# APPLICATION OF REMOTE SENSING TECHNIQUES [AERIAL PHOTOGRAPH] TO THE ESTIMATION OF BUILDINGS IN (SOJE WARD) OF MINNA, NIGER STATE.

BY

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# APPLICATION OF REMOTE SENSING TECHNIQUES (AERIAL PHOTOGRAPH) TO THE ESTIMATION OF BUILDINGS IN (SOJE WARD) OF MINNA, NIGER STATE

This study was carried out in partial fulfillment of the Department of Geography Federal University of Technology, Minna in the award of Masters of Technology (M,Tech.) in the Department.

## CERTIFICATION

This is to certify that the research work entitled,, Application of REMOTE SENSING TECHNIQUES (AIR-PHOTOGRAPH) TO THE ESTIMATION OF BUILDINGs IN (SOJEWARD) OF MINNA, NIGER STATE, was carried out by Mr. MOHAMMED Abdulkadir ( M.TECH./ SSSE/97/148) of the Department of GEOGRAPGY, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, under my supervision, and it is hereby approved:

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# DEDICATION

This project is dedicated to my parents Madam Aishat Aminu, Mallam Aminu Umar, Madam Hausetu Amana Muye, also including the rest members of the family who have been pillars in my pursuit for success and who have done everything in their power to see that I succeed. Most especially, Dr. Mohammed Usman Kandi, (Late) also, to my sisters, brothers, friends and my lovely wife, Madam Hawawu Abdulkadir and our two children Musa and Habibat.

Lastly, to my best friends, Yahaya Ndatsu Suleiman, Ndatsu Idris and Adamu Zubair Evuti for their moral support and prayers.

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Mohammed Abdulkadir.

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# CHAPTER ONE

## INTRODUCTION

Remote sensing is the science and art of obtaining information about an object area, or phenomenon through the analysis of data acquired by a devices that is not in contact with the object area phenomenon under-investigation Thomas M. L. nd Kelfer, R. W. (1979). Collectively, remote sensing encompasses a wide range of natural processes such as vision and hearing, and artificial techniques such as photography and radar detection. In science and technology today, however, remote sensing refers specifically to the use of artificial devices usually electromagnetic sensors to monitor the earth's surface and atmosphere on a regional and global scale.

In urban and regional planning, the complexity of human activities and the high density of buildings, mapping the land use of an area is always difficult But nowadays, most land-use and land covers surveys make use of air craft or satellite imagery. The success of the photo- interpretation depends on a good correspondence between function (human activities) and form.(morphology) of the built-up area. Planners require nearly continuous acquisition of data to formulate governmental programmes and policies. These policies programme might range from the social, economic and culture domain to the context of environmental and natural resources planning. The role of planning agencies is extending to wider range of activities. Consequently, there is an increased need for these agencies to have timely, accurate and cost effectives sources of data of various forms. Several of these data needs are well served by air photo-interpretation in population estimation, housing studies, traffic and parking studies, and route, and site selection processes.

In population estimation study, for example, these can be obtained indirectly through the air-photo interpretation. The procedure is to use medium-to-large scale aerial photographs to estimate the number of dwelling units of each housing type in an area (single-family, two family, multiple family and then multiply the number of dwelling units by the average family size per dwelling units for each housing type).

Air-photo interpretation in the studies of housing; many environmental factors affecting housing (residential) can be readily interpreted from aerial photograph, while others (such as the interior condition of building cannot be directly interpreted. A reasonable estimation of housing quality can usually be obtained through statistics analysis of a limited carefully selected set of environmental quality factors. Environmental factors that are interpreted from aerial photographs and that have been found to be useful in housing studies include house size, lot size, building density, building set-back, street side walk condition, drive way presence/absence, vegetation quality, yards and open space maintenance, proximity to park land, and proximity to industry land-land use. Large scale panchromatic photography has typically been used for housing quality studies.

However, a noticeable feature of the previous studies is the over dependence on the wind-shield survey that makes use of questionnaires administered by the enumerator's on the selected samples. These data are therefore subject to vagaries of the enumerator's intuition, background experience and their levels of intelligent interpretation of the featured questions in the research. For instance, a building with few cracks and some defective windows may be judged as being in fair condition by an enumerator, while another may consider similar building as being in poor condition. The poor data acquisition will obviously affect the result of any analysis based on them. The data collected through the conventional method rely heavily on the integrity of the respondents answers to questions raised in the questionnaires. The respondents may mis-interprete the purpose of the research and give wrong responses, often times the respondents may feel they do not have anything at stake in the research, therefore they are not obliged to give accurate information.

In view of these, it is ripe to try other methods of identifying, analysing, accessing and predicting urban residential building and the problems associated with it. As early as 1970, the possibilities of employing remote sensing data to assist in the study of urban qualities have been suggested. Moore (1970), suggested the use of remote sensing data as alternative means of effectively measuring housing quality. He noted the growing concern on the inadequacies in urban data.

There are two types of contribution which remote sensors can make in an applied context. The acquisition of data and execution of tasks which were currently undertaken with different techniques.

However, this study attempts to use remote sensing techniques to estimate the numbers of buildings in the sample areas; percentage distributional pattern of residential land use density and to provide accessibility index in the sample areas. Such approach should allow intelligent intercomparison of cities the study will concentrate on evolving a procedural mechanism to monitor the process using visual photo-interpretation of the remotely sensed data with mirror stereo-pairs and field check to reconcile the building.

Finally, this research is strictly limited to the numbers of buildings of any type i.e single building(mud & cement block) one-stories building, two storied buildings, three storied buildings and uncompleted buildings.

## 1.1 PROBLEM STATEMENT

Minna as a metropolitan town is seen to be growing gradually at a specific rate. As the capital of Niger State, in terms of developments Minna has been expanding and engulfing its surrounding areas. The study area, Soje was amoung the early settlement since 60's and was mostly in the original Minna settlements and for the fact that it is believed to have been an old settlement, changes or development in terms of building is seen to be a gradual process, this could be traced to the landscape of the area. However, this could be addressed by intergrating remote sensing data with conventional data (field work) in a system that describes and report these developments. Remote sensing application provide a means of monitoring changes in the distribution of activities which in turn are related to socio-economic changes.

The problem faced by this research may be classified into problem of manpower shortage, product acquisition, etc. this problem restricts the use of sensors to mainly the photographic type, to the virtual exclusion of electro-optical imaging and radar/microwall. This restriction on its part, limits the potency of remote sensing technique as a tool for solving developmental problems. Indeed, the level of interpretation, which determines the extent of usefulness of remotely sensed data, is a function, interalia, of the nature of sensor used. for instance, whereas a target may be identified as a building from a simple image identification, more linkage requiring expertise and possible change of sensor are needed to interpret the use to which building is put. Such applications, leading to suitable distinctions demand experience in applying image enhancement and transformation techniques. Their position is further worsened by an inability to define the tasks and targets precisely in terms of their spatial, spectral and temporal characteristics, owing to the usual absence of necessary research data on the prevalent peculiar targets.

With the current pricing of remote sensing data products on a cost recovery basis, coupled with the need to make the payments in hard currencies, these products find virtually beyond the reach of this research.

With the prevalent gross inadequacies in financial resources, this situation considerably limits the type and level of information that can be generated in these research projects.

This study is to use remote sensing approach in order to evaluate the extent to which estimation of buildings can be made on aerial photographs. Because housing problems in most urban areas relates to lack of proper data during the researches conducted.

## 1.2 OBJECTIVES OF THE STUDY

The study will focus on these special objectives

i. To examine and estimate the number of buildings in sample area

ii. To determine the distributional pattern of buildings in the area

iii. To examine the extent to which dwelling houses/unit can be estimated from aerial photographs in the sample area of Minna

iv. Make suggestions on future physical planning in the area.

## 1.3 JUSTIFICATION FOR USING REMOTE SENSING

Remote sensing of the earth, is the science and art of deriving information about the earth's land and water areas from images acquired at a distance level from the surface, which relies upon measurements of electromagnetic energy reflected or emitted from the features of interest.

One of the best modern techniques for estimating residential building is remote sensing, because it provides a permanent synoptic, spatial and temporal records of an environment.

These qualities permits rapid in-house assessment of land use changes with reduced field work, highly, verifiable and consistent result.

In broader sense, based on its application to census surveys population estimation and survey for urban renewal. The first prerequisite information for population count is the identification of where the people live, this means the identifications of residential buildings in the area. (Adeniyi, 1975). In order to locate correctly, all settlements aerial photographs are necessary. Having identified all the settlements the next step is the identification and delimitation of residential areas within each settlement. From the result of the photographic count aforementioned, and the time taken to do this. It is estimated that about 349-500 residential houses can be counted on black and white aerial photograph of 1:6,000 by using mirror stereoscope within an hour as against 127-200 houses on the ground. This exercise is considered to be very important for the fact that most urban centres in Nigeria are not planned hence street patterns cannot be used for accurate delimitation of EAS as it done in places such as the United States of America and Canada.

Finally, in justifying remote sensing data, field (ground) are collected for verification, evaluation or assessment of results obtained from remote sensing investigation and to provide reliable data to guide the analytical process.

1.4 **DESCRIPTION OF THE STUDY AREA.**

1.4.1 **Location:** Minna lies at latitude 90 37' North and longitude 6033' East on geological base of in differentiated basement complex of mainly gneiss and magnetite. To the North East of the town a more or less continues steep outcrop of granite occurs limiting any urban development in that direction.

It is located near the federal capital territory (F.C.T,)Abuja, and found in the middlebeit of Nigeria. It shares common boundaries with Kebbi State in the North and North East by Kaduna, and Kwara State in West.

The area (Soje ward) of Minna lies West **of** the stream and in the West is the dual carriage, bounded by rail line of two different routes (fig. 1.1).

**1.4.2 CLIMATE**

The mean annual rainfall is 1334mm taken from an exceptionally long period of 54 years. This highest mean monthly rainfall is September with almost 300mm.

The rainy season is on an average of between 190-200 days. The mean monthly temperature is highest in March at $30.5^0$C and lowest in August at $25.1^0$C.

Since climate is the is the fundamental physical features as well as economic features of a region are related, that of Minna cannot be exceptional. Before a photographic mission is intended for a region, it's climate and weather condition has to be noted with parameter references to parameters like cloud cover, rainfall and eventime of the day including visibility.

Minna, for any reasonable photographic mission to be undertaken, it must be within the month of December and March.

This is because of the cloud cover that persists within the month of April and November. However, within the ideal period of photography for this area (Minna), we usually experienced the north-easterlies dry and dust laden wind which reduces visibility appreciably. The dust laden and dry easterlies originate from the high pressure/horse latitude in the desert.

### 1.4.3 AREA EXTENT

The study area extend along the main spine road from Chanchaga in south Bosso in the north, a distance of about 16 kilometers (about 885 hectares).

The hills to the north and east, being steeply sloping rock outcrops from the principal physical constraints on the East Side.

### 1.4.4 DRAINAGE

A major drainage valley flows from the centres of the town southwest wards with many minor drainage channels feeding into it with storm run off from the hills to the east. In places these streams form large areas of flood land. There are large but isolated rock outcrops in this landscape and also some areas of scattered rock.

### 1.4.5 SOILS AND VEGETATION

The soils and vegetation communities of Niger State occupy an important position in her development. The soils in the state were derived from:

(a) The hydromorphic and organic soils developed on alluvial, and fluviuo deposits of varieties texture notably along the river flood plains and

(b) The terrasols, developed especially on sedimentary rocks.

This classification is based on the food and agricultural organisation. Flood plain soils are found along the river valleys such as those at the river Niger. This favour the production of sugar cane. The most useful alluvial basins in the country are those of the smaller rivers in the state for example, the fadama lands of the river Niger used in growing yams and in some places rice cultivation as in Badeggi near Bida and Gwari areas.

Fadama lands are also cultivated under a system of irrigation. These land have been so useful because they are less water logged, less forested and are therefore, more manageable than the flood plain.

The soils, example the Nupe sandstone, the soils are less leached because of lower mean annual rainfall and low population density favours larger period of fallow.

There are two broad types of vegetation in Niger State; forest and savanna communities. The principal determinations of these trends in the ecological balance of Niger State is derived from the significance of tree forest, shrub grassland and farmland.

The forest indicates the Guinea/Sudan characteristics, while shrub/grassland gives an indication of the increasing influence of sahelain-decertification problems in the state. The extent to which farming especially on large scale, may be a controlling factor in between is suggested by the percentage cover of farmlands. The main virgin forest zone is in the southern parts of Mariga/Magama Local Government Areas and Western sector of Lavun.

1.4.6 **GEOLOGY:** The basement complex and Sedimentary basin are two different ecological units in the state. Basement complex rocks underline Chanchaga, Rafi, Suleja, Magama, about 40% of Mariga and about 20% of Gbako local government areas of Niger state. It consists of various suits of metamorphic and igneous rocks.

The sedimentary basin consists of two confining units of acquifers. These are confined and semi-confined acquifers extending from Agaie to Katcha and stretches northeastwards to Kotagora-Auna area, broken in places by the so called alluvial acquifer. The is limited to the small area around Mokwa and Zungeru area. It occupies less than 20% of the total area of the sedimentary basin.

**1.4.7 TOPOGRAPHY:** Over most of the state, there is a close correspondence between the landform and the underlying rocks. Flat lying of gentle dupping rock series tend to be eroded into tubular relief. These are invariably terminated by steep scarps, example of which is Bida plains on Nupe sandstones.

On each major rock group, different types of unit landform, landform complexes, landform systems and regions can be recognised. Example, the flat to gently undulating plains, like the Kontagora Bida plains. The Zuma rock at Suleja near Abuja, because of its aesthetic appeal have become a tourist attraction.

## 1.5 LIMITATION AND SCOPE OF STUDY

This research is limited by the inability of the research to obtain more recent aerial photographs which would have presented a tool for growth and expansion between 1982 and now. This made the collection of data difficult. With this lack of recent aerial photographs, it is apparently clear that field work of 1998 has to be performed to determine only the number of the building of the area from aerial photograph of 1982 and field work of 1998.

## 1.6 ORGANISATION

Chapter one provides an introduction to the research work. This is followed by literature review in chapter two. Chapter three discusses the research materials and methodology, while chapter four is devoted to analysis and discussions of results.

Finally, chapter five presents recommendation and conclusions.

# CHAPTER TWO

## 2.0 LITERATURE REVIEW

Research into the application of aerial photograph to urban studies dates, perhaps from the late forties through the works of branch (1948). Witenstein (1952, 1954, 1955, 1956) Green (1956,1957), Hadfield (1968). One of areas where research has already started is in the development of methods of estimating the number of dwelling units (household) in urban areas. Implicit in some of these research work is the actual estimation of population in the high density areas. Some of the attempts made on dwelling unit estimation using aerial photographs include those of Green (1955), Hadfield (1963), Binsell (1967), Eyre et al. (1970). Lindgreen (1971) and Hsu (1971).

Green carried out his own study in Birminham, Alabama using panchromatic stereo pairs of 1:7,500. He examined 17 residential neighbourhoods and recorded several categories of house types ranging from single family categories of house types ranging from single family to 9-11 multi-family buildings. Green's identification of housing types was based on such diagnostic criteria as form and structure of roofs; size, shape and height of structure and in some cases, the spatial relationship to other buildings. His work revealed three major interpretation errors. Firstly, dwelling units per blocks were underestimated by seven percent; secondly, single unit attached buildings were overestimated by eight percent, and thirdly, the amount of error increased with higher percentage of multi-family buildings. Significantly, however, 99.8 percent of all residential structure were fully accounted for by aerial photo-interpretation.

Hadfield study of Chicago (1963) included the estimation of dwelling units using the same method s Green's but with photograph at a large scale; 1:4,800. His aerial photographic investigation showed 10 percent fewer dwelling units than census count. The error according to Hadfield was later reduced to 0.4 percent after the application of a correction factor (which was never made clear) based on fieldwork activities.

Binsell (1967) studied Chicago with natural colour continuos strip transparencies at a scale of 1:5,240 for the estimation of dwelling units in 19 neighbourhoods. Unlike in the first two studies above, stereo-pairs were not used. The methodology of Binsell entertained the compilation of a list of keys necessary for the estimation of the number of dwelling units per residential structure from the aerial photographs. A field check of the neighbourhoods revealed that dwelling units were underestimated by 15.7 per cent while single detached unit were overestimated by 4.3 percent magnitude of error increased with prevalence of multi-unit structures. However, 99.9 percent of the residential structures were identified by aerial imagery. In pursuance of this line of research, Lingren (1971) studied blocks of high density housing in the metropolitan Boston area employing the colour infrared (CIR) photography of 1:20,000. Lingren's primary objective was to evaluate the extent to which medium-scale imagery could be used in making dwelling unit estimation. His analysis was done monoscopically using hand lenses, the most powerful of which could magnify by a factor of 18.

After systematically adopting Binsell's keys to three test blocks, field check was conducted. Dwelling units were identified in the field on the basis of door bells, mail boxes, and utility meters. On the basis of the field check, Lingren modified the keys and came out with the following diagnostic criteria; type of roof, relatives size of structure, number of storeys, division of buildings, availability of parking space and amount and quality of vegetation. On the basis of the new key Lingren studied 15 additional blocks. His result showed, among other things that the CIR film was extremely helpful by providing sharp contrast between buildings and their environment. The result showed an underestimation of only three residential structures out of 655, an underestimation of 54 dwelling units or 3:1 present, (i.e. 1,744 dwelling units were counted on the ground as against 1,690 interpreted on aerial photograph. Lingren's result are very consistent with those of previous researchers. This consistency of results only that accurate dwelling units estimations can be made from aerial photographs of a much smaller scale but taken with better quality films.

Unlike the studies so far mentioned, the work of Hsu (1971) was purely on population estimation with particular references to the study of inter-census change in the area near Atlanta Georgia. Hsu attempt was on the estimation of population in 1952 and in 1967. The 1952 population estimate was based on housing counts on the 1:24,000 topographs of the closely built up areas which appeared as blocks on the maps. In the 1952 population estimation two quadrangles (plane figure with four-sides e.g square or rectangle) that were compiled from 1952 air photos were not mentioned. A grid cell size of one-fourth square mile was used as a base for the construction of choropleth maps of population distribution. The population of each cell was obtained by multiplying the number of houses in the cell by the average number of person per household as listed by census tracts in the 1950 census of population.

In the 1968 estimation, the 1:5,000 aerial photographs taken in April 1968 were used. The estimation was done in each cell as for 1952. Dwelling houses were counted and population density per square mile of each was calculated by the following relation. Population density = (persons per household) x (Housing count)/4. The number of persons per household was obtained from local planning agency's'census statistics. Hsu work confirmed he usefulness of aerial photograph estimation. His random error of housing counts in most residential neighbourhood was less than 5 percent. Some of the random errors were due to the difficulty of distinguishing the high-rise apartment buildings from multi-stored office building.

Another attempt at using aerial photographs for the estimation of population was made by Eyre et al (1970) in Jamaica. Their study was prompted by what seemed to be an unreliable census count in the country. By using aerial photographs, Eyre et al found out that some settlements found on the ground (i.e. on the aerial photographs) were not found on the aerial photograph (that is on the ground) were counted. These errors may seem to be compensated in nature but since the sizes of such settlements are not likely to be the same, they are politically important since planning and development in the area is tied to the number of inhabitants in each locality.

Adeniyi, P.O (1975), study some selected residentials districts within the urban region of greater Lagos. In order to select the areas, he delimit the residential districts in their spatial context. In order to construct an up-to-date and intergrated though generalised, residential land use map of greater Lagos, a large uncontrolled mosaic was made from the 1973, 880 aerial photographs of the city at a scale of 1:6,000. The identification and the delimitation of the residential areas into spatial sub-categories was partially based on the textural characteristics of the city landscape as depicted on the aerials and partly on the shape and pattern of the houses and local knowledge of the area. The spatially oriented classification was based on the textural characteristics of the urban landscape which is closely correlated with Sada's socio-economic classification of residential districts of Lagos. (Sada, 1972). Residential areas were therefore classified as planned residential areas with or without garden; planned but poorly developed areas and unplanned areas. From these subcategories, five sample areas which, to a greater extent, represent the various types of residential neighbourhood, and covering 328.5 hectares were selected. These areas central Ikoyi, a section of Ebute-Metta/Yaba, Somolu/Bariga, part of Mushin and a central section of Lagos Island. Having selected the sample areas, the stereo-pairs covering each sample area were used for the identification and counting of the residential building.

From the foregoing, it is clear that most of the researchers in this field.have been carried out in the developed countries where urban areas have undergone several planning processes. Also, population counts have taken place several times and figures are generally mere accurate so that they can be used on aerial photographs. It seems, by contrast as Lindgren (1971) observed, that estimation of dwelling houses/units rather than the estimation of population would have more relevance and of immediate positive effect in the developing countries.

Adeniyi (1975) estimated population through the aid of aerial photographs in Nigeria and the level of success achieved was encouraging, he stated.

In his studies through aerial photographs interpretations were based on; the number of dwelling units within each dwelling houses, number of swelling houses, the average number of people per dwelling unit within a homogenous residential neighbourhood. Put, thus the estimated population of an urban area as:

$$EP = DU_1 x\ {}_1R_1 + DU_2 x_2 R_2 + \ldots\ldots\ldots\ldots\ldots DU_n x\ {}_n R_n$$

Where EP is estimated population

DU is the number of dwelling units

X is the average number of people per dwelling unit all in the residential neighbourhood R.

Street sleepers and homeless inhabitants are generally not included in the estimation.

From the above equation, he stated that the critical variables are the dwelling unit and the average number of people per dwelling unit. And that the identification and recognition of dwelling unit on aerial photographs as done in the United States of America cannot easily be carried out in Nigeria, and that this situation arises simply as a result of socio-cultural, socio-economic and technological differences between the developed and developing countries. In the developed countries and specifically in the United States of America where aerial photographs have been used to estimate number of dwelling units, a household lives either in a separate bungalow, flat or in an apartment. In each case, only the immediate family members are accommodated. In the developing countries most people live in rooming type houses. In 1964 for instance, about 96 percent of the houses in Lagos Island were rooming type (LEDB, 1964). In central Lagos Island alone, about 85 percent of residential houses were rooming type (Shonubi, 1975). In this case, one can find, in a single building three to ten households depending on the size of the building. In each of the households too, one finds in addition to the immediate family members, other "extended" family members and housemaids. With this situation, it is not even easy to identify individual dwelling units in the field using such identification variables as door bells, mail boxes, television aerials back or front gardens, motor garages etc., as used in the developed countries.

In developing countries, therefore dwelling houses, which can be identified and counted on aerial photographs with considerable accuracy, may be used to replace the dwelling units, he stated. By replacing dwelling units with dwelling houses, particular attention must be given to boys quarters. This feature, which is one of the legacies of the colonial period, is very common in the GRA, and the residential sectors of the higher educational institutions. In these areas, the boys' quarters are always detached from the main building. He stated that, in counting the residential houses, such boys quarters should be regarded as part of the main building. Also the number of people per household now will be replaced by the number of people per residential house. A homogenous residential area used in equation 1, withhold for equation 2 which becomes:

$$EP = DH_1 Y_1 R_1 + \ldots\ldots DH_2 Y_2 R_2 + \ldots\ldots\ldots + DH_n Y_n R_n$$

Where DH is the number of dwelling houses and Y the average number of people per dwelling house within a particular residential neighbourhood. The exclusion of the size dwelling buildings in equation 2, is due to the fact that buildings of different sizes are in close juxtaposition in most urban centres in Nigeria. Besides, it appears there is an unsignificant correlation between the sizes of buildings and the number of people living in Lagos Island are larger than those in central Lagos Island but the occupancy ran homogenous residential neighbourhoods; while that of latter is 4.5 (Sada 1972). The delimitation of homogeneous residential neighbourhoods can easily be done on aerial photographs by just considering the pattern, size, height and shape of buildings.

The average number of people per residential neighbourhood carried out by applying either stratified systematic or stratified random sampling depending on whether a particular residential neighbourhood is planned or not. Any sampling method adopted must be applied to each type of dwelling building (e.g. one, two, three storied buildings) in each residential neighbourhood. He highlighted that identification and counting of residential houses in the sample areas is however, reported in this research, next stage is the sample count of people in each sample area so as to arrive at an average number of people per residential house within each residential neighbourhood.

Weller (1968). 'As one means of evaluating the capability of aerial photograph for providing housing quality data, he compared the information extracted from multiband aerial photographs directly with the information contained on apha (American Public Health Association) appraisal forms.

For the part, data derived from the aerial photography correlated well with ground truth data obtained from the APHA appraisal forms. A variety of features related to housing quality analysis were identified on the aerial photography, including several not covered by APHA. The identifiable features included; building frontages, open or vacant land, unpaved versus paved parking lots, amount of on-street parking, architectural style, land scaping, conditions of lawns, presence of litter and lack of curbing along parkways. In the determination of housing quality, the surface rounding landscape was found to be an important criterion; aerial photographs are useful because they show dwellings in relations to surrounding features.

Mumbower and Donaghe (1967) employed a techniques to acquire socio-economic data on the urban poor. Large scale photography (1:10,000) was found capable of revealing a number of features associated with poverty including structural deterioration; debris; clutter; and the lack of vegetation, walk paved street. A strong correlation was found between urban poverty and residential areas located adjacent to the CBD (central business district), industry and major transportation arteries. On the basis of other studies, such areas were found to correlate with low income, unemployment low education achievement, family crowding, crime low health status, and lack of community facilities. However, this research will examine the extent to which building can be estimated from aerial photographs in the sampled area of Minna, Nigeria.

# CHAPTER THREE
# METHODOLOGY

The process of undertaking this study can be succinctly grouped into basic sub-heading; geographic data base development and data analysis.

## 3.1 GEOGRAPHIC DATA BASE DEVELOPMENT

The researcher collect the following data:

(a) The aerial photograph of Minna taken in sheet (82562-20 and 82562-22) and field work of 1998 November.

(b) The map of Minna or base map containing the areas of delimitation.

## 3.2 DATA ANALYSIS

Mirror stereospairs was used for visual photo-interpretation. This is to allow preliminary assessment of the quality of the scenes and the tone variation of the elements recorded by sensors. The transparent acetate was been used for identifying and representing the elements, depending on whether the identified elements are completed building and buildings under construction both old and recent buildings.

This will be followed by field check to reconcile the buildings counted on the photograph and those on the ground, so as to determine the changes that has taken place between the time of photograph.

The following features was used to delineate the study area (based on Moore 1970, Abumere , 1986)

i. Building type

ii. Accessibility to houses, access type and the condition of access

iii. Street width

iv. Drive-ways

v. Drainage pattern

vi. Density (number of buildings per unit area)

## 3.3 IMAGE INTERPRETATION PRINCIPLES

This consists of four basic principles:

(1) A remote sensor image is a pictorial representation of the landscapes.

(2) The image is composed of patterns, indicators of things and events which reflects the physical, sociological and cultural compliments of landscape.

(3) Similar patterns in similar environments reflects similar conditions and unlike patterns reflect unlike conditions.

(4) The type and amount of information obtained from image is proportional to the knowledge, experience, skill and motivation of

the analysts, interpret, the efficiency of the method used, and an awareness of the limitations imposed on the analysis by the remote sensor system, data format and analytical method.

## 3.4 PRINCIPLES OF AERIAL PHOTOGRAPHY

The most commonly implored sensor for aerial photography is the conventional photographic camera designed to detect energy in the visible 0.4-0.7mm and near infrared (0.7-0.9) portions of the electromagnetic spectrum. This is made possible by the use of suitable black and white or colour films sensitized to these spectral regions. In order to enhance the contrast between the object and the background of interest in the resultant photograph, a minus blue filter (i.e. yellow) is normally employed at the time of photograph to eliminate the ray/eight scatter in the atmosphere.

An important component of the photographic camera is the lens system which should be relatively free of lens apparation or distortion to avoid causing the images of points to be displayed on the photograph.

Photographs are taken on board aircraft which serve as the platform with a metrically accurate camera for photogrametric purposes. This usually involves vertical aerial photographs terrains with 60% forward overlap between successive frames of photographs along the flight strips and 15% to 20% lateral side lap between two adjacent flight strips. These flight configuration permits aerial photographs to be viewed telescopically to give an impression of three dimensions thus facilitating the interpretation of the terrain feature.

Electromagnetic energy is reflected from the terrain to pass through the lens and it's regarded as a bondle of light rays travel in straight line points.

The normal scale of the vertical photograph is given as

$$S\frac{F}{H}$$

where F = focal length of camera

H = flying height for assumed flat terrain

Where relief of the terrain is taken into account, the scale at point 'A' is given as:

$$s = \frac{H}{H - ha}$$

ha = height at point 'A' from the datum on the whole, the average scale (sav) should take into account the average terrain so that is

$$sav = \frac{F}{H = hav}$$

hav = average terrain height

The standard film type for aerial photographs is panchromatic black/white film which is sensitivity ranging from 0.35-0.7um. a minus blue (yellow) filter is normally used to absorb the atmospheric haze found in the blue portion of the spectrum.

Another film type is the infrared black/white film which has spectral sensitivity range from about 0.7-0.9um leaf mesophy/of vegetation is highly reflective and water bodies are highly absorptive of infrared radiation. These functions coupled with it's ability to absorb haze make infrared black and white film ideal for rural land use and land cover up.

The focal lens used for 1982 aerial photograph was 5mm and the height was 5,000 metre above sea level.

## .5 ELEMENTS OF INTERPRETATION

These are some important characteristics used in analysing and interpreting remote sensing imagery.

These include:

**Size:** The size of an object is very critical in its identification. The length and breath, area and volume of an object could be used to differentiate items in the same class.

**Texture:** The visual impression of roughness or smoothness also helps by tonal representation in group objects often too small to be discern as individual objects.

**Tone:** Continuous gray-scale varying from white to black e.g dry sand (white), wet sand (black).

D. **Pattern:** regular, usually reported shaped with respect to an object e.g. rows of houses, regularly shaped rice field, interchanges of highway etc.

E. **Site:** location of area e.g country, altitude etc.

F. **Association:** specific combination of elements, information of the surrounding or the context of an object can provide the user with specific information for interpretation.

G. **Topography:** total of the shapes of all terrain components, of an area. Tell us about geographical, geological characteristics of an area.

# CHAPTER FOUR

## 4.0FINDING AND DISCUSSION OF RESULT

### ESTIMATION NUMBER OF BUILDING IN SAMPLE AREA.

The result of the panchromatic aerial photograph interpretation on a scale of 1:5000 and the ground observation are shown by table, since the study is tritely by estimation of buildings.

**TABLE 4.1 ESTIMATED NUMBER OF BUILDING IN SAMPLE AREA**

| | **Single Building** | | **One-Stored Building** | | **Buildings Under construction** | | **Total** | |
|---|---|---|---|---|---|---|---|---|
| Sample Area | Photos | Ground | Photo | Ground | Photo | Ground | Photos | Ground |
| Soja Ward | 231 | 390 | - | - | 18 | 67 | 249 | 457 |

**SOURCE: Aerial photograph (1982) and fieldwork (1998).**

From the 1982 aerial photograph a total of 249 buildings were counted using mirror stereoscope, out of which 18 were counted as buildings under construction appeared to be single building due to the elements of image interpretation, like pattern and shape of the building. No stories buildings were identified from the stereoscope.

Similarly, on the ground during the field work of 1998, it was found out that in most cases the long single buildings on the photograph were re-erected and separated by very narrow spaces and these spaces again are being filled by commercials structures, religious and institutions, in which most of these, are affiliated or part of the buildings used as residentials. With the level of development, more modern buildings were built and the old buildings renovated, rebuilt and re-designed thereby, thereby increasing the numbers of buildings in the open spaces. However, 457 were counted during the field including those counted in the aerial photograph of 1982; out of which 67 of these were counted as uncompleted building or buildings under constructions 80% increase. In analysing these, number of 67 uncompleted buildings, 18 were initially counted from aerial photo during the interpretation as against 49 on the ground during the field work. Though, most of those identified and counted from aerial photos were still not completed and now occupied by the reptiles. While some were already completed at 1998 and were been used mostly for residential.

## 4.2 ESTIMATED NUMBERS OF BUILDING AND THE CLASSIFICATION IN SAMPLE AREA

TABLE 4.2 .. SINGLE BUILDINGS

| SAMPLE AREA | PHOTOS | TOTAL |
|---|---|---|
| | COMPLETED TRADITIONAL BUILDING | 136 |
| | COMPLETED MODERN BUILDING | 76 |
| | TENAMENT BUILDING | 85 |
| SOJE WARD | FAMILY COMPOUND | 127 |
| | UNCOMPLETED BUILDING | 18 |
| | COMMERCIAL BUILDING | 6 |
| | RELIGIOUS BUILDING | 10 |
| | INSTITUTIONS BUILDINGS | 3 |

*SOURCE: Aerial photograph (1982)*

Table 4.3 .

SINGLE BUILDING

| SAMPLE AREA | GROUND | TOTAL |
|---|---|---|
| | COMPLETED TRADITIONAL BUILDING | 90 |
| | COMPLETED MODERN BUILDING | 247 |
| | TENAMENT BUILDING | 197 |
| SOJE | FAMILY COMPOUND | 151 |
| WARD | UNCOMPLETED BUILDING | 67 |
| | COMMERCIAL BUILDING | 20 |
| | RELIGIOUS BUILDING | 21 |
| | INSTITUTIONS BUILDINGS | 12 |

*Sources: Fieldwork (1998)*

From the table above, a cursory observation of the study area, during the field check to reconcile the buildings for classification. In reconciling, a classification were made into categories like completed traditional building, completed modern building, tenament building, family compound, uncompleted building, commercial building, religious building and institutions building were undertaken. However, buildings were reclassified as tenament building and family compound.

From the analysis above, it was found out that, out of 249 buildings counted from the aerial photograph of 1982 on scale 1:5000, 136 were identified as completed traditional residential buildings, 76 identified as completed modern residential building; with this a total of 85 were observed as tenament (rented) residential building, while 127 were observed as residential family compounds, 6 were observed as religious buildings, 3 identified as institutions buildings.

This classification were done using the aerial photograph of 1982 on the scale 1:5000 to locate position of the building, to determine the level of accuracy of aerial photograph in estimation and to see the changes been effected after the 1982 aerial photograph.

It was apparently find out that, such changes were effected on some buildings, most still identified as it was in 1982, while buildings that undergone such changes were informed by the occupant of the building during the reconciliation.

In analysing the field work of 1998, from above, a total of 390 completed building were observed, while 67 were identified as uncompleted or buildings under constructions. From a total of 390 completed buildings, 90 were observed to be completed traditional building, 247 were observed as completed modern building. 89% increased as to what was identified on the aerial photo of 1982. From, a total 390 completed building, 197 were seen to be tenament (rented) building given an increment of 72% as against 28% obtained from aerial photo or 1982. 151 were observed to be family compound, mostly of which are traditional buildings made up of mud blocks and plastered with cements, 20 were observed as commercial building, 21 as religious buildings, 12 as institutions building. However, all the analysed results does not exclude those obtained from the 1982 aerial photographs of the study area.

It was observed during the fieldwork that most of the completed traditional buildings were rebuilt. The commercial buildings identified in the field are mainly uses for retail business, some as restaurants, for the sale of foods and drinks, some are used for grading engines and mechanic workshops.

The institutions building identified are all used mainly for Islamic educations while the building identified as religious buildings are seen to be mosques. However, due to this result, it could be said the sample area are predominantly Muslims.

However, the total area of sample zone in hectare and the total area of residential area in hectare were determined using the trape zoidal rule using the aerial photograph (1982).

Table 4.5 ACCESSIBILITY TO THE BUILDINGS

| | TOTAL NUMBER OF BUILDING | NUMBER OF INACCESIBLE BUILDING | INDEX OF ACCESSIBILITY IN SAMPLE AREA. |
|---|---|---|---|
| SAMPLE AREA SOJE WARD | 457 | 120 | 0.72 |

*Source: Aerial photograph (1982) and fieldwork (1998)*

Apart from the above table, the aerial photograph of 1982, each building was examined in relation to the available motorable roads in the area. When a building can be reached by a motor vehicle such a building is described as being accessible. A count of inaccessible buildings in sample area was made and the results are shown in table 4·5 above.

From the above table, 457 building were obtained with 120 numbers of inaccessible building, which is 0.72 index of accessibility in the area. As regard this, the condition of the road network is not very encouraging either. With the exception of the express road (western by pass) which provides access to the study area (Soje) most of the roads are in poor condition. Roads within the study especially the major one providing access to the street remained untarred even before the aerial photograph was taken and to date, and most of the footpath linking the major one are found to have been severely damage by the effect of erosion, inadequate drainage facilities are in most places partially blocked by fences of some residential buildings.

In the above (table 4.5) an index of 0.72 means that 72 percent of the buildings are accessible in the study area.

Even, though there are no locally and strictly adopted standards relating to the number, size and design of building and route ways within the urban area, the sample areas can still be divided into categories in terms of their densities and accessibilities indices.

Lastly, it was found out during the field work that most of the completed traditional residential buildings were traditional residential building were built or reconstructed and redesigned into a modern residential buildings within the same plot, and also some of the openings identified during the aerial photograph interpretation as farm lands and slumps were filled up and buildings erected in modern design.

This is because the study area has no provision for expansion to accelerate development or growth in terms of building due to the location of the sample area in this case the area has been cut off by the stream at the southern part, and to the north-eastern part by rail track and to the west come the express ways (Western by pass). The only portion left for expansion is the Northwest of the study area, and during the field work, most part of the land were already built up and been occupied, where some were underconstruction, and in some cases the long single building in the aerial photograph were reconstructed and separated by very narrow spaces and these spaces again are being filled by other structures e.g. kiosks.

However, during the field work, insignificance numbers of errors were made during the aerial photograph interpretation the buildings were over-estimated, especially in centre of the study area, as some buildings are separated by very narrow spaces, and interpretation error however occurs were a building which by interpretation keys used, appear to be a residential house is used entirely for another purposes such building are not many and they can always be detected during the field work.

# CHAPTER FIVE

## 5.1 CONCLUSION AND RECOMMENDATION

This research has attempted to provide some background information on how aerial photographs could be used as an information system with special references to some urban area studies. The major conclusion of this preliminary investigation is that aerial photographs of 1:5,000 can be used, with a high degree of accuracy, to estimate the number of dwelling houses in Minna or part of Minna.

It has also been demonstrated that the same photographs used for the estimation can be used to supply background information on census surveys especially for the delimitation of enumeration area.

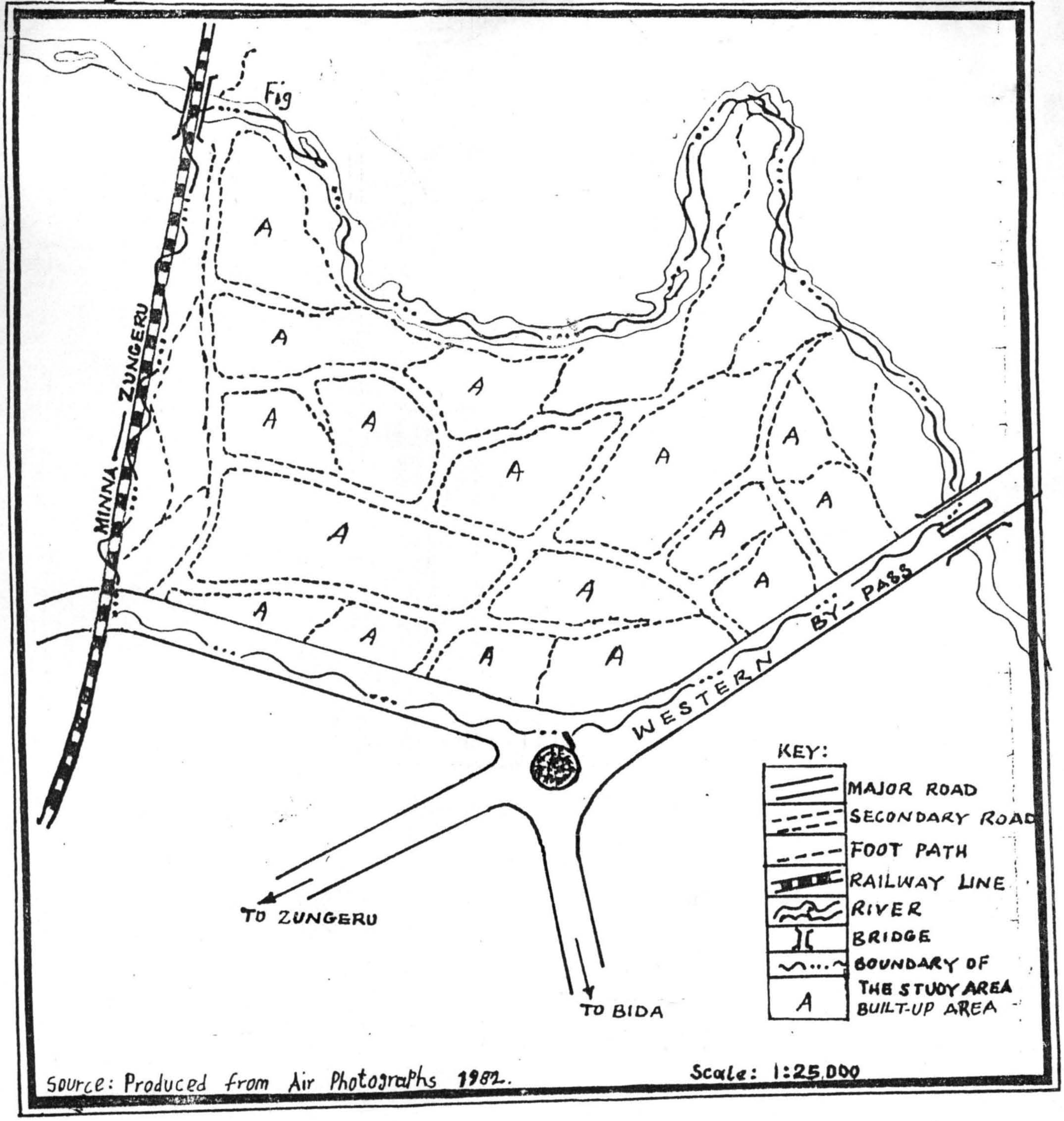
In addition, it has been shown that with some caution, population can be estimated more objectively by using aerial photographs particularly in the rapidly growing urban centres of the development countries. Finally, complementary background information on urban renewal programmes can be obtained from the same photographs used for the census surveys. It is however, necessary that this method be tested in more cities, as to be able to have or develop flexible, but standards criteria for the identification of dwelling houses in Nigerian cities.

In most developing countries, there is always a lack of up-to-date lands use maps of the urban centres. The lack of such maps always affect the conduct of census surveys in the sense that not all residential areas within the urban area are always located during the count. The delimitation of the residential areas within the urban area where there is no such basic map can be done more accurately by using aerial photographs as been shown above.

In urban renewal, one of the major problems facing urban centres in the developing countries lies on data. Writing on urban growth and development in Nigeria, Sada (1974) observed that the major problem of orthogenetic centres lies mainly in their physical modernization and provision of housing for the heterogenetic centres. Many criteria have been used in identifying such criteria include the physical characteristics, such as degree of structural deterioration, presence of garbage accumulation, and missing sanitary, recreational and social facilities such as playground, public water, sewage system and adequate street drainage facilities (Chapin 1965). For this exercise housing density and accessibility are the criteria used in identifying and locating areas needing physical improvement.

Be that as it may, the result discussion and findings of this study will go along way to help the state government taking some relevant actions regarding rapid development. This research should also serve

Fig. 4.1 LAYOUT OF THE STUDY AREA.



## 5.2 RECOMMENDATION

The future of the Earth's dwindling resources may rest on the ability to analyse data quickly and accurately and in a manner that the general public can understand.

The research effort will recommend the followings:

1. Introduce remote sensing in all national institutions of higher learning
2. Raise adequate manpower in remote sensing through appropriate training to ensure a diversification of its application.
3. Frequently, holding seminars, symposia and workshop in remote sensing and related disciplines.
4. Attempt to reduce duplication of efforts and to benefit from cost-sharing effects.
5. Enter into bilateral and regional cooperative arrangements in an effort to establish and utilise remote sensing facilities.
6. To provide national communication networks with a view to streamlining the dissemination process for data and information derived from remote sensing applications to ensure prompt supply of data to the user communities.
7. To diversify, strenghten and intensify any existing contacts with appropriate scientific communities of industrialised nations

operating remote sensing system on both bilateral and multilateral basis. where no such contacts currently exist, they should both be promptly established.

8. Establishment of National remote sensing centre that will be fully equipped for gather up to-date data for research purposes.

9. An intensive campaign exercise should be carried out to demonstrate the use, importance and capabilities of remote sensing application to various authorities in the federal, state and local government levels.

10. At an international level, the initiative should be taken to institute a comprehensive survey of the actual operational use of remote sensing especially for urban purposes, specifically with regards to dwelling unit and population estimation which are the basic ingredients for urban decision making.

11. It is recommended that a standing working group on urban remote sensing application should be established by town and urban planning and management divisions at the state ministries concerned at the federal level.

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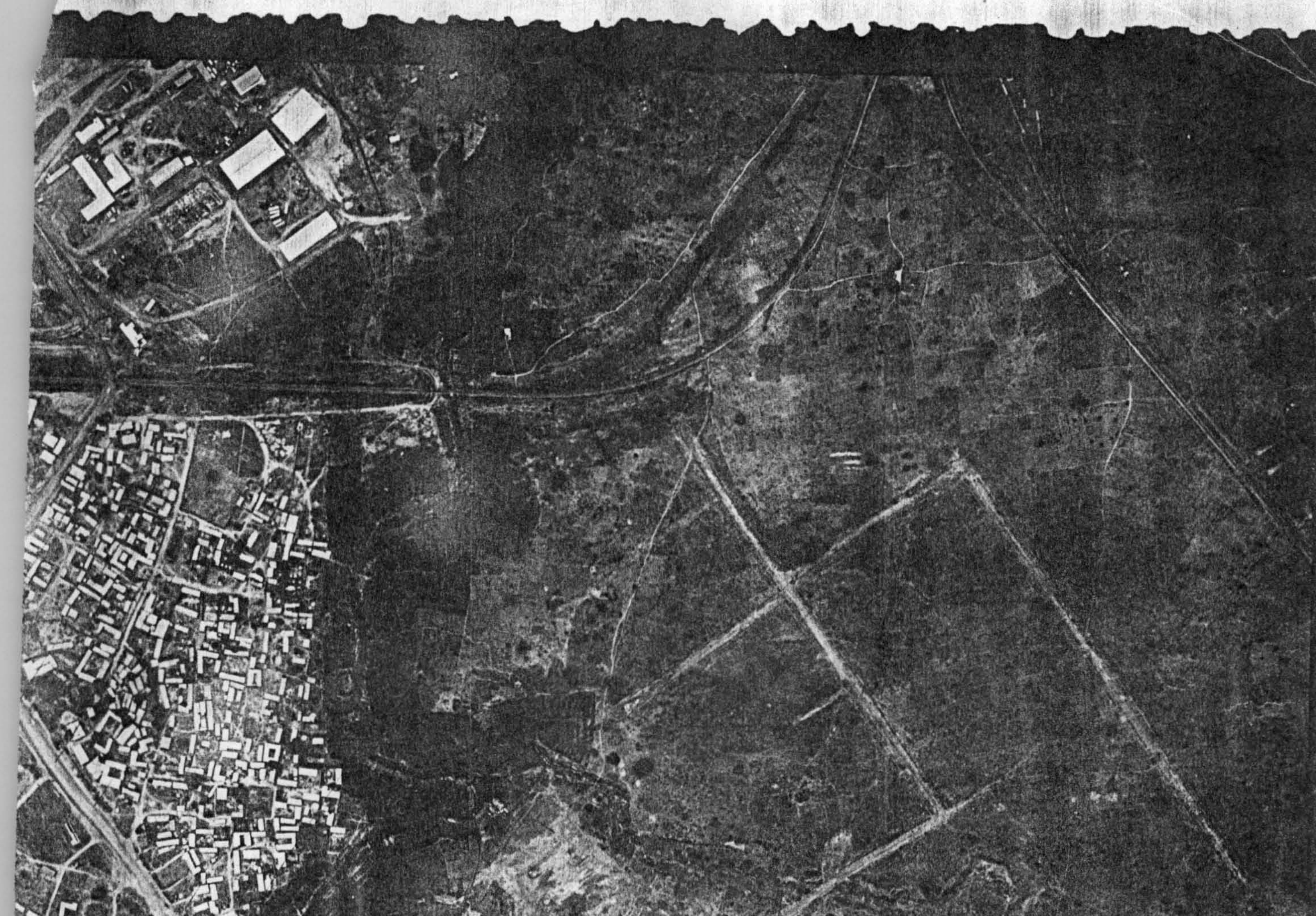

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AERIAL PHOTOGRAPH(1982) SHOWING BUILDING DISTRIBUTIONs OF THE STUDY AREA.


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AERIAL PHOTOGRAPH (1982) SHOWING BUILDING DISTRIBUTIONs OF THE STUDY AREA.