LANDUSE/LANDCOVER OF WURNO AND IT'S ENVIRONS IN SOKOTO STATE OF NIGERIA.

BY

IDRIS MOHAMMED
M. TECH/075/96

SUBMITTED TO
THE DEPARTMENT OF GEOGRAPHY
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF A DEGREE IN MASTER OF TECHNOLOGY IN REMOTE SENSING

FEBRUARY 1998.

CERTIFICATION.

This is to certify that this Dissertation entitled "Landuse/Landcover of Wurno and it's Environs in Sokoto State of Nigeria; was undertaken by Idris Mohammed (M.Tech/SSSE/075/96); in the Department of Geography of the school of Science and Science Education. Federal University of Technology, Minna was aproved for its contribution to knowledge under the supervision of:

....	....
DR. G. N. NSOFOR	**DATE**
....	....
PROF. J. M. BABA **(DEAN SSSE)**	**DATE**
....	....
PROF. J. O. ADENIYI **(DEAN, POST-GRADUATE SCHOOL)**	**DATE**
....	....
DR. NDUAGUBA, D. C. **(EXTERNAL EXAMINER)**	**DATE**
....	....
DR. G. N. NSOFOR **(CHIEF EXAMINER AND HOD)**	**DATE**

DEDICATION

This piece of work is dedicated to my beloved prophet and messenger of Allah; Muhammed (S.A.W)

ACKNOWLEDGEMENT.

This work would have not seen the light of the day, without the full co-operation an assistance of my supervisor **Dr. G. N. Nsofor.** Who went beyond been a supervisor, but also assumed and played the role of parent, by giving me every encouragement for this work to the accomplished.

I am seriously, and indeed grateful for his crificism and advice. My profound gratitude goes to Prof. D. O. A. Adefolalu the Director Linkage Centre, Federal Environmental Protection Agency, Federal University of Technology, Minna for the provision of both computer compatible tape (CCT) and the satcllite image map used for this study.

I also appreciate the role played by Mallam Halilu Ahmed Ayuba, in the fulfilment of this study for allowing me to use his soft ware package for this study for this study.

I am equally grateful to all the staff in the department of Geography, both academic and non-academic staff. I appreciate the brotherly contribution of Mallam Usman M. G. Isah, Mallam Abdulrahim Tariq (Nma) Agaie, Ndako Worogi, Mohammed Kudu Usman Ibbi, Abdullahi Ndagana Agaie, Mallam Dalahatu Bida, Abubakar D. Usman Ibbi, Haruna Usman Ibbi, Mohammed Usman Khattamba,

Mohammed Saba (Yakpotun), Mallam Abubakar Danladi Agaie, Mallam Aishetu Usman M. G. Isah, Teni Isah , and Zainab Usman Chado Ibbi.

I am short of words to appreciate the financial and moral contributions of my parents towards the successful completion of the degree programme.

This acknowledgement would have been found wanting without special mentioning of my Darling, Hauwa M. Umar Bida, who took all her time praying

I am most grateful to Almighty Allah (S.W.T.) for giving me the strength, health and directed me throughout this work.

IDRIS MOHAMMED.

ABSTRACT.

The study of landuse/landcover is very important for many reasons. The land is a renewable resource from which man's activities derive the necessities for life as well as those for his luxury. The knowledge of our resource base is in jeopardy, filled with either a lot of guess work, part of which includes misinformation which are either correct initially or outdated. The area of this study Wurno and its environs which lies in the desert fringes is susceptible to desert encroachment. There is therefore the need to monitor it continously to arrest the situation.

The main objectives of this study were to determine or to classify the various landuse/landcover of Wurno and its environs; using visual and digital methods and to compare the efficiency of the two methods i.e visual and digital techniques.

For the above to be achieved, landsat multispectral scanner 5 of 1985 was used. In the visual analysis, magnifying lenses and the familia-liarisation of the researcher with the study area was used for interpretation and classification. Maximum likelihood approach was used for digital analysis.

The findings indicated that ten (10) classes of landuse/landcover were indentified by the visual classification system . Twelve (12) classes resulted in the digital classification system.

In the visual classification the dominant landuse/landcover was sandy soil with 6.11 hecteres (24.37%), while laterite surface with 9.88 hectares (39.39%) was the dominant landuse/landcover in the digital analysis. While it takes very little time for the digital to be accomplished, the visual analysis is time consuming, labour intensive, but cheap and does not require much training to be carried out. However the digital analysis

was faster, more likely to accurate but capital intensive and requires much expertise to be carried out.

This study could be improved upon by making use of the multi-temporal satellite data.

TABLE OF CONTENTS.

CHAPTER ONE.

INTRODUCTION.

Land is much more to man than the stage on which he carries out his various economic activities. Man has been so much connected to the land that separating the two is almost impracticable. From the world classic religions we learn that man was created from clay which is derived from the land and virtually all human activities are practiced on the land. In view of this: there are different shapes and patterns today. Agriculture which is the oldest human activity is practiced on the land. The land supports all forms of lives by providing food for their survival in terms of growth and development. In view of the above assertion, land, is seen as such an indispensable resource that conscious and deliberate studies of it is paramount to our continuous existence on the face of the globe.

BACKGROUND TO THE STUDY AREA.

Wurno is the Headquarters of Wurno Local Government area of Sokoto State. The area is approximately 343 square KMs. It lies approximately within longitudes 5 degrees 25 minutes east and latitudes 13 degrees 18 minutes north.

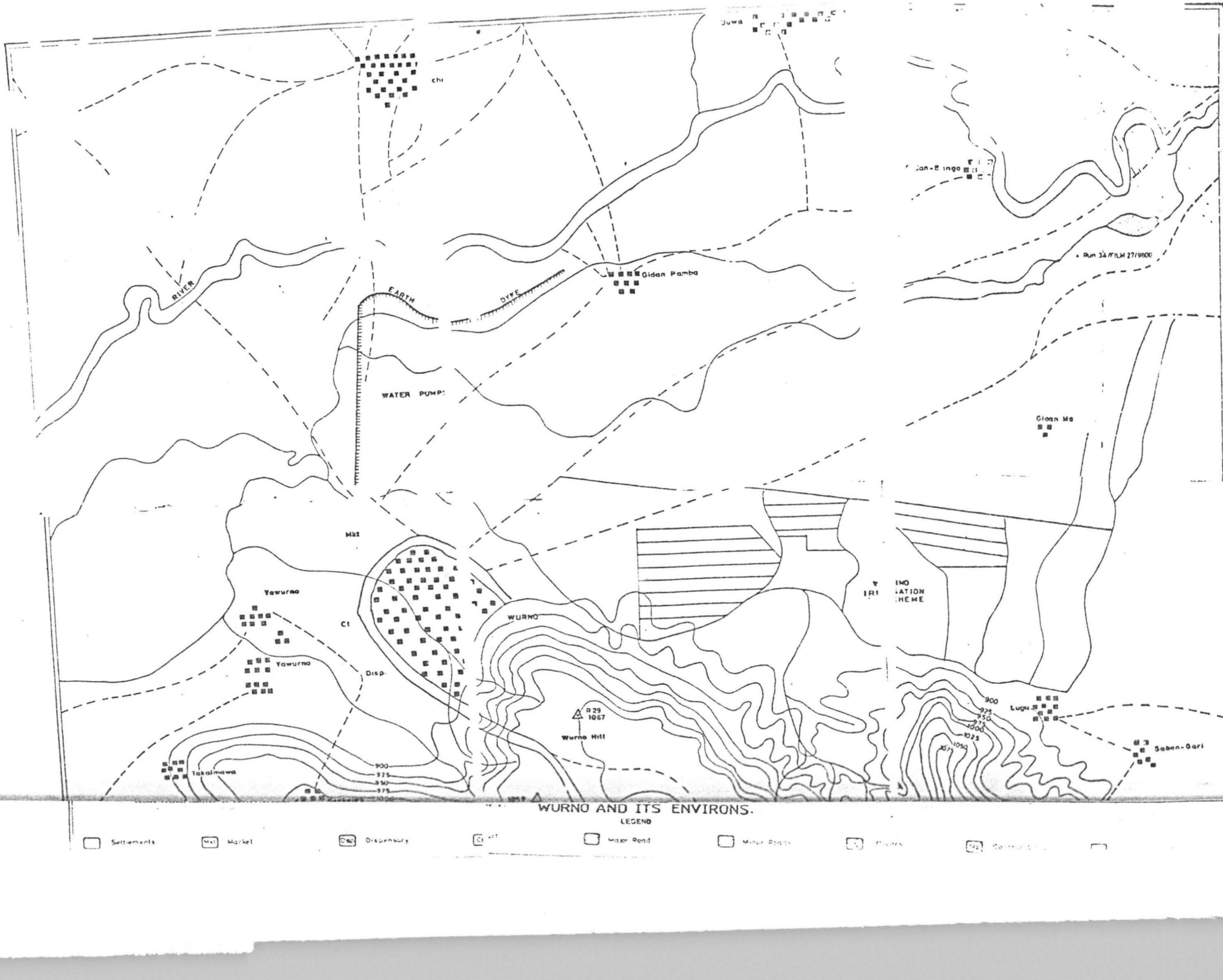
The area is semi-arid with prolonged dry season (October - May) and a short wet of rainy season (end of May - early October). The study area lies within the Sokoto plains and it is composed of sedimentary rocks with scattered hills capped by lateritic rocks. The soil in the up land areas consists of brown to light brown sandy loans while soils in the lower areas are more variable ranging from clay loans to sandy clay loans with high organic content (Agyepong, 1984). The vegetation is dominated by mixed wood land and short grasses from 1 to 1.5m high.

The climate is semi-arid. It is norally experience. From October until April and very short, erratic pattern of rainy season of about four (4) months from May to early September. The average annual rainfall in Wurno and its environs is about 670.3mm

The temperature is generally high. The minimum temperature could be as low as 15°c and sometimes 10°c. Temperature begins to rise fast in March and diurnal variations of 28°c is not uncommon. The highest temperatures are recorded in the month of April, May and June due to fewer amount of cloud cover to block the rays of the rays of the sun. The mean temperature of this time may exceed 32°c with a maximum of 42°c or more. The mean minimum daily temperature is about 24°c. The relative humidity is high and a maximum of about 80 percent is attained in August. During the long dry season, relative humidity is generally low particularly in January and February.

The area experiences wind velocity of between 5 - 10 kilometres per honour (Oboho 1986). Vegetation of Wurno area is sahel savanna whose climax vegetation has totally disappeared as a result of degradation by human activities. It is composed principally of open shrubs and also woodland. The flora of the area is dominated by short trees mostly less than lometres high. Species of trees found include <u>combretum, migricau</u> (ciriri), <u>Acacia nilotica combretum micramthun</u> (gaza)(Ofri sarpong, 1985 Oboho, 1986).

The traditional activities of most of the people is mainly subsistence agriculture, herding and craft making. Agricultura activities in the basin vary from intensive permanent farming in the upland areas.



WURNO AND ITS ENVIRONS.

LEGEND

Settlements · Mkt Market · Disp Dispensary · Ct · Major Road · Minor Roads

Farms are usually small from 0.2ha to 0.9ha in the fadama while the average upland farm size is about 0.53ha (Adanjyi et al 1988)

PROBLEM STATEMENT

The study of landuse and land cover is a very important venture for many reasons. The land is a renewable resource from which man's activities derive the necessities for life as well as those for his
luxury
luxury.

The knowledge of our resource base's in most cases filled with a lot of blank spaces, part of which includes misinformations which are either initially in-correct or out dated. Therefore a better inventory of our environment is of paramount importance, because "charge is to day an reality of nature". (Rudd, 1974).

Wurno has a dam called lugu dam which is bound to have an impact on the landuse pattern of the area. This necessitate studies of this kind. It is also fed by Goronyo dam downstream, that may also have an impact on the landuse pattern of Wurno and its environs.

With the regional concern for desert like conditions; it is necessary to find out what causes this desert - like conditions. The findings may help to chart remedial solutions to check further proliferations of these conditions.

There is therefore, the need to monitor and assess the trends of development of the land in Wurno and its environs. To realise this objective there is the need to use modern, powerful techniques for resource investigations, in-ventories and evaluations. Remote sensing is known to provide apermanent synoptic, spatial and temporal record of the environment. It also permits rapid in-house assessment of resources with reduced field work and therefore low cost.

AIMS AND OBJECTIVES.

The aim of this research is to make use of the advantages of remote sensing techniques in monitoring landuse overtime in space. The specific objectives include:

1) To identify the various landuse/landcovers in the area from landsat imagery.

2) To assess the advantages or accuracy of the digital analysis over visual.

3) To integrate information acquired from other sources (topographic map and ground base data) with the remotely sensed data (landsat MSS) for the proper assessment of landuse/land cover.

JUSTIFICATION.

Wurno and its environs is situated in the north western part of Nigeria on the desert fringes. The area is therefore very susceptible to desert encroachment. There is the need to continuously study and monitor the landuse/landcover of this area by the use of a technology which gives constant and repetitive information about the area. For this study, remote sensing techniques (landsat MSS5) will be use.

The presence of Lugu dam at Wurno has the potential to influence the various landuse/landcover in the area either positively or negatively.

There is therefore the need for this kind of study in order to bring into focus the impact of the dam on the various types of landuse and land-cover and to assertain the likely impact on the socio-economic development of the people of this are (Wuron and its environs).

SCOPE AND LIMITATION OF THE STUDY.

The satellite imagery (Landsat 5 MSS) acquired in the year 1991, obtained from the linkage climatic change centre of Federal Environmental

. Agency Federal University of Technology Minna, is used

Topographic maps are used as secondary sources of information for the analysis. Field work is carried out to compliment the available data and verify as well as up-date both matural and cultural features observed on the landsat imagery.

PLATE: 1.1: LUGU VILLAGE.

PLATE. 1.1: LUGU VILLAGE.

CHAPTER TWO

REVIEW OF RELATED LITERATURE.

Several studies have been conducted on changing landuse using different types of remote sensing data and the impact of the different development projects which result in these changes. Knowledge of what is currently in existence is of importance for one to answer questions emanating from the use of land. In order to understand why landuse charges as well as how the changes occur, it is neccessary to have due of information on the land cover and land use mapping over different epochs. Though this have been very much accomplished internationally, but there is little work done in our local scene as of today.

Remote sensing techniques have been variously applied on monitoring change detection and landuse/landcover studies in Nigeria.

Adeniyi (1980) carried out a study on land-use change using a combination of remote sensing (Aerial photograph) and computer techniques. He was able to acquire landuse data for monitoring urban growth in Lagos, Nigeria.

Adeniyi (1983b) investigate the possibility of dogital classification of land use for both dry and wet seasons. Several issues were revealed in this conclusion using landsat in a semi-arid environment. He identified changes indifferent landuse/landcover especially on prime agricultural lands. Phenological and human induced changes were demonstrated to be separable in his study.

Adeniyi (1986) he also made use of land sat imagery of both dry and wet seasons to monitor changes in semi-arid area in Nigeria, the results showed evidence of land degradation in flood-plain areas where floodplain cutivation has been reduced by as much as 50 percent.

Adefila (1987) applied aerial photography to land use mapping in Samaru area. The study conducted in 1980 was primarily aimed at studying landuse changes and distribution from aerial photographs. In that respect two sets of panchromatic aerial photographs taken in February, 1974 and July, 1979 at the scale of 1:20,000 were used.

Adefolalu (1987) used a combination of SLAR and landsat data with ground truthing observations to study both the West African and Nigerian land use situation. The study recognised five major vegetal cover-woodlands, grass lands, shrubland, farmland and forests. He showed that two States in the Sahel Savannah, Borno and Sokoto states as of 1986 were experiencing harsh effects of desertification. Arable land had been reduced to 19 - 29% and 41.89% respectively while grass land/shrubs were 59.97% and 38.36% respectively. Human activities made situations in Kano and Kaduna States equally pathetic. Both states have between 68% and 82% of the land under intensive agriculture. He had forecast that at early part of 1991 - 2000, arable land in the two states would be turned into shrub land vegetation and the sahel proper.

All has been said as a preamble for this chapter on the internally schoolarly attempter on various work **accomplished on landuse changes and** mapping, though an attempt is made by this study to highlight on the work of some schoolars in this direction.

Macharakiltic (1985), used sequential landsat of 1988, MSS imageries of 1973, 1977 and 1982 to study the land cover of North Eastern. The land covering mun, chin phong, Hong, Phon watershed. Land use classification and mapping were performed using major categories of forest land, agricultural land, and water resources. A comparison of the area of landuse map overlay in 1973 versus 1978 and 1978 versus 1982 provided the initial estimates of forest land use in the study area. Great changes were recorded on phenchi, and khong water shed. High forest land depletion were recorded in phen 10.85%, respectively. The results showed that forests reduced from 30% of the area to 15.33% in 1982. Chi and Phen were critical locations with annual rate of deforestation in the North East. The main causes were given as illegal settlement by migrant for building and the cutting of wood for fuel.

Roger et al (1985), conducted a study to assess quantitatively the changes in the land surface occurring as a result of man's activities or as an impact of climate variability. Time series analysis of landsat 1955 of 1970, 1976 and 1979 covering st. Lawrance valley in Qucbec, Canada, were used to monitor seasonal and long term variation in the land use and vegetation covers. Global **albedo** was the land surface parameter studied. Four (4) types of land cover were distinguished; forest, Agriculture, Urban water and others; fallow, abandoned lands, young forest in regeneration. The result showed that deforestation occurred, and there was significant decrease infarm land and a marked process of urbanisation.

Poulton C.E et al (1977) made a comparative analysis of 1944 and 1968 aerial photographs to detect change and assess causes of the changes as they relate to land management in a range /forest land environment in Sierra Nevada. California. Ground data was not available to verify conditions in 1944 photographs. Therefore only that of 1968 was used. Some changes detected were that most meadow site and riparian vegetation had disappeared from the 1968 photograph while encroachment of sage bush shrub had occurred.

Osterhund H. (1992), produced deforestation and change images for the chiang Isai province in northern Thailand. Enhanced landsat colorhard copies were visually interpreted and area cover classes were manually delineated using a "modest land approach" developed and evaluated by swedish space co-operation, and swedish University of Agricultural Sciences. Forest area cover and rate of change has estimated with the use of sampling design from 1977, 1984, and 1990.. landsat imageries of the same season. Aerial photographs were used as reference data. Six summary classes of water, forest plantation, forest fallow, shrubland and other land were used. Annual rate of deforestation was calculated to be more than 2% per year between 1977 and 1984. This doubled to 4% during the period of 1984 - 1990. Forest decreased by 64% within a period of 13 years. Owivedi (1985) found that a combination of data derived from landsat were false.

Olsson et al (1992), studied deforestation in African dry lands using sudan. He used landsat imageries of 1974, 1979 and 1987. Wood resources were quantified and manual stratification was used to delineate areas of irrigated and mechanized rainfed agriculture. The classification used was open woodlands and forest, irrigated agriculutre, mechanized rainfed agriculture and other uninhabited areas. The results showed that landuse had changed dramatically during the study period but the conclusion reached was that woodlands and forest resources was as a result of the expansion of rainfed agriculture. About 1.1 million hectres was transformed into agricultural land from 1973 to 1987.

Haefer et at (1985) used aerial photographs and 1979 landsat MSS imageries to monitor land surface changes in Sri Lanka. A fundamental thematic map-bench mark map was established and it formed the basis of the assessment of landuse category (and overlaid on the enlarged landsat imageries). It was established from the study that the annual rate of deforestation amounted to 1.75%.

Sir Coulon (1984), also used eleven (11) years of landsat MSS data to monitor vegetation in lake chad; it was noticed that the recent concern for climatic change.. was demonstrated on the vegetation of the lake chad.

Nichol (1987), used SPOT and aerial photographs to assess changes in the soil moisture status. The conclusion drawn from the study was that serious reduction in soil moisture during post-dam period resulting in a change in landuse from fadama to mainly rainfed had occurred.

Avery)1965), used aerial photography at 1:20,000 scale of 1944 and 1960 to evaluate landuse changes in climate of the county, Georgia. A land use map for each period was obtained and the area for each category was determined with the aid of a grid. He discovered a shift of the agricultural pattern of clarks country, Georgia from a heavy emphasis on cotton to poultry production, livestock and farm wood lot management while crop land was reverted to forest land as a result of the influx of manufacturing industry to provide employment.

Lo (1972), also used aerial photographs, 1970 and 1983 to study the landuse change in clarke country, Georgia. He matched two landuse maps compiled for the two different dates over a light table and to only delineate any changes. He was able to obtain a landuse change map. There was an increase in the urban or built up land category particularly in residential, commercial and services as well as a decrease in the agricultural land and forest land categories were noted.

Schmid (1971), carried out rural landuse mapping in a hilly country of Nepal to study the development of the jiri area. He made use of aerial photographs which were interpreted with a stereoscope and the landuse categories were delineated continuous field checking was made with the aid of binoculars. He come out with different categories of landuse: paddy used land and forest settlements and corresponding non-agricultural cotegories, uncleared pastures.

Ojaleye (1996), carried out a study on the evaluation of landuse and landcover changes in the hilly area Idanre. In her study she used topographical map sheet of idanre 1982 and spotxs image of Akure SW (1992) and the results showed that Agricultural landuse and vegetel cover (forest) topped the list in areas of hectres covered. In 1966, forest covers 3962.5 hectares in 1982 it was 2066.5 and in 1992, loss in vegetal cover means gain to agricultural land hectre ; price was paid in vegetal cover.

Most of the studies carried out are in the developed countries and the reason are due to high cost in obtaining the needed data for third level sophistication and also the soft ware packages to use in classifying and analysing this data are not readily available. (This study has attempted to take advantage of the advances in remote sensing technology as have been applied in the studies described above, to further enhance our knowledge on land use/landcover situation in Wurno and to assess the rate of landuse/landcover changes, locations, magnitude and provide maps, statistics and reports for planning). How this will be carried out is discussed in the next chapter.

CHAPTER THREE

METHODOLOGY.

This Chapter focuses on the types of data to be used for this study, their sources and the methods to be used in analysing the data together with the instruments for realising the aims and objectives of this research.

3.1. SOURCES OF DATA.

The landsat MSST used is with identification number ESA (ACS - LANDSAT MSS 5), Vol. 5 and acquired on March 11/1985 in form of computer compatible tape (CCT), processed by Earthnet - Maspalomas acquisition centre - Fucino. The image in computer compatible tape (CCT) was processed, while standard prints were produced in form of maps. The image used has identification number; 5 - 190-91. 12.4 - 01 1023 - 1800, acquired on 18 - 11 - 1987 and was processed by Telepazia for ESA - EARTHNET; The image in computer compatible Tape (CCT) and contact prints were obtained, from the linkage centre on climate change of the, Federal University of Technology, Minna, under the auspices of the Federal Environmental protection Agency (FEPA). The image was cloud free and of high quality. It is very important to obtain a good quality imagery for assessment and mapping of different landuse and its dynamics. The Topographic map: Sokoto north east sheet 7 was obtained from the Federal department of Geological Survey, Kaduna.

Table I below gives a summary of the data used and their sources.

TABLE 3.1: DATA SOURCES AND THEIR CHARACTERISTICS.

S/NO	TYPE	DATE	SCALE	IDENTIFICATION	SOURCES
1)	Topographic map sheet	1968	1:50,000	Sokoto north East sheet 7	Federal Department of Geological survey, Kaduna.
2)	Computer Compatible Tape (CCT) LANDSAT MSS	04/11/85	1:250,000	LANDSAT 5E.	Earth net spalomas acqu-isition centre -fucino.
3)	Landsat MSS (image map)	Nov. 1987	1:250,000	B and 5 5-190-91 12.4-01 1023-1800	The linkage climate change F.U.T. Minna
4)	Ground Tru-thing	OCT - NOV 1997	4 Times	-	Researcher

3.2. DATA AND INSTRUMENTATION.

Computer hard ware and Idrisi soft ware were used for the analysis of the landsat 5 MSS image.

Magnifying lenses and stereoscopes were used for visual interpretation of the land resources imagery. The interpretation was done in the Departmental Laboratory, of the Federal University of Technology, Minna, using light table to enhence identification.

Standard landsat multispectral scene with swath width of 185 km, an instantaneous field of view (IFOV) of 79m, covering part of North Western Nigeria at scale 1:250,000, of November, 1987 was used.

Topographic map of Wurno and its environs, that is Sokoto North East (sheet No. 7), at a scale of 1:50,ooo of 1968 produced by the Federal Surveys of Nigeria was used as a base map for the study.

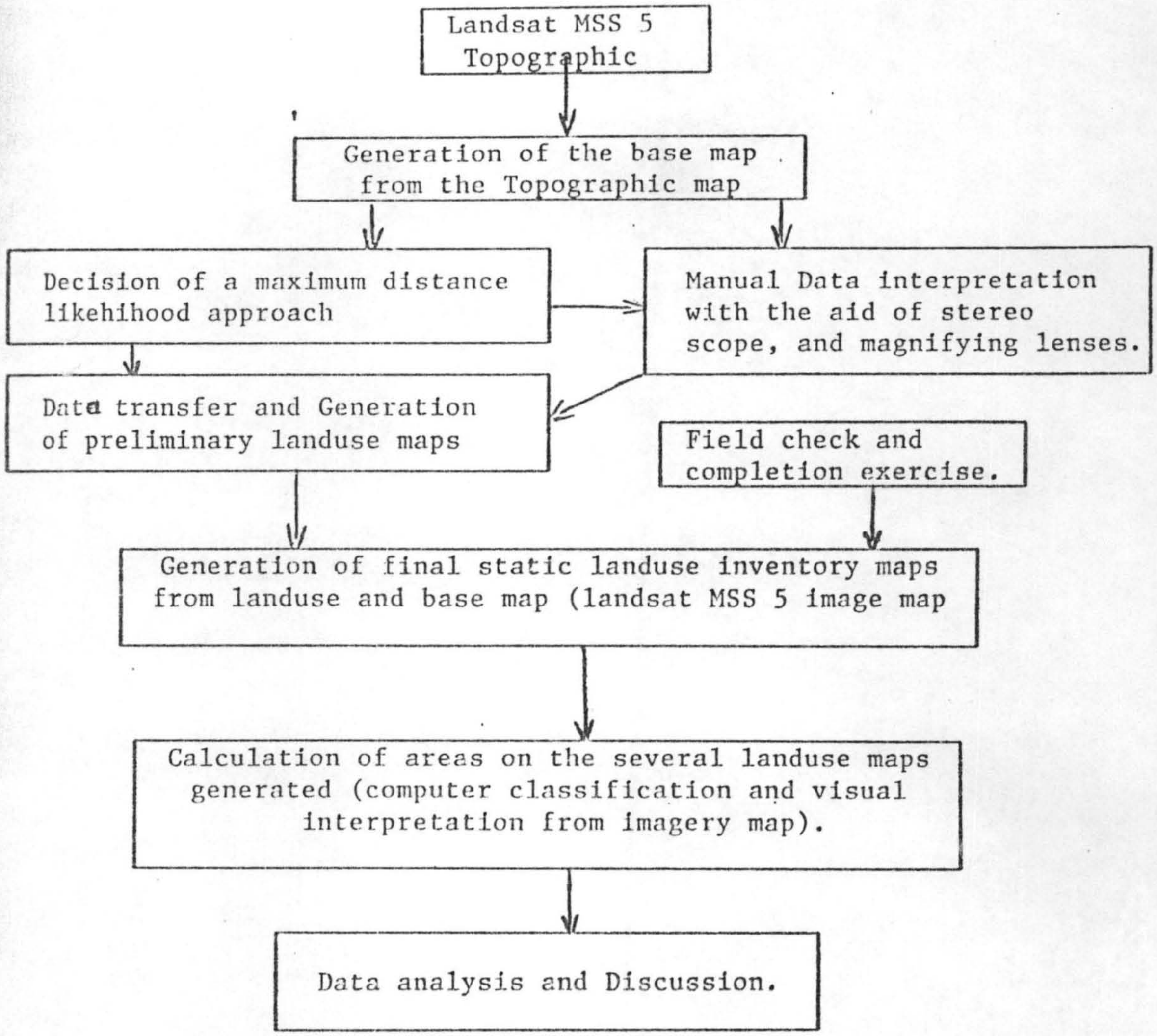
ESA/ACS - LANDSAT MSS in computer compatible tape, is the original image of the landsat MSS data. It was from this computer compatible tape (CCT), that the image the landsat MSS 5 was produced in map form and used for visual interpretation, for identification and mapping of the various landuse types. Ground Truthing was often carried out. To verify the delineated boundaries and doubtful features, were checked to ascertain their extent of domination in the area. Clarifications and verifications of the accuracy of the interpreted data were also done.

The ground truthing for this study, was carried out between October and November in 1997. About the same period the image was acquired from the satellite. The image was displayed on the screen and classification done with computer. Landsat MSS image map was used for landuse classification visual bases. During these, several ground truthing exercises, errors were detected and were immediately corrected on the preliminary landuse map. This was because of the time lag between the time the Topographic map and the image were taken. Intensive care was taken so that changes in landuse may not be taken as interpretation errors.

Table 3.2 METHODOLOGICAL FRAME WORK OF THE STUDY.

Table 3.2. gives a summary of the methodology used in the study from data acquisition through analyses and interpretation.

DATA ACQUISITION



3.3 DATA TRANSFER.

The landsat MSS image used on the computer hard ware was originally in the format of the computer compatible tape (CCT). This was then transformed or down loaded into diskettes inorder for the soft ware package to accomodate it for the analyses. Hence the classification or the analyses is only possible using the computer soft ware package; The landsat MSS has 4 bands in the visible (V.I) and the near infrared regions of the Electromagnetic spectrum (EMS). The image has a swath width of 185km. The whole image was therefore divided into Eight (8) parts with each part distance of 1024 by 1024 pixels. The whole image was too large to be displayed on the computer screen. For the colums and the rows, the study area covering Wurno and its environs (Including LUGU DAM) was found in 'A' i.e the first part (See figure 11 below).

Title:- Thedigital location of study area in diskett

A	B	C	D
E	F	G	H

Idrisi soft ware (95 version) was used for the analysis. Based on this the landuse classification for the study area was obtained in digital format. While image map too was used for the visual analysis and of the same scale of 1:250,000.

3.4. VISUAL INTERPRETATION.

In the course of the visual interpretation, complex patterns of extremely small units were encountered. Generalisation was made in some cases where the predominant category present within each parcel was labelled.

A systematic field check was undertaken for accurate assessment and familiarisation with some cultural and natural features of the area identified. Also terrestrial photographs were used for verification and additional information. During the visual interpretation of the landsat 5 imagery, stereo scope and magnifying lenses were used. Also, during interptretation proces; image elements such as tone, color, pattern, texture, shape, size, site and assocaition were used for the interpretation.

MAXIMUM MAPPING UNIT (MAXIMUM DISTANCE LIKELIHOOD).

The maximum likelihood classifier quantitatively evaluates both the variance and covariance of the category spectral response parterns when classifying an unknown pixel. To do this, an assumption is made that the distribution of the cloud of points forming the category training data is Gaussian (normally distributed). This assumption of normality is generally reasonable for common spectral response distributions.

The maximum mapping unit was decided upon before interpretation. This was based on what could be satisfactority interpreted and delineated on the images depending on the scale of the satellite images, spatial characteristics of the objects and of course the relevance of the research.

In situations where a complex pattern of extremely small units were encountered, generalisations were performed so that such small area could be identified by two digits symbols or codes, indicating the primary categories (level) and secondary categories (level II) and also from landsat image. There are various types of classification scheme, but this study used the classification scheme below as indicated in table 2 belows.

Table 3.3 **Classification scheme used after Adeniyi (1985)**

	Landuse/Cover class	Manual Sub-class	Computer sub-class
1.	Agricultural land	1:1 crop and pasture land	Crop and pasture land
2.	Vegetation	2:1 Wooded shrub land and Thicket 2:2 Grass land shrub land	Wooded shrub land and Thicket Grass land and shrub land.
3.	Water	3.1 River 3.2 - 3.3 -	- Deep reservoir Shallow reservoir
4.	Wet land	4.1 Non-Forested wet land	Non-Forested wet land.
5.	Bare surface	5.1 Exposed rocky surface	Exposed rocky surface.
6.	Settlement	6.1 Built up areas 6.2 Farm house	Built up area Farm house.

3.6. 1987 LANDUSE/LANDCOVER SITUATION.

The landsat MSS data of the study area was interpreted and drawn on tracing paper. Which was over laid on the area. The traced area from the landsat image showed the respective landuse and landcover situati of the study area. With the use of square grid paper in which each box represent one square kilometre, the area of each landuse category was drawn to show the landuse situation of the area in the year. 1987.

3.7. COMPARISON BETWEEN VISUAL AND COMPUTER ANALYSIS.

The two methods were compared i.e visual and digital in order to assess the efficiency and the accuracy of the respective methods. The various advantages and disadvantages that are inherent in the two methods were high lighted.

The details of the analysis and the results obtained there from; form the bulk of the discussion in the next chapter.

CHAPTER FOUR

4.0. DATA ANALYSIS AND DISCUSSION.

For a clear understanding, this chapter is divided into two main section viz;

i) Analysis of visual interpretation of the landsat MSS 5 image map of 1987.

ii) Analysis of the landsat MSS 5 of 1985 using computer soft ware package that is Idrisi for Window (95 version) for landuse classification.

4.1. ANALYSIS OF VISUAL INTERPRETATION OF LANDSAT MSS 5 OF 1987.

Table 4.1: Landuse/Landcover and their hectares and percentages.

	Classes	Area extent in Hectares	Percentage%
1.	Water body (Reservoir)	0.34	1.32
2.	Sandy soil	6.11	24.37
3.	Irrigated agricultural land	2.49	9.93
4.	Sanddunes	0.18	0.72
5.	Shrub land	3.05	12.16
6.	Rainfed agriculture	1.05	4.18
7.	Laterite	3.20	12.76
8.	Vegeted wetland	2.49	9.93
9.	Non-vegeted wetland	3.82	15.23
10.	Forest	3.34	9.33
11.	Settlement	0.00	0
	TOTAL	25.08	99.97

Table 4.1 shows landuse/landcover classes identified and classified visually. Each class was measured and values given in hectares and their percentages were computed for the respective classes. The study are from the landsat MSS 5 image map has an area extent of 25.08 hectares of land.

As depicted in table 4.1 above, sandy soil dominated the area of study with 6.11 hectares (24.37%), followed by non-vegeted wet land with 3.82 hectares (15.23%). The next is the laterite surface which has 3.20 hectares (12.76%). As for shrub land, it has 2.49 hectares (9.93%). The irrigated agricultural land also occupies 2.34 hectares (9.93). Forest constitutes 2.34 hectares (9.33%), while rain rainfed agricultural land (Tudu) has 1.05 hectares (4.18%). The water body (reservoir) which is known as LUGU DAM has an areal extent of 0.34 hectares (1.32%), while the sand dune has o.18 hectares (0.72%). The Figure 2 shows the landuse/landcover of Wurno and its environs based on the visual interpretation.

4.12 LANDUSE/LANDCOVER OF DIGITAL ANALYSIS.

Table 4.2: Digital analysis of landuse/landcover of Wurno and its Environs:

	Landuse/ Landcover	Digital value	Pixe-cells	Colour	Hectarec	Percentage
1.	Waterbody (Reservoir)	170	1914	Blue	0.19	0.75
2.	Inundated area	165	1135	Yellow	0.11	0.43
3.	Irrigated land	151	24374	Red	2.43	9.65
4.	Rainfed agriculture	188	17533	Reddish pink	1.75	6.97
5.	Shrubland	34	2777	Green	0.27	1.07
6.	Sandy soil	208	33828	Orange	3.38	13.47
7.	Laterite surface	185	98837	Light blue	9.88	39.39
8.	Wetland vegeted	168	25539	Red	2.55	10.16
9.	Non-vegeted wetland	160	16446	Light red	1.64	6.53
10.	Sand dunes	207	2609	Yellow	0.26	1.03
11.	Forest	122	26141	Deep green	2.61	10.40
12.	Ditch	25	129	Light blue	0.01	0.03
	TOTAL				25.08	99.91

Table 4.2 shows the landuse/landcover classification of the study area interpreted digitally by the use of computer. The computer classification was able to give about twelve (12) different classes of landuse/landcover of the study area.

As depicted in the table laterite surface occupies 9.88 hectares (39.39%), while sandy soil has 3.38 hectares (13.47%), followed by forest which has 2.61 hectares (10.40%). The vegeted wet land occupies 2.55 hectares

(10.16%), the next is the irrigated land for agriculture which is 2.43 hectares (9.68%). The rainfed agricultural land occupies 1.75 hectares (6.97%), while non-vegeted weland has 1.64 hectares (6.53%). The shrub land is 0.27 hectares (1.07%). As for the sand dunes it has 0.26 hectares (1.03%). Water body (reservoir) has 0.19 hectares (0.75%), while the areal coverage for the inundated area is 0.11 hectares (0.43%). The least interms of areal coverage is the ditch which has 0.01 (0.03%).

In the computer or digital classification as stated earlier, in the methodology, **maximum** likelihood approach was used for this study, as can be seen on plate 4.3. It depicted various land use/land cover of wurno and its environs, by the use of digital values to assign colours to various features. Three approaches of digital analysis were used to bring out the best findings for the study. The approaches are parallel pipe, maximum likelihood approach and minimum distance approach. The results are shown in the tables 4.3, 4.4, and 4.5. And this indicated that the minimum and maximum approaches gave almost the same result. The paralled pipe approach gave only ten (10) classes of classification of the features for land cover/landuse of the study area. While the maxium and minimum gave twelve (12) classes of features of classification of the land use/landcover of the study area. Maximum likelihood approach was used for the digital classification by the researcher as earlier stated in the methodology, There is little difference existing between the minimum and the maximum, but it was a matter of subtraction and addition of ten (10) digital value to the irrigated agriculture from minimum to maximum. This clearly indicates that one particular landuse/landcover by minimum approach was over **generalised**

These are clearly shown on table 4.3, 4.4 and 4.5 these makes provision for showing the differences. Parallel pipe approach tends to gives a

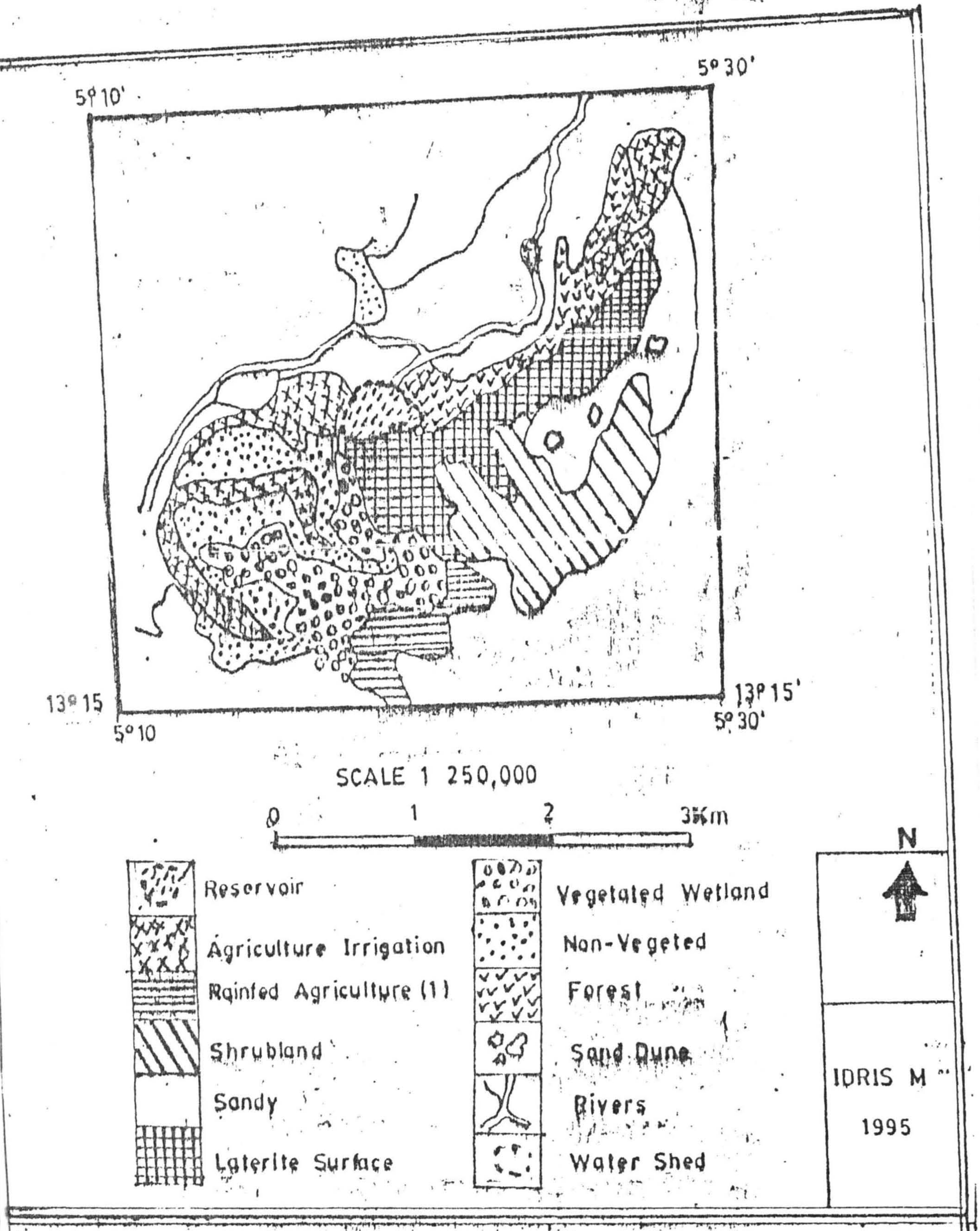
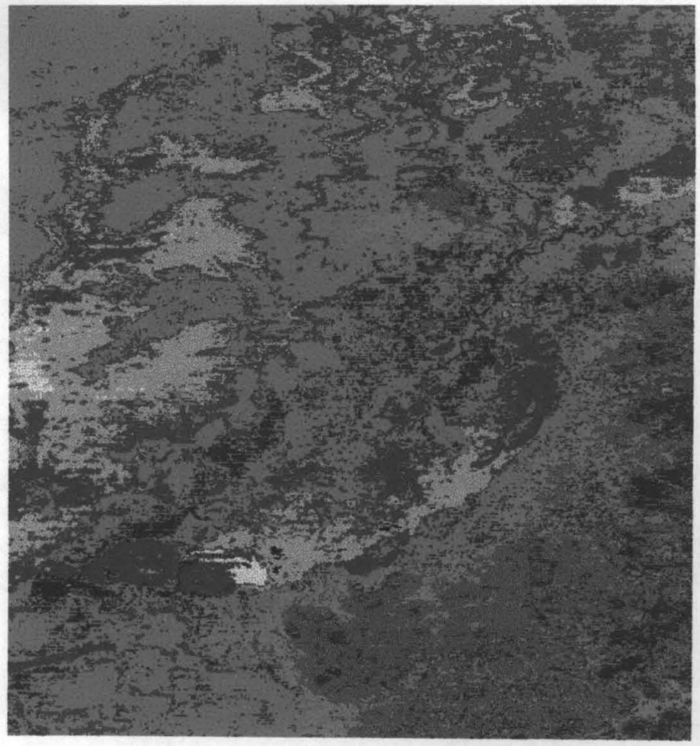


Fig. 2: LANDUSE / LANDCOVER MAP OF WURNO

DIGITAL LANDUSE /LANDCOVER CLASSIFICATION OF WURNO AND IT'S ENVIRONS



WATE BODY BODY RESERVIOR

INUDATED AREA

IRRIGATED AGRICULTURE

RAIN AGRICULTURE (TUDU)

SHRUB LAND

SANDY SOIL

LATERITE SURFACE

VEGETATED WETLAND

NON- VEGETATED WETLAND

SANDDUNE

FOREST

DITCH

PLATE 4:4 DIGITAL LANDUSE/LANDCOVER CLASSIFICATION OF WURNO AND IT'S ENVIRONS

DIGITAL LANDUSE / LANDCOVER CLASIFICATION OF WURNO AND IT'S ENVIRONS

WATER BODY RESERVOIR

INUDATED AREA

IRRIGATED AGRICULTURE

RAIN AGRICULTURE (TUDU)

SHRUB LAND

SANDY SOIL

LATERITE SURFACE

VEGETATED WET LAND

NON/ - VEGETATED WET LAND

SANDDUNE

FOREST

DITCH

PLATE 4.3: DIGITALLANDUSE/LANDCOVER CLASIFICATION OF WURNO AND IT'S ENVIRONS

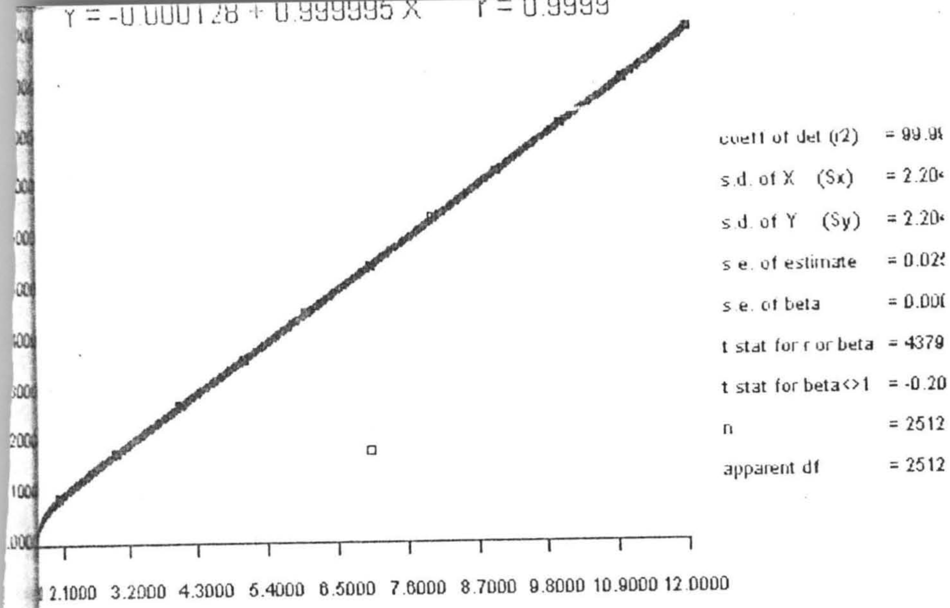


FIGURE: 4.2 REGRESSION OF MAXIUM AGAINST MIMIUM DISTANCE METHOD.

lot of generalisation, which is good for linearment by the geologists.

Regression analysis was done for the digital classification; **maximum** likelihood was regressedover the minimum distance; (figure 4.3) The amount of correlation is $(.9999)^2$.

Figure 4.6 shows the relationship among the various landuse/landcover in the form of histogram. From the histogram **laterite** surfaces dominated other features of landuse/landcover which is in consonant with table 4.2 above.

The **two** tables 4.1 and 4.2 shows landuse/landcover classification of the study area. The visual analysis indicated ten (10) classes, while digital analysis gave twelve (12) classes of landuse/landcover. The visual analysis was based on the interpretation elements and the familiarisation of the researcher with the study area. There is always a limit to what human sight can differentiate between and among colours. With digital analysis: the computer is able to scale about thirty two (32) colours into twelve (12), which give the attribute of the various landuse/landcover. This is shown on plate (4.3) as colour composition. The computer has the capability of differentiating between and among more colours than the human sight can accomplish.

Based on the visual interpretation, sandy soil dorminates the features classified. This is in sharp contrast to what was obtained in digital analysis. This is not unconnected with the fact that settlement was classified as part of laterite surface. This happens; simply because through field check, it was known that the buildings were built from laterites, and even the roofing. In view of this, the reflectance value of both laterites surfaces and that of the buildings were the same. Therefore when digital

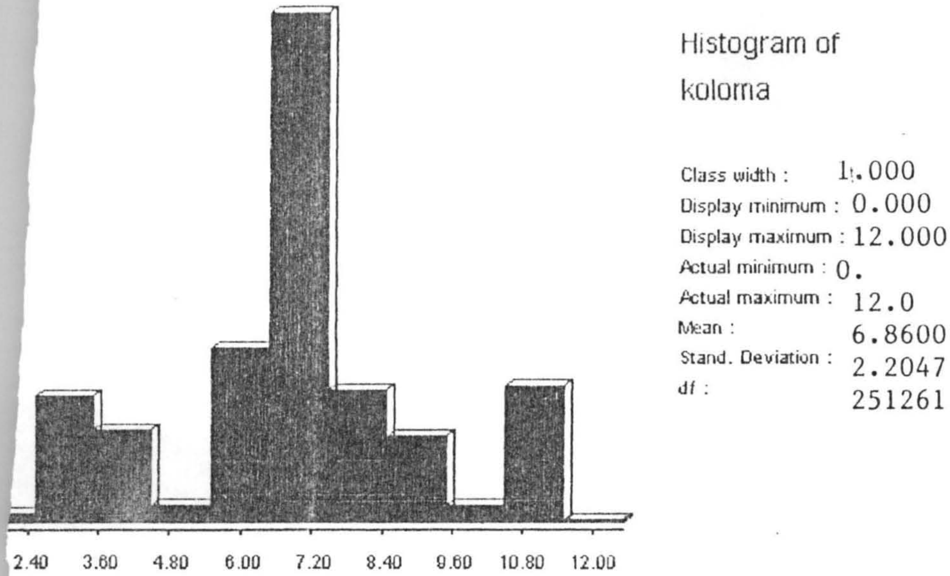


FIGURE 4.3: HISTOGRAM OF DIGITAL CLASSIFICATION OF WURNO AND ITS ENVIRONS.

COLOUR COMPOSITE

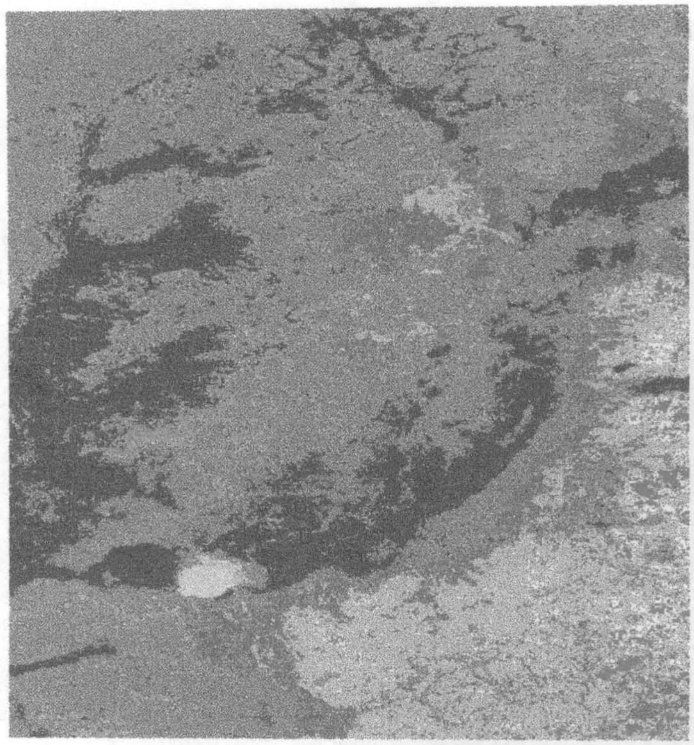


PLATE 4:4 COLOUR COMPOSITE

PLATE 4.4: COLOUR COMPOSITION

classification were made, settlements were classified as laterite surfaces thus, giving it a higher percentage of areal coverage in digital analysis. The settlements are purely of traditional setting, giving rise to difficulties in the classification.

As for the water body (reservoir); in the visual analysis; it was classified in one class of landuse/landcover feature. While in the digital analysis; the reflectance values from the water body was classified in to two (2), that is reservoir and the inundated area. The ditch was one of the classified landuse/landcover by the digital analysis. It was classified as part of the non-vegeted wetland in the visual analysis. That explains why its value appreciated compared to its value in digital analysis.

Some part of the rainfed agricultural land (Tudu) was taken to be as shrub land which makes the shrub land relatively of a higher value as against what is obtained in the digital analysis. This was based on reflectance value and colour of the feature classified.

Since the image used (landsat MSS 5) is a dry season image, this is probably the reason why non-vegeted wetland, has more percentage than the vegeted wetland. It may be that during the satellite pass over the study area, crops were alread harvested. In view of this the non-vegeted wetland has some stunted grasses; which in any case are not been harvested and this added some reflectance value to the area. And this probably makes it to have higher reflectance value than the vegeted wetland.

All other landuse/landcover of the study area, for instance irrigated land, forest are similar in terms of hectarage and percentages covered by the two methods used, as indicated in tables 4.1. settlements were not among the features classified as landuse/landcover of the study area. This

This is because visually, using the interpretation elements, settlements were not depictable, because of the image being used (LANDSAT MSS) has a very poor spatial resolution of 79m. In view of this, there was the risk of the settlement being classified among other features of landuse/landcover of the study area.

From the ground truthing, crops mostly planted in the irrigated areas are, onions, tomatoes, lettuce, carrots and vegetables. Water from the reservoir is used for irrigating these crops. Though the dam is about two kilometres (2Km) away from Wurno settlement. There are other smaller settlements; like Lugu village which makes use of the dam for farming. This dam is used for irrigating their farms which are mostly sugarcane and rice farms. The non-vegeted wetland is not been put to serious farming or agricultural use. This might be do to the reson of poor soil or low fertility. However stunted grasses do grow there. So there are some crops that can be planted there and it will do well; for instance sugar-cane. In case of the rainfed agriculture, crops mostly grown are quick yielding varieties such as the millet, guinea-corn, and sorghum. Infact the inhabitants depends on these crops as their staple food for survival. While the animals being reared are shelp, goats, cattles, etc which feeds on the dry grasses, both on the rainfed agricultural land, and the stunted grasses on the non- vegeted wetland. Even the stalks from the harvested grains are being used in feeding the animals. Animals like camels mostly feeds on thorns which are readily available, and usually associated with either desert or semidesert environment. In which case the study area is a semi desert environment.

The species of the trees that forms the forest environment are the Acacia, Baobab with big stem, long tap roots and spine-like leaves to control transpiration from the scoarching sun of the environment. The forest was

PLATE 4.1: LUGU DAM IRRIGATION SITE.

PLATE 4.2: INUNDATED OF THE RESERVIOR

PLATE 4.1. LUGU DAM IRRIGATION SITE

PLATE 4.2. INUNDATED PART OF THE RESERVIOR

further buttress by the recent clamour for afforestation programme by government and non-governmental organisations.

The ditch which appear on the digital classification was confirmed by ground truthing. And through personal observation and oral interview, it was gathered that the ditch came as aresult of the inhabitand digging for water, especially during the dry season period. This serves as an alternative to well. After the results have been presented, analysed and discussed, the next thing is the overall conclusion and possible recommendations which the researcher deem useful for both the inhabitants and the government. This forms the next chapter of the work.

Table 4.3.

Parallel pipe classification with the classes and there cells values:

Category	Cells
0	962
4	27
5	2777
6	52749
7	123310
8	26112
9	16446
10	2609
11	26141
12	129

Table 4.4.

Minimum distance approach

Category	Cells
1	1914
2	1135
3	24364
4	17533
5	2777
6	33828
7	98837
8	25539
9	16446
10	2609
11	26141
12	129

Table 4.5.

Maximum likelihood distance.

Category	Cells
1	1914
2	1135
3	24375
4	17533
5	2777
6	33828
7	98837
8	25539
9	16446
10	22609
11	26141
12	129

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS.

5.1. CONCLUSIONS.

The main objectives of this study were:

a) To determine or to classify the various landuse/landcover of Wurno and its environs, using the two methods of visual and nigital techniques;

b) To compare the efficiency of the two methods i.e visual interpretation and the digital analysis,

c) To integrate information acquired from other sources (topographic map and ground base data) with the remotely sensed data (landsat MSS), for the proper assessment of landuse/landcover of the study area.

For the above to be achieved, landsat MSS 5 of 1985 was used. The image was in diskett in the computer for the digital analysis. While the same image but in print map format, which was produced in 1987 was used for the visual analysis, for classifying various landuse/landcover of the study area.

The topographic map of the study area was used as a base map, which was produced in 1968; This is to know the kinds of landuse/landcover that existed before this landsat image of 1985.

The ground truthing was embarked on, on four (4) different occassions to the study area; before starting the two methods of classification. And also when the analyses of classifications were being done; In order to asscertain or account for the cultural and natural features in the study area that proved difficult to be interpreted or classified with the two methods.

The visual interpretation was done using stereoscope, and magnifying lenses. The visual analysis was used for classifying the landuse/landcover of the the study area. Digital analysis, using computer soft wave package was used for classifying landuse/landcover of the study area.

The results were able to give use the various landuse/landcover classification of the area. The results of the classification using visual analysis indicated that sandy soil dominated the environment. The result also shows that laterite surfaces dominates the environment in the digital analysis. Coupled with ground-truthing, and for the fact that the study area lies at the desert-fringes, which are characteristically sandy in nature, the visual analysis classification of attributing sandy soil as the do-minating landuse/landcover is not far from the reality.

In the digital analysis, there was generalisation by computer in assigning digital values used in the classification scheme. Features with the same reflectance values are normally generalised to be of the same feature. This reduced the accuracy of the digital analysis in the classification scheme.

From the results, the visual classification of landuse/landcover of the study area was ten (10). While that of the digital was twelve (12) classes of landuse/landcover of the study area. While it take no much time for the digital analysis to be accomplish, the visual analysis is time consuming, labour intensive but cheap and does not require much training to be carried out. However the digital analysis was faster, more accurate but capital intensive and require much expertise to be carried out.

But inspite of this problem, there is no denying the fact that digital analysis is more accurate, efficient and faster in doing the classification. The decrease or increase in some landuse/landcover classification are attributable to the two approachers used for the study. Inspite of the problems associated with the two approaches, **There. no. better** methods than these as of now. They give an insight into what they have in stock in terms of cultivable land and non-cultivable land, and a complete picture about the landuse/landcover of the study area. Forany planning to be meaningful and to have a direct bearing on the people, resource inventory is needed to be done.

Remote Sensing technique is of great advantage inmapping landuse/ landcover. It also goes to the extent of detecting landuse/landcover changes. Satellite images, that is LANDSAT MSS 5, gives a detailed information, especially on the vegeted areas in the study area. The greatest advantage that accrued inusing remote sensing in this work is that the same landuse type is represented by the same colour. The colours are good indicators of land cover due to difference in moisture content and vegetation. It also enhenced the interpretation of landuse/landcover system.

5.2. RECOMMENDATION.

It is necessary to have studies on landuse/landcover on various areas; for any meaningful development of an environment to be realised, with respect to planning and management. The physical environment has to be considered and made use of effectively. The dam built in the study area (LUGU DAM) should at least be developed to standard in order to measure up as with the neighboring areas like Bakolori and Goronyo dams. The lugu Dam is an earthfed dam fed by Goronyo Dam.

It would have been better if it is independent because any fluctuations in the water level at the up stream where Goronyo is damed, it will invariably affect the lugu dam at the down stream. Consequently, it will affect the irrigation project in the area.

The government on her part should embark on enlightenment compaign to make the people to realise the importance of all the year round farming. Incentives such as provision of seedlings, fertilizers and provision of extension workers should be provided to boost peoples agricultural output.

The non-vegeted wetland can be subjected to meaningful agricultural use if help is rendered by the authorities concerned. The farmers could be enlightened that the non-vegeted wetland can be used for sugar-cane plantation which does not require much fertilizer, but only labour intensive at the first start. The government should also change its Luke warm attitude, towards this area. This could be achieved by popularizing the dam and its activities like the other neighbouring dams. Similar studies should be carried out here routinely to monitor the progress of the area, so that literature will be readily available and this will ease the work of future researchers. But presently there is dearth of literature on the study area. This is clearly envident for the change detection studies is not possible with the available data. For this to be areality multi -temporal satellite data are needed.

The government should endeavour to provide access road from Wurno and other neighbouring settlements with road to the irrigation site where farming activities are taking place. These roads should be constructed to link villages and the market centres for easy conveyance of produce from the farms to the market centres. It should be borne in mind that the more accessible an area is, the more it generates agro-economic activity are.

Above all, remote sensing data, particularly satellite images must be acquired regularly. so that there will be enough and adequate data or information to monitor the landuse/landcover activities in particular, and also to monitor all forms of resources from space to the crust of the earth in order to avoid devastating conditions as a result of careless use of the resources, and also possibly to bring to a halt any type of landuse/landcover that will cause environmental deterioration. Moreso, remote sensing data collection system is also recommended in evaluation or in mapping landuse/landcover of the area in time and space.

BIBLIOGRAPHICAL REFERENCES.

1. **Adefila, E. Y. (1987),** Use of Aerial photography for landuse mapping and monitoring. A paper presented at the Annual conference of Nigeria Society of Remote Sensing, Kano.

2. **Adefolalu D. O. (1985)** Regional studies with satellite data in Africa on desertification of the Sudan Sahel both in Nigeria. In procislsc p, conference in Rome-Italy (Erolfe, ed); 429 - 439.

3. **Adeniyi, P. O. (1985)** Digital Analysis of multispectral landsat Data for landuse/landcover classification in a semi-arid area of Nigeria. Photogrammetric Engineering and Remote Sensing Vol. 51, No. 11 PP 1761 - 1774.

4. ______________ **(1986)** Application of remote sensing technique in Nigeria, The role of remote sensing in Landuse Planning in proceeding of Nigeria Society of Remote Sensing, (Musisi Nkanbwe ED) Ilesa Diocese printing press pp 14 - 18.

5. ______________ **(1987)** Landuse/landcover mapping **in management large scale** irrigation project in a semi-arid of Nigeria. The Bakolori pro-project. A paper presented at the nations conference on desertification and environment resource monitoring in Nigeria, Kano.

6. __________________ (1988). Using Remote Sensing to evaluate the impact of dam construction in North Western Nigeria. A paper presented at the 22nd internal symposium on Remote Sensing, Abdjan, Cote-D'voire.

7. **Agyepong. G. T. (1984).** Commercial Fuel wood cutting: A Research Note (unpublished Department of Geography University of Sokoto).

8. ________________ **(1984);** Soil Erosion, its nature and incidence in Sokoto State (unpublished Seminar Paper, University of Sokoto) in proceedings of the symposium on photogrammetry and Remote Sensing in Economic Development Commission. Vol, 22 - 26 September, 1986.

9. **Avery, G. (1965).** Measuring landuse changes in USDA photographs, photogrammetric Engineering and Remote Sensing 45: 66 - 8.

10. **Ejre, A. L. (1985).** Vegetation change and desertification in the carribean. In proceedings of ISLSCP conference Rome 190. 509 - 514.

11. **Haefner, H. et al, (1985).** Monitoring land surface change in Sri-Lanka. Proceedings of ISLSCP conference ROME. PP 501 - 507.

12. **Hellden, V. (1985).** Desertification monitoring. Remote Sensing data for drought impact studies in the sudan. Proceedings of ISLSCP conference. Rome pp 497 - 499.

13. **Iheruo, R. V. (1987).** Changes in landuse/landcover in the Bakolori irrigation project (1979 - 1986). Unpublished M. Sc the-Sis, Department of Geography University of Lagos, PP 64.

14. **Lo, C. P (1981),** Landuse mapping of Hong - Kong from landsat images: an avaluation. International Journal of Remote Sensing 2: 231 - 252.

15. **Rueben K. U. (1970).** Geographical Regions of Nigeria: London Heinemari Nairobi/Ibadan P. 1 - 16.

16. **Ojaleye O. A. (1996).** Evaluation of landuse and landcover changes in the hilly area of ldanre using Remote Sensing Techniques. Unpublished M. Sc Thesis, Department of Geography, Federal University of Technology Minna, pp 61.

17. **Olsson, L. and Ardo (1992).** Deforestation in African drylands - Assessment of changes in woody vegetation in semi-arid sudan. Remote Sensing information from sweddish space co-operation NO. 22.

18. **Osterhund, H. (1992),** Tropical forest monitoring with high Resolution Satellite data. Remote Sensing information from sweddish space co-operation No. 22.

19. **Otterman J. (1974),** Baring High - Alabedo soils by overgrazzing. "A hypothetical deserification mechanism". Science 186: pp 531 - 33.

20. **Okhimahne, A. A. (1993),** Assessment of Environmental impact of Dam construction in Nigeria. A case study of Tiga Dam in Kano State. MSc THESIS, Department of Geography Federal University of Technology, Minna 45pp.

21. **Pillon, P. G. (1986).** Detecting changes in a semi-arid Environment using landsat MSS data. A study of the Bakolori irrigation scheme, Nigeria M. A. THESIS, Department of Geography, University of water-loo 154pp.

22. **Poulton E. C. (1975),** Use of conventional panchromatic aerial photographs in range monitoring in range research inventory, Evaluation and monitoring. Manual of Remote Sensing. 1453 - 1455pp.

23. **Rajago Paln V (1975),** Dam safety and environment, seminar world Bank Technical paper No. 115.

24. **Royer, (1985).** Preliminary results of an-thropogenic albedo change over the past 18 years in Eastern Canada. proceedings of ISLSCP conference in Rome; 497 499pp

25. **Strahlar, A. N. and Strahler A. H. (1973).** Environmental Science: interaction between Natural Systems and Man. Hojn Willey and sons international united states.

26. **United Nations Water Conference. Economic Committees for West Asia (1977).** Regional preparatory meeting; Baghdad.

27. **Wachakaratti, S. (1985).** The application of land sat imagery for landcover assessment. Proceesing of ISLSCP conference in Rome 483 - 491pp.

17:57:34