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Management of First Order DGPS Geodetic Infrastructure in Anambra State

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Abstract: *A geodetic infrastructure is a control network that functions as a wire-frame or the skeleton on which continuous and consistent mapping, Geographic Information Systems (GIS), and cadastral surveys are based. Geodetic Infrastructure is divided into Zero order, first order, second order, third order and forth order. First order geodetic infrastructure has its accuracy specification as 10ppm which is used in multipurpose scientific studies, mapping of country. The handling procedure and management of geodetic infrastructure is poorly executed in study area such as non re – establishment of missing monument and not knowing the integrity as well as the status of geodetic control Management of first order geodetic infrastructure is a process adopted in handling geodetic data to ensure efficient storage, easy dissemination of geodetic information to the users, quick updating and retrieval of geodetic data, in a sustainable manner through the use of programs developed as software. Aim of this research is for Provision of a decision support system for management of first order DGPS geodetic control in Anambra State. The procedures are acquisition of Geodetic Control data of the study area from office of Surveyor General, Abuja, Nigeria, Physical visitation to the geodetic control site, to determine the conditions of the geodetic data in the field, To determine the local government of coverage for geodetic control and creation of a decision supporting system for management of geodetic infrastructure within the study area. The result obtained indicated that out of fifteen (15) first orders, three were not physically on ground, two were visible on ground but defaced while the remaining ten still physical exist on the ground and in good order. Up-dating of geodetic information in geodetic database and using of station identifier to search for geodetic control was also demonstrated. Recommendation was also given as Re-establishment of geodetic control within the study area where the controls do not physically exist on ground, Implementation of penalty code as stipulated by constitution of Federal Republic of Nigeria as regards tampering with integrity of geodetic control.*

Keywords: *Control Network, Differential Global Positioning System (DGPS), Geodetic Infrastructure, Geographic Information System(GIS)*

1. INTRODUCTION

A geodetic infrastructure is a control network that functions as a wire-frame or the skeleton on which continuous and consistent mapping, Geographic Information Systems (GIS), and cadastral surveys are based (Emenari, U.S. 2021). This geodetic infrastructure is a positioning infrastructure which encompasses both the passive ground control marks and active CORS to support positioning and mapping with reference to datum (Rizos, 2009). Again, these Geodetic Infrastructures are used for connection/tying of all surveying activities, for monitoring activities of engineering structures, for setting out of gigantic structure, for cadastral survey and mapping of nation. The geodetic infrastructure consist of Horizontal Control, Vertical Control, Gravity Control, database archive, the computer and telecommunication equipment and software to make it operate as well as staff to manage it, Magnetic Control, Tide-Gauge Control, Continuously Operating Reference Station (CORS), that form a framework upon which the national development, security and defense of any nation is hinged (Ono, M.N., Onwuzuligbo, C.U., & Ogonobo, T., 2013; Mohammed, 2012). The purpose for geodetic infrastructure is centered on development, planning, mapping, security and defence of any nation (Mohammed, 2012).

Fig1. *Two of the first order federal DGPS controls situated at Adazi-Nnukwu, Aniocha Local Government Area with inscription XVS 995 and Ekwulobia, Aguata Local Government Area with inscription XVS 857, both in Anambra State*

Geodetic Infrastructure is divided into Zero order, first order, second order, third order etc. The precision, accuracy encountered, time of observation, connection to the base/ CORS determine the order of Geodetic Infrastructure. Zero order geodetic infrastructure has its accuracy specification as one part per million (1ppm) thus employed in geodynamics studies as well as seismic activities. Method used in this order is Differential Global Positioning System Receiver (DGPS), Satellite Laser Ranging (SLR) and Very Long Baseline Interferometer (VLBI). Again, first order geodetic infrastructure has its accuracy specification as 10ppm which is used in multipurpose scientific studies, mapping of country. Method employed for first order geodetic infrastructure includes DGPS, Triangulation, and Total Station. Both second and third order geodetic control has their accuracy specifications as 20 – 33.3ppm and 100 – 200ppm respectively. The method employed for both are EDM, DGPS, and Triangulation (Ono, 2002), (Surcon, 2003).

This research work is limited to only first order federal DGPS geodetic control in Anambra State. Initially, first order geodetic infrastructure is usually situated on mountain tops. Mountain tops encourages intervisibility between one points to another. Special devices are used to ensure visibility such as scaffold formation, special type of lamp, special instrument as well as communication gadget. Method usually employed for this is triangulation, trilateration and traverse where necessary. Today satellite fixes are employed in determination of geodetic control. The satellite fix can be in form of GPS, GLONASS, DEIDOU and CALILEO. Global Positioning System (GPS) is accepted in this part of the word. GPS consist of minimum of 24 satellite in atmosphere, arranged about four (4) in each orbit. GPS receiver is adopted to track GPS satellite. Many forms of GPS receiver is used to track the satellite such as Hand held GPS receiver and differential Global Positioning System (DGPS) receiver. Differential Global Position System (DGPS) is used for geodetic work such as first order geodetic infrastructure without considering intervisibility. In fact, this type of surveying operation is well accepted due to some advantages it posses over triangulation method. Some of the advantages of using DGPS receiver instruments include: use of satellite which is located far above the observer thus issue of intervisibility cancelled, reduction in calculation mechanism, easy way of carrying out working procedure, minimal time consumption.

These first order geodetic infrastructures in Anambra State are fifteen in number and were distributed within the state. It is denoted as (XVS). Geodetic Infrastructure is of great important to the nation and people in general especially in aspect of security and defence as well as boundary delineation to ensure peaceful coexistence between one country and another, one state and another, local government and its equivalent as well as town by town but despite its importance, its handling procedure and management of geodetic infrastructure is poorly executed

Consequences encountered by poor handling and management of Geodetic Infrastructure

1) Non unification of various geodetic data in the study area in a common database thus access to them becomes more difficult.
2) Non re-establishment of removed Monuments
3) Removing, tampering of geodetic control by some farmers and construction companies without punishment such as non implementation of penalty code as stipulated by constitution of Federal Republic of Nigeria.

4) Not knowing the integrity and status of existing geodetic controls
5) Not knowing the important of geodetic control by public due non creation of awareness by concerned agencies.
6) Non investment by survey department for state on the software dedicated for geodetic data handling.
7) Non investment by survey department of a state on Server for effective internet application to display geodetic information to the users to enhance its management,

Management of Geodetic Infrastructure in Nigeria

Management of geodetic infrastructure is a process adopted in handling geodetic data to ensure efficient storage, easy dissemination of geodetic information to the users, quick updating and retrieval of geodetic data, in a sustainable manner through the use of programs developed as software (Emenari, U.S., 2021). According to (Boucher, C., Poder, K., Schwarz, C.R., Tsheming, C.C., 1981), advise was given to geodesists to develop programs for management of geodetic controls especially based on the listed outcome of symposium such as the role and function of a geodetic database, the use of commercial database management system, the validation of observation data and the use of abstract data to enhance the management of geodetic infrastructure.

The geodetic data management provides the ability to store, access, manage or analyze location based round earth information with the use of software application for weather, defence, intelligence or natural resources application for commercial or government use (Olexander, 2014). A lot of software with various versions have been developed and some as still being developed for the management of this geodetic data such as ArcGIS, Oracle, Access Database, Map info, PostgreSQL.

The following reasons for management of geodetic infrastructure

i) The voluminous nature of geodetic control infrastructure data which can number up to millions with attachment of their metadata.
ii) Fast way to update any attribute of geodetic control monument that is changed.
iii) Easy way to retrieve geodetic information needed by government agencies and other individuals such as Surveyors that rely on the data. This is made possible through query analysis.
iv) Easy accessing of geodetic information by many users such as geographers, oceanographers, surveyors, engineers.
v) Data generated by other users can easily be integrated with the national network database, if data standards are developed and agreed upon among the user community.
vi) Serving as a platform for saving geodetic infrastructure information without any deterioration or mutilation of geodetic data.
vii) Reduction in cost of carrying out surveying activities
vii) It encourages the sharing of geodetic data among the locals

Aim: Provision of a decision support system for management of first order DGPS geodetic control in Anambra State

Study Area

Anambra state is one of the South Eastern states of Nigeria. The state lies between coordinates, longitude 6 ^{0}35'E – 7^0 30'E and latitude 5^0 40'N – 6^0 48'N. It was created on 27 August 1991 and has an approximate area of 4,844 km^2 (1,870.3 sq mi). It is made up of 21 local governments and 177 autonomous communities, (Obiogbolu, n.d). Boundaries are formed by Delta State to the west, Imo State and Rivers State to the south, Enugu State to the east, and Kogi State to the north. The name was derived from the Anambra River (Omambala) which flows through the area and is a tributary of the River Niger. Awka is the capital city of Anambra State. The state slogan is "Light of the Nation."

2. METHODOLOGY

This ranges from the planning, physical visitation to GPS geodetic control site in the field, data acquisition, creation of database for decision supporting system for management of geodetic infrastructure.

2.1 Objectives

i) To acquire the Geodetic Control data of the study area

ii) Physical visitation to the geodetic control site

iii) To acquire the condition of the geodetic data in the field

iv) To determine the local government of coverage for geodetic control

v) To create a decision supporting system for management of geodetic infrastructure within the study area

2.2. Sources of Data.

Primary Data Sources: Primary data was gotten from; attribute data of the visited DGPS geodetic controls, oral interview from staff of office of Surveyor General of federation Abuja, Nigeria.

Secondary Data Sources: These data were gotten from Control records kept by statutory bodies (these data were assumed to be correct with minimum distortion). The statutory body that kept this data is Office of Surveyor General of Federation Abuja, Nigeria and the data gotten is DGPS First Order Federal Controls in Anambra.

2.3. Hardware and Software Requirement

Hardware used include: Computer, tape, prismatic compass, flash drive, handheld Gps, Calculator, Infinix x559c hot 5 series mobile phone with built in camera of 3264 x 2448 pixels, field book and other writing materials while software requirement are Microsoft Excel 2007, Microsoft word, ArcGIS 10.5 software, Online Hiper Scientific Calculator

2.4. Data Acquisition

Geodetic data required for this work was gotten from Office of Surveyor General of Federation Abuja, Nigeria. Geodetic data collected from office of surveyor general Abuja, Nigeria is DGPS first order federal control (XVS) in Anambra State. After collation of the geodetic control data, the inspection of the control sheet was executed through oral interview with staff of the surveyor general of federation, Abuja, Nigeria. Physical visitation to control site were embarked upon, to determine the conditions of geodetic control. Condition of geodetic control is to indicate if controls are physically or not physically exist on ground. The condition gotten from physical visitation will be integrated with the geodetic data acquired. Then followed by geodetic database creation in order to incorporate all the required geodetic control information (attribute data for geodetic control), in order to provide a decision supporting system for management of geodetic infrastructure within the study area.

3. ANALYSIS OF RESULT

3.1 Result showing location, coordinates, address and conditions of control station as derived from physical visitation.

Table3.1. *Result showing DGPS Geodetic Data (coordinates) for First Order Federal Control and their location in Anambra State*

Station No	Locality	Easting (m)	Northing (m)
XVS 982	Unizik Awka	517532.439	248602.146
XVS 983	Unizik Awka	518779.472	248103.806
XVS 992	Oko	516470.228	226849.031
XVS 993	Oyiolueze	483161.294	242247.686
XVS 994	Ogboji	521078.951	222786.324
XVS 995	Adazi Nnukwu	505913.345	232416.936
XVS 091	Achalla	502772.174	256764.471
XVS 779	Nzam	474092.454	270796.870
XVS 911	Ukpo	502805.102	245091.760
XVS 912	Nnewi	495375.488	221159.640
XVS 913	Ajalli	528209.157	225961.329
XVS 914	Ihiala	489436.432	207070.064
XVS 855	Abagana	503792.100	241541.977
XVS 856	Neni	505019.679	317968.913
XVS 857	Ekwulobia	514813.628	222797.590

Table3.2. *Result Obtained from Physical Visitation to the control site to determine its address of location and conditions of first Order (Primary Controls) DGPS Federal controls in Anambra State.*

S/N	CONTROL POINTS	LOCATION	ADDRESS OF LOCATION	CONDITION
1	XVS 982	AWKA	UNIZIK POSTGRADUATE OFFICE	VISIBLE ON GROUND
2	XVS 983z	AWKA	UNIZIK GATE	VISIBLE ON GROUND
3	XVS 992	OKO	FED POLY OKO	UP ROOTED/REPLACED
4	XVS 993	ONITSHA	OYIOLUEZE	UP ROOTED
5	XVS 994	OGBOJI	CENTRAL SCHOOL OGBOJI	VISIBLE ON GROUND
6	XVS 995	ADAZINNUKWU	UNION PRIMARY SCHOOL, ADAZINNUKWU	VISIBLE ON GROUND
7	XVS 091	ACHALLA	AWKA NORTH SECREATARIATE ACHALLA	VISIBLE ON GROUND
8	XVS 779	NZAM	ANAMBRA WEST SECREATARIATE NZAM	VISIBLE ON GROUND BUT DEFACED
9	XVS 911	UKPO	DUNUKOFIA SECREATARIATE UKPO	VISIBLE ON GROUND BUT DEFACED
10	XVS 912	NNEWI	NNEWI NORTH SECREATARIATE NNEWI	VISIBLE ON GROUND
11	XVS 913	AJALI	ORUMBA NORTH SECREATRIATE AJALI	VISIBLE ON GROUND
12	XVS 914	IHIALA	IHIALA LOCAL GOVT HEADQUARTERS IHIALA	VISIBLE ON GROUND
13	XVS 855	ABAGANA	NJIKOKA SECREATARIATE ABAGANA	VISIBLE ON GROUND
14	XVS 856	NENI	ANIOCHA SECREATARIATE NENI	PHYSICALLYNOT ON GROUND
15	XVS 857	EKWULOBIA	AGUATA SECREATARIATE HEADQUARTER	VISIBLE ON GROUND

First Order DGPS federal control controls covering Anambra State, established by the Office of Surveyor General of Federation are fifteen in number, from findings in Table 3.2, three were not physically on ground, two were visible on ground but defaced while the remaining ten still physical exist on the ground and in good order. The existing controls consist about 80% as against 20% of non existing controls on ground.

3.2 Result for local government coverage analysis of DGPS first order federal control in Anambra State

The first order DGPS geodetic controls based on the findings are located within Awka South and North, Nnewi North, Onitsha South, Anambra West, Anaocha, Njikoka, Dunukofia, Ihiala, Aguata, Orumba North and South. Out of twenty one (21) local governments in Anambra State, twelve (12) local governments were covered by first order DGPS federal control while nine (9) other local government were not covered. The nine local government not covered include Nnewi South, Onitsha North, Anambra East, Idemili North, Idemili South, Oyi, Ayamelum, Ekwusigo and Ogbaru Local

Government Area of Anambra State. All these local governments not covered have a close proximity to other local government covered. Most of the controls are located in local government headquarters for easy accessibility.

3.3 Result Obtained through Creation of a Decision Supporting System for Management of first order DGPS Geodetic Infrastructure

Query 1: All the First Order Federal Controls in Anambra

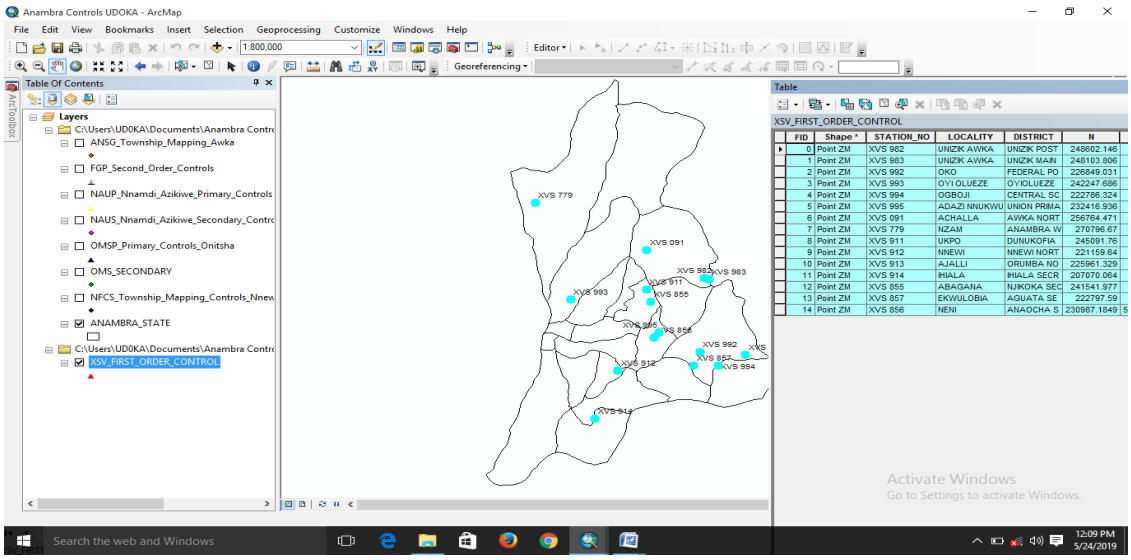

Fig3.1. *Query for First Order Federal Controls in Anambra State.*

All the first order federal controls are fifteen (15) in numbers within Anambra state (Figure 3.1). Findings shown that they are evenly distributed and also located mainly at various headquarters of the local government such as Awka, Onitsha, Achalla, Nzam, Ukpo, Nnewi, Ajalli, Ihiala, Abagana, Neni and Ekwulobia. Those that locate outside the Local Government Headquarters include Oko, Ogboji and Adazi-Nnukwu

Query 2: All the First Order Federal Controls Existing on Ground.

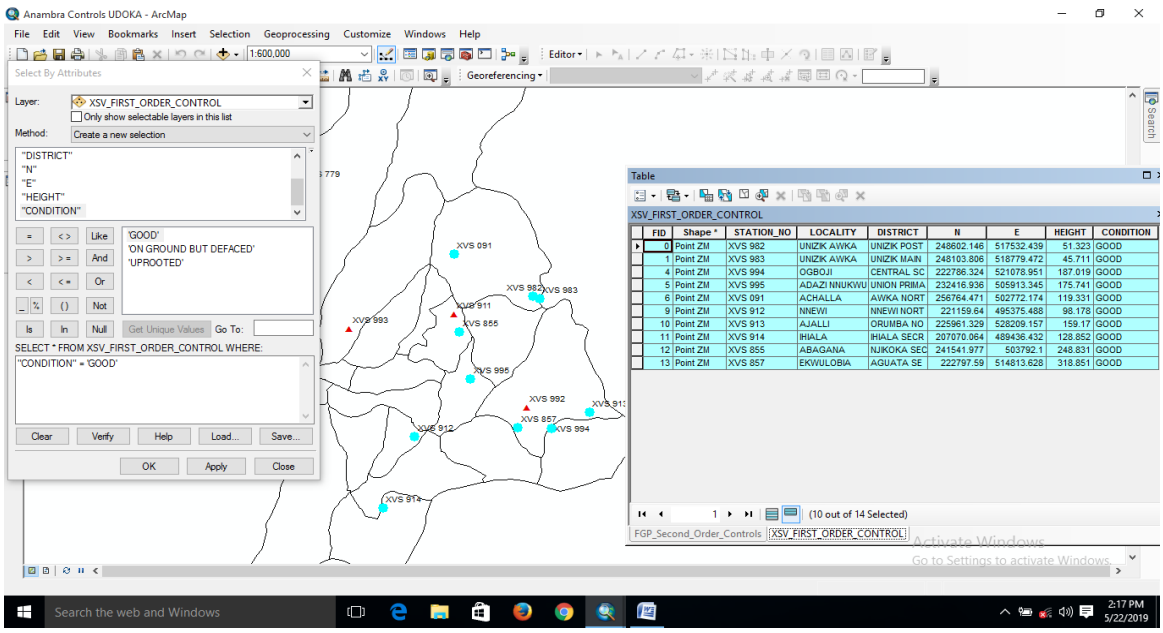

Fig 3.2: Query Analysis of First Order Federal Controls Existing on Ground

From findings, result from figure 3.2, indicates that ten (10) out of fifteen (15) first order, federal controls which represent 66.67% of all the control physically exist on the ground with its inscription intact. Their locations include; two at Unizik Awka, one each at Ogboji, Adazi-Nnukwu, Achalla, Nnewi, Ajalli, Ihiala, Abagana and Ekwulobia. Other attributes of them were shown.

Query 3: All the First Order Federal Controls that Exist on Ground without Inscription (Defaced).

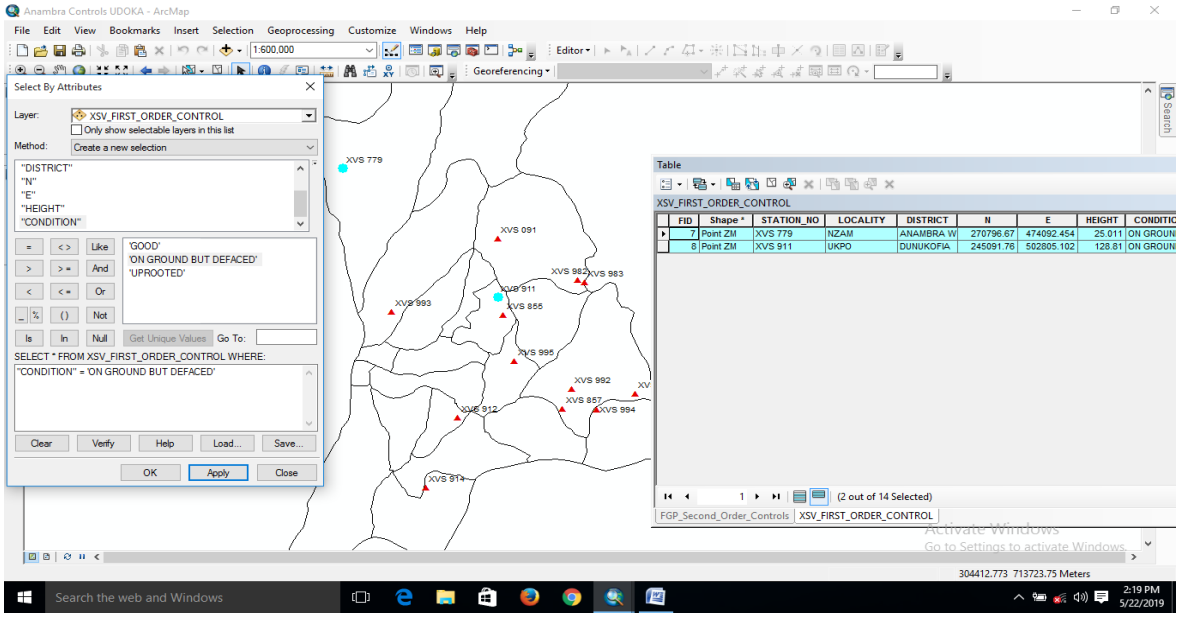

Fig 3.3: Query Analysis for First Order Federal Control (without Inscription) that Defaced

From findings, two (2) out of fifteen of first order federal controls existing physically on the ground are without inscription or defaced (Figure 3.3). Those controls are located at Anambra West Local Government Area Secretariat Nzam and Dunukofia Local Government Area Secretariat Ukpo in Anambra State respectively. It appears that the cement mixture was inappropriate or rain fell on the day capping was done thus washing it away. These defaced controls stand at 13.33% of the total federal first order controls.

Query 4: All the Uprooted First Order Federal Controls in Anambra

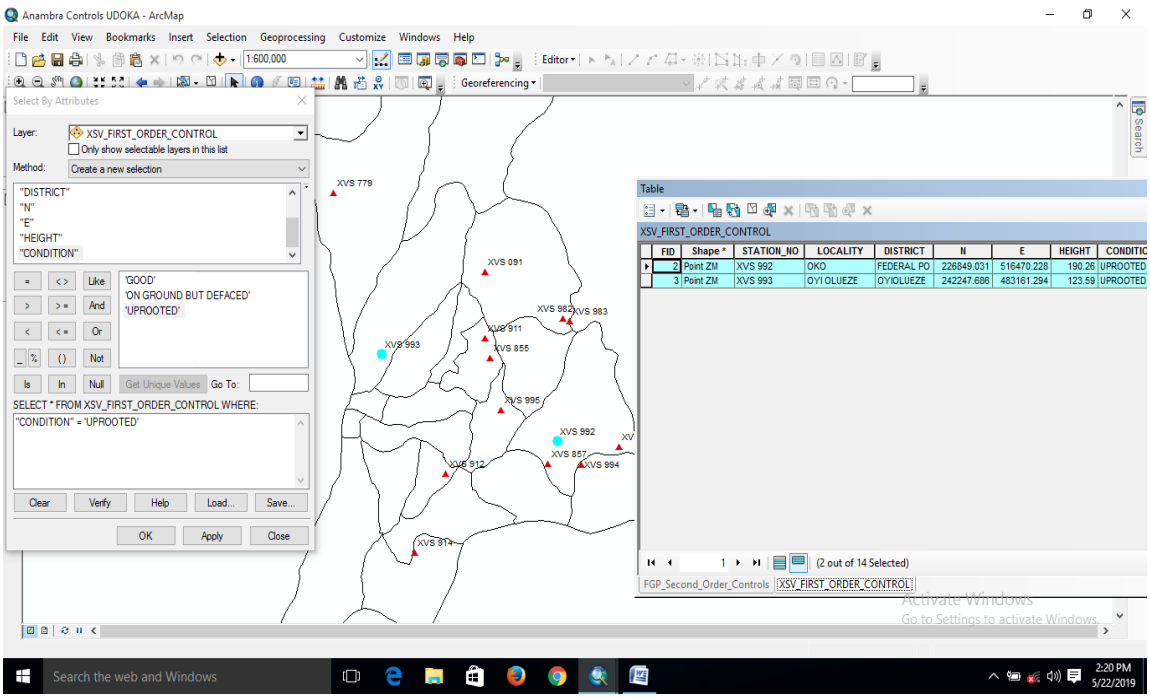

Fig 3.4: Query for First Order Federal Control not physically on ground.

From findings, figure 3.4 indicates that three controls out of fifteen controls representing 20% of total controls were not physically visible on ground within the time of carrying out this research. Those controls are located at Federal polytechnic Oko in Orumba South Local Government Area, Oyiolueze at Onitsha South Local Government Area and Neni, at Aniocha Local Government Area. At Federal Polytechnic Oko, tower was erected in particular position made for the control.

Query 5: Up-Dating of Geodetic Information in Geodetic Database.

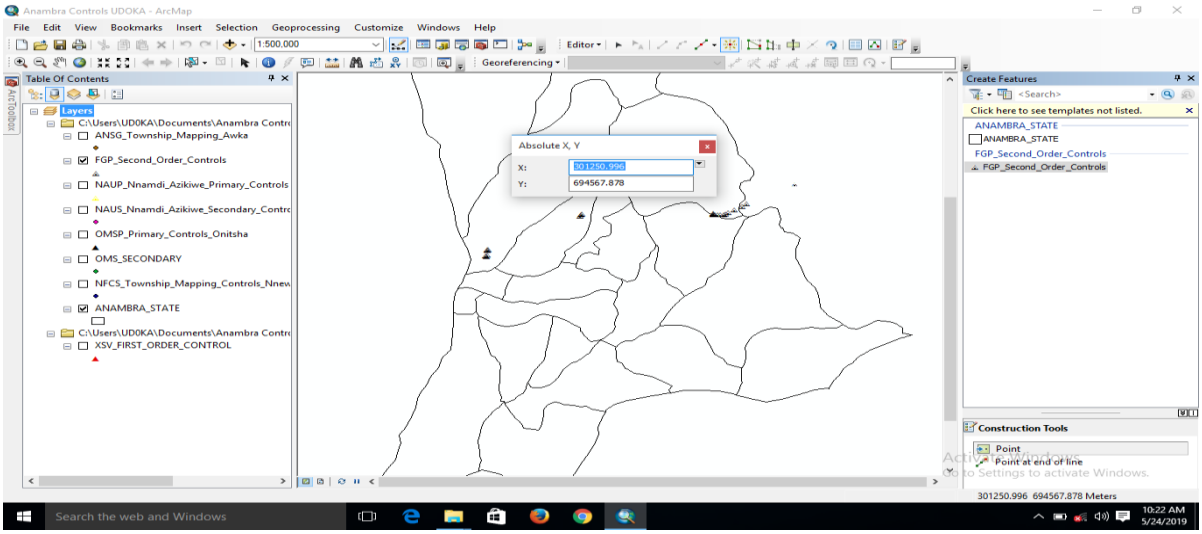

Fig 3.5: Query Analysis for Up-Dating of Geodetic Information.

Updating of geodetic information in the geodetic database created (Figure 3.5). The coordinates about to be updated is included in the database, by typing it through absolute X, Y. X representing Easting while Y is representing the Northing. The coordinates will enter into the database of already created geodetic database and updated automatically. This platform will be helpful to accommodate newly established geodetic controls and mistake made initially which is about to be corrected.

Query 6: Search for Coordinates and its Attribute, using Station Number

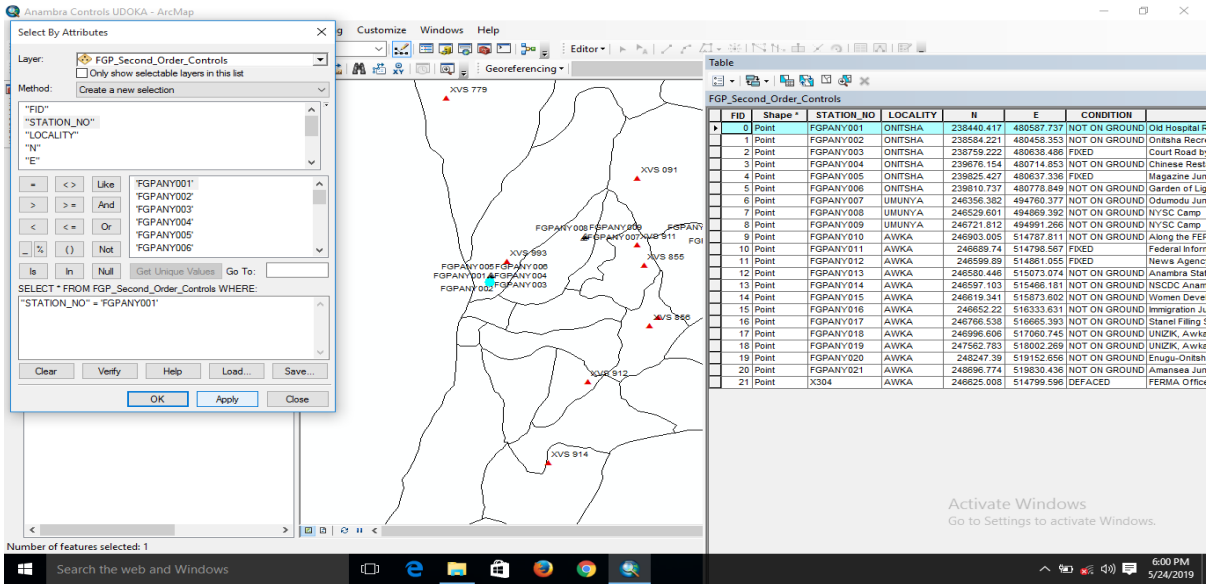

Fig 3.6: Query Analysis for Searching Coordinates and its Attribute using Station No

Retrieval and searching of coordinate points is possible using the station identification number (Figure 3.6). The station identification number of interest was selected, and then on a click, all the contents of the station number will be showcased. This increases the rate of accessibility and retrieval of geodetic information without much work. Station identifier is usually written on every control monuments, thus the surveyor interested in tying his work on the monument will only copy the identifier, and one click will bring out coordinate of interest.

4. CONCLUSION

The aim of this project has been achieved by provision of a decision support system for evaluation and management of geodetic control in Anambra State. The task for evaluation of geodetic infrastructure which involved physical visitation and in situ check to determine the status and stability of geodetic control was accomplished. The management of geodetic infrastructure was also

determined. In order to proffer solutions on the variables under investigation, recommendations are made based on findings of this study.

Recommendation given include Re-establishment of geodetic control within the study area where the controls do not physically exist on ground, Implementation of penalty code as stipulated by constitution of Federal Republic of Nigeria as regards tampering with integrity of geodetic control, Creation of awareness on importance of geodetic control among people especially construction workers and farmers, The survey departments for state should invest more on the software dedicated for geodetic compilation and survey departments should invest on Server for effective internet application to display geodetic information to the users

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