual frequency GPS by comparing the observational results taken from the XSN07 (FSS. Oyo), L11 (Agidan Hill), Y1 (Koso), Y2 (Erelu Hill), Y3 (Bosero), Y4 (Akube Hill), Y5 (Ikolaba Hill) and Y6 (Owini Hill) with that of (NIGNET) Continuously Operating Reference Station (CORS).

## BRIEF DESCRIPTION OF THE STUDY AREA

The geographical extent of the area under study covers parts of Oyo East, Oyo West and Atiba Local Government Areas of Oyo state. It was observed that all the triangulation points were well established on rocky points at the peak of the hills. Most of these points fell within Oyo West L.G.A. while Owinni hill (Y6) and Federal School of Surveying, Oyo are located at Atiba

L.G.A. and Oyo East L.G.A. respectively as shown in figure 1.1. The study area is located in Oyo State and lies between latitudes 7°49′48′′N and 7°54′36′′N and longitude 3°52′48′′E and 3°57′00′′E.

**REVIEW OF RELEVANT LITERATURE**

Recent developments in surveying and mapping equipment have now evolved to the point where the traditional instruments that were used until about the 1960s or 1970s the theodolite, dumpy level, and steel tape have now been almost completely replaces by an array of "high-tech" instruments. These include electronic Total Station instruments, which can be used to automatically measure and record horizontal and vertical distances and angles as well as Global Navigation Satellite Systems (GNSS) such as the Global Positioning System (GPS) that can provide precise location information for virtually any type of survey.

GPS receivers collect signals from satellites in view and display the user's position, velocity and time, as needed for their marine, terrestrial, or aeronautical applications. Some display additional data, such as distance and bearing to selected Waypoints or digital charts. The GPS concept of operation is based upon satellite ranging. Users determine their position by measuring their distance from the group of satellites in space. The satellites act as precise reference points.

Each GPS satellite transmits an accurate position and time signal. The users' receiver measures the time delay for the signal to reach the receiver, which is the direct measure of the apparent range (called a "pseudo range", to the satellite. Measurements collected simultaneously from four satellites are processed to solve for the four dimensions of position (latitude, longitude, altitude and time). Position measurements are in the Worldwide Geodetic Reference System (WGS-84), and time is with respect to U.S. Naval Observatory Time (USNOT) reference.

GPS satellites transmit at two L-band frequencies. The L1 frequency is set at 1575.42 MHz. The L1-band carries the C/A code (civilian), P code (military), Y code (anti-spoofing code), and the navigation message that includes clock corrections and orbital data. The L2 frequency is set at 1227.60MHz. The L2 band carries the P and Y codes only. The GPS can be used to determine position in Differential (DGPS) mode or in single mode. Using any of the modes, position can be determined while the receiver is stationary (static) or while it is moving (Kinematic).

The United States announced in early 1999 its intention to modernize the GPS system and to add two additional civilian signals on the next generation of satellites. The second civilian signal (L2C) was added in 2005 (PRN17) and 2006 (PRN31 and PRN12 to the Block I1R-M satellites. A third civilian signal, called L5, was included on the new Block IIF satellites that was in 2009. This new civilian signal transmits on a frequency of 1,176.45 MHz. Once the modernized constellation is complete, the addition of these two new civil signals will make positioning faster and more accurate under many measuring conditions and will make the GPS system comparable with the proposed Galileo system for civilian applications. Eventually, expanding Block II satellites in V the constellation consisting of more advanced Block III satellites will gradually replace the present GPS system. Some believe that the completed constellation of L2C and L5 capable satellites, as well as the proposed Block III satellite constellation (which may include the fourth civil signal called L1C), is still many years away.

There are several types of GNSS receivers, which can utilize the multiple signals available from several different constellations; dual-frequency receivers, which can observe and process the multiple signals from the GPS constellation; and single-frequency receivers, which can observe only the band. In precise surveys, GNSS and dual-frequency receivers are preferred for several reasons: they can (i) collect the needed data faster; (ii) observe longer baselines with greater accuracy; and (iii) eliminate certain errors, such as ionospheric refraction, and therefore yield higher positional accuracies. Receivers also vary by the number of channels. This controls the number of satellites that they can track simultaneously. As a minimum, carrier phase-shift receivers must have a least four channels, but some are capable of tracking as many as 30 satellites from the GPS, GLON4SS, and Galileo constellations simultaneously using multiple frequency bands resulting in more than 60 channels. These receivers provide higher accuracies due to the increased number of satellites and increased strength in satellite geometry. The major differences in the receivers are the number of channels available (the number of satellites that can be tracked at one time) and the condition whether or not the receiver can observe both L1 and L2 frequencies and measure both code and carrier phases.

Genera1ly speaking, the higher-cost dual-frequency receivers require much shorter observation times for positioning measurements than do the less expensive single-frequency receivers and can be used for real-time positioning. Some low-end general purpose GPS receivers track only one channel at a time (sequencing from satellite to satellite as tracking progresses). An improved low-end general-purpose receiver tracks on two channels, but it still must sequence the tracking to other satellites to achieve positioning.

Single frequency receivers have the obvious weakness in that it takes longer to resolve integer ambiguities at the beginning of an observation session and after a cycle slip, compared to dual frequency receivers. Typically for Li data it can take anything up to 30 minutes (Sharpe 1999), whereas, for dual frequency receivers, this is reduced to under a minute in most cases. Some processing software does not even attempt to resolve integer ambiguities OTF for single frequency receivers. Leica Geosystems' Ski-Pro is one example of software that will not process single frequency data in an OTF manner. GPS which reached Full Operational Capability (FOC) July 17, 1995 as allowed by the U.S. Policy and Law provides two levels of services:

- A Standard Positioning Service (SPS) for general civil use; and
- A Precise Positioning Service (PPS) primarily for military and precise geo-intelligence services.

The GPS Standard Positioning Service (SPS) is available as intended for use by the Department of Defense and U.S. allies to civil users worldwide for their navigation, scientific, and other uses free of direct user charges. The GPS satellites operate in circular 20,200km 12-hour orbits at an inclination of 55 degrees. They are not in geo-stationary orbit.

Ezeigbo (1990) suggested the need to transform co-ordinates derived with GPS to that of the Local Reference Ellipsoid for such to be useful for local use. The Z-axis coordinate (vertical) coordinate is not desirable for vertical movement analysis in Nigeria. This is as a result of the unreliability of the derived geoidal undulation in Nigeria. The geoidal heights of L40 in Minna agree with the orthometric height of L40, therefore, it is not possible to ascertain the fit of this datum to the geoid in Nigeria. Due to the unreliable vertical coordinate obtained from the GPS the geodetic leveling technique was applied using geodetic digital level. It is considered to be more accurate for height determination than other methods.

According to Ray *et al*, (2007) The National CORS system is rapidly becoming the preferred method for accurate 3D positioning in the United States and abroad. The advantage to GPS practitioners is that they only need to deploy one GPS receiver and download corresponding CORS data via the Internet to process these data in differential mode. The Web-based utility, UFCORS has made such downloads easy. As part of the CORS project, NGS is working with scientists around the world to develop digital models and techniques that will enable GPS users to determine accurate positions economically and in a timely manner.

Ojigi *et al* (2011) gave the following conditions for CORS Network Observations: Centering an instrument over the station mark is always important. However the centimetre-level accuracy gives the centering of the antenna special significance. A tribrach with an optical plummet or any other device used for centering should be checked and, if necessary, adjusted before the observation begins. With good centering and leveling, an antenna should be within few millimetres of the station mark. The measurement of the height of the antenna in a GPS survey is often not made on a plumb line. A tape is frequently stretched from the top of the station monument to the reference mark on the antenna. The tape reading is recorded.

CORS operations require its receiver operators to keep a careful log of each observation. The process begins with the CORS as the control, while, one or more roving receivers occupying stations with unknown coordinates and simultaneously observing to four or more satellites for a time period depending on the baseline length. Longer baseline requires greater observing times. Data are stored in the internal memories or data card inserted into the receiver for post-processing various types of observation methods can be applied. These include the following:

**a. Static Relative:** The minimum observation period for baselines less than 10km should be in excess of 30 minutes. The recording rate should be 15 or 30 seconds. The satellite geometry should change significantly during the observation session At least four, but preferably as many satellites as possible should be common to all survey sites simultaneously occupied. Dual frequency receivers are preferred however; single frequency receivers may be used for short lines for non-high precision applications. It is essential that the carrier phase ambiguities are constrained from lines less than 15km.

**b. Rapid Static:** Enough data should be collected to resolve ambiguities. The manufacture's recommendations should be consulted on relation to the lengths of-observation periods, number and geometry of satellites and suitability of single or dual frequency Dual frequency receivers are preferred. Multipath can be a significant source of errors, particularly when short occupational times are used and special attention should be paid to this issue. The recording rate varies between 5 to 15 seconds.

**c. Stop and Go Kinematic:** Five or more satellites should be observed. Receivers should be initialized per manufacture's recommendations. Each point should be occupied in a different session with different satellite geometry. The recording rate should be between one and five seconds. Multipath can be a significant source of errors, particularly when short. Occupational times are used and special attention should be paid to this issue. Single frequency receivers may be used although dual frequency receivers are preferred.

**d. Real Time Kinematic (RTK):** Dual frequency geodetic quality receivers are preferred, although single frequency can be used. The typical range for RTK surveys is up to 15 km, although meeting required accuracies may limit this range to 10 km. Precision .claimed by most manufacturers is 10 mm plus 2 ppm or better. Real time update may vary according to the application Ambiguities must be resolved for all occupations. Multipath can be a significant source of errors, particularly when short occupational times are used and special attention should be paid to this issue. To allow sufficient change to the satellite constellation being used and improved detection of errors such as multipath, re-occupations should be made more than 45 minutes apart and with independent ambiguity resolution.

Remondi, B.W et al (2002), stated that in order to ensure the accuracy of land record systems as well as natural resource, communication, transportation, and other mapping projects, it is essential to have a consistent coordinate system. Santerre, R. (2007), stressed the importance of Least Square Adjustment in Static Control Points Survey suggested that Least Square is a powerful statistical technique that may be used for adjusting or estimating the coordinates, in survey control networks. The term adjustment is popularly used but does not give any proper statistical means of analyzing coordinates. However, a better term used conventionally, is called Least Square Adjustment.

## Installation steps for GNSS CORS

Ojigi, et al (2011) provides the installation steps for GNSS CORS as follows:

i. If it is to be on a building, it must be installed on a pillar that ran from the foundation with reinforcement iron.

ii. There must be a connection from the antenna installation base plate to the reinforcement iron that ran from the foundation.

iii. If it is on a stable ground, it must be dug at least 2m with reinforcement iron properly fixed and cast to make a monument.

iv. Before the installation of the antenna, the plate must be properly leveled.

v. The antenna is installed and connected using the cable provided by the manufacturer to the receiver in the rack.

vi. Since the stations must be up for all year round then there must be need for an alternative power supply e.g a solar system is provided as a backup.

**Field Procedures in CORS Operations**

i. **Planning:** Small GPS surveys generally do not required much in the area of project planning. However, for large projects, and for high-accuracy surveys, project planning is a critical component in obtaining successful results.

ii. **Existing Control:** One of the first thing that must be done in planning a new project is to obtained information on the availability of the existing control (CORS) stations near the GPS project site. For planning purposes, this should be plotted in their correct locations on an existing map of the aerial.

iii. **Rover Station:** The roving station should be within the radio radius of the CORS in the given area (e.g.) 500km, 300km, 150km, 100km, 50km, etc.). Please. For real-time applications, the reference station transmits differential corrections due to biases arising from ionospheric delay, tropospheric delay, and satellite clock offset from GPS time, to all users in the coverage area of the reference station (CORS). Users incorporate these corrections to improve the accuracy of their position solution. For the basic local area DOPS .(LADG1S) the position solutions of users further away from the reference station are less accurate than those closer to the monitoring station because pseudorange measurement errors tend to be spatially correlated. This loss of accuracy due to spatial correlation can be improved with more sophisticated techniques that fall under the heading of wide area DGPS (WADGPS) such as WAAS.

**iv. Sky Visibility:** As a minimum, it is recommended that visibility be clear in all directions from an altitude angle (mask angle) of 150 from the horizon.

**v. Observation Windows:** Selecting suitable observation windows is another important activity in planning the surveys. This consists of determining which satellites will be visible from a given station or project area during a proposed observing period. To aid in this activity, azimuth and elevation angles to each visible satellite can be predetermined by conputers from times within the planned observation period. The inputs for these are the station's latitude and longitude, date and time for the observation. Similarly, a relatively current satellite almanac is used. The result of this is called Multi-station Analysis: A multi-station analysis is carried out as the first step to determine the availability of the GPS satellites during observation sessions. This allows for checking simultaneous observation of the same satellite, the satellite elevation and the

Dilution of Precision (DOP). Low Geometry Dilution of Precision (GDOP) indicates strong satellite geometry with a higher possibility of accuracy.

**vi. Safety:** The high-visibility vest, cones lights, flagmen and signs needed for traffic control cannot be neglected in GPS work. Unlike traditional surveying operation, GPS observations are not deterred by harsh weather. Occupying station in a highway is dangerous enough under any condition. Equipment and plans to deal with emergencies should be part of any GPS project. First aid kits, fire extinguishers, and the usual safety equipment are necessary.

**vii. Station Data Sheet:** The principles of good field notes have a long tradition in surveying, and they will continue to have validity for some time to come. In GPS, the station data sheet is often an important bridge between on-site reconnaissance and the actual occupation of monument. Every organization develops its unique system of handling its field record; most have some form of the station data sheet. The data sheet can be prepared at any period of the project, but most time during the planning stage. Neatness and clarity, always paramount virtues of good field notes, are of particular interest when the station data sheet is to be later included in the final report.

**viii. Observation Using CORS:** In practice, field procedures employed on GPS surveys depend on the capabilities of the receivers and the type of survey. Some of the field procedures currently being used in surveying include the static, rapid static, kinematic, and real-time kinematic. All are based on carrier phase-shift measurements and employ relative positioning techniques; that is, two receivers occupying two different stations and simultaneously making observation to several satellites.

## MATERIALS AND METHODS

Methodology is a composite rules, procedure and postulates that are adopted for the successful execution of the project at various stages as office- planning, reconnaissance, data. capturing (i.e. field observations), office works such as data download, data processing, plotting, analysis and information presentation stage. In a nutshell methodology is the overview of the techniques and rules applied in executing the project work.

### Reconnaissance

This is the initial visit to the proposed project site. It involves the inspection of the sites to obtain the overall picture idea of the extent of work to be done, method to be adopted and the type of instrument to be use. It is paramount for any survey work/data collection exercise to carry out reconnaissance as it determines the success of the project. Two stages are involved in reconnaissance namely office and field reconnaissance. Reconnaissance is usually carried out because of these basic factors: Purpose of the survey, Required accuracy and Method of data acquisition.

**Office Planning**

Due to the nature of the project work which involved location of previously established control on hills around Oyo over a decade ago. The office planning becomes essential for the successful location of the controls and knowing the best route to ply in getting to each hill. The SIWES and practical office of the Federal School of Surveying, Oyo was consulted for the records of the stations coordinate values (i.e. E,N and H coordinates) and some instructions on how to navigate our way to the controls. The coordinates were converted to Universal Transverse Mercator (UTM) zone 31 Minna Datum using GEOCAL conversion software. The UTM coordinates was then log onto GOOGLE EARTH online to obtain the positions of the controls and the routes on the imagery. All these activities carried out only gave the researcher picture idea of the distance of each control to one another. Below are the list of coordinates collected from SIWES and practical office of Federal School of Survey, Oyo.

**Table 1: Coordinates of the Controls in NNO**

| Station Name | Eastings(m) | Northings(m) | Heights (m) |
|---|---|---|---|
| **FSS/XSNO7** | 170112.294 | 424788.610 | 309.972 |
| **Y1 (Koso)** | 166899.618 | 429267.020 | 319.976 |
| **Y2 (Erelu Hill)** | 162702.640 | 428509.142 | 290.441 |
| **Y3 (Bosero Hill)** | 165484.768 | 431587.500 | 304.188 |
| **Y4 (Akube Hill )** | 164100.226 | 429938.305 | 265.189 |
| **Y5 (Ikolaba Hill)** | 165963.533 | 435587.097 | 329.224 |
| **Y6 (Owinni Hill)** | 172225.593 | 429938.826 | 325.421 |
| **L11 (Agidan Hill)** | 163649.828 | 432047.807 | 354.083 |

Source: SIWES and Practical Office, Federal School of Surveying, Oyo.

**Table 2: Location, Longitude and Latitude of the Study Area**

| Location | Longitude | Latitude | Height |
|---|---|---|---|
| **FSS/XSNO7** | 70 50’ 32.78849 | 30 56’ 57.86968 | 309.972 |
| **Y1 (Koso)** | 70 52’ 58.52996 | 30 55’ 12.74737 | 329.224 |
| **Y2 (Erelu Hill)** | 70 52’33.64734 | 30 5255.70417 | 265.189 |
| **Y3 (Bosero Hill)** | 70 54’13.96616 | 30 54’26.39102 | 304.188 |
| **Y4 (Akube Hill )** | 70 53’20.20954 | 30 5341.27981 | 290.441 |
| **Y5 (Ikolaba Hill)** | 70 5624.20378 | 30 54’41.89164 | 354.083 |
| **Y6 (Owinni Hill)** | 70 53’ 20.62620 | 30 58’ 06.70567 | 325.421 |
| **L11 (Agidan Hill)** | 70 54’28.85230 | 30 53’26.45594 | 319.976 |

Source: SIWES and Practical Office, Federal School of Surveying, Oyo.

**Table 3: Converted Coordinates of Controls into UTM**

| Station Name | Eastings (m) | Northings (m) | Heights (m) |
|---|---|---|---|
| **FSS/XSNO7** | 604753.215 | 866889.923 | 309.972 |
| **Y1 (Koso)** | 601525.001 | 871356.996 | 319.976 |
| **Y2 (Erelu Hill)** | 597331.112 | 870584.130 | 290.441 |
| **Y3 (Bosero Hill)** | 600101.925 | 873672.199 | 304.188 |

| | | | |
|---|---|---|---|
| **Y4 (Akube Hill )** | 598723.437 | 872018.169 | 265.189 |
| **Y5 (Ikolaba Hill)** | 600566.219 | .877673.186 | 329.224 |
| **Y6 (Owinni Hill)** | 606848.199 | 872047.886 | 325.421 |
| **L11 (Agidan Hill)** | 598265.491 | 874125.858 | 354.083 |

**Source: GEOCAL Coordinate Conversion Software**

## Field Reconnaissance

The success of any project of this scope is strongly tied to the quality of the reconnaissance. The site was visited to have pictorial view of the project site. Sketching of reconnaissance diagram together with but not limited to the activities listed below was undertaken at this stage:

i. Location of the positions of all the existing ground control pillars.

ii. Making sure that all the stations have clear sky visibility on the hills.

iii. Familiarization with the natives.

iv. Easy and fare accessibility to the control pillars location.

## Data Acquisition

The ability to acquired genuine and relevant data is the bedrock of successful execution of any survey project. This process entails the actual field measurements and observations with the recording of the data on the field using the requisite instruments and adapting the most suitable method while bearing the project specifications and instructions to acquire data on the field in mind. Static method of global positioning system is employed in this project. Each station was occupied for period of 40 minutes.

## Equipment Used

The type of equipment used for a particular project will depend on the laid down specifications, which includes the accuracy required. Instrument accuracy regarded as the closeness to true value that is capable of being achieved by an instrument in the course of field observations. Bearing the foregoing in mind, the equipment listed below were selected and used for the project.

## Hardware

Leica System Dual frequency GPS receiver (1200); Megellan Promax Single Frequency GPS receiver; Hand Held GPS; Laptop- Dell Vostro (Vista- Pentium Dual-core); Printer — Hp Deskject 1280 and 2600 (A3 & A4 respectively); Cutlass; Prismatic Compass; SONY Camera; and Linen Tape (lOOm)

## Software

AutoCAD 2007, DATUM II Transformations, LeicaGeo-Office Combined, GNSS Solution, Microsoft Word, Hatinaka(crx 2mx).

## GPS Configuration

a. Mode of operation was configured in static mode
b. Reference coordinate system was configure inWGS84
c. The GDOP was within 1-3
d. Cut off angle was configure as $15^0$
e. Time zone was + l hour
f. Satellite tracking parameters was four satellites

## Test of Instruments

Of critical importance to successful field operation in surveying is the condition of the instruments. Consequently, it's imperative to test the equipment before taking them to field so as to ascertain their reliability. In order to know the condition of the instruments, instrument test were carried out on both the Leica GPS and ProMark3 GPS using the XSNO7 control pillar. The acquired data from the instruments test was downloaded using Leica Geo-office Combined (LGO) for Leica GPS 1200 while that of the ProMark3 GPS was downloaded using GNSS Solutions software.

The following were also checked before the above test was carried out on the GPS equipment's:

i. The batteries were confirmed to be well charged and in good working condition
ii. The connecting cable was used to connect the receiver and the antenna and confirmed that the ports and the cable were well connected
iii. There was prompt response as the stylus touches the screen of the instrument during the test run operation.
iv. Each pages of the Data logger displayed as required

However, tables 4 and 5 reveal the outcome of the tests.

**Instrument Test for Leica GPS 1200 series**

**Table 4: The transformed and observed coordinates of FSS 1/40/96 from XSN**

| STN | Northing (m) | Easting (m) | Height(m) | Remark |
|---|---|---|---|---|
| **FSS 1/40/96** | 867587.56 | 602592.846 | 296.964 | Observed |
| **FSS 1/40/96** | 867587.562 | 602592.838 | 298.365 | Given |
| | +0.002 | -0.008 | -1.401 | Discrepancy |

**Instrument Test for Magellan Premark's Instrument**

**Table 5: Transformed and Observed Coordinates of FSS 1/40/96 from XSN 07**

| STN | Northing (m) | Easting (m) | Height (m) | Remark |
|---|---|---|---|---|
| **FSS 1/40/96** | 867587.491 | 602592.851 | 297.899 | Observed |
| **FSS 1/40/96** | 867587.562 | 602592.838 | 298.365 | Given |
| | -0.071 | +0.013 | -0.466 | Discrepancy |

Based on the minimal discrepancy between the observed coordinates and the given coordinates, the result shows that the instruments are in good working condition.

**Control Check**

The control used for the project was XSNO7and the control check was carried out using Y3 BOSERO control. The reference receiver was set on XSNO7 and the roving receiver was mounted on the other control. The result obtained was compared with the coordinates received from our project supervisors. This confirmed that the pillars are in-situ. The results are listed below:

**Table 6: The Transformed and Observed Coordinates of FSS 1/from XSN 07**

| STN | Northing (m) | Easting (m) | Height (m) | Remark |
|---|---|---|---|---|
| **FSS 1/9** | 867219.502 | 604852.107 | 304.6585 | Observed |
| **FSS 1/9** | 867219.493 | 604852.112 | 304.6610 | Given |
| **Discrepancy** | -0.009 | +0.005 | +0.0025 | |

$$1/\left(\frac{\sqrt{\Lambda NZ+(\Delta NZ)}}{TOTALDISTANCT}\right)$$

For FSS 1/9

Error in Northing = 0.009,

While Error in Easting = 0.005

$$1/\left(\sqrt{0.009^2+0.005^2}\right)/343.941$$

= 1/0.000029934

= 33406.82836= 1: 300,000

**Table 7: The Transformed and Observed Coordinates of FSS 1/40/96 from XSN 07**

| FSS 1/40/96 | 867587.56 | 602592.846 | 296.964 | Observed |
|---|---|---|---|---|
| **FSS 1/40/96** | 867587.562 | 602592.838 | 298.365 | Given |
| **Discrepancy** | +0.002 | -0.008 | -1.401 | |

**DATA PROCESSING**

Data processing describes the process involved in the downloading, sorting and analyzing of acquired data and manipulation of this data into meaningful information that can easily be understood by users. The new information derived from the acquired data is also subjected to further analysis (i.e. interpretation) in other to make inference from the project work.

## Data Downloading and Transformation

The downloading of the acquired data were done by the software that came alongside with the two GPS equipment used which are Leica Geo-Office Combined for Leica GPS 1200 and GNSS Solutions V for ProMark3. Online CORS data required were downloaded via internet. All the downloaded data were transformed to the needed coordinate system.

## LEICA GPS 1200 Downloading

Downloading and processing procedure of the data captured with Leica GPS1200 instrument is explained below:

1. After the installation of the downloading software (i.e. Leica Geo Office Combined), the downloading cable was connected to the Computer system and the instrument, then the instrument automatically power itself on.
2. Leica Geo-Office Combined was launched from desktop. Goto TOOLS to select Data Exchange Manager, then a partition window pop up that contain the instrument contents on the right-side and the computer contents on the left-
3. A folder was created at the computer contents side in drive C or it can be created in drive C before launching the software and named it as CORSPROJ.
4. At the instrument contents side, right click to set the COM port, then double clicked the serial ports which revealed Jobs that are in the instrument. All necessary settings was made.
5. Job was selected to search for the name of the Job, CORSPROJ; the Job was dragged and dropped (i.e. Copy and Paste) to the right-side of the window in drive C in the folder created.
6. The option IDX was selected and the acquired data download began.

## PROMARK 3 Downloading

Downloading and processing procedure of the data captured with ProMark instrument is as explained below.

1. On the ProMark3, the following procedures were followed:

- Clip the I/O module to the back of the ProMark3.
- Connect the USB cable between the ProMark3 and your office computer.
- Turn on the receiver.
- Double-tap the Surveying icon.
- Make sure the ProMark3 Storage option setting will allow the Download utility to access the desired files. For example, if the files to be downloaded are on the SD Card or the internal memory makes sure that the desired storage memory is selected as the
Storage option. To set this information, press the MENU key then select Setup then Storage.

2. On the Computer the following procedures were followed:

- From the Windows task bar, select Start>Programs>GNSSS Solutions >Tools>Download. (Double-click in the right side of the window if you want to access the parent directory and open another folder on your Computer.)

- In the Download window, select File>Connect> Receiver>Connect via Cable.

This opens the Connect via Cable dialog.

- In this dialog, choose the “USB.” port created on the Computer following the installation of the USB driver and then cliök OK. The left side of the Download window then lists the files stored in the ProMark3.

- Select the files you want to download. If necessary, hold down the Ctrl key to make a multiple selection.

- Press the F5 key. A Copying file dialog appears during data transfer.

- Close the Download window.

Do not forget to double-tap the Surveying icon or else no communication will be possible between ProMark3 and the computer.

**Note:** The ProMark3 must be connected to the computer before running Download.

3. On ProMark3, quit the Surveying function, turn off the receiver and remove the cable between the PC and ProMark3.
4. Repeat the previous five steps for each of the ProMark3 units involved in the project to download their respective files to the same project folder on the Computer.

**Note:** Also the processing procedure for the ProMark3 is explained in Appendix.

**CORS Data Online Downloading**

The steps involved in downloading the required online CORS data are listed below:

1. After connecting the PC to an internet service. Launch Mozila firefox. or Explorer.
2. Open Google search window, type www.nisnet.net/idex. Rinex and Orbit file folder is then open side.
3. To download the Rinex file folder, keeping in mind the day in the year that our observation was carried out. Double click on the Rinex folder, and then navigate to the needed days which were 348 & 349days of 2011 i.e. 14th and 15th December 2011. Double clicked on the day to reveal the list of operational CORS stations.
4. Downloading them one after the other and saving each with all file in a created folder on the PC’s download or save it somewhere else.
5. Go back to step 2 for the Orbital data and repeat step3- 4.
6. The Rinex data file for each CORS sations is a zip folder, which have to be unzipped.
7. An unzipping software called WinRAR was use to unzip the Z-file to D-file. The D-file is finally decompressed with “Hatanaka” software to 0-file (i.e. observation file).

**Note:** There is no need to decompress the orbital files because it already in a readable format, that is, N-file meaning Navigation file.

## DATA TRANSFORMATION

The transformation coordinate system adopted in Nigeria is Clarke 1880 system which was used to transform from the GPS WGS 84 Geographic coordinate system (i.e. Latitude, Longitude, and Height) to UTM (i.e. Rectangular/Grid coordinates).

## DISCUSSIONS

**Table 8: Coordinates obtained when XSN 07 FSS, Oyo was used as reference.**

| | FSS Single | | | FSS Dual | | |
|---|---|---|---|---|---|---|
| STN ID | Easting (m) | Northing (m) | Height (m) | Easting (m) | Northing m) | Height(m) |
| XN07 | 604753.215 | 866889.923 | 309.972 | 604753.215 | 866889.923 | 309.972 |
| Y1 (Koso (Hill) | 601526.056 | 871347.722 | 319.882 | 601526.374 | 871347.312 | 319.284 |
| Y2 (Erelu Hill) | 597332.997 | 870575.101 | 290.38 | 597333.302 | 870574.685 | 289.801 |
| Y3 (Bosero Hill) | 600103.155 | 873662.255 | 303.978 | 600103.474 | 873661.875 | 303.397 |
| Y4 (Akube Hill) | 598725.092 | 872008.784 | 265.728 | 598725.419 | 872008.372 | 265.171 |
| Y5 (Ikolaba Hill) | 600567.673 | 877662.523 | 328.856 | 600567.998 | 877661.54 | 328.312 |
| L11(Agidan Hill) | 598267.27 | 874116.003 | 354.039 | 598267.605 | 874115.595 | 353.486 |
| Y6 (Owinni) | | | | 606850.825 | 872037.46 | 342.211 |

Table 8 reveals the coordinates of the study area when XSN 07 (FSS, OYO was used as references. The observation involved the use of Single and Dual frequency observed coordinates and their respective heights.

**Table 9: Coordinates obtained when all the operational COR Stations were used as reference**

| | ALL CORS SINGLE | | | ALL CORS DUAL | | |
|---|---|---|---|---|---|---|
| STN ID | Easting (m) | Northing (m) | Height (m) | Easting (m) | Northing (m) | Height (m) |
| XN07(FSS) | 604756353 | 866878.91 | 310.882 | 604756.554 | 866879.339 | 3313.674 |
| Y1 (Koso (Hill) | 601525.838 | 871347.306 | 320.135 | 601526.63 | 8712347.263 | 323.028 |
| Y2 (Erelu Hill) | 597332.77 | 870574.68 | 290.675 | 597333.026 | 870574.948 | 293.02 |
| Y3 (Bosero Hill) | 600102.937 | 873661.85 | 304.258 | 600103.441 | 873662.139 | 306.986 |
| Y4 (Akube Hill ) | 598724.871 | 872008.371 | 266.002 | 598724.758 | 872008.677 | 268.978 |
| Y5 (Ikolaba Hill) | 600567.451 | 877662.138 | 329.224 | 600567.555 | 877662.477 | 332.036 |
| Y6 (Owinni) | | | | 606849.896 | 872035.478 | 345.445 |
| L11 (Agidan Hill) | 598267.065 | 874115.601 | 354.342 | 598266.723 | 874115.839 | 357.266 |

Table 9 indicates the scenario where all the operational CORS station were used as reference while coordinates and heights of the 8 sites were obtained. The operational CORS stations used include UniLag,, OSGoF, FUTY.

**Table 10: Co-ordinates obtained from Canadian Spatial Reference system Online**

| | ALL CORS SINGLE | | | ALL CORS DUAL | | |
|---|---|---|---|---|---|---|
| STN ID | Easting (m) | Northing (m) | Height (m) | Easting (m) | Northing (m) | Height (m) |
| XN07(FSS) | 604756.286 | 866879.141 | 310.242 | 604756.522 | 866878.905 | 310.854 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Y1 (Koso (Hill) | 601526.173 | 871347.288 | 320.062 | 601529.236 | 871346.871 | 319.972 |
| Y2 (Erelu Hill) | 597332.689 | 870574.434 | 291.179 | 597332.882 | 870574.686 | 289.84 |
| Y3 (Bosero Hill) | 600102.857 | 873661.548 | 303.729 | 600103.147 | 873661.838 | 304.285 |
| Y4 (Akube HILL) | 598724.607 | 872008.498 | 266.014 | 598725.039 | 872008.376 | 266.07 |
| Y5 (Ikolaba Hill) | 600567.294 | 877662.525 | 326.828 | 600567.699 | 877662.102 | 329.231 |
| Y6 (Owinni Hill) | | | | 606850.499 | 872037.443 | 343.82 |
| L11 (Agidan Hill) | 598265.8 | 874115.649 | 353.448 | 598268.868 | 874113.199 | 354.488 |

Table 10 showcases the coordinates obtained using online processed data using RINEX format while solution is computed and estimated coordinates are obtained. This entails four different task namely Online Positioning. User Services (OPUS), Scripts Coordinates Update Tool (SCOUT) AUSLIG'S Online GPS Processing Service and Canadian Spatial References System Online Global GPS Processing Service (CCSRS PPP).

**Table 11: The GPS Coordinates**

| Station ID | | Dual | Single | Online | Nignet CORS | Existing |
|---|---|---|---|---|---|---|
| XSN 07 | E | 604753.215 | 604753.215 | 604756.286 | 604756.353 | 604753.215 |
| | N | 866889.923 | 866889.925 | 879.141 | 866878.910 | 866889.923 |
| | H | 309.972 | 309.972 | 310.242 | 310.882 | 309.972 |
| Y1(Koso Hill) | E | 601526.374 | 601526.056 | 601526.173 | 601525.838 | 601525.001 |
| | N | 871347.312 | 871347.722 | 871347.288 | 871347.306 | 871356.996 |
| | H | 319.284 | 319.882 | 320.062 | 320.135 | 319.976 |
| Y2 (Erelu Hill) | E | 597333.302 | 597332.997 | 597332.689 | 597332.770 | 597331.112 |
| | N | 870574.685 | 870575.101 | 870574.434 | 870574.680 | 870584.130 |
| | H | 289.801 | 290.380 | 291.179 | 290.675 | 290.441 |
| Y3 (Bosero Hill) | E | 600103.474 | 600103.155 | 600102.857 | 600102.937 | 600101.925 |
| | N | 873661.875 | 873662.255 | 873661.548 | 873661.850 | 873672.199 |
| | H | 303.397 | 303.978 | 303.729 | 304.258 | 304.188 |
| Y4 (Akube Hill ) | E | 598725.419 | 598725.092 | 598724.607 | 598724.871 | 598723.437 |
| | N | 872008.372 | 872008.784 | 872008.498 | 872008.371 | 872018.169 |
| | H | 265.171 | 265.728 | 266.014 | 266.002 | 265.189 |
| Y5 (Ikolaba Hil) | E | 600567.998 | 600567.673 | 600567.294 | 600567.451 | 600566.219 |
| | N | 877661.540 | 877662.523 | 877662.525 | 877662.138 | 877673.186 |
| | H | 328.312 | 328.856 | 326.828 | 329.224 | 329.224 |
| L11(Agidan Hill) | E | 598267.605 | 598267.270 | 598265.800 | 598267.065 | 598265.491 |
| | N | 874115.595 | 874116.003 | 874115.649 | 874115.601 | 874125.858 |
| | H | 353.486 | 354.039 | 353.488 | 354.342 | 354.083 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Owinni(6)** | E | 606850.825 | | | | | 606848.199 |
| | N | 872037.460 | | | | | 872047.886 |
| | H | 342.211 | | | | | |

From the table 11 above it could be observed that the coordinates obtained from the field observation are consistent. The table also showed similarities in the coordinates obtained from NIGNET CORS stations and online service provider.

**Table 12: The Difference in Coordinates in the table 11.**

| Station ID | | Dual Single | Dual Existing | Dual Online (CSRS) | Single Online (CSRS) | Nignet CORS online (CSRS) | Existing Nignet CORS |
|---|---|---|---|---|---|---|---|
| **XSN 07** | E | 0.000 | 0.000 | -3.071 | 0.267 | 0.067 | -3.138 |
| | N | 0.000 | 0.000 | 10.782 | 0.198 | -0231 | 11.013 |
| | H | 0.000 | 0.000 | -0.270 | 0.472 | 0.640 | -0.910 |
| **Y1(Koso Hill)** | E | 0.318 | -1.373 | 0.201 | -0.117 | -0.335 | -0.837 |
| | N | -0.410 | 9.684 | 0.024 | 0.434 | 0.018 | 9.690 |
| | H | -0.598 | 0.692 | -0.778 | -0.180 | 0.073 | -0.159 |
| **Y2 (Erelu Hill)** | E | 0.306 | -2.190 | 0.613 | 0.308 | 0.081 | -1.658 |
| | N | -0.416 | 9.445 | 0.251 | 0.667 | 0.246 | 9.450 |
| | H | -0.579 | 0.540 | -1.378 | -0.799 | -0.504 | -0.234 |
| **Y3 (Bosero Hill)** | E | 0.319 | -1.549 | 0.617 | 0.298 | 0.080 | -1.012 |
| | N | -0.380 | 10.324 | 0.327 | 0.707 | 0.302 | 10.349 |
| | H | -0.581 | 0.791 | -0.332 | 0.249 | 0.529 | -0.070 |
| **Y4 (Akube Hill )** | E | 0.327 | -1.982 | 0.812 | 0.485 | 0.264 | -1.434 |
| | N | -0.412 | 9.797 | -0.126 | 0.286 | -0.127 | 9.798 |
| | H | -0.557 | 0.018 | -0.843 | -0.286 | -0.012 | -0.813 |
| **Y5 (Ikolaba Hill)** | E | 0.325 | -1.779 | 0.704 | 0.379 | 0.157 | -1.232 |
| | N | -0.983 | 11.646 | -0.985 | -0.002 | -0.387 | 11.048 |
| | H | -0.544 | 0.912 | 1.484 | 2.028 | 2.396 | 0.000 |
| **L11(Agidan Hill)** | E | 0.335 | -2114 | 1.805 | 1.470 | 1.265 | -1574 |
| | N | -0.408 | 10.263 | -0.054 | 0.354 | -0.048 | 10.257 |
| | H | -0.553 | 0.597 | -0.002 | 0.551 | 0.854s | -0.259 |
| **Y6 (Owinni)** | E | | -2.626 | | | | |
| | N | | 10.426 | | | | |
| | H | | 2.679 | | | | |

Table 12 indicates coordinates comparison for Dual and Single Frequency GPS receivers with respect to Dual –Online (CSRS), Dual –Online (CSRS), Single- Online (CSRS), Nignet CORS-Online (CSRS) and Existing-Nignet CORS.

However, there are obvious discrepancies when these set of coordinates (observed and online) are compared with the existing coordinates as contained in the coordinate register of the school. It could also be noticed that the errors displayed in the comparison are seemingly consistent; hence, systematic error as the effect could be noticed in the Northern axis of the coordinate.

**Table 13: Comparism of the Existing with Dual and Nignet CORS coordinates.**

| Station ID | | Existing-Dual | Existing –Nignet CORS |
|---|---|---|---|
| **XSN 07** | E | 0.000 | -3.138 |
| | N | 0.000 | 11.013 |
| | H | 0.000 | -0.910 |
| **Y1(Koso Hill)** | E | -1.373 | -0.837 |
| | N | 9.684 | 9.690 |
| | H | 0.692 | -0.159 |
| **Y2 (Erelu Hill)** | E | -2.190 | -1.658 |
| | N | 9.445 | 9.450 |
| | H | 0.640 | -0.234 |
| **Y3 (Bosero Hill)** | E | -1.549 | -1.012 |
| | N | 10.324 | 10.349 |
| | H | 0.791 | -0.070 |
| **Y4 (Akube Hill )** | E | -1.982 | -1.434 |
| | N | 9.797 | 9.798 |
| | H | 0.018 | -0.813 |
| **Y5 (Ikolaba Hill)** | E | -1.779 | -1.232 |
| | N | 11.646 | 11.048 |
| | H | 0.912 | 0.000 |
| **L11(Agidan Hill)** | E | -2.114 | -1.574 |
| | N | 10.263 | 10.257 |
| | H | 0.597 | -0.259 |
| **Y6 (Owinni)** | E | -2.626 | |
| | N | 10.426 | |
| | H | 2.679 | |

Table 13 reveals the coordinates that were obtained when XSN 07 FSS, Oyo was used as reference.

## APPLICATIONS AND FUTURE PROSPECTS OF THE CORS NETWORK

Applications and future prospects of the CORS network are numerous to mention as it has more important contributions to the scientific community. Many surveying engineers, geodesists,

mapping specialists, as well as scientists from different backgrounds, are using CORS on a daily basis by downloading GPS data through UFCORS and anonymous FTP, and then post processing these data for a variety of applications. The CORS network has contributed significantly to geodetic• positioning by providing easy and accurate access to the NSRS. The CORS network should also be recognized for supporting the research of numerous scientific investigations. Finally, the CORS network serves as the primary data source for all types of GNSS solutions.
In a nutshell, there are numerous advantages or benefits that can be attached to the, use of CORS stations, such as:

a. Land cadastral boundaries and title holdings are demarcated in such a way that communities, hamlets, villages, towns, etc. are recognizable for effective infrastructure development, resources inventory and planning.
b. Therefore, GNSS CORS will facilitate the accurate location and rapid mapping of all landed properties and resources.
c. CORS will practically reduce the labour, cost and time spent in small and medium scale mapping across the nation;
d. Rather than using two receivers, the surveyor would need only a receiver (as a rover) to pair with CORSs for his/her jobs; thereby reducing survey equipment cost.
e. It will enhance the consistent monitoring of ground and structural subsidence activities in the coastal and mine field areas of the country;
f. The use of CORS will enhance effective modeling of atmospheric errors that frequently distorts survey measurements
g. CORS is used for land, sea, and airborne navigation, and for asset car tracking facilities;
h. CORS provides the best stable infrastructure for property tax mapping for the states and the country in general.

The establishment of NIGNET CORS stations spread across the country prompt the purpose of this research work, in order to compare single and dual frequency receivers static position observation of some previously known control station namely XSN 07 (FSS, Oyo), LII (Agidan Hill), Y2 (Erelu Hill), Y3 (Bosero), Owinni(6) Hill, Y5 (Ikolaba),Y4 (AKUBE HILL ) and Yl (Koso)) in Oyo, Oyo State with regard to the download and post processing of data from the NIGNET CORS data download. The receiver instrument used for single frequency (Li -band) observation was the Magella Professional ProMARK 3 while GPS receiver Leica GPS 1200 was used for the dual frequency observation (L1 And L2-band, GPS+GLONASS).

## CONCLUSION AND RECOMMENDATIONS

The study has being able to test the reliability of both the single and dual frequency GPS by comparing the observational results taken from the XSN 07 (FSS, Oyo), LII .(Agidan hill), Y2 (Erelu hill), Owini hill and Y 1 (Koso) with that of• (NIGNET) Continuously Operating

Reference Station (CORS). The study took series of observations on each of the control points using the single and dual frequency GPS. Data were captured from NIGNET with regards to time of observation on website. The exercise involved downloading of the acquired data from the GPS for processing (computation) purposes while the data were analyzed and the results compared. The result was compared using Excel while the outcomes were presented in tables, graphs and charts.

The study has examined the differences between the given coordinates of all the eight site namely XSNO7, FSS Oyo, Ikolaba, Agidan Owinni, Koso, Erelu, Akube and Ikolaba Hills compared with the observed coordinates of both Single and Dual Frequency GPS using XSNO7, UNILAG COR, All CORS and the Online Processed Data. One can make the assertion that there is no significance difference in both the given coordinates and the observed coordinate with respect to Single and Dual Frequency GPS when CORS stations are used as referenced.

The establishment and operation of CORS in Nigeria will enhance the realization of unified coordinate system, enhance the consistent monitoring of ground and structural subsidence activities in the coastal and mine field areas of the country as well as effective modeling of atmospheric errors that frequently distorts survey measurements

As revealed by the analysis, there is no significant difference between dual and single frequency coordinates, however, the following recommendations are proffered:

i. When project site is far from control, dual frequency GPS receiver is recommended for base line solution.
ii. The single frequency GPS could be used for 3rd order jobs.
iii. Ministry of Lands, Housing and Urban Development may consider recoordinating the existing control points with NIGNET CORS station
iv. In subsequent observations that will entail comparison of coordinates, rover stations should not be less than an hour for better resolution of ambiguities.
v. The Oyo State Government should apply to OSGOF to establish CORS at strategic locations to serve the State instead of depending on the UNILAG CORS.

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