# COMPARATIVE STUDY OF LAND SURVEYING AND REMOTE SENSING AS METHODS FOR LARGE SCALE LAND COVER MAPPING

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# DECLARATION

I, Okediji Kolapo Ayodele, hereby declare that this thesis has been conducted by me under the supervision of Dr. G.N. Nsofor of Geography department, F.U.T Minna, Niger State.

Okediji Kolapo .A.

# DEDICATION

This research is dedicated to the following

(i) The Father, the Son and Holy Ghost

(ii) Jael Imole Okediji and her Mother (Seun Okediji)

(iii) Mr and Mrs Oyedele Raliat Okediji

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# ABSTRACT

Any country without a current map is approminately a dead country interms of development and advancement. The only thing that can be transferred from one generation to another is land which is fixed in nature. Lives have been lost and property worthy of billions have been destroyed based on lack of proper land records. Land records are properly kept with the aid of maps which can be produced from either Land Surveying method or remote sensing method. In this country, cost, speed and accuracy of these methods are of paramount importance. This research deals with assessing the accuracy, speed, cost and dependability of each method as means for large scale Land cover mapping.

Data for the study include aerial photograph of 1982, topographical map of 1998 and professional scale of fees for surveyor 1996, and supported with field observations. Maps were produced from the interpreted datum and likewise compared the measurements of them with that of ground truth. Pythagoras theorem, percentage of error determination and statistical analysis were employed for data analysis.

The result of the analysis showed that Land Surveying is more accurate, dependable and cost effective than remote sensing as methods for large scale land cover mapping. The searcher therefore, concluded by making recommendation that land surveying method is for large scale mapping of high accuracy while remote sensing is majorly for the small scale mapping for the purpose of environmental monitoring.

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# CHAPTER ONE

## 1.0 INTRODUCTION

Land is life. There was nothing that was made that was not from the Land. The human existence is principally based on Land. The degree of any area or country will be based on how effectively the Land of such an area has been used or developed.

Land can simply be defined as the solid dry part of the earth's surface (Paul,1978). Although, the definition is very simple but when it is digested, it has lots of meanings. The Land therefore, on the other hand, can be referred to as the physical quantity of the earth which includes all the things that can be found both on and within it (Dashe, 1987).

Agriculture can not be done without Land, and without Agriculture there is no life. Minerals of different kinds are found within the Land. Water that makes life to have meaning is also found both within and on the Land. Structures for human use can not be erected on anything but land. Dashe (1987) was of opinion that the wars that emanate from not paying greater attention to the issues of land would be greater than the havoc done by the atomic bomb, because all these resources are not evenly distributed for human use. The land is fixed in nature. This therefore, calls for proper maintenance. The importance of land to man kind can not just be over emphasised. The problems that are associated with not giving serious attention to land matters are beyond what man can just over look.

And how can the problems be over come without a good record on the land and land related matters? The information on land and any other related matter are best kept with the aid of maps. Maps are produced either by traditional method (Land Surveying) or by modern method (Remote Sensing). The subject of this work is to see which of the methods mentioned above will produce a very accurate large scale map with less cost and with high speed. There are lots of problems that are associated with land as some of them are enumerated under the statement of the problem.

## 1.10 STATEMENT OF THE PROBLEM

Land in-dispute between Families, Communities, Villages, Towns, States and even Countries is always a case in any court of law. Modakeke and Ife engaged in a very hot war based on land in - dispute. The ethnic hostilities in Warri and its environs is mainly due to Land. Nigeria and Cameroun are engaging in war basically because of land.

It is also obvious that most of the political problems always come up from the poorly demarcated boundaries. Location of many Local Government Headquarter was wrongly done in many States in Nigeria due to the lack of current maps of such an area. Maps in Nigeria which are generally out-dated therefore, need to be up-dated. For example, the maps that covered Minna in Niger State have the following names that are no longer in existence. Niger Baptist College, St. Malayche College and St. Fatimah College which are now Ahmadu Bahago Secondary School, Bosso Secondary school and Government Secondary School respectively. Bosso Secondary School (St. Malayche College) has had her location changed and Federal University of Technology is now occupying her former location. There is no map that shows all these details.

Engineering works are always in shambles in Nigeria as a result of poor or non availability of land record. Generally speaking, all the problems enumerated above boil down to non-availability of current, accurate and adequate maps in Nigeria. Fortunately, there are two ways by which maps can be produced namely: land Surveying (Traditional method) and remote Sensing (Modern Method). But which of these two named methods will produce an accurate Large Scale map with high speed and low cost? This is the question that this work has made an attempt to answer. Many other issues that this work has made attempt to address have been stated under the aims and objective.

## 1.20 AIMS AND OBJECTIVES

The main aim of this work is to assess the accuracy of maps produced from Land Surveying and Remote Sensing as methods for land cover mapping. The objectives of this work are as follows:

(i) Assessing the reliability of each method in production of maps

(ii) Assessing the cost and the speed of each method in mapping and

(iii) Assessing the independence of each method in the area of Land cover mapping.

## 1.30 THE HYPOTHESIS

The hypothesis of this research is that Land Surveying (Traditional Method) is better than Remote Sensing (Modern Method) terms of accuracy, dependability and cost as a method for large scale Land cover mapping in a developing country like Nigeria.

## 1.40 SIGNIFICANCE OF THE STUDY

Maps that can be got from both Federal and State ministries in Nigeria are those produced from the aerial photography of 1974 when Nigeria was having less than twelve States. Since then, Nigeria has undergone about four stages in states creation without any well accurate maps for each stage. As of now, Nigeria has thirty six States without the Federal Capital which is Abuja. Most of the States, if not all, have the numbers of their Local Government areas increased without being reflected on any map. Many names of places found on the maps produced in the year 1974 have been changed especially in the Western part of Nigeria. There are lots of Villages that are found on Nigeria maps that are no longer in existence at the said location on the maps. Many Villages have been relocated especially in the Northern Part of Nigeria, and no map carries all these.

Majority of the roads that were constructed some ten years ago can not be found on any map. Engineering works have been found very tedious due to the lack of current maps. Several inter-tribal wars were recorded claiming many lives based on lack of good record on the boundaries of plots of land. Therefore, the result of this work has made an attempt in indicating the best method that can be quickly applied in the production of maps out of Land Surveying and remote sensing especially in Nigeria. In other to tackle the enumerated problems. It would not be too much to say that everyone who has anything to do with land will find the result of this work useful.

## 1.50 SCOPE AND LIMITATIONS OF THE STUDY.

The third order traversing was employed for the perimeter survey. Theodolite (10") was used for angular measurements while the steel tape was used for linear measurements. Detailing was limited to the use of Theodolite and tape.

The Aerial Photography of 1982 was used due to the lack of any other recent photographs .

In this work, the height of points are not considered due to the lack of equipment for the determination of heights from the photograph.

The area chosen for this research as A.B.S.S. Bosso, Bosso Local Government, Niger State in Nigeria.

## 1.60 DETAILS OF THE AREA OF STUDY.

Ahmadu Bahago Secondary School is located in Bosso Local Government of Niger State. It was formally called Niger Baptist College. It is found on Minna topographical map sheet 164 which is on a scale 1:100,000. It lies between longtitudes $6^{0}$ 32' 30" E - $6^{0}$ 33' 15"E and latitude $9^{0}$ 38' 30"N - $9^{0}$ 39' 00"N; Occupying the total land area of 25.62HQ. It is also found on the aerial photograph of Minna (82563-22, L-13E).

The topography of the area comprises of both highland and lowland areas. Part of lowland areas are traversed by streams and other water bodies, especially South-East of the area. The fairly uniformly undulated area of highland area is taken for the playing ground which is along the main road that goes to Zungeru. Immediately after the playing ground almost at North-East of it, are located Class-rooms, Halls and Offices. Behind all these are found the students hostels. Adjacent to the hostels are located the staff quarters. The beauty of the area is also enhanced by well planted flamboyant plants round the major areas. The areas where buildings were not erected have been taking for farming activities; The major crops being planted are maize, rice and yam.

## 1.70 BRIEF HISTORY OF SURVEYING

Surveying started from the concept of private possession of real properties by man in society. When our primitive societies first reached the level of settled Agriculture development; with the increase in the population and the amount of fertile land available for Agriculture; war over land emanated. The method of precise determination of properties boundaries was called for. The Greeks and the Romans appreciated the need for well documented land records, thus they offered surveying initially for fiscal purposes which formed the bases of their taxation programes. The military took over surveying for the purpose of determination of the territory of enemies (Dashe, 1987).

Surveying since then has undergone or graduated from different stages e.g from

(i) Chain to Plane - Table

(ii) Plane - Table to Compass

(iii) Compass to Theodolite traverse

(iv) Traverse to Trigonometrical Survey and etc.

Today as a result of advancement in technology, surveying has undergone a lot of transformations which make it useful virtually in all disciplines.

## 1.71 BRIEF HISTORY OF REMOTE SENSING

Remote sensing had its origin from some of the earliest photographs that were taken from the air. Camera was strapped to the breast of a pigeon and when the pigeon was released in the air,the camera started working. The pigeon returned, and aerial photographs came out of the operation after the film had been processed. The photographs were found useful especially during the world war II in which it was used to do the topographic mapping of the enemy's territories.

Aerial photography became widespread after the second world war. The applications of its products spread from topographic mapping to include applications in Geology, Agriculture, Forestry, Archeology and etc.

As a result of advancement in technology, Remote Sensing also was changing from one stage to another. Initially aerial photography had been characterised by being primarily concerned with visible and near infrared parts of the electromagnetic spectrum. The other parts of the spectrum were not fully considered at the initial stage but now satellite era is passing through the thermal infrared (Harris, 1987).

## 1.80 DEFINITIONS

Some of the terms used in this thesis are explained below:-

**SURVEYING:-** The art of making measurements of relative positions of both natural and man-made features on the earth's surface, and plotting of these measurements on some suitable material and a suitable scale to form maps, plans or sections is called surveying (Bannister A & Raymond S, 1977)

**TRAVERSING:-** It consists of the measurements of

(a) Angles or bearing between successive lines, and

(b) The length of each line. (Bannister A & Raymond S, 1977)

**RECONNAISSANCE:-** It simply means taking a general view of an area to be surveyed before embarking on the exercise (Ramsay J.P., 1971)

**DETAILING:-** It involves an act of taking measurements to all the details that may be within the area of land under consideration for the purposes of fixation.

**REMOTE SENSING:** The acquisition of data and derivative information about objects or materials located on the Earth's surface or in its atmosphere by using sensors mounted on platform located at a distance from the targets to make measurements of interactions between the targets and electromagnetic radiation (Harris, R. 1987).

**SATELLITE IMAGES:** These are datum got mainly from the space-borne sensors.

**AERIAL PHOTOGRAPHS:-** The data form of photographs got from air-borne sensors.

**RESOLUTION:-** The finest spatial detail visible on an image is called SPATIAL RESOLUTION.

## 1.90 ORGANISATION OF THE THESIS

The thesis is organised or planned into five chapters. The first chapter deals with the introduction where are the background information, research problems, aims and objectives research hypothesis, significance of the study, scope and limitation, the study area, brief history of surveying and Remote Sensing as well as some definition. This is followed by the literature review chapter, which contains background information on previous related studies. The third chapter discusses the method used in carrying out the study while the fourth chapter explains the analysis of the data and the findings. The last chapter gives the summary and recommendation of the work.

# CHAPTER TWO

## LITERATURE REVIEW

### 2.0 MAPS ARE ESSENTIAL

One of the means of communication system that cannot just be looked down upon is map. All information about man and his environment can best be kept and communicated with the aid of maps. Virtually all the disciplines have, in one way or the other, something to do with maps. Robinson (1978) has the following to say about the importance of maps; "The rapidly growing population on earth and increasing in the complexity of modern life, with its attendant pressures for available resources, has made necessary detailed studies of physical and social environment, ranging from population to pollution and from production to energy resources. The geographers, preeminently, as well as Planners, Historians, Economists, Agriculturalist, Geologist and others working in the basic Sciences and Engineering long ago found map to be an indispensable aid".

A large scale map is always needed, and makes available the knowledge of relationship necessary to plan and carry on many works intelligently in the field of Engineering. The small scale maps showing things such as flood plain hazards, soil erosion, land use, population character, climates, income, and so on, are indispensable to understanding the problems and the potentialities of an area.

He also rightly observed that a maps of the whole earth indicate generalizations and relationships of broad earth patterns with which we may intelligently consider the course of past, present, and future events"

Ramsay (1971) referred to maps as a means of representation of features found both on the surface and within the earth on a paper, and unto a suitable scale.

## 2.10 SURVEYING (TRADITIONAL METHOD)

Surveying was known for the purpose of establishing the boundaries of land. Land Surveying deals with the laying off or the measurements of the lengths and directions of lines forming the boundary of the real or landed property. Whenever possible, the field procedure is such that the lengths of the boundary lines and the angles between the boundaries are determined by direct measurements (Davis, 1981)

Davis talked on two important things namely:

(a) The purpose of surveying at early stage and

(b) The principle of surveying.

The purpose of surveying is just more than demarcation. Ramsay (1971) was of opinion that "When angles (between the lines) are measured and the distances are known, plotting can be done and all the details within the plot can be fixed in to form maps or plans". He also observed that surveying has been found useful in many areas such as:

(i) Military

(ii) Geology

(iii) Civil Engineering

(iv) Environmental Science and etc.

It was critically commented by Ndukwe (1990) that due to the need for up-to-date knowledge of uses of various parcels of land in any Country, State or Town, necessitates the use of accurate and quiker method of production of land cover maps. The wide application of remote sensing to the solution of problems of mapping derives from continued research and development in instrumentation. It could easily be deduced from the above statement that surveying has some problems that only remote sensing can solve and these problems are:

(a) Time Consumption

(b) Energy Consumption

(c) Validity of the map at the end of production,tends to be nothing.

The main problem of surveying is the time that it consumes. Right from the begining of any operation to the end has been found to be very slow. Most of the aspects of surveying involves direct labour and as a result, found to be a tedious task to embark on purposely because of time and energy consumption, it was pointed out by Ndukwe (1990) that the map that could be produced from traditional method would no longer be of any importance at the end of completion. But is this conclusion really true for any size of any project particularly for large scale mapping.

## 2.20 REMOTE SENSING (MODERN METHOD)

Davis (1981) has this to say about remote sensing "Maps are more frequently compiled photogrametrically using data from aerial photographs or other remote sensors supported by aircraft or satellite. Maps of this type are constructed using a combination of manual, photographic, and automatic compilation techniques".It can be easily deduced from the statement above that maps are now frequently produced from remote sensing methods. The frequent use of remote sensing was believed to solve the problems of surveying. Again, it was also of a belief that remote sensing has the following advantages:

(i) Provision of datum for environmental scientists

(ii) Provision of data in locating resources for human use

(iii) It helps in providing information in decision making and planning.

It has to be understood that surveying provides these advantages as long as both of them result in the production of maps.

## 2.21 PROBLEMS OF REMOTE SENSING

Ihemadu (1985) has observed that though remote sensing is gaining ground in almost every field, for the purpose of its application, yet it has not been freed from some associated

problems especially in any developing country. These problems are:

(i) Product acquisition

(ii) Manpower shortage

(iii) Inadequate financial resource

(iv) Inadequate communication systems

(v) Other limitations.

**PRODUCT ACQUISITION:-** The product of remote sensing are mainly in two forms i:e satellite imageries and aerial photographs. The former cannot just be tried in the developing countries at all. The only one (aerial photograph) that developing countries are even trying in dealing with cannot also be used to its maximum. The acquisition of photographs (aerial) depends on contractual arrangements with foreign organisation which make the product only more expensive. The contract always delays the execution of projects and, in particular, prevents the utilization of very limited favourable weather condition for the execution of projects.

In some developing countries, national or regional satellite ground receiving and processing station are located but their performance are principally controlled by the space systems or space agencies which are in developed countries. Therefore, the acquisition of data is a major problem of remote sensing. For example, even for this work, photographs of 1982 is used, and these photographs were produced by the foreign bodies.

**MANPOWER SHORTAGE:-** Okhimamhe (1998) was of opinion that aerial photographs cannot be easily interpreted without acquiring certain skill in the field of remote sensing. She pointed it out that the ability to interprete effectively would depend again on the level of exposure of the user. Now, how many users in developing countries have enough knowledge and exposure? She did not stop there but went further to say that "The ways and manners by which human eye sees things are quite different from the ways images are being observed on the photograph or satellite imageries".

Ihemadu (1985) believed that identification of image on the photographs or satellite imageries has not even solved the problem of data interpretation as compared with knowing what the datum are being used for or how to use them. And in other to know all these very well, large numbers of experts are needed in different areas and of course, developing countries are yet to be up to the task. He also observed that the experts that we have always operates from the disadvantage position as a result of not being consulted at the planning and design stages of remote sensing system. He therefore, drew the conclusion that "Dearth of indigenous personal with adequate expertise restricts the use of sensors to mainly the photographic type, to the virtual exclusion of electro-optical imaging and radar or microwave".

**INADEQUATE FINANCIAL RESOURCES:-** Ihemadu (1985) has categorically discribe the problems in five ways. He observed that most developing countries have not their priorities on remote

sensing application due to the fact that there are other matters that need urgent attention. If a country is battling with the provision of basic needs of her citizen, he wonders how such country will embark on remote sensing application. He was also of the opinion that due to the current pricing of remote sensing data products on a cost-recovery basis, coupled with the need to make the payment in hard currencies, the developing countries find these products virtually beyond their reach. He argued further that purposely because of inadequacies in financial resources, bulk-processed paper prints and transparencies constitute the main satellite remote sensing products commonly used in developing countries. This situation considerably limits the type and level of information that can be generated. He observed also that "Developing countries find it difficult to acquire the necessary image processing and analysis equipment. Where such equipment exists, the maintenance cost is enormous and at variance with their usage. Adeniyi (1985) made an observation that the tendency among the developing countries to give higher priority only to the projects that are already known to yield fast returns and visible results stand in the way of reasonable investments in remote sensing techniques. He noticed that government of developing countries tend to perfer funding such projects as road construction which can be easily completed, yield dividends and be easily identified as an achievement made during the usual short period in office and not mapping projects which merely serve as imput for execution of other developing projects.

**INADEQUATE COMMUNICATION SYSTEM:-** Communication within and among the developing countries, as well as between the industrialized nations is unreliable as stated by Ihemadu (1985). Unreliability of the communication system renders the maintenance of regular contact with the operating agencies of remote sensing system difficult and reduces the chances of necessary consultations with such agencies. As a result of this, problem always emanated in the improvement of relevance of subsequent images to the prevalent environmental conditions in developing countries. He maintained his ground in the area that due to the long delays in supplying data for users, in developing countries, this has drastically affected the usefulness of processed data in a large number of application areas.

**OTHER LIMITATIONS:-** The ways and manners by which agriculture is being practised in developing countries have made the use of remote sensing in the area of agriculture difficult. The size of the farmland may be too small to be easily identified on the photographs. Mixed cropping being practised has a terrible effect on the usage of remote sensing. Ihemadu (1985) said that the cloud cover poses a serious threat to remote sensing application in some developing countries. Furthermore, he noticed that very few number of higher institutions in developing countries offer courses in remote sensing which does not encourage the development of the requisite manpower in the field.

Therefore, from the above problems, it can be easily deduced that developing countries are yet to be matured for the application of remote sensing. And due to the fact that Nigeria is one of the developing countries, and that remote sensing application is being offered, in at least one of her higher institution, then the way forward should be to completely reassess remote sening applications.

## 2.30 LAND COVER CHANGES

There are two terms that always go hand in hand, and these terms are land cover and land use. Thomas (1987) has defined these two terms as follows: Land cover relates to the type of features present on the surface of the earth: Urban buildings, Lakes, Trees and Glacial ice are all the examples of land cover types. The term land use relates to the human activities associated with a specific piece of land. As it can be seen from the two definitions, land use depends entirely on land cover. Therefore, appropriate information is needed on land cover. And how can we get this accurate information if not from land cover mapping.

A modern nation must have adequate information on many complex interrelated aspects of its activities in order to make decisions. Land use is only one such aspect, but knowledge about land use and land cover has become increasingly important as nations plan to overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of prime agricultural lands, destruction of important wetlands, and loss of fish and

wildlife habitat from the above statement by stewart (1965), it will be seen that problems are highly associated with land cover that is not properly maintained. Before land use there must be land cover. Without land cover map, how can we easily identify the agricultural areas and wetlands. Stewart (1965) rightly observed that most of our land covers were rapidly changing from one stage to another. For example most of the places known to be forest have almost been turned to ordinary bare land. He has this one to say "Land use data are needed in the analysis of environmental processes and the problems that must be understood of living conditions and standards are to be improved or maintained at current level". Stewart (1965) was of the opinion that one of the prime prequisities for better use of land is information on the existing land use patterns and change in land use through time. At this juncture, one can ask a question, what really is responsible for land cover changes?

## 2.31 FACTORS OF LAND COVER CHANGES.

The factors that cause the land cover changes can be summarized into two;

(i) Natural factors and

(ii) Human factors.

The natural factors can be broken into

(a) Desertification

(b) Drought and

(c) Rainfall

**DESERTIFICATION:-** This is th term used to describe any area being affected by dry air and where there is little or no rainfall. The area is always identified with lack of vegetation and the cloud cover. The land around this region being affected by desertification, may also be referred to as barren land. If desertification extends to any area, such an area will be left unproductive. And it has been shown by many environmental researchers and scientists that desertification always shifts or moves. Therefore, due to the movement of it land cover of many areas have been changed, (Adeleke, 1979).

**DROUGHT:-** This is a condition that describes the absence of enough moisture for plants and animals, or the condition at which water level falls below the water table. It was noted by Adeleke (1979) that farming would be highly affected and vegetation would be affected as well when drought is being prolonged beyond normal. He stressed further that, it is only if irrigation could be applied but forgetting that during this period availability of water is always strenuous and costly.

**RAINFALL:-** It has been rightly observed that rainfall varies from one place to another. Again, the vegetation is also controlled by the amount of rainfall. The areas of heavy rainfall have the vegetation called forest while the areas of little rainfall are referred to as savannah. Forest is known with the presence of trees of different variety. But on the other hand, Savannah is know

with the presence of grasses. The life of both trees and grasses depend on the availability of rainfall. If the rainfall happens to be little, plants will surely dry and land will be left uncovered. Also if the rainfall happens to be too much, erosion will commence and wash the good part of the land needed by the plants for their survival away. Many plants will also be up-rooted, and of cause this makes the land to loose its cover.

The topography of the land keeps on changing day in day out due to the effect of erosion. Many highlands known before have been turned to lowlands due to the effect of erosion. Most areas that can be used for agricultural activities have lost their credit due to effect of erosion. Too much of rainfall is responsible for flooding that is also responsible for loss of lives and property. People move from one place to another in order to either avoid flooding or barreness of the land for farming or even for both of them together. And for sure, when people shift from one place to another one should expect changes in the land cover of those areas, (Adeleke, 1979).

The human factors can be also broken into:

(a) Farming activities

(b) Lumbering activites and

(c) Modernization

**FARMING ACTIVITIES:-** Adeleke (1979) pointed it out that the main source of soil erosion is as a result of farming activities which occur from the methods being applied by the farmer and the level of education of farmers. He observed that majority of the farmers

adopt bush burning during the process of cultivation. The bush burning indeed affects the land cover into two ways. The fact that both wanted and unwanted plants will get burnt is not up to the fact that micro-organism very close to the top surface of the soil will get burnt as well. When plants get burnt, for sure land cover has gone; and such an area will be exposed to the effect of erosion. If other plants are being planted, it will require extra cost and energy to get them survive once the nutrient that can be had from the soil has been burnt away. He also observed that many farmers remained for so long on a parcel of land for many years and be producing the same kind of crops. Adeleke (1979) was of opinion that such method could only make the soil to loose its strength against erosion. He therefore, made suggestions for crop rotation and shifting cultivation in an appropriate way.

**LUMBERING ACTIVITIES:-** Adeleke (1979) said that deforestation was greatly responsible for land cover changes especially where people engaged mainly in it and forgetting about afforestation. Most of our forest areas have been turned to savanna due to the felling of trees without any replacement. The action of erosion cannot be checked in many areas due to the deforestation.

**MODERNIZATION ;-** This one has contributed in the changes of land cover in different ways. All engineering works e.g Road, Ports, Dams, and etc. came to be in existence as a result of modernization. These engineering works have been in one way or the other the vehicle for land cover changes. There is no area where such work will be going

on that the land cover will not be affected. Industrial areas have been known for pollution of either water or air pollution. Water pollution is responsible for the death of aquatic lives and the contamination of drinkable water, plants and other animanl living on land are always affected by the air pollution.

Therefore, if our land cover has to be properly maintained, adequate measures have to be taken. How can adequate measures be taken if information about land cover is not available? How can information about land cover be available without land cover maps? How can land cover maps be had if not through either land surveying or remote sensing techniques? Then which method is the best for the production of land cover maps? Fortunately, this work makes an attempt in answering these questions.

## 2.40 RELATED WORKS

Okediji (1990) carried out Topographical survey of kajuru village in the area of Kaduna State using both traversing and tacheometry. He employed theodolite traverse in the angular measurements. The linear measurements was done with the aid of substence bar method. The height measuremtents was done with the aid of tacheometry. It was discovered that the accuracy of the work was seriously affected due to the fact that substence bar method does not have high accuracy as compared with the use of steel tape especially if it is used in form of caternary. The error of the job was mainly from the methods employed for the distance measurement and heighting. Levelling is preferred to tacheometry method in terms

of height determination. The detailing also was done with the aid of tacheometry, though the methods were very fast and less tedious but less accurate. He also employed plane - table method for certain parts of the mapping. In his report, he observed that though plane - table method was fast but much more less accurate as a method for mapping. Okediji (1990) then suggested that using all these methods for mapping outsides traversing, triangulation and levelling for a very large operation would be tantamount to job not done at all.

Extension of controls was carried out by Okediji (1997) from Western bye pass to Federal University of Technology Minna in Niger State. He employed mainly Traversing method. Angular observations were done with the aid of theodolite and EDM (electromagnetic distance measurement) was employed for the distance measurements. The method was very fast and of higher accuracy, but a little bit expensive due to the EDM instrument that cannot just be easily bought due to its price. Federal University of Technology Minna has only one called total station.

Alamu (1995) mapped Federal University of Technology using traversing for perimeter survey. He employed the used of tape and theodolite for detailing. The traversing done was of third order. In third order survey of such, a lot of things will not be put into consideration once there is a set accuracy for such work. In his report, he concluded by saying that third order survey would be the best for the purpose of detailing once the scale on which bigger job would be plotted would be very small and as a result would take care of any careless errors that might have committed by the surveyor.

Odiase (1998) mapped Ahmadu Bahago Secondary School Minna in Niger State using traversing. The angular measurements were done with the aid of theodolite while the distance measurements were done with the aid of steel tape. Detailing was done using both theodolite and the steel tape. All the necessary precautions that must be followed in carryingg out such an operation in surveying was observed. Necessary corrections were also applied at the appropriate areas. All the data collected were properly represented. The accuracy of the job done was high enough. The author of this work used the map produced by Odiase (1998) and some other datum as material needed for land surveying (traditional method) as a method for mapping.

Ufoegbune (1996) employed remote sensing technique in mapping flood area of Garanga river in Kaduna State. He used satellite imageries (spot X, HVR) in carrying out the operation. He noted that the method was good enough if not the best in mapping such a task. But also noted that the only problem of using the technique was the availability of the data. Adewuyi (1998) used aerial photographs in assessings the road network in Kaduna township. To assess road network is simply mapping out the road newtwork using remote sensing technique. In his observation, he noted that the method was good and faster for mapping road network. He also said that aerial photograph was preferred to other forms of satellite imageries due to its spatial resolution quality.

Nurhie (1999) could not properly monitored, the land use and land cover changes of Abuja without mapping the area out. He

employed the use of aerial photograph for this purpose. He found the use of aerial photographs in mapping to be highly effective but also noted that there was a set back in the availability of it to the user. In his report, he noted that not all the parts of Abuja had the aerial photographs. On the other hand, a good credit was still given to the availability of other forms of satellite imageries.

Onuigbo (1995) carried out research on the comparative investigation into conventional surveying and remote sensing as methods for land cover mapping. The findings of his work serve as ground for this new work, in his work, he adopted traversing and aerial photograph as means of mapping for both land surveying and remote sensing respectively. Very few number of samples were selected. He compared few details on the photographs with those plotted on the plan got from traversing. The ground truth was done and finally compared the result with those from the plan and the photographs.

Information was not gathered on those details to know if they have been renovated or not since 1982 to the time he conducted the research. Again, on the cost, there was no information at all. In his conclusion, he was of opinion that remote sensing is more accurate and economical than land surveying.

In this work we have used the same geographical location as well as the same approach. Large number of samples was considered information about the details was gathered. Data were collected on the cost of mapping; applying both methods from differents related organisations.

## 2.50 GENERAL VIEW ON BOTH METHODS.

The two methods have been dealt with on a seperate account, and it has been discovered that each method has both advantages and disadvantages. Land surveying (traditional method) has a lot of problems and likewise remote sensing (modern method). Onuigbo (1995) made this observation concerning both methods, and said 'Nowadays, most land use and land cover surveys make use of aircraft or satellite imagery, and ground surveys are restricted to the field check of interpreted result only. All aspects of land cover are directly visible from the remotely sensed imagery. This is not so in conventional survey plans or maps. The use of remotely sensed data is particularly appropriate for the production of land cover maps". From the above observation, the following can be drawn:

(i) Remote sensing method is mainly for mapping

(ii) Land surveying can be limited to the field checks.

(iii) All aspects of land cover are visible from the remotely sensed imagery which, is not so for surveying and.

(iv) The appropriate method for mapping is remote sensing.

This observation has not adquately considered all the aspects of remote sensing in mapping, Mapping cannot be said to be done without the ground controls which can only be provided by ground methods. Apart from that, land surveying is not limited to the field checks but for both field checks and mapping of large scale maps. Also the detail that can be seen on the photograph or satellite

imagery depends on the scale of the photographs; and as a result its cannot just be said that all aspects of land cover can be seen. Apart from the scale, the resolution of each method in remote sensing technique also varies.

Furthermore, to say that remote sensing is appropriate method for mapping simply implies that land uses can be done without getting to the field. Aerial photographs or satellite imagery and maps without names of places or features are not maps; and all these can only be provided by land surveying. As a result of all these, this work is making an attempt to see the best way maps can be produced comparing the two methods.

# CHAPTER THREE

## 3.00 METHODOLOGY.

As been said earlier, the aim of this work is to find out the best way mapping could be done between remote sensing and land surveying. The methods and the ways of acquiring data were dealt with respectively. Analysis of data was done seperately and later compared together. The area that has the data on the photograph was selected for the case study, that is, a small area like Ahmadu Bahago Secondary School in Minna.

## 3.10 GENERAL PRINCIPLE OF LAND SURVEYING.

The principle of land surveying is simply called "working from whole to parts". The boundaries of the whole area was first established and thereafter, the detailing within the area then followed, Ramsay (1971) has simply divided the process of surveying into three stages, and which are :

(a) Taking a general view.

(b) Observations and measurements and.

(c) Presentation.

**TAKING A GENERAL VIEW ;-** This one deals with the process of getting the overall picture of what is required before any type of survey work is done. The process is alway achieved during the reconnaissance. In another language, this stage deals with the familiarization of the surveyor to the site concerned. At this stage, the surveyor will be able to know the kind of obstacles that is likely

to occur during the data collection and possible ways of overcoming them. What kind of method is to be applied will be also settled at this stage.

**OBSERVATION AND MEASUREMENT : -** The next stage in land surveying after reconnaissance is the observation. Observation and measurement will be done to determine the relative position and size of both natural and artificial features on the land. The angular observation may be done with the aid of theodolite while the linear measurement is done with the aid of steel tape or EDM.

**PRESENTATION: -** In any survey done, data collected must be presented in a form which allows the information to be clearly interpreted and understood by others. This presentation may take the form of written reports, Bill of Quantities, data sheets, drawings, etc, and in land surveying may result in maps and plans showing the features on the ground in graphic miniature, (Ramsay, 1971). Therefore, for this work, these processes were undertaken.

## 3.20 DISCRIPTION OF MAPPING (TRADITIONAL METHOD)

The process involved in mapping by the application of traditional method can be listed as follows

(i) Familiarization to the site.

(ii) Pegging all the changed points

(iii) Identification and inspection of the control points.

(iv) Running of perimeter travserse from the control points on all the changed points.

(v) Running of the sub-sidiary traverse on the temporary points (TP) within the site for the purpose of detailing.

(vi) Obsevation from the "TP" to all the needed features

(vii) Adjustment of all the observed datum as required.

(viii) Co-ordination of those pegs and temporary points.

(ix) Representation of those points and other details on the paper to get the map.

## 3.21 OBSERVATION PROCEDURE (FIELD WORK)

(i) The three control points were identified.

(ii) Theodolite was set up on the middle one and targets on the remaining two.

(iii) Angular observation was done and the value had was compared with the initial computed angle from the co-ordinates. (These processes formed in-situ check).

(iv) Target on control point ($CP_1$) was transferred to the first changed point ($P_1$) and both angular and linear measurements were done.

(v) The targets and the instrument were moved in squencial order to occupy all the changed points earlier

selected. And on each of them both angular and linear measurements were done.

(vi) Sub-sidiary traverse was run over all the temporary points.

(vii) Detailing was done.

(viii) All the datum were recorded in the field book.

## 3.22 OFFICE WORK

This aspect was divided into

(i) Angular adjustment

(ii) Computation

(iii) Plottings

**ANGULAR ADJUSTMENT:-** The whole angles measured were summed together and compared with the one from the formular.

$$\sum A = (2n + 4)90 \quad \text{---- (3.1)}$$

$$Er = \sum ob - \sum A \quad \text{---- (3.2)}$$

$$Al = 30''\sqrt{n} \quad \text{---- (3.3)}$$

Where

$\sum A$ = Sum of angles from the formular

$\sum ob$ = Sum of the observed angles

Er = Error

Al = Allowable error

n = Number of the observed angles

Er was compared with AL and found to be in order. The whole observation would have been repeated if Er were to be greater than AL.

Computation was finally done in the computation sheet. Plotting followed the computation.

## 3.30 DISCRIPTION OF MAPPING (MODERN METHOD)

The discription of mapping procedure here was purely based on aerial photograph. The basic principle of surveying still holds also for remote sensing. The operation is divided into both field and office work in general. Although before embarking on any task in the area of remote sensing, the following points must be as well put into consideration first. These are:

(i) The purpose of the mapping

(ii) The extent of the area to be mapped and

(iii) Weather condition.

The purpose of work will help in the determination of the type of the film to be used whether panchromatic or multspectral. But the extent of the area to be covered will be of help in knowing the number of exposures needed. Invariably, the two points will help in the determination of cost. After all these might have been done then follows:

(i) Getting familiarity with the site

(ii) Selection of some points to serve as control points.

(iii) Carrying out the ground survey of such points.

(iv) Taking of the exposure at a regular interval such that an overlap of 55% and end lap of 30% will be accounted for.

(v) Carrying out photo interpretation and thereafter mapping. (These form general mapping patterns)

But in the case of this work, steps one to four had been done already, the researcher only dealt with the photographs. In order to carry out the photo interpretation effectively the researcher got himself acquited to the basic knowledge of photo interpretation using shape, shadow, texture, pattern, tone and etc.

## 3.31 INTERPRETATION

In carrying out photo interpretation after having the basic knowledge of photo interpretation, then the following step were adopted.

(i) Overlapping of the photographs to produce mosaic

(ii) Identification of the needed area on the photographs

(iii) Chosing of classification scheme

(iv) Using of some simple tools such as strewscope for direct interpretation.

(v) Carrying out measurements on the photographs

(vi) Getting the measured value converted to the given scale and

(vii) Plotting of the converted value to get map.

## 3.40 MAPPING OF BAHAGO SECONDARY SCHOOL

The land use map of Bahago Secondary was produced from both land surveying and remote sensing method.

## 3.41 SOURCES OF DATA

TABLE 3.1 BELOW GIVES A SUMMARY OF THE DATA USED

TABLE 3.1 SUMMARY OF DATA USED

| Data | Date | Scale | Source |
|---|---|---|---|
| Topographical Map of Bahago Secondary School | 1998 | 1:1000 | Land Surveying Department F.U.T Minna |
| Aerial Photographs | 1982 | 1:6000 | Geography Dept. F.U.T Minna. |
| Professional Scale of fees. | 1996 | - | The Nigerian Institution of Surveyors. |

## 3.42 MAPPING FROM SURVEYING

The author simply got the topographical map of Bahago Secondary School from land surveying department. The report on the map was throughly read. The accuracy of the map was considered and seeing that all the necessary procedure discribed earlier was strictly followed by the producer (odiase, 1998), the author reproduced the map of this work from it. The only details needed were traced out on the tracing paper and then printed. The measurements of the needed details were done and tabulated as shown in the table 4.2

## 3.43 MAPPING FROM AERIAL PHOTOGRAPH

In carrying out this, the following instruments were used.

(i) Aerial photograph (1982, 82563-22,L-13E)

(ii) Set Squares

(iii) Tracing paper

(iv) Card-board paper

(v) Pencil

(vi) Set of drawing pens.

The tracing paper was fixed on the photograph and the needed details were traced out with the aid of pen and set squares. The girds were constructed on the tracing paper that has the details based on the scale of the aerial photograph (1:6,000). Another set of squares were constructed on the card-board paper based on the scale needed for map (1:1000). The details were transferred from the tracing paper to the card-board. This process simply denotes the enlargement of map.

Another piece of tracing paper was fixed on the enlarge map, on the card-board, and all the details were traced on it. The printing of the map was done at the end of tracing. The measurements of the details were done and tabulated as shown in the table 4.2

## 3.44 GROUND TRUTHING

The measurements of selected buildings on both maps were done on the field and tabulated as shown in the table 4.2

The details considered were purely buildings. The information was gathered by the author from the reliable source to know whether some of the buildings have been reconstructed since 1982 to 1998. The infromation showed that no building had been reconstructed except those that have been abandoned since the taking over of the school from the original owner.

## 3.50 COST EVALUATION

The cost of mapping either by traditional or modern method was lifted from the professional scale of fees of the Nigerian institution of surveyors of the year 1996. Fees can be charged principally in two ways and they are:

(i) As a consultant (indirect costs) and

(ii) Direct costs.

This work employs the two ways by which cost can be done. Purposely because of the set goals, the cost for each method was considered on a separate account based on the hectares of land.

The cost for common process was considered also on a separate ground.

The cost for surveying was principally based on the perimeter survey and the detailing. The cost of involved in remote sensing was principally based on acquisition of the photographs and the detailing. Although, detailing is among the common process to both methods and therefore, treated under common process. Establishment of controls, report writing and printing all fall under common process.

## 3.51 COSTING FOR REMOTE SENSING.

As it has been said, the cost here is controlled by the availability of photographs. If the cost of a single exposure using a cameral of format 230mm x 230mm on a scale 1:6000 is known, and end lap of 55% as well as side lap of 30% is required for any operation, the number of the photographs needed would be determined and invariably the cost. In order to determine the number of photograph needed for any number of hectares of land. The following process was taken.

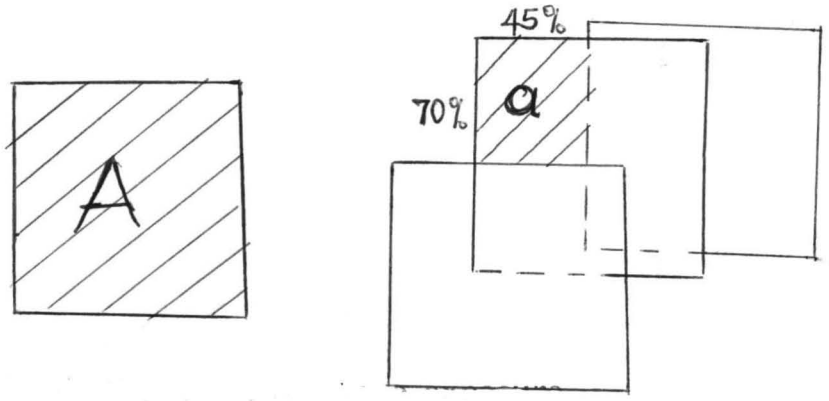



Fig 3.5:- Shows the coverage exposure

If S = 1:6000 (Scale)

F = 230mm x 230mm (Format)

Then

A = 0.23 x 6000 by 0.23 x 6000

= 1380 x 1380

= 1904400$m^2$

A = 190.44Ha

Also

a = 0.23 x 6000 x 0.45 by 0.23 x 6000 x 0.7

= 621 x 966

= 599886$m^2$

a = 60Ha

Therefore,

$$Ne = 1 + (Y - 190)/60 \quad \text{--- (3.4)}$$

Where

A = area covered by a single exposure

a = area not over lapped by exposures

Ne = Number of exposure required

Y = Hectares of land needed to be covered.

## 3.60 METHODS OF DATA ANALYSIS

Data was analysed in different ways based on the aims and objectives of the work. The analysis was done in four classes:

(a) Comparison of maps from both methods

(b) Comparison of data from both methods with ground truthing (Statistically).

(c) Comparison of cost for both methods and

(d) General comparison of both methods for both large and small scale mapping.

## 3.61 COMPARISON OF MAPS

Maps produced from each of the method was traced out, each on a seperate piece of tracing paper. At the end of the tracing, both of them were super-impossed on each other and the differences were noted. The differences that were noted happened to be on whether.

(i) The whole detail on each map fall on one another

(ii) If they do not fall on one another, are they equally displaced.

(iii) Do the details on each cover the same area?And

(iv) Do details on both maps have the same orientation?

## 3.62 COMPARISON OF DATUM FROM BOTH METHODS WITH GROUND TRUTHING

The measurements made from both maps were compared with the measurements of the ground truth respectively, and on a separate

account. Due to the measurements that where taken (lenght and breadth of buildings), pythagoras theorem was applied to get their diagonals. $L_0$ is assigned to the diagonal of the ground truth and $L_1$ to that of surveying while that of remote sensing is $L_2$ comparism was made between $L_0$ and $L_1$ as well as $L_0$ and $L_2$. The steps followed are:

(i) $L_0 = \sqrt{L_2^2 + B^2}$ (ground truth data) -- (3.5)

$L_1 = \sqrt{L_1^2 + B_1^2}$ (surveying data)

$L_2 = \sqrt{L_2^2 + B_2^2}$ (Aerial photograph data)

(ii) $\Sigma J_1^1 = \sum L_0 - \sum L_1^1$ ---- (3.6)

$J_2^2 = \sum L_0 - \sum L_2^2$

Observation was made between $J^1$ and $J^2$.

(iii) Statical analysis then followed using simple linear regression. $L_0$ was taken as constant while $L_1^1$ and $L_2^2$ were taken as variables. Coefficient of determination ($R^2$) and correlation coefficient (r) were determined for each method of mapping.

$L_0 = a + bL_1^1$ ------ (1) ------ (3.71)

$L_0 = a + bL_2^2$ ------ (2) ------ (3.71)

$$b = \frac{\sum dL_0 \, . \, dL_1}{\sum dL_1^2} \qquad \text{------ (3.8)}$$

$$a = \bar{L}_\theta - b\bar{L}_\theta$$

$$R^2 = 1 - \frac{\sum e^2}{\sum dL^2} \qquad \text{------ (3.9)}$$

$$r = \sqrt{R^2} \qquad \text{------ (3.9)}$$

where

Equation (3.7) and (3.71) are linear regression equations for both surveying and remote sensing respectively. a and b are the constance of equation. $R^2$ is the coefficient of determination while r is the correlation coefficient.

## 3.63 COMPARISON OF THE COST

The cost of mapping both large and small scale maps were compared for both methods.

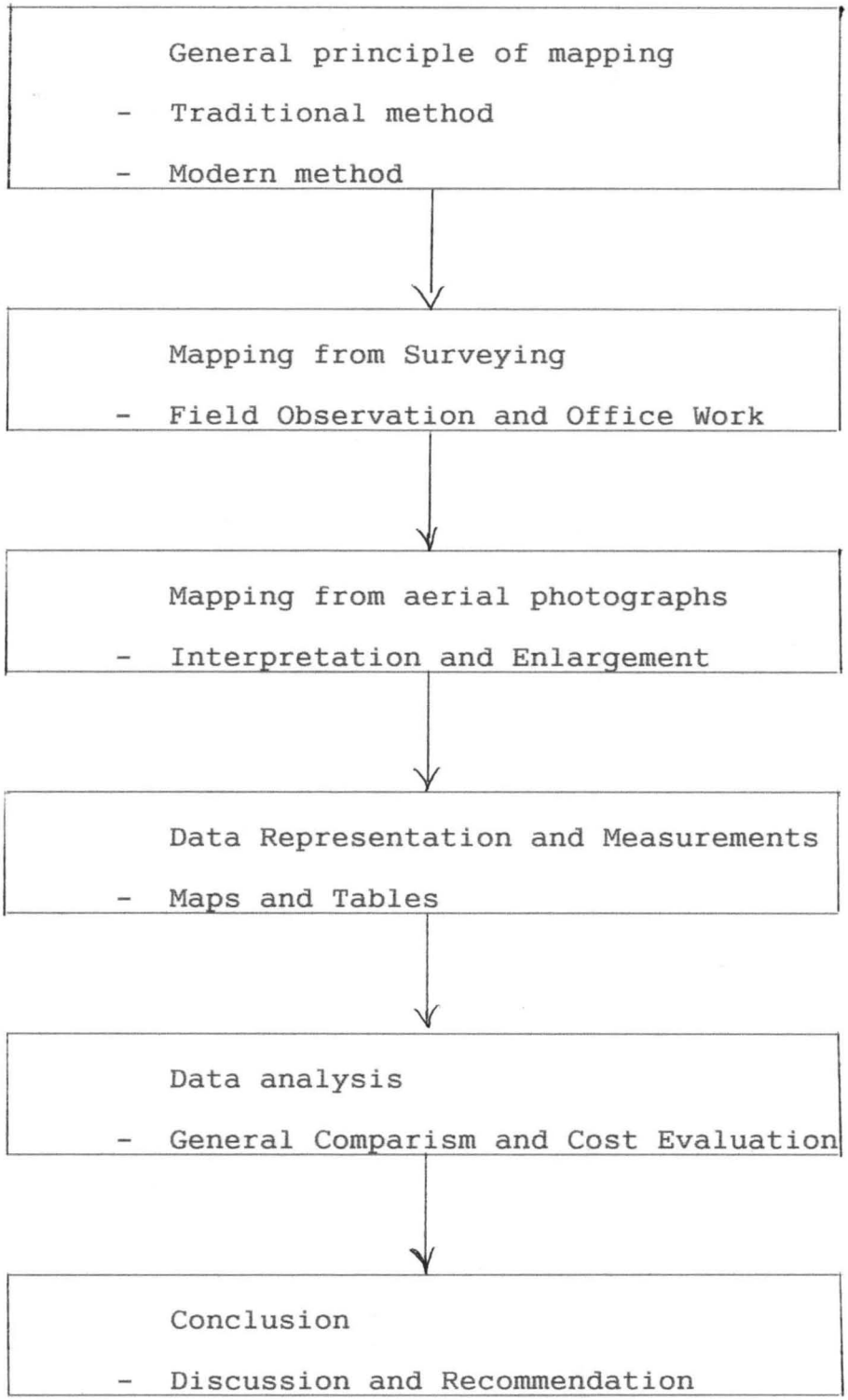
## 3.64 GENERAL COMPARISON OF BOTH METHODS

Both methods were compared generally based on the findings. It was from this that conclusion and discussion were then drawn.

## 3.70 FLOW CHART REPRESENTING THE METHODOLOGY.

The figure below illustrates the flow chart of the methodology followed in this research work.

Table 3.3: The flow chart of the methodology.



The flow chart clearly shows the main six sections of the methodology. The first section deals with general principle of mapping. This was followed by mapping from both surveying and remote sensing, Data representation and measurements and data analysis and discussion of the result.

# CHAPTER FOUR

## 4.0 DATA ANALYSIS

The data analysis, as it has been explained in the methodology chapter, was strictly done under four headings.

## 4.10 MAPS VARIATION

The maps produced from both land surveying and remote sensing were fully considered in order to ascertain variation between the two methods. The researcher had in mind that if there were variation between the two maps then variation is said to exist between surveying and remote sensing. At the end of thorough consideration, the researcher found the following differences between the two maps.

(i) Details did not totally coincide:- When the traced maps of each method were placed on each other, the details were not exactly on each other. Although they have the same orientation and equally displaced.

(ii) Details did not cover the same area:_ The details were found not to cover the same area of land. The details on the map produced from remote sensing appeared to be bigger i:e cover larger area than those details from surveying. Most of the details from remote sensing had their shadow round them which in most cases posed a lot of problems in the measurements and the interpretations.

The measurements of a block (hostel), for example, from both maps are given below

| | Ground Truth | Surveying | Remote Sensing |
|---|---|---|---|
| L | 41.35 | 41.00 | 48.00 |
| B | 7.70 | 8.50 | 9.00 |
| D | 15.22 | 15.00 | 10.00 |

Note:-

L = Length of the hostel

B = Breadth of the hostel

D = Distance between two blocks.

The actual area of land cover is $A^0$ while the area covered as measured from both surveying and remote sensing are $A^1$ and $A^2$ respectively.

$A^0$ = 41.35 x 7.70

= 318.395$m^2$

$A^1$ = 41 x 8.50

= 348.500$m^2$

$A^2$ = 48 x 9

= 432.000$m^2$

The calculation shows that details on remote sensing map covered larger area than details on surveying map, and compared with the actual area covered by the details on the ground. It shows

that surveying is much more closer to the actual than the remote sensing. The distances between details also showed that surveying is far more closer to the actual than remote sensing.

## 4.20 DATA PRESENTATION (MEASURMENTS)

The table 4.2 below gives the measurements of detail that were done on both maps produced from surveying and remote sensing as well as the ground truth.

**TABLE 4.21 SHOWING THE MEASUREMENT FROM GROUND TRUTH, SURVEYING AND REMOTE SENSING.**

| Ground Truth | | Surveying | | Remote Sensing | |
|---|---|---|---|---|---|
| L | B | L | B | L | B |
| 31.90 | 6.62 | 30.00 | 7.50 | 33.00 | 9.00 |
| 28.40 | 6.65 | 28.00 | 7.50 | 30.00 | 9.00 |
| 19.10 | 6.62 | 19.00 | 6.50 | 21.00 | 9.00 |
| 36.15 | 8.90 | 36.00 | 9.00 | 39.00 | 11.00 |
| 28.28 | 9.00 | 30.00 | 9.00 | 28.00 | 12.00 |
| 22.20 | 6.57 | 22.50 | 7.00 | 25.00 | 9.00 |
| 28.65 | 9.00 | 30.00 | 9.00 | 29.00 | 12.00 |
| 30.90 | 12.85 | 31.00 | 13.00 | 33.50 | 12.00 |
| 41.35 | 7.70 | 41.00 | 8.50 | 45.00 | 9.00 |
| 14.15 | 6.58 | 14.00 | 7.00 | 15.00 | 8.00 |
| 21.40 | 10.65 | 20.00 | 7.00 | 22.00 | 11.50 |
| 11.70 | 6.40 | 12.00 | 7.00 | 14.00 | 8.00 |
| 29.60 | 10.55 | 31.50 | 12.00 | 31.00 | 12.00 |
| 17.22 | 6.10 | 18.00 | 7.50 | 18.00 | 9.00 |
| 29.95 | 11.10 | 30.00 | 11.00 | 33.00 | 14.00 |
| 19.48 | 5.96 | 20.00 | 6.00 | 22.00 | 7.00 |
| 23.48 | 8.94 | 22.00 | 6.50 | 25.00 | 8.50 |
| 14.51 | 9.62 | 14.00 | 6.00 | 15.50 | 9.50 |
| 38.75 | 9.22 | 40.00 | 6.50 | 42.50 | 9.00 |
| 9.70 | 5.92 | 10.00 | 6.50 | 10.00 | 7.00 |

As has been said earlier, L and B stand for the length and Breadth of buildings.

## 4.30 CALCULATION OF DIAGONALS

The diagonal of each building was determined with the aid of length and breadth as measured from both maps and the ground truth. Pythagoras theorem was applied as describe in the methodology chapter. $L^0$ is taken for the ground truth diagonal while $L^1$ and $L^2$ are for surveying and remote sensing respectively. The table 4.3 below shows the diagonal for each method and coupled with the ground truth.

**TABLE 4.3 SHOWS THE DIAGONALS.**

| Lo | L1 | L2 | Lo-L1 | Lo-L2 |
|---|---|---|---|---|
| 32.58 | 30.92 | 34.21 | 1.66 | -1.63 |
| 29.17 | 28.99 | 31.32 | 0.18 | -2.15 |
| 20.21 | 20.08 | 22.85 | 0.13 | -2.64 |
| 37.23 | 37.11 | 40.52 | 0.12 | -3.29 |
| 29.68 | 31.32 | 30.46 | -1.64 | -0.78 |
| 23.15 | 23.56 | 26.57 | -0.41 | -3.42 |
| 30.03 | 31.32 | 31.38 | -1.29 | -1.35 |
| 33.47 | 33.62 | 35.58 | -0.15 | -2.11 |
| 42.06 | 41.87 | 45.89 | 0.19 | -3.83 |
| 15.61 | 15.65 | 17.00 | -0.04 | -1.39 |
| 23.90 | 21.19 | 24.82 | 2.71 | -0.92 |
| 13.34 | 13.89 | 16.12 | -0.55 | -2.78 |
| 31.42 | 33.71 | 33.24 | -2.29 | -1.82 |
| 18.27 | 19.50 | 20.12 | -1.23 | -1.85 |
| 31.94 | 31.95 | 35.85 | -0.01 | -3.91 |
| 20.37 | 20.88 | 23.09 | -0.51 | -2.72 |
| 25.12 | 22.94 | 26.41 | 2.18 | -1.29 |
| 17.41 | 15.23 | 18.18 | 2.18 | -0.77 |
| 39.83 | 40.52 | 43.44 | -0.69 | -3.61 |
| 11.36 | 11.93 | 12.21 | -0.57 | -0.85 |
| 526.16 | 526.19 | 569.26 | -0.03 | -43.10 |

$$J_1^1 = \sum(L^0 - L_1^1)$$

$$J_1^1 = -0.03$$

$$J_2^2 = \sum(L^0 - L^2)$$

$$J_2^2 = -43.10$$

$J_1^1$ denotes the variation between the ground truth and surveying while $J_2^2$ stands for the variation between the ground truth and remote sensing. From the calculation above, the researcher found out again that the variation between ground truth and surveying is extremly so small in comparison with that of remote sensing. The calculation of $J_1^1$ and $J_2^2$ are just to show the comparism of errors of land surveying and remote sensing with the ground truth measurements. Therefore, it was clearly shown that surveying is more accurate than remote sensing.

## 4.40 STATISTICAL ANALYSIS

For analysis, any set of data just simply with the aid of observation and summarization may not be enough for drawing conclusion. Therefore, in order to show the proof further, statistical analysis followed. The relationship between the ground truth and surveying and as well as the ground truth and remote sensing were statistically analysed as shown in the tables 4.41 and 4.42 respectively. The diagonals computed were used believing that raw dimensional measurements might be subjected to some little errors.

**TABLE 4.41 SHOWS THE STATISTICAL ANALYSIS BETWEEN GROUND TRUTH AND SURVEYING.**

| | | Y | X | | | | ∧ | | |
|---|---|---|---|---|---|---|---|---|---|
| Lo | L1 | Lo-Lo | L1-L1 | $y^2$ | $x^2$ | x.y | L0 | e=Lo-Lo | $e^2$ |
| 32.58 | 30.92 | 6.272 | 4.611 | 39.338 | 21.261 | 28.920 | 30.773 | 1.807 | 3.265 |
| 29.17 | 28.99 | 2.862 | 2.681 | 8.191 | 7.188 | 7.673 | 28.904 | 0.266 | 0.071 |
| 20.21 | 20.08 | - 6.098 | - 6.229 | 37.186 | 38.800 | 37.984 | 20.276 | -0.066 | 0.004 |
| 37.23 | 37.11 | 10.922 | 10.801 | 119.290 | 116.662 | 117.969 | 36.767 | 0.463 | 0.214 |
| 29.68 | 31.32 | 3.372 | 5.011 | 11.370 | 25.110 | 16.897 | 31.160 | -1.480 | 2.190 |
| 23.15 | 23.56 | - 3.158 | - 2.749 | 9.973 | 7.557 | 8.681 | 23.646 | -0.496 | 0.246 |
| 30.03 | 31.32 | 3.722 | 5.011 | 13.853 | 25.110 | 18.651 | 31.160 | -1.130 | 1.277 |
| 33.47 | 33.62 | 7.162 | 7.311 | 51.294 | 53.451 | 52.361 | 33.388 | 0.082 | 0.007 |
| 42.06 | 41.87 | 15.752 | 15.561 | 248.126 | 242.145 | 245.117 | 41.376 | 0.684 | 0.468 |
| 15.61 | 15.65 | -10.698 | -10.659 | 114.447 | 113.614 | 114.030 | 15.987 | -0.377 | 0.142 |
| 23.90 | 21.19 | - 2.408 | - 5.119 | 5.798 | 26.204 | 12.327 | 21.351 | 2.549 | 6.497 |
| 13.34 | 13.89 | -12.968 | -12.419 | 168.169 | 154.232 | 161.050 | 14.282 | -0.942 | 0.887 |
| 31.42 | 33.71 | 5.112 | 7.401 | 26.133 | 54.775 | 37.834 | 33.475 | -2.055 | 4.223 |
| 18.27 | 19.50 | - 8.038 | - 6.809 | 64.609 | 46.362 | 54.731 | 19.715 | -1.445 | 2.088 |
| 31.94 | 31.95 | 5.632 | 5.641 | 31.719 | 31.821 | 31.770 | 31.770 | 0.170 | 0.029 |
| 20.37 | 20.88 | - 5.938 | - 5.429 | 35.260 | 29.474 | 32.237 | 21.051 | -0.681 | 0.464 |
| 25.12 | 22.94 | - 1.188 | - 3.369 | 1.411 | 11.350 | 4.002 | 23.046 | 2.074 | 4.301 |
| 17.41 | 15.23 | - 8.898 | -11.079 | 79.174 | 122.744 | 98.581 | 16.580 | 1.830 | 3.349 |
| 39.83 | 40.52 | 13.522 | 14.211 | 182.844 | 201.953 | 192.161 | 40.069 | -0.239 | 0.057 |
| 11.36 | 11.93 | -14.948 | -14.379 | 223.443 | 206.756 | 214.937 | 12.384 | -1.024 | 1.049 |
| 526.16 | 526.19 | | | 1471.630 | 1536.569 | 1487.914 | | | 30.829 |

$$\bar{L0} = \frac{\sum L0}{20}$$

$$= \frac{526.16}{20}$$

$$\bar{L0} = 26.308$$

$$Y = L0 - \bar{L0}$$

$$\bar{L1} = \frac{\sum L1}{20}$$

$$= \frac{526.18}{20}$$

$$= 26.309$$

$$x = L1 - \bar{L1}$$

$$b1 = \frac{\sum xy}{\sum x^2}$$

$$= \frac{1487.914}{1536.569}$$

$$= 0.968$$

$$a1 = \bar{L0} - b1\bar{L1}$$

$$= 26.308 - 0.968 \times 26.309$$

$$= 0.842$$

$$\ell$$

$$L0 = 0.842 + 0.968L^1$$

$$e = L0 - \hat{L0}$$

$$R^2 = 1 - \frac{\sum e^2}{\sum y^2}$$

$$= 1 - \frac{30.829}{1471.630}$$

$$= 1 - 0.02095$$

$$= 0.9791$$

$$R^2 = 97.91\%$$

$$r = R^2$$

$$r = 0.9791$$

$$= 0.9895$$

$$\therefore r = 98.95\%$$

Thus, the co-efficient of determination $R^2$ indicates the variation in Land Surveying, as explained by linear regression, on the ground truth to 97.91%. The correlation co-efficient r shows that there was positive relationship between surveying and ground truth to 98.95%.

In a nutshell, the calculations show that there was indeed variation between land surveying and the ground truth measurements.

**THE TABLE 4.42 SHOWS THE STATISTICAL ANALYSIS BETWEEN GROUND TRUTH AND REMOTE SENSING.**

| Lo | L2 | $y$ $L0-\bar{L0}$ | $x$ $L2-\bar{L2}$ | $y^2$ | $x^2$ | x.y | $\wedge$ L0 | e Lo-L0 | $e^2$ |
|---|---|---|---|---|---|---|---|---|---|
| 32.58 | 34.21 | 6.272 | 5.797 | 39.338 | 33.605 | 36.359 | 31.734 | 0.846 | 0.716 |
| 29.17 | 31.32 | 2.862 | 2.907 | 8.191 | 8.451 | 8.320 | 29.029 | 0.141 | 0.020 |
| 20.21 | 22.85 | - 6.098 | - 5.563 | 37.186 | 30.947 | 33.923 | 21.101 | -0.891 | 0.794 |
| 37.23 | 40.52 | 10.922 | 12.107 | 119.290 | 146.579 | 132.233 | 37.640 | -0.410 | 0.168 |
| 29.68 | 30.46 | 3.372 | 2.047 | 11.370 | 4.190 | 6.902 | 28.224 | 1.456 | 2.120 |
| 23.15 | 25.57 | -3.158 | -2.843 | 9.973 | 8.083 | 8.978 | 23.647 | -0.497 | 0.247 |
| 30.03 | 31.38 | 3.722 | 2.967 | 13.853 | 8.803 | 11.043 | 29.085 | 0.945 | 0.893 |
| 33.47 | 35.58 | 7.162 | 7.167 | 51.294 | 51.366 | 51.330 | 33.016 | 0.454 | 0.206 |
| 42.06 | 45.89 | 15.752 | 17.477 | 248.126 | 305.446 | 275.298 | 42.666 | -0.606 | 0.367 |
| 15.61 | 17.00 | -10.698 | -11.413 | 114.447 | 130.257 | 122.096 | 15.625 | -0.015 | 0.000 |
| 23.90 | 24.82 | - 2.408 | - 3.593 | 5.798 | 12.910 | 8.652 | 22.945 | 0.955 | 0.912 |
| 13.34 | 16.12 | -12.968 | -12.293 | 168.169 | 151.118 | 159.416 | 14.802 | -1.462 | 2.137 |
| 31.42 | 33.24 | 5.112 | 4.827 | 26.133 | 23.300 | 24.676 | 30.826 | 0.595 | 0.354 |
| 18.27 | 20.12 | - 8.038 | - 8.293 | 64.609 | 68.774 | 66.659 | 18.546 | -0.276 | 0.076 |
| 31.94 | 35.85 | 5.632 | 7.437 | 31.719 | 55.309 | 41.885 | 33.269 | -1.329 | 1.766 |
| 20.37 | 23.09 | - 5.938 | - 5.323 | 35.260 | 28.334 | 31.608 | 21.326 | -0.956 | 0.914 |
| 25.12 | 26.41 | - 1.188 | - 2.003 | 1.411 | 4.012 | 2.380 | 24.433 | 0.687 | 0.472 |
| 17.41 | 18.18 | - 8.898 | -10.233 | 79.174 | 104.714 | 91.053 | 16.730 | 0.680 | 0.462 |
| 39.83 | 43.44 | 13.522 | 15.027 | 182.844 | 225.811 | 203.195 | 40.373 | -0.543 | 0.295 |
| 11.34 | 12.21 | -14.948 | -16.203 | 223.443 | 262.537 | 242.202 | 11.142 | 0.198 | 0.039 |
| 526.16 | 568.26 | | | 1471.630 | 1664.545 | 1558.208 | | | 12.959 |

Where Lo and L2 are the diagonals calculated from the measurements of both ground truths and remote sensing respectively.

$$\bar{L}o = \frac{526.16}{20}$$

$$Lo = 26.308$$

$$\bar{L}2 = \frac{568.26}{20}$$

$$= 28.413$$

$$R^2 = 1 - \frac{\sum e^2}{\sum y^2}$$

$$= 1 - \frac{12.959}{1471.63}$$

$$= 1 - 0.0088$$

$$= 0.9912$$

$$R^2 = 99.12\%$$

$$\therefore r = R^2$$

$$= 0.9912$$

$$= 0.9956$$

$$r = 99.56\%$$

It implies that there is a positive relationship between ground truth and remote sensing to 99.56%. $R^2$ shows that the total variation in remote sensing on the ground truth, as explained by the linear regression, is to 99.12%. $R^2$ and r, indicates that there is variation between remote sensing and ground truth measurements.

The calculations of $R^2$ and r for both land surveying and remote sensing with respect to the ground truth clearly showed that surveying is more accurate. The variation that exists between remote sensing and the ground truth is greater than that of land surveying and ground truth.

## 4.50 ERROR DETERMINATION IN PERCENTAGE

Though, many ways have been used in the anaysis of the data, it will not be too much to express the totality of error being committed in percentage. From table 4.3

$\sum L_0 = 526.16$

$\sum L_1 = 526.19$

$\sum L_2 = 569.26$

$$\sum r_1 = \frac{(\sum L_1 - \sum L_0)}{\sum L_0} \times 100\%$$

$$= \frac{526.19 - 526.16}{526.16} \times 100\%$$

$$= \frac{0.03}{526.16} \times 100\%$$

$$= \frac{3}{526.16}$$

$Er_1 = 0.006\%$

$$Er_2 = \frac{(\sum L_2 - \sum L_0)}{\sum L_0} \times 100\%$$

$$= \frac{569.26 - 526.16}{526.16} \times 100\%$$

$$= \frac{43.1}{526.16} \times 100\%$$

$Er^2 = 08.2\%$

The error in surveying as shown by $Er_1$ is 0.006% while that of remote sensing as shown by $Er_2$ is 08.2%.

## 4.60 COST ANAYSIS

The cost was analysed for each method on a seperate grounds. Surveying was done on the grounds of perimeter survey and detailing while remote sensing was on acquisition of photographs and the detailing. The tables below give the step by step of the costing.

**TABLE 4.6 SHOWS THE COST OF PERIMETER SURVEY PER HECTARE.**

| Land Area (Hectare) | Cost # Savannah Region |
|---|---|
| up to 1 | 80,000 |
| 1 - 10 | 109,125 |
| 10 - 20 | 121,765 |
| 20 - 30 | 130,885 |
| 30 - 40 | 137,935 |
| 40 - 50 | 143,335 |
| 100 | 268,335 |
| 200 | 518,335 |
| 400 | 768,335 |
| 500 | 1,018,335 |
| 1000 | 2,268,335 |
| 2000 | 4,768,335 |
| 10,000 | 24,768,335 |
| 20,000 | 49,768,335 |
| 50,000 | 124,768,335 |
| 100,000 | 249,768,335 |

(Source:- Professional Scale of Fees)

The area of study belong to savannah region and its of 26 Hect, The total sum of ONE HUNDRED AND THIRTY ONE THOUSAND (131,000:000) would have been spent if it were to be contracted out of a survey firm.

**TABLE 4.70 SHOWS COST PER NUMBER OF EXPOSURES**

| Land Area (Hect.) | Ne | Cost (#) |
|---|---|---|
| ≤ 190 | 1 | #x |
| 250 | 2 | 2x |
| 500 | 6 | 6x |
| 1000 | 14 | 14x |
| 2000 | 31 | 31x |
| 5000 | 81 | 81x |

Ne stands for the number of exposure and #X stands for the cost of a single exposure. But the main problem here is how to get the cost of a single exposure. In the professional scale of fees, it was clearly stated in the section 90.2 to 90.3 that "Most of the jobs under this group are major jobs and are likely to be subjected to tender. For this type of survey, the invitation to tender will contain details of specifications, procedure, and process parameters depending on the needs of the client and the bills of quantities upon which the costing of the project will be based

with prevailing rate". An alternative way also was given in the scale of fees in a situation when the cost of the project is known in that case table 4.71 will be applicable.

**TABLE 4.71 SHOWS FEES FOR KNOWN COST OF PROJECT**

| Cost of Project | Fees Payable as a % of Project |
|---|---|
| First 5 Million | 4.75% |
| Next 10 Million | 4.50% |
| Next 15 Million | 4.25% |
| Next 45 Million | 4.00% |
| Next 75 Million | 3.50% |
| Next 150 Million | 3.00% |
| Next 200 Million | 2.50% |
| Balance over 500 Million | 1.75% |

(Source:- professional scale of fees)

It is not always possible especially in the developing countries like Nigeria to get the cost of the project from the clients. But if this one could be settled, the other forms of costs are the same as that of land surveying.

## 4.70 GENERAL ANALYSIS

The two maps produced from each method were properly examined and some important differences were noted. From the aerial photograph alot of features that were less than 3m in length or breadth could not be identified. The scale of the aerial photograph is 1:6000 which gives room for minimum plotable error of 3m in the length or breadth. The minimum area that can be identified for any feature is $9m^2$. It therefore implies that many tiny features can not appear on the photographs. Bore-hole or a well, electric poles, telephone line and etc. cannot be easily identified on the photographs while all these details were provided on the map from surveying.

It was also noted that production of map from aerial photograph manually was much more tasking than surveying especially when a very high accuracy is needed. Surveying was found to entail fine wastage for any work where high accuracy is not demanded. It was also discovered that the usefulness of the photographs was highly affected by how they were being kept. Shrinkage affects the photographs alot. Many photographs were also found out to be affected by expansion due to the overusage which may be responsible for error when they were being arranged with those that have not been over used.

The observation of both maps and due to the measurements on them, it was discovered that measurements from photograph were of uniform variation with the ground truth though very large; and

which made it to be of lower accuracy compare with surveying of very little variation.

## 4.80 DISCUSSION OF RESULTS

The main aim of this work was to compare Land Surveying and remote sensing as methods for land cover mapping under accuracy and cost among other things. In other to achieve the aims and the objectives of the study an hypothesis was formulated. After the presentation and analysis of all the data collected; Statistically and mathematically, the following findings were made.

There was variations between the measurements taken on both maps produced from both methods as compared with the ground truth measurements. The variation between the ground truth and surveying was very small while the variation in the measurements of the ground truth and remote sensing was very large.

From the percentage error arrived at, it was clearly shown that land surveying was more accurate than remote sensing as method for large scale land cover mapping. The error of surveying as compared with the ground truth was 0.006% while that of remote sensing was 08.2%. Although, the percentage of error for both were small still land surveying has the lowest error out of the two.

The statistical analysis provided an insight into land surveying and remote sensing as compared with the ground truth measurements. It was discovered that the relationship between ground truth and the remote sensing, as explained by regression line

equation, was greater than that of surveying 99.12% and 97.91% respectively. This simply implies that the two methods can be used as methods for land cover mapping. It was discovered that the variation coefficient of correlation for remote sensing was greater than that of surveying, 99.56 and 98.95 respectively. Therefore, it shows that surveying is better than remote sensing in terms of variation.

The cost analysis shows that land surveying was a little bit economical in the developing countries like Nigeria more than remote sensing. The researcher was able to get cost for surveying but found it difficult to get for remote sensing. Many firms dealing with mapping were consulted and the answer gave were almost the same. Many frankly said that they do not embark on such projects. And many like sapol mappers and planners limited was of opinion that using of remote sensing in mapping is entirely the work of developed nation. In the professional scale of fees for surveyors where the cost for surveying was taken from categorically pointed it but that the job under remote sensing was subjected to tender. Ihemadu (1985) said that due to the current pricing of remote sensing data products on a cost-recovery basis, coupled with the need to make the payment in hard currencies, the developing countries found these product virtually beyond their reach. Therefore, it was simply deduced that remote sensing is more expensive than land surveying as a method for land cover mapping.

The research also showed that remote sensing could not be wholly applied as method for land cover-mapping without land surveying.

Ground controls are needed for the orientation and co-ordination and ground controls are mainly produced through land surveying techniques. The scale of the photographs cannot be determined without having controls. But maps are being produced from land surveying techniques without referring to remote sensing. It therefore, implies that remote sensing depends on land surveying.

It was also dicovered that one could be of impression that both methods as of today, could be said as of having the same speed in the excursion of any operation. Not all the 365 days of a year are condusive for taking photographs and which of course delay the operation. The processing of photographs is not done in any developing countries which serves as another delay. Development of aerial photographs will not be possible without the ground controls that will come via surveying. It implies that any delay in surveying will increase the days of delay in remote sensing. And in the case of surveying, some instruments have been designed now that are capable of giving the co-ordinate of any point e.g GPS instruments. This one has now greatly reduced the time taken in perimeter survey of a large area. And in case of a small area, the instrument called total station has beeen equally designed. This instrument can measure both the angles and the distance. In detailing, for surveying, though tedious more than remote sensing, the operation is done once during field work but it will be twice for remote sensing; one on the photograph and two during the field inspection.

Therefore, we may venture to conclude on the basis of answer

finding in this work that land surveying is better than remote sensing in terms of accuracy, dependability, speed and cost effectiveness as a method for large scale cover mapping in developing countries like Nigeria.

# CHAPTER FIVE

## SUMMARY AND CONCLUSION

The importance of maps and other forms of land and land related records cannot just be over emphasized due to the roles being played in our socio-economic and political development. Land in-dispute between the Families, Communities, Villages, Towns, States and even countries is always a case in any court of law. Many lives and property worth of billions have been destroyed in both Modakeke and Ife. Niger Delta crises is not on anything more than their cherished land. Nigeria and Cameroun are engaging in war based on land matter.

Land controls life. Mineral resources that always empowered the economy of any country can not be got from any where more than from land. The only asset that can be transferred from one generation to another is land. The final resting place of anyone is land. Therefore, land records such as map must be seriously protected.

The engineering works today are always in shamble due to the lack of proper record on the land. Political problems in many Local Government areas and as well as States would not have been erupted if proper land record were available. The problem of Ife and Modakeke was as a result of Head quarter of a Local Government that was wrongly located. Such a problem would not have been ocurred or prevented if proper and current maps were to be available at that material time.

Maps that are available in Nigeria both at States and Federal level are those produced from the aerial photograph of

1974. Most of them are still having their tittle as either Western or Northern or Eastern region. Nigeria has undergone different stages of States creation since then. Original it was divided into regions later in 1976 into twelve States. Thereafter, Nineteen States and followed by twenty one States. Not sooner than later Nigeria turned out to have thirty six States excluding the Federal Capital Territory. As the country is changing in the number of States so also the States are changing in the number of Local Government. But it is a sad thing to know that most of these stages being passed through by the country were not properly documented. Many places, Villages and Towns in Nigeria have had their names changed and without being reflected on most of our maps that cover such areas. Many of the Villages have been relocated and without being reflected on the maps. Most of the roads that were constructed just ten years ago were not having any map showing them.

Now that maps are so vital to the development of any nation how could maps be then produced? There are two ways by which maps can be produced and which are by either land surveying technique or remote sensing method. But which of them will produce the best map at very high speed and less cost. In a simple language, this work was aimed at assessing the accuracy of the map produced from land surveying and remote sensing as methods for large scale,Land cover mapping. The cost and dependability of each was also put into considertion.

The aims and objectives of this work were achieved by chosing Ahmadu Bahago Secondary School which is located at Bosso Local Government of Niger state of Nigeria.It was formally called Niger

Baptist College, and it was found on Minna topographical map sheet of 164 which is on a scale 1:100,000. it was also found on the aerial photograph of Minna township (82563 - 22, L - 13E). The area of this study is purely lied in savannah region. The main reason why the area was chosen was because of the fact that it has both topographical map and the aerial photograph which give ease assessement. Details that appeared on the photograph and topographical map happened to be still in - situ.

Some details were identified on both topographical map and the aerial photograph and as well as on the land. The dimensions of such detils were measured from both maps produced from both surveying and remote sensing method. The ground truths were also measured on the field. The data was collected on the cost for each from both the professional scale of fees for surveyors and some survey firms. Therefore, the methodology followed can be stepped down to the acquisition of data (The aerial photographs, topographical maps and scale of fees for surveyor), interpretation and mapping. The datum were presented inform of maps, tables and figures.

The analysis of datum was mainly be observation and computations. The two maps produced from the two methods were critically examined and the differences were noted. Pythagoras theorem was used for the determination of the diagonals of the details measured on both maps and well as on land. The computations of the diagonals were then compared. The percentage of errors for both methods with respect to the ground truth were also computed and compared. Statistical analysis were carried out between ground truth

and land surveying and as well as ground truth and the remote sensing.

The information gathered from the data analysis affirmed the hypothesis which says that "Land surveying is better than remote sensing in term of accuracy, cost and dependability". From the error computation; remote sensing has greater error which showed that surveying is more accurate. The comparison of the source of cost for each method showed that surveying is relatively cheaper for small area. From the linear regression, it was discovered that both methods are good for mapping of different functions. Therefore, in conclusion, land surveying is more accurate than remote sensing especially for a large scale map.

## 5.20 RECOMMENDATION

Having carefully studied both land surveying and remote sensing as methods for land cover mapping . The following recommendations are hereby made:

(i) Land surveying has the lowest error; therefore, recommended for mapping of higher accuracy.

(ii) The error of remote sensing is greater, therefore recommended for a small scale mapping due to the fact that the scale will take care of any error to the bearest minimum.

(iii) The environmental monitoring needs only small scale maps therefore, remote sensing is higly recommended for the mapping of environmental monitoring.

The researcher of this work only dealt with the cost on estimation especially that of the remote sensing, thereby, is of opinion that future research could be carried out properly on the cost and as well as using other means of land surveying and remote sensing, besides traversing and aerial photographs, for methods of land cover mapping.

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