ASSESSMENT OF LAND USE CONFIGURATION IN GORONYO USING LANDSAT MSS IMAGERY

A CASE STUDY OF GORONYO IN SOKOTO STATE

By

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A project submitted to the department of geography, School of Science and Science education, Federal University of Technology Minna, In partial fulfilment of the requirements for the award of the degree of masters of Technology (M.tech) in Remote sensing application.

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DECLARATION

Elukpo Alemye Ajeichi of the department of Geography, school of science education, Federal University of Technology Minna, hereby declare that this project is on Authentic research conducted by me under the supervision of Dr. G.N. Nsofor. This work has not been presented wholly or partly for any degree elsewhere. All references are dully acknowledged.

CERTIFICATION

This project entitled Assessment of land use configuration in Goronyo, Sokoto State using Landsat Mss imagery meets the regulation governing the award of the masters degree in remote sensing application of the Federal University of Technology, Minna and is approved for its contribution to knowledge and literacy presentation.

DR. G.N. NSOFOR **Major Supervisor.**	.... Signature	16/6/98 Date
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DEDICATION

This projects is dedicated to my Almighty Father who has been my provider, sustainer and guide. Words are not enough to say my thanks. Thank you in God. Blessed be your name forever.

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I wish to appreciate all that stood by me during my academic pursuit, may God in his infinite mercies do much more for you than you have done for me.

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ABSTRACT

Land is dynamic and if proper care is not taken it will lead to deterioration of the land. This will affect the lifestyle of the people. Land is affected through urbanisation, deforestation, farming activities, draining of marshes or creation of dams etc. These are meant to make life easier but end up affecting the land adversely.

This study was focused on mapping the land use of Goronyo visually and digitally and making comparison between the two land use maps generated.

Visual interpretation of the air photographs was done with the aid of stereoscope and magnifying lens. The aerial photograph was interpreted and transferred to a base map which was generated from a topographic map. Matrinc cells was used to create or calculate the proportion of each of the land use.

Factors that were put into consideration during the interpretation of visual and digital classification are pattern, texture, tone, shape, size/association.

Land sat MSS imagery acquired on 18th Nov 1987 at the scale of 1:250,000 was used. Maximum likelihood classifies was used in enhancing the image using bands 4,5 and 6 for analysis and classification.

The result of the manual interpretation and digital interpretation were tabulated and compared. In both visual and digital classification bare surface had the highest percentage. This can be said to be due to the area having the Sudan Savanna Climate that is, short duration of rainfall and long dry spell and also the effect of man of the land. In visual interpretation, twelve classes of land use were identified while eleven were identified in the digital classification. The lowest land use in terms of area coverage in visual interpretation is inundated area. With digital classification, it is forest area.

This reservoir in Goronyo has both negative and positive effects on the landuse. It was found that digital and visual interpretation are best done hand in hand with field trip in order to achieve a good result.

This study is important in that it suggests to us to monitor our environment properly through the aid of satellite data. The recommendations made will be useful for proper management and planning purposes.

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CHAPTER ONE

1.1 INTRODUCTION

Man's environment is made up of the atmosphere, land and the various forms of life. Our environment determines how we live and what we do in order to survive, Human activities can affect our environment through urbanisation, deforestation, farming activities, drainage of marshes or creation of dams. These activities are meant to make life easier for people but they end up causing problems that will affect the land in future. In order to study our environment properly, we need space borne, remote sensing data. This we believe will help us to do proper landuse planning and proper environmental monitoring purposes. The acquisition of relevant information for the effective management of land and land related resources has been one of the major problems of planning in Nigeria (Areola, 1982; Adeniyi, 1979). The only way this problem is solved is through the means of remote sensing applications which monitors the changes in the distribution of activities that are related to social and economic changes. Monitoring of an environment is the act of observing, recording or measuring changes that occur in a place. This becomes easy with different remote sensing data which are intergrated in a system and it helps to report any changes. This changes can be either in the physical, social or economic sub-system of the area. This technology is suited for monitoring of impact of development such as landuse, soil, moisture required, vegetation and animal production.

Remote sensing data can be used to monitor the current condition of things, natural or produced by man. This type of information helps manage the country's resources and to monitor the environment to reduce undesirable effect on the environment.

In studying on area, remote sensing data can be used either singly or in combination to study changes in an area. These data are useful for landuse and landcover monitoring and mapping.

Landuse is the use of land by people usually with emphasis on the functional role of land in economic activities while landcover is said to be items that cover the land either natural or man made.

Landcover designates, the visible evidence of landuse to include both vegetation and non-vegetation feature and is subject to direct observation (Campbell, 1987) and it is the vegetation and artificial constructions covering the land surface [Burley, 1961].

Configuration is the structure arrangement, conformation, contours according to the standard dictionary of English Language (vol 1, 1978). Landuse configuration can be said to be the use of land and the structure arrangement of the land.

In order to study the complex nature of Nigerian's environment and the uncontrolled form of land utilization, it is necessary to search for rapid, accurate and cost effective technique for the mapping and monitoring of the land resources. Remote sensing has been used in the last decade and it has been found to be suitable for rapid inventory and monitoring of changes in the environment. Apart from remote sensing, other data from survey are needed to study the changes. A standard image interpretation techniques is needed for doing efficient identification and mapping of all major landuse classes. Interpretation experience from areas with similar natural condition will make things easier.

In a forested area, there will be different shades of dark red and brown, water areas are blush, agricultural areas, green, vegetation in shades of red to light red and bare soil in whitish colour. Field patterns can be identified from the imagery which will provide indirect information on firm sites and agricultural practices. Major roads and railway lines are often identified, the distribution and development of population density are visible. Topography features such as valleys, plains, mountains can be seen. Areas unsuitable for agriculture can also be mapped because of the excessive slopes or flood risks that are visible on the imagery. Landuse data have high resolution, It is possible to see minor roads, details of the road patterns etc. This can be used in city or settlement maps, industrial area, landuse and landcover patterning in an area.

For changes in an environment to be monitored, it is important to have at least 2 images or data that are produced in the same condition. For example 2 images of a place taken during wet and dry season will differ because of agricultural crops. This type of data will be useful for crop changes or monitoring of vegetation in a period.

Remote sensing can be used in monitoring of water system i.e drainage, catchment areas and to know the extent of water in major rivers and lakes.

In the area to be studied, majority of the population depends largely on the exploitation of the land resources. It is therefore important that the agricultural development planning must take into consideration the physical constraints of the environment. This constraints are mainly in climate, soil, vegetation and availability of water. A dam is found in the area because of the decreasing mean annual rainfall and increased variability of the onset and ceasation of rain. These are bound to increase agriculture insecurity. The continuous removal of vegetation by human activity has led to increased dessication and erosion of soil reserves. This study can be said to be done based on the magnitude of the environmental and resource problems in the area and need for greater resorce information to serve as inputs into several land and water development projects being executed and planned for in future. It can also reveal potential management problems and opportunities (Charles, 1981).

1.2 PROBLEM STATEMENT AND OBJECTIVES

Sokoto state is a place with dynamic land. This is because of the various activities that occur and because of the weather condition. These effects the land terribly and has made this study a necessity. The aim of the study is to probe the landuse, using remote sensing technique with visual interpretation to ascertain landuse configuration and to infer indirectly the social economic status of the place by comparing the satellite imagery taken years ago and what is happening presently.

THE OBJECTIVES OF THE STUDY

1. To map out the landuse of Goronyo.
2. To asses the advantages of digital classification over visual classification.

1.3 JUSTIFICATION

Goronyo is located within the Sokoto Rima Basin. It lies approximately with longitude 3° 49' East and 6° degrees East and latitude 13° 29' North and 13° 39' North. It is in a semi-arid region and is being threatened by drought and desertification.

Adefolalu (1986) pointed out that desertification in Sokoto State is due more to human activities such as intensive farming and it requires only long spell of drought such as the ones forecasted for the early part of 1991-2000 (Adefolalu, 1973) to turn arable land into shrub-land vegetation. This is what is happening presently.

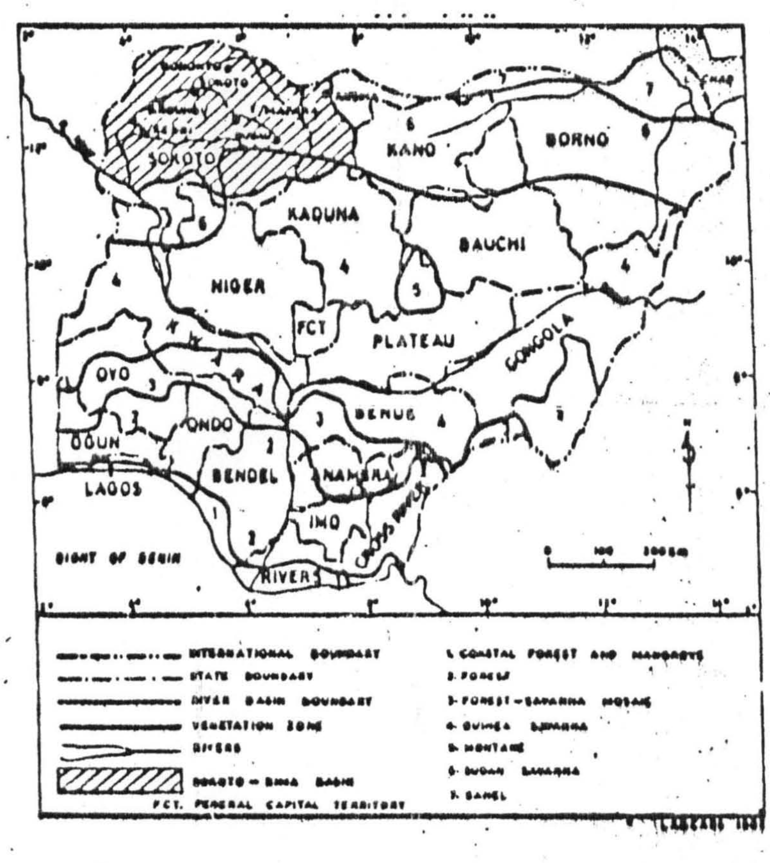
This project on assessment of landuse configuration in Goronyo in Sokoto State using Landsat Mss imagery was chosen because of the changes that occur in the landuse and we need to have a good monitoring device in order to monitor our environment. The extent of landuse configuration that is, landuse structure arrangement looked into. The landuse, areas will be mapped, the satellite imagery, aerial photograph and terrestrial photograph will all be used as a guide in studying the landuse.

A knowledge of landuse and landcover is important in order to overcome the problems of hazard, uncontrolled development, deteriorating environment quality, loss of agricultural lands, destruction of wetland etc. Landuse data are needed in the analysis of environmental problems and the processes is living conditions and standards are to be improved or maintained at current levels (Anderson et.al 1976). Landuse information will help to improve the way the land is used. This study imtends to demostrate the importance of remote sensing technique including the use of general photography in complementing surveys based on ground observation and enumerations. The need for environmental studies show different human activities and their effect on the land and this method is cost effective and timely.

1.4 THE STUDY AREA

The Goronyo dam is located in Goronyo Local Government Area of Sokoto State. The area is approximately 343sq. km and is located in the Sokoto Rima Basin. Goronyo lies within 3° 49' East and 6° East and latitude 13° 37' North. The area is semi-arid with prolonged dry season. (October-May) and a short wet season (end of May-early October). Annual rainfall ranges, from 43.4cm to 38.9cm; when considering run-off, the character of rainfall is important. Harmattan periods are from November to March during which normal vegetation growth ceases. The temperature remains high in the day and the nights are cold. The wind is dry and comes from the desert such that stationary objects are quickly covered by dust while visibility is greatly impaired by the haze of dust particles.

FIG. 1.1 NIGERIA, SHOWING SOKOTO-RIMA BASIN AND VEGETATION ZONES.



Goronyo lies within the Sokoto plains and the area is composed of sedimentary rocks with scattered hills capped by lateritic rocks. The soil in the upland area consist of brown to light sandy loans while those in the lower areas are clay-loam to sandy-clay loam with high organic content (Agyegong, 1984). The vegetation is dominated by mixed woodland and short grasses from 1 to 1.5m.

The traditional activities of most of the people is mainly subsistence agriculture, herding and craft manufacturing. Agricultural activities in the basin vary from intensive permanent farming in the fadama to once a year cropping in the upland areas. Farms are usually small from 0.2 ha to 0.9ha in the fadama while the average upland farm size is about 0.53ha. The area is populated due to the presence of the dam.

Agriculture is dominated by grain based cultivation of millet, guinea corn, upland rice and maize for food as well as cash crops like cotton, groundnut and tobacco. Millet is the most widely used grown and it is intercropped with guinea corn.

Goronyo dam is designed to store 942 million cubic of water for irrigation, development of down stream areas from Goronyo to Argungu covering an area of 17,000 ha while the reservoir created by the dam is to cover 20,000 hectares (SRRBDA, 13th Annual report).

1.5 SOURCES OF DATA

To accomplish the aims of this research, the study made use of data both from primary and secondary sources, the primary sources involves direct field observation and personal observation with terrestrial photographs taken during the observation and base map created from the topographic map.

The secondary sources include, the Landsat Mss imagery with identification No. 5 - 190-91 12.4-01 1023-1800 acquired 18th Nov 1987 which was processed by Telepazio for ESA-Earthnet and used for analysis. This was obtained from the linkage centre on climate change, Federal University of Technology, Minna under the auspices of Federal Environmental Protection Agency (FEPA). The image is on 1:250,000 scale and it is clear and not cloudy.

Landsat Mss Computer Compactible Tape was also acquired from the FEPA office at the Federal University of Technology, Minna.

Goronyo's topographic map sheet No. 4 and 11 of 1971 was acquired from the Sokoto Rima River Basin Development Authority, the scale is 1:50,000. The aerial photographic used was acquired from Sokoto Rima River Basin, the scale is 1:20,000.

Microsoft window 95 hardware was used with Idrisi software which was provided by a staff of National Population Commission. The sterocoscope and the magnifying lens were acquired from the survey department of the Federal University of Technology, Minna.

The terrestrial photographs used were acquired during the field trip to the study area. Local farmers were also interviewed to find out how the landuse was. This information acquired was also used in the understanding the landuse of the area.

CHAPTER TWO

2.1 LITERATURE REVIEW

A lot of studies have been carried on the landuse using different types of remote sensing data and the impact of the development that resulted from them.

On the international scene, remote sensing has reached a high level of sophistication especially in the study of the environment.

On the local scene, Nigeria is still lagging behind seriously. We are yet to complete National coverage of aerial photographs obtained in the last 30 years. Those acquired have different dates and scales but modern remote sensing techniques dictate the change in methods of study landuse change activities. Consequentely, SLAR (side looking airborne radar) and other new equipment are yet to be acquired and are needed in order to make serious advances in remote sensing technology.

Adefolalu D.O (1985) used a combination of SLAR and landsat data with ground truth observation to study the West Africa and Nigeria's landuse (vegetation situation). He recognised 5 major vegetal cover, woodland, grassland, shrubland, farmland and forest from his study. He showed two states in the Sahel Savanna, Borno and Sokoto States at 1986 were experiencing harsh effects of desertification of arable land and had reduced to grass land/shrub. Human activities also made the situation worse. He forecasted that by the early 1991-2000 A.D, arable land will be turned into desertification and the evidence is being seen now.

Adeniyi et.al (1988) used digital and visual analysis of Landsat for identifying, classifying and monitoring the impact of dam construction in the Sokoto-Rima Basin. Landuse and landcover were classified using maximum likelihood produced at standard visual analysis, and to investigate the changes in the area. A lot of information such as monitoring of agricultural resources of the area were found. Combination of digital and visual analysis of a higher resolution e.g Landsat would provide base line data for detailed agricultural resources, planning and management.

Hannah (1969) used large scale colour photograph to find out urban data, the type normally acquired by Ashevilla Metropolitan Planners. From his studies, he found out that the large scale colour photograph is more accurate than the field mapping techniques that had been used earlier.

Nunnally R.N (1969) used Radar Satellite on landscape of an area. It was used successfully to map out integrated landscape regions in the Ashevilla basin.

Avery, G. (1965) made up of United States department of Agriculture aerial photograph at 1:20,000 scale in 1944 and 1960 to evaluate landuse changes in Clark county, Georgia. From his study, a six category landuse scheme was designed for use in the interpretation. This categories were cultivated land, pine forest, hardwood forest, urban land, idle land, and water. A landuse map for each of the period was obtained.

Adefila E.Y. (1987) applied aerial photograph to landuse mapping to Samaru, Zaria. The study was concluded in 1981 and was aimed at studying the landuse changes and its distribution from aerial photographs. Two sets of panchromatic aerial photographs were taken in February 1974 and July 1979 at the scale of 1:20,000.

Adeniyi P.O. (1985) investigated the possibility of digital classification of landuse, landcover using both wet and dry season. He found the importance of using Landsat in a semi- arid environment after the study. The importance of using Landsat Mss integrated with ancillary data was stressed on. The problems were attributed to low spatial resolution of Landsat Mss.

Adeniyi P.O. (1980) also presented how a good example of change detection can be done. He used sequential aerial photographs carried out in Lagos. He then compared them and got the change detection. The study area encompassed urban built-up areas, urban vacant body and non-urban land.

Brown and Holz (1976) used infrared scanning imagery for landuse classification using USGS. The scanner was AN/AA 18 linescan infrared detecting set in the wavelight range from 3-14 μm. The imagery was obtained in the early evening hours of Nov 11th 1976.

Pillion, P.G. (1986) used digital method to explore the possibility of multi-temporal Landsat Mss data for change detection within a semi-arid environment. He identified changes in different landuse/landcover especially in prima agriculture lands. Phenological and human induced changes were demonstrated to be seperable to estimate residential units in Chicago.

Colwell et.al (1966) also showed through analysis the usefulness of thematic and other related imagery in evaluating agricultural resource of a place.

Iheruo (1987) used aerial photograph in black and white to study the vegetation and landuse change in a rain forest ecosystem (North East Edo State). The result obtained showed that a great reduction of forest land and wood shrub grassland occured between 1967 and 1977. There was increase in land used for agricultural plantation, forming and notable changes in the settlement area, the study revealed the state of equilibrum of rain forest ecosystem in Nigeria and photographic techniques as potential tools for monitoring landuse and landcover.

Eyr A.L (1985) studied desertification in the Caribbean using sequential Landsat Imagery of 1972 and 1985. Significant changes were verified for several important location especially in the larger Islands. The changes that occured during that period was too obvious and the changes were terrible. More than 18,000cm^3 in the Dominican Republic was badly affected.

Olsson et.al (1992) studied deforestation in Africa drylands using western sudan. He used Landsat of 1973, 1979 and 1987. The wood resource were quantified and manually stratified in delineating the areas of irrigation and mechanized rainfall agriculture. About 1.1 million hectares was transformed into agricultural land from 1973 to 1977.

Adefolalu et.al (1985) used aerial photography and 1979 Landsat Mss Imagery to monitor land surface changes in Sri Lanka. A thermatic map was used and a base map was established and this found the basis by assessment of Landuse features. Construction was done on each delinated landuse category and airland of the enlarged landsat imageries. Annual average rate of deforestation amounted to 1.75%.

LO C.P (1972) used the aerial photograph of 1970 and 1983 to study the landuse change in Clark county, Georgia. He matched two landuse maps which were compiled in different periods over a light table and delinated the changes that occured. This enabled him to make a landuse change map. He found that there was increase in urban areas particularly in residential, commercial and services as well as decreases in agricultural land and forest land categories were taken note of.

Schmid (1971) carried out a landuse mapping in Nepal which is a hilly country to study the development of Jiri area. In his study he made use of aerial photographs which were interpreted with a stereoscope and landuse categories were delinated. In his field study, he used binoculars and at the end of his study, he came out with different categories of paddy cultivation landuse, agricultural used land and forest, settlement and corresponding non-agricultural ternitories uncleared pastures.

Poulton C.E et.al (1977) made a comparative analysis of 1944 and 1968 using aerial photographs to detect change and asses causes of the change as they relate to land management range/forest land environment in Sierra, Nevada., Ground data was not available to verify coditions in 1944 photographs so only that of 1988 was used. The changes that were detected were moist meadow site and riparian vegetation which had disappeared from 1968 photograph while the encroachment of sagebush shrub had occured.

Henderson (1975; 1979) attempted to evaluate the usefulness of SLAR for general landuse mapping. He made use of map with 1:250,000 scale. He delinated the landuse by regionalization method, the physical and cultural features of the environment was integrated from the Imagery rader by using West House AN (Apq-97) real aperature k-bandover the West AN Midwest of United States. He was able to detect five major components of landuse regions, surface configuration natural vegetation, field pattern and size, settlement pattern and transport and communication network.

Heafover et.al (1985) used aerial photograph and 1979 Landsat Mss to monitor land surface changes in Sri-Lanka. In his study, a thematic map bench was established and this formed the basis on which the landuse assesment featured. Marks were constructed on each delinated landuse category and overlaid on an enlarged Landsat Imagery. Average annual rainfall amounted to 1.75%.

Bradbury et.al (1986) used Landsat Mss and Landsat TM for classification of woodland in southern Wales in 27th July 1984. They study area comprised of lands of spruce, larch and pine on the uplands and oak, ash, beech and elm on the poorer soils and steeper slopes. The other terrain cover types included moorland communities, agricultural areas, base surfaces and water.

As shown above, remote sensing has played a major role in monitoring the environment effectively. In Nigeria, we are still lagging behind because of the exhorbitant price of purchasing software and lack of awareness on the Government of Nigeria. This study attempts to take advantage of the available image processing software and the satellite Imagery available to perform a supervised computer assisted classification of the Imagery.

CHAPTER THREE

3.0 DATA AND METHODOLOGY

3.1 METHODOLOGY

This chapter deals with the data acquired for the project, the methodology used and the process by which the data were analysed so that the aims and objectives of the project will be fulfilled.

Table 3.1: Data and equipment used.

Types of Data	Date	Scale	Aquisition source
1) Landsat Mss CCT	11th March 1985	1:250,000	Climate change -FEPA office, Federal University Technology, Minna
2) Landsat Mss photographic print	18th November 1985	1:250,000	"
3) Topographic map sheet	1971	1:50,000	Sokoto Rima River Basin Development Authority
4) Aerial photograph	1992	1:20,000	"
5) Terrestrial photograph	10th -18th November,1997		
6) Stereoscope			
7) Magnifying lens			
8) Computer			

hardware.			Mr. Haliru Ayuba
Computer (Idrisi).			

Landsat multispectral scene CCT was down loaded and transferred into diskette, it was used for digital classification analysis.

A standard multispectral scene (MSS) with a swath width i.e image size of 185km with an instantenous field of view (IFOV) of 79km covering a part of Northwestern Nigeria at a scale of 1:250,000 was used for analysis of both visual and computer classification.

Topographic map at scale 1:250,000 aided the analysis of the visual interpretation. Terrestrial photograph was also used in interpretation of the satellite imagery. Mirror stereoscope and magnifying lens were used for both visual and manual interpretation of both satellite image and aerial photograph. Aerial photograph of the study area at a scale of 1:20,00 covering the area was used. The aerial photograph used is in black and white.

Grid matric photograph with each all representing 1km was used for calculating the area covered in hectarage represented by each landuse class after the classification had been done.

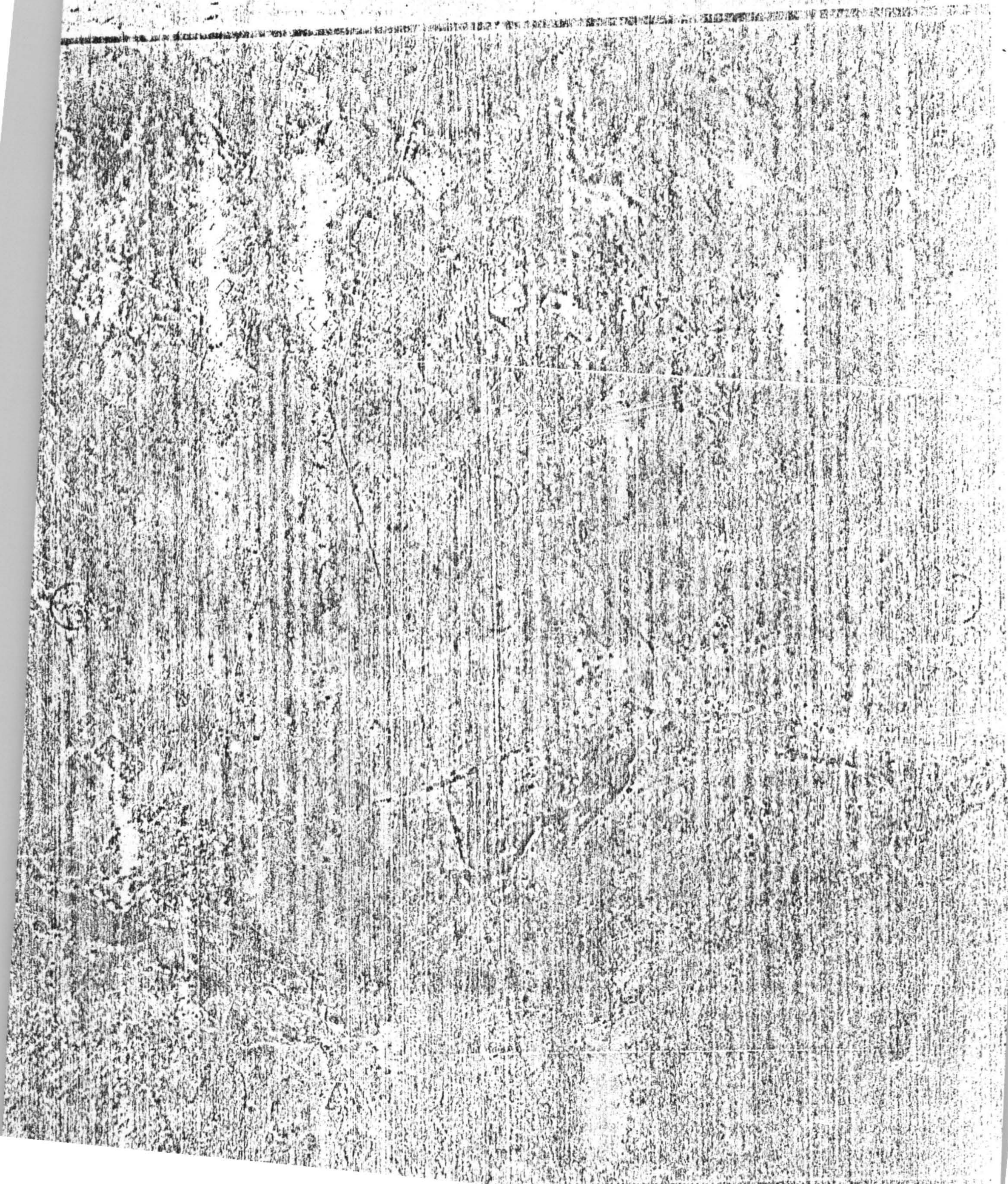
3.2 SOURCES OF DATA

Primary Sources: This involves direct field observation and personal observation with terrestrial photographs taken. Interviews were conducted with the local farmers while the base map used was generated from the topographic map.

This secondary sources include the Landsat Mss Imagery with identification No 5-190 124-01 1023-1800 acquired 18th Nov 1987. It was processed by Telepazio for ESA-Earthnet, SRRDA

[illegible]I

Aerial photograph of Gorong[illegible] dam



which was used for analysis. This was obtained from the Linkage Centre on Climatic Change, Federal University of Techonology Minna under the Federal Environmental Protection Agency.

The Computer Convertible Tape which was processed and digitited into diskette was also acquired from the Linkage Centre on Climatic Change, Federal University of Technology, Minna.

Topography map was obtained from the Sokoto Rima River Basin Development Authority, Sokoto State, Aerial photograph was also obtained from the Sokoto Rima River Basin Development Authority. Microsoft Windows 95 computer hardware and Idrisii software was used, they are obtained from a staff of National Population Commission.

The magnifying lens stereoscope used were obtained from the Survey Department of the Federal University of Technology.

The satellite Imagery used was cloud free and of good quality. This is necessary in order to have good result. It made the interpretation of data easy.

3.3 VISUAL/ MANUAL INTERPRETATION.

This mapping aspect will be based on visual (manual) interpretation of the enhanced landsat (colour component). The aerial photograph and terrestrial photographs will be used in complimenting the visual analysis of Landsat Imagery. The aerial photographs in black and white is attached showing the study area plate 3.1.

The procedure to be followed will include:

1. Creation of base map.
2. Interpretation of Landsat and other image data.

3. Transfer of interpretation landuse data to the map with the aid of grid.

4. Field checking of preliminary landuse.

5. Classification scheme generated and interpretation and mapping.

6. Analysis of the landuse types

Landuse mapping concerns the identification, classification and mapping the landuse of Goronyo.

The base map used was generated from the topographic map available. The topographic map had to be reduced from its original scale of 1:50,000 to 1:250.000 in order to correspond to the satellite Imagery and to make interpretation easy. The reduction was done manually.

The base map used was generated by using a clear acetate paper on the topographic map and all the boundaries of each landuse was identified and drawn onto the accurate overlay. Grid information was used to create geometric control over the measurement made, it helped to calculate the hectares of land of each landuse.

The aerial photographic acquired for the project was interpretation through the aid of sterescope and the magnifying lens.

Certain factors were noted during classification of landuse, they were used for visual and manual analysis of the aerial photograph as well as the landsat imagery. These factors are colour, pattern, texture, shape, size, site and association.

Field checking was carried out in order to study the landuse and familiarise one with the area. Interviews were conducted with the local farmers most especially down stream.

Classification scheme and final interoretation was done after the field work. It is important to note that areas that had very small units was generalised and the predominant present in each area was labelled.

The socio-economic aspect was also studied. During the interview, attempts were made to study the land system and the farmers' perception of their environment. This was done in order to evaluate the various landuse types.

3.4 LANDUSE CLASSIFICATION

There are no prior national landuse and landcovers schemes. Thus, a classification scheme was pragmatically generated. This classification is numerically coded and shown below in the table.

Table 3.2 Landuse classification scheme.

Major landuse classes	Manual interpretation	Digital interpretation
1) Reservoir	1.1 water bodies 1.2 Inundated areas	water bodies Inundated areas
2) Forest land	2.1 forest reserve	forest reserve
3) Bare surface	3.1 laterite surface 3.2 Sandy surface 3.3 Sand dunes 3.4 Graded area	laterite surface sandy surface sand dunes Graded area.
4) Flood plains	4.1 swampy flood plains 4.2 unswampy flood plains	swampy flood plains unswampy flood plains
5) Vegetation	5.1 vegetation 5.2 grassland 5.3 vegetated wetland	vegetation grassland

The land use of Gonronyo classification is shown on plate 3.2

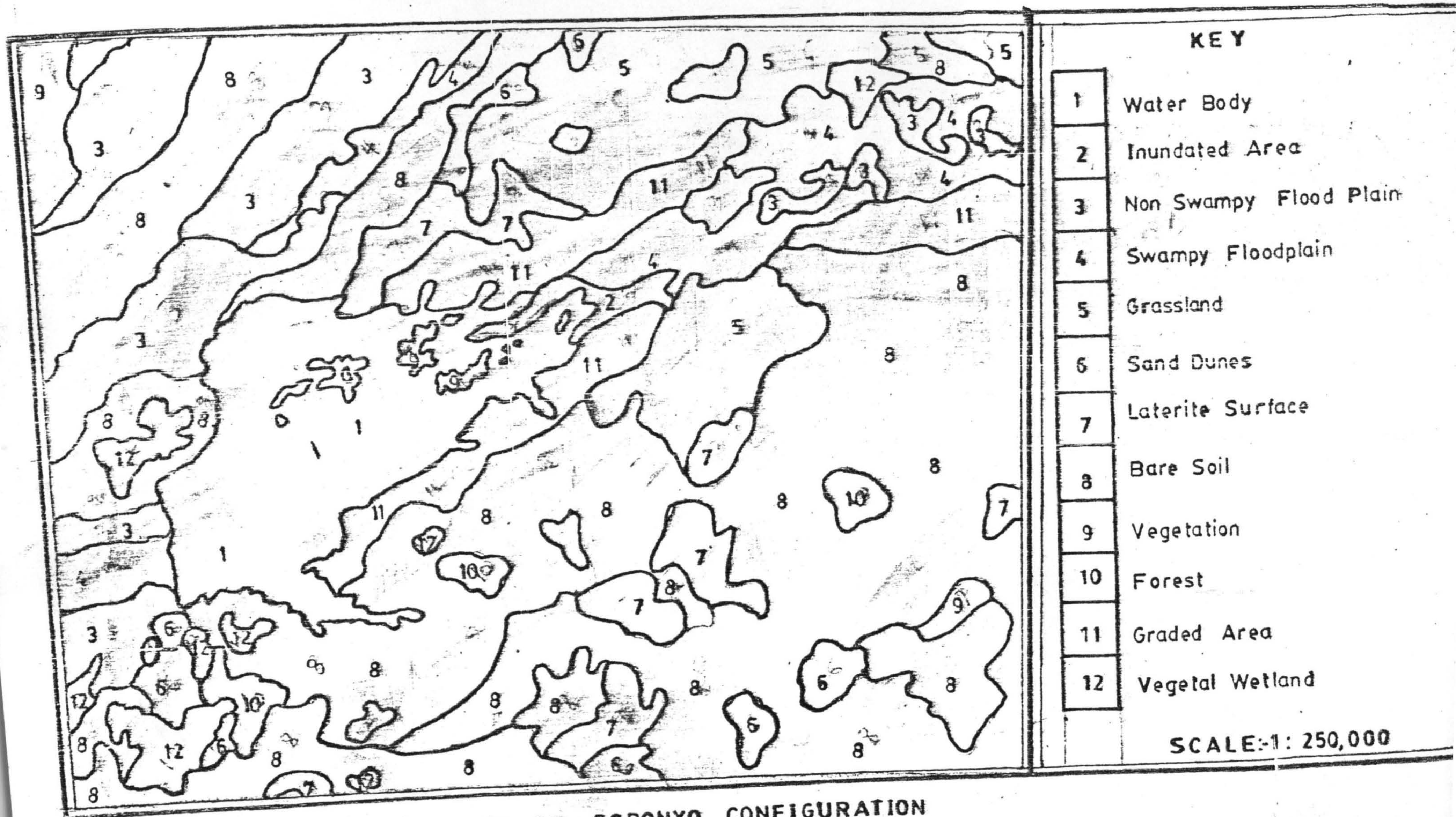


Fig III LANDUSE OF GORONYO CONFIGURATION

Fig 3.I

3.4 COMPUTER ASSISTED CLASSIFICATION

Landsat imagery is acquired when polar orbiting satellite passes over an area in real time. The data is recorded and down linked to the acquisition centre. Landsat satellite takes 16 days to pass each point on the earth. The data collected from the satellite is recorded in raw from (serial) in high density tape which is corrected at the recieving stations.

Microsoft 95 hardware was used with Idrisi software for the computer classification. The computer CCT was down loaded and transferred to bands 4,5 and 6 by computer hard disc then finally into diskette using the magnetic disc drive of the National water resource institute at Kaduna.

The Idrisi software used, processed the data which was used for analysis by doing density slicing, re-classification of spectral signatures, supervised classification, maximum likelihood classification, minimum distance to mention a few. This was done during the analysis of the data.

Analysis of hardware and software can be said to include the following.

The imput of the digital data acquired from one satellite into magnetic tape drive where high density digital tape (HDDT) was converted to CCT.

The storage of the acquired data on a hard disc of a computer and the transfer to diskette is the next stage.

The pixel data acquired is processed using the Idrisi software package of the Clark Laboratory. Finally the data is displayed and the analysis is performed using a colour printer and monitor.

Certain steps were taken during the analysis and this can be seen below:-

1. Creation of the study area from the satellite imagery.
2. The unsupervised classification of each sub-area. This is based on the spectral information from the computer.
3. Production of copies of unsupervised classification.
4. Field work.
5. Training area selection and establishment of landuse classification scheme.
6. Supervised classification based on trained data.
7. Analysis and integration.

The image acquired was divided into 8 parts because of its size. It was divided into

A – H. Each part covers a distance of 1024 by 1024 pixel for both column and row. The study area covers B as can be seen shaded in the box below.

A	B	C	D
E	F	G	H

Fig 3.2

The study area with 688 pixels on the X-axis which is the column and 713 pixels on the Y-axis being the row distance. This is the study area, the area was then enlarged thereby enhancing it. This was done to make identification of various landuse easier to identify and map.

The unsupervised classification was done based mainly on the spectral information from the computer. The reason for this type of classification done is to categorise the pixels in the image into different landuse classes since different features have different digital number, this difference exist because different features emit and reflect different spectral pattern. This was also done to make the final classification easier.

Copies of the unsupervised classification was made, this can be said to be a preliminary map, this landuse map is what was developed at a later stage after field work. Field work was carried out and the result of the unsupervised classification was verified and compared to what was done initially and what was presently on the ground.

A hundred and ten(110) training sites were selected, this can be seen on plate 3.1 showing the various training sites. Colour composite was done on image before it was digitised on polygon. The colour composite helped to make the landuse classification easy and the colour can be seen on plate 3.2 showing the study area.

Supervised classification was done based on the trained site. This was done by

Training site of Goronyo Area

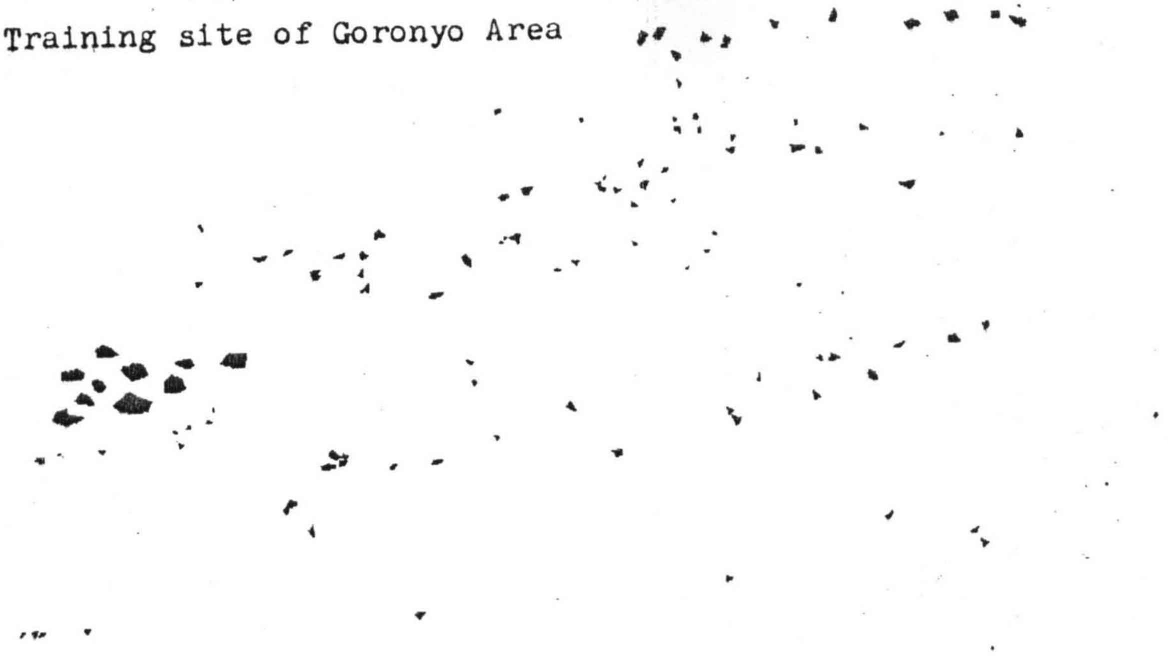


Plate 3.3

COLOUR COMPOSITE OF GORONYO

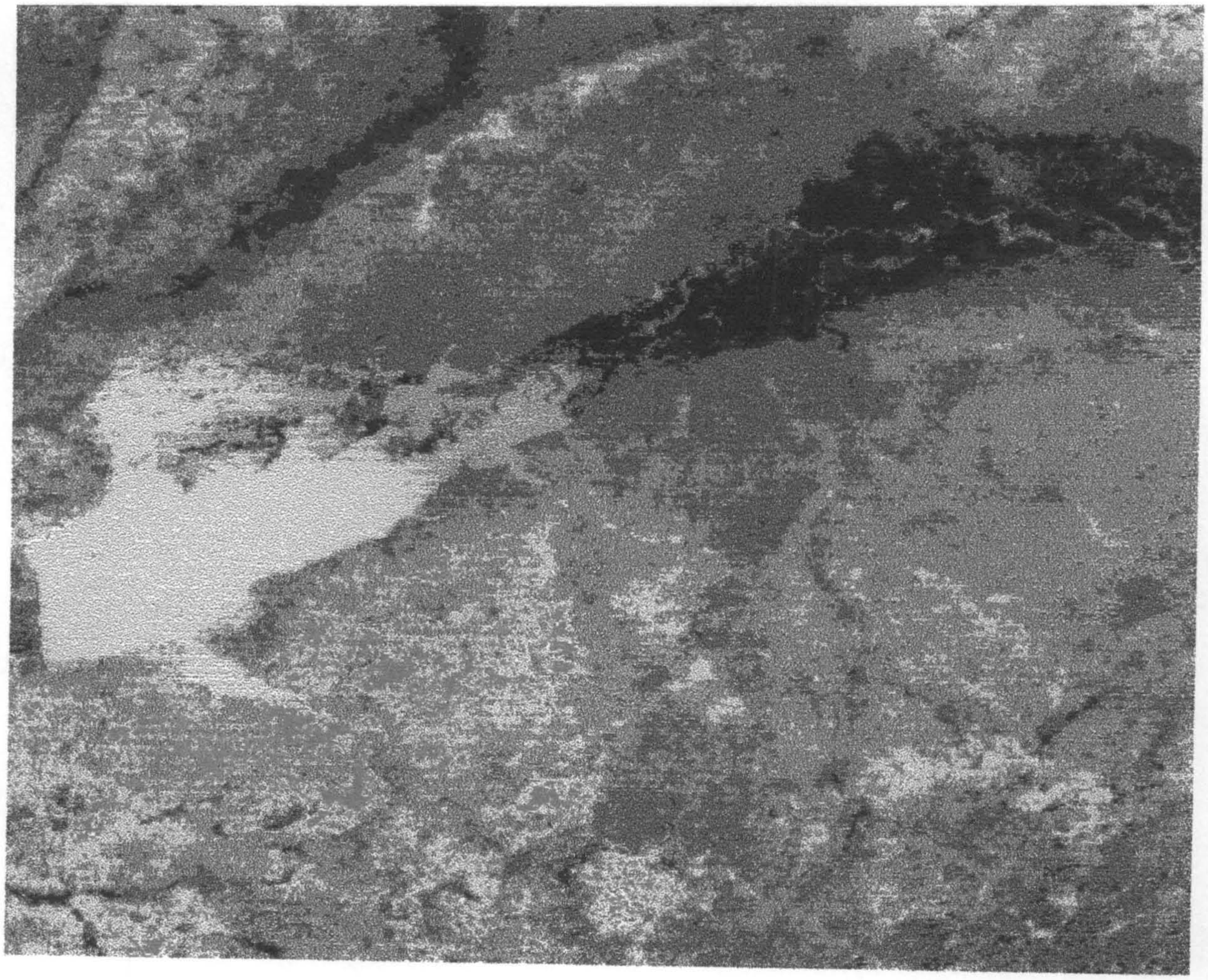


Plate 3.4

identifying the various pixels categorised by specifying the computer algorithm, the numerical description of the landuse types available.

Density slicing was done, this involves the grouping of the digital numbers (DN). interactively.

Minimum distance was done, this was done to get the distance between two objects. The person classifying the landuse will determine the mean spectral value in each band for each category and the pixel that is not classified is assigned to the nearest class.

Maximum likelihood quantitatively evaluates both the variance and co-variance of the spectral response patterns when the points are normally distributed that is points forming a landuse. The computer in this type of classification assigns unknown pixels to the most likely one (highest probability valued) which greatly reduces the chance of classifying a pixel as an unknown one. Bands 4,5 and 6 was used for the data analysis.

Analysis and integration was carried out and the landuse classification is shown in plate 3.3 clearly each landuse and the colour depicting it. The analysis is shown in chapter four.

GORONYO LANDUSE
DIGITAL CLASSIFICATION OF GORONYO

LEGEND

- WATER BODY
- INUDATED BODY
- NON SWAMPY FLOODPLAINS
- SWAMPY FLOODPLAINS
- GRASS LAND
- SAND DUNES
- LATERITE SURFACE
- BARE SURFACE
- VEGETATION
- FOREST
- GRANDED AREA

Plate 3.2

CHAPTER FOUR

4.0 DATA ANALYSIS

This chapter deals with the discussion of the results after Goronyo landuse classification has been mapped out:

This chapter is divided into 3 parts:-

4.1 Analysis of visual interpretation

4.2 Analysis of digital interpretation

4.3 Comparison between visual and digital interpretation

Table 4.1 Extent of landuse classes in the visual interpretation

	Landuse classes	**Extent in hectares**	**Percentage**
1	Water body	14300	11.07%
	Inundated Area	950	0.73%
	Nonswampy flood plain	8850	6.85%
	Swampy flood plain	7500	5.88%
	Grass land	11350	8.79%
	sand dunes	4150	3.21%
	Laterite surface	17600	13.63%
	Bare soil	444000	34.39%
	vegetation	3500	2.71%
	forest	2850	2.20%
	Graded Area	10300	7.97%
	vegetable wetland	3350	2.59%

		ε = 129,100	ε = 100

As shown in the table 4.1 above, Bare soil dominate the area of study with 444000 hectares (34.39%) followed by laterite surface with 17600 hectares (13.63%) the next class is the water body (reservoir) with 14300 (11.07%) while grassland occupies 11350 hectares (8.79%), graded area with 10300 hectares (7.97%) and nonswampy floodpain occupies 75 hectares (5.88%) with sand dunes found in the area with 4150 hectares (3.21%) and the lowest being vegetation (3500 hectares (2.71%).

Bare surface has the highest number of hectarage. This is because the area where Goronyo is located. Goronyo is situated in the semi-arid region with prolonged dry season (october - May) and a short wet season (end of may-early october). Most of the crops die off and leave the surface bare because of lack of water and the intensity of the temperature.

The acquisition time of the image also plays a major role in how the landuse will look. The image was acquired during the dry season and that is why these are less grasses as can be seen from the classification.

Laterite surface occupies the second position in the landuse classification because the soil found these is mainly laterite. Goronyo is composed sedimentary rocks with scattered hills capped by lateritic rocks. The soils in the lover appears brown to light brown sandy soils loam while soils in the lower area vary from clay to sandy loam with high organic content. (Anyepong, 1984). This was confirmed during the field trip.

The reservoir which comes in the ranking was designed to cater for the needs of the people because of the long dry season which makes life difficult for the farmers and cattle rearers.

The reservoir helps farmers since their main type of agriculture is subsistence farming. The reservoir also has its disadvantages as will be seen later. Around the basin area, the agricultural activities vary from intensive permanent farming in the fadama to once a year cropping in upland area.

Grassland occupies 8.77% of the area which is fourth in the landuse. The grasses found in Goronyo are usually short from 1 to 1.5m and they are fed upon by the herds.

Graded area 10300 hectares. The area was graded so that there will be no flow back to the reservoir from the water when released. This graded area is man made and make up of concrete.

Nonswampy area comes next to graded area in the landuse. Nonswampy floodpain occupies 6.85% of the Goronyo area. This floodplain does not contain too much organic matter. This area has more of sandy soil than laomy soil and this explains why is non swampy in nature.

Swampy floodplain occupies less number of hectares than non swampy floodplain. The soil in swampy area ranges from clay loamy to sandy clay loam with high organic content. They are found mainly in the lower regions of Goronyo.

Goronyo upland contains a lot of sandy soil. This is why there are a lot of sand dunes in the area. This area does not contain much water as the lower part of Goronyo where the dam is situated. Most of the areas are dry channels rivers and erosional plains, vegetal wetland occupies 3350 hectares (2.59%). This area has vegetation in small quantity. The type vegetation found is mixed woodland and short grasses. The vegetation is more concentrated in the lower parts because of the presence of water. Forest occupies only 2.2% of the area. The trees in the forest are quite scanty and most not too high. This is due to the semi-arid nature of the area.

Inundated areas occupies the least area. This area is said to be inundated because it is covered by water. This area occupies only a small part of the land because of nature of rainfall.

4.2 Analysis of digital interpretation

Table 4.2 Extent of landuse classes in the digital interpretation

	Class Unit	**Element of interpretation**	**Image appearance**
1	Water body	Tone size	Water body was easily identified because of its size and colour. It is dark blue in colour and occupies 5.45% of the study area.
2	Inundated area.	Tone	Inundated area appears yellow on the imagery. It occupies 3.2% of the study area concentrated and the dam area.
3	Nonswampy floodplain	Tone	This appears red on the imagery and occupies 3.3%. It has more sand than loam soil.
4	Swampy floodplain	Tone	This occupies 4.4% of the study area. It appears green on the satellite imagery. The soil type ranges from sandy loam to clayey loam soil
5	Grassland	Tone	This appears purple is colour in the classification. It is obvious and can be mapped though it is scattered round the image especially around the water body.
			Sand dunes occupy 3.1% and

6	Sand dunes	Tone	appears green in colour. The sand dune is more obvious because of the imagery was acquired during dry season.
7	laterite surface	Tone	This occupies 9.7% of the study area and appears light blue in colour. From the field trip, it was found that areas with laterite surface had no vegetation.
8	Bare surface	Tone	This occupies the major part of the area. It appears orange in colour and can easily be mapped out. It occupies 27% of the study area. Most of the areas are dry channel rivers and erosional outwash plains.
9	Vegetation	Tone	Vegetation occupies 9.7% of the area. It is easily identified because of its reflectance. It appears navy blue in colour.
10	Forest	Tone	Occupies only 0.1% of the area. This is due to the nature of the area that is semi-arid. It appears brown in colour.
11	Graded Area	Tone	This region occupies 25% of the study area. The graded area helps to prevent flow back into the reservoir. It appears dark pink in colour.

4.3 Comparison between digital and visual interpretation.

Table 4.3:- Showing the landuse classes and percentage of visual and digital classification.

	Visual Interpretation		**Digital Interpretation**	
	Classes	**Percentage**	**Classes**	**Percentage**
1	Water body	11.07	Water body	5.4
2	Inundated area	0.73	Inundated area	3.2
3	Nonswampy floodplain	6.85	Nonswampy floodplain	3.3
4	Swampy floodplain	5.88	Swampy floodplain	4.4
5	Grassland	8.79	Grassland	9.1
6	Sand dunes	3.21	Sand dunes	3.1
7	Lateritic surface	13.63	Lateritic surface	9.7
8	Bare soil	34.39	Bare soil	27%
9	Vegetation	2.71	Vegetation	9-7%
10	Forest	2.20	Forest	0.1%
11	Graded Area	7.97	Graded Area	25%
12	Vegetal wetland	2.59	-	-

E = 100 E = 100

In the studies carried out, it was found that there are more differences than similarities in the classification. This may be due to over generalization of the computer in some aspects. In the case of vegetation and grassland they both occupy a high percentage in the computer interpretation whereas with visual interpretation vegetation is low while grassland is high. The high concentration of the vegetation and grassland in digital classification is due to the high refectance of vegetatation and grassland.

In visual and digital classification, It was found that bare soil occupies the largest area in the study area. This as earlier said is due to the fact that Goronyo is found in the semi-arid region where there is short duration of rainfall and long dry season. Apart from this, the imagery was acquired during the dry season when most of the plants have died off due to the lack of rain and intensive temperature.

In the digital interpretation, graded area comes next in the herachy while laterite surface occupies more space in the visual inerpretation. This can be said to due the fact that the human eyes cannot distinguish as many colours as the computer.

In the third category, with digital classification, vegetation and laterite surface have the same percentage and comes after graded area. In visual classification, reservoir comes third in the classification.

In the fourth category under digital grassland comes next while in visual we also have grassland.

The fifth shows water body in the digital classification while graded area is clasified in visual intepretation as the fifth.

The sixth in the digital classification has swamping floodplain while visual has nonswamping floodplain.

The seventh under digital have swampy floodplain while the visual also have swampy floodplain.

In the eigth class under digital inundated area while in visual sand dunes comes next.

The 9th classification, under digital sand dunes comes next while under visual vgetation comes next.

In the 10th classification graded forest appears in the digital while vegetal wetland appears in visual interpretation.

In visual classification, graded area appears in the 11th classification while inundated area occupies 12th place.

In the computer analysis, there was no vegetal wetland and two landuse had the same percentage.

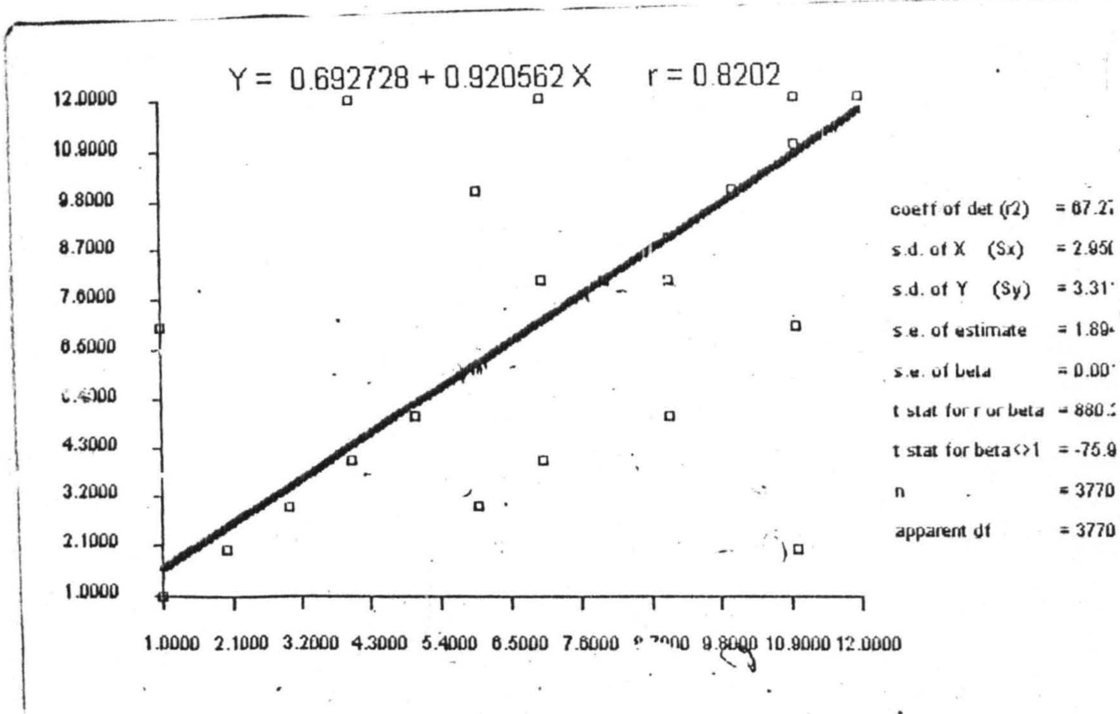
With visual interretation, it was difficult to interprete some areas because the eye cannot discern more than 7 colours. With digital classification, the computer hsas the ability to identify 255 resulting in over generalisation in some cases as earlier pointed out.

Visual and digital interpretation should be done hand in hand in order to achieve good result. Field trip will help to make it clearer and more correct most especially in cases where over generalisation is done in computer or whose the eyes cannot discern features.

Maximum likeliwood and minimum distance were used during classification before maximum likeliwood was finally closen. Minimum distance was rejected because there was a lot of over generalisation in come of the classification done. A regression of maximum and minimum was carried out. This can be seen in fig. 4.2.

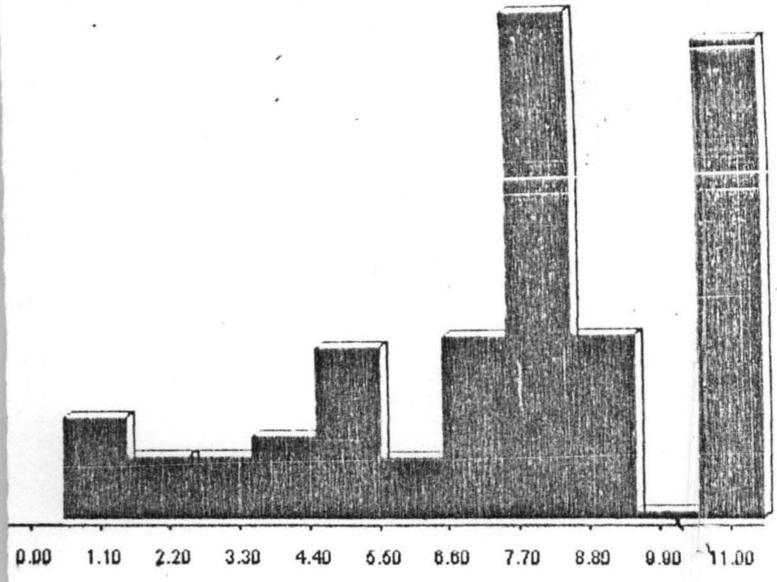
Histogram of the computer classification was done showing bare surface having the highest frequency followed by graded area while the least one is forest. The histogram can be sern in figure 4.4.

With the analysis done in this chapter, It shows the different landuse classes and the difference s between digital and visual classification. Further discussion will be done in the next.



A Regression Analysis of Maximum and Minimum

Fig. 4,2.



Histogram of land use classification
pmax

Class width :
Display minimum :
Display maximum :
Actual minimum :
Actual maximum :
Mean :
Stand. Deviation :
df :

Fig 4.1

chapter.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATION

DISCUSION: 5.1

From the analysis carried out in chapter four, certain factors are brought to light. The study are a semi - arid region and so many fidings point towards this.

The study area landuse was mapped out with the aid of aerial photographs and satellite Imagery. Visual interpretation was carried out followed by digital interpretation. The results achieved was compared to see the similarities and difference and to see what method was more appropriate.

Goroyon is a small growing town. The growth rate increased after the contruction of the dam. The dam as resevoir shown in plate 5.1 occupies 34sqkm and it is located in the Sokoto Rima, Sokoto State. After the construction of the dam, life become easier for some people but there has been a lot of complaints amongst farmers as will be seen as we go on. In the digital and visual interpretation the dam was visible and easily mapped out. From the table, there are disparities in terms of the land use size and the percentage of area they occupy.

Goronyo has high temperature and prolonged dry season (October - May) and a short wet season (end of May to early October). This has made the construction of the dam a necessity.

There is a high rate of evapo - transpiration which has negative effect on the balance in most months. Its marginality for agriculture is compounded by the variety of the rainfall regime. Though the temperature is sufficient for plant grow, the precipitation imposes limitation on rainfed agriculture.

The soil surface (sandy) upland are fairly uniform. They are well drained with sand

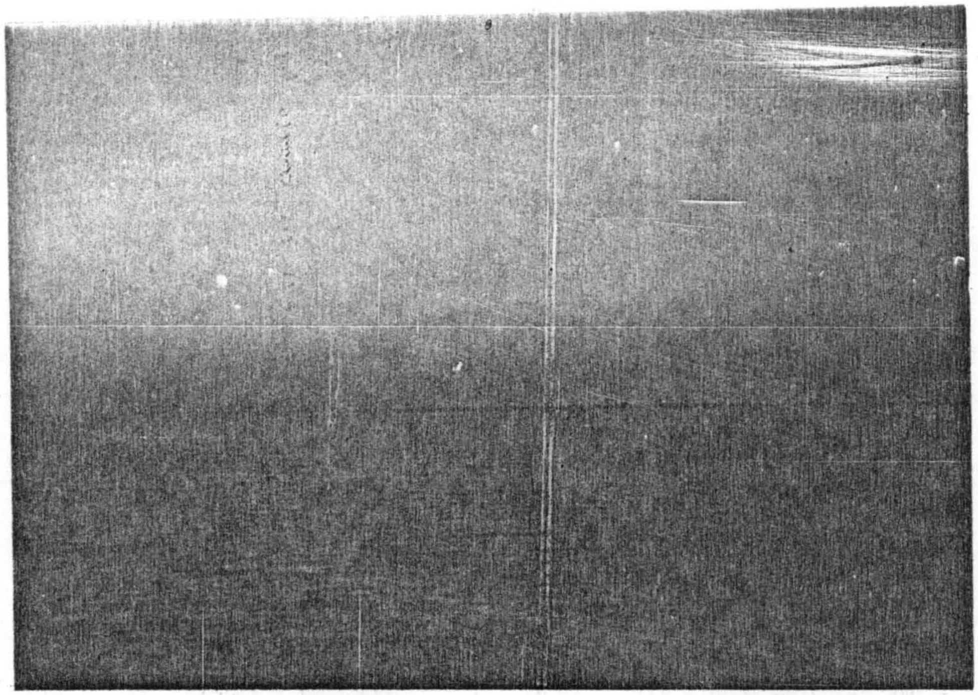


PLate 5.1 Gornoyo Reservoir

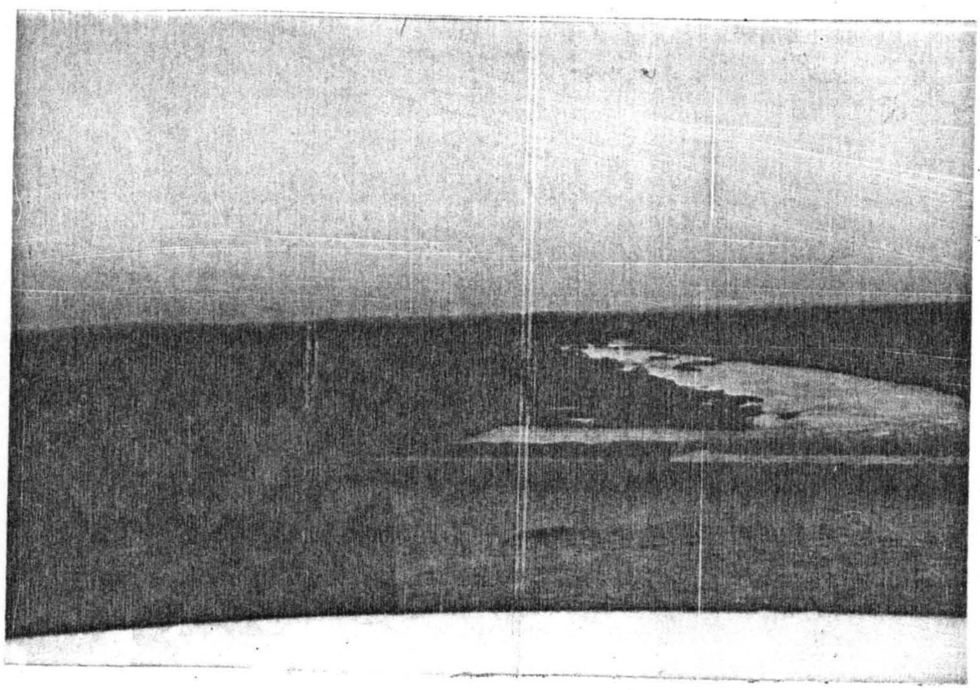


PLate 5.2 Goronyo Dam Stream Showing Left Side of the Dam

fraction up to 75%. They are subject to wind erosion. This soil in the lower areas range from clay loam to sandy, clay loams. The organic content is high, they often retain moisture and fertility. The information provided by farmers during the interview showed that there used to be more woodland in the lower regions but it has changed due to human use. The land was cleared by slash and burn method and the remaining wood land is exploited for firewood. This is why forest records a very low percentage in the study. Due to the presence of the few trees, the opening of canopy increases wind speed and this leads to increased dessication which will also increase soil erosion in the long run.

Plate 5.2 shows the downstream of Goronyo on the left handside while figure 5.3 shows the Goronyo dam and downstream sharing the right hand side.

The information gathered from farmers was that there used to be more land for cultivation in the downstream but with the advent of the dam the method of farming changed from intensive to non intensive cultivation. The farmers were made to move upland so that more land will be used downstream for the construction of the dam.

The cultivated land falls into 2 categories, the fadama and the tudu. Fadama is a land which is seasonally flooded. This is found in the floodplains although only a few can be found in higher grounds . Fadama may be flooded up to 3 months at a maximum. This is good for growing dry season crops, although it may also be cultivated in the wet season where it is suitable for rice variaties. Part of the area can also be used for grazing.

Tudu is a land not seasonally flooded. farming is restricted to rain - fed agriculture in wet season. The farm sizes are usually small and are a mixture of fadama and tudu. These are usually inherited and faces problems because of the continous high population growth and movement of farmers from their original land.

Plates 5.3 shows the Goronyo dam crest. This crest is man made and it is used

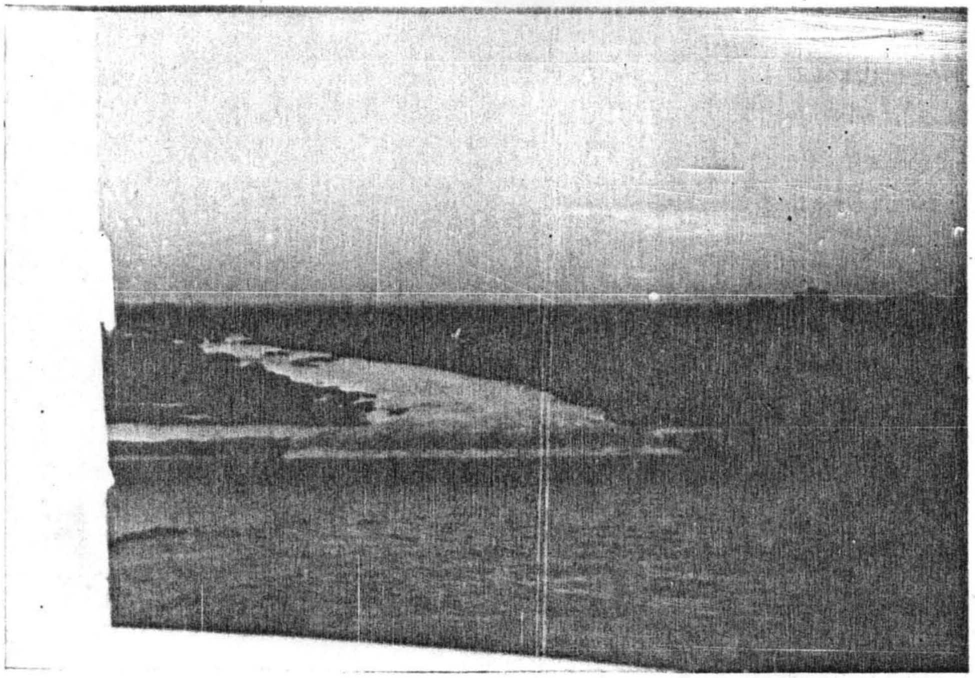


Plate 5.3 Goronyo Dam and Down Stream Showing Right Side

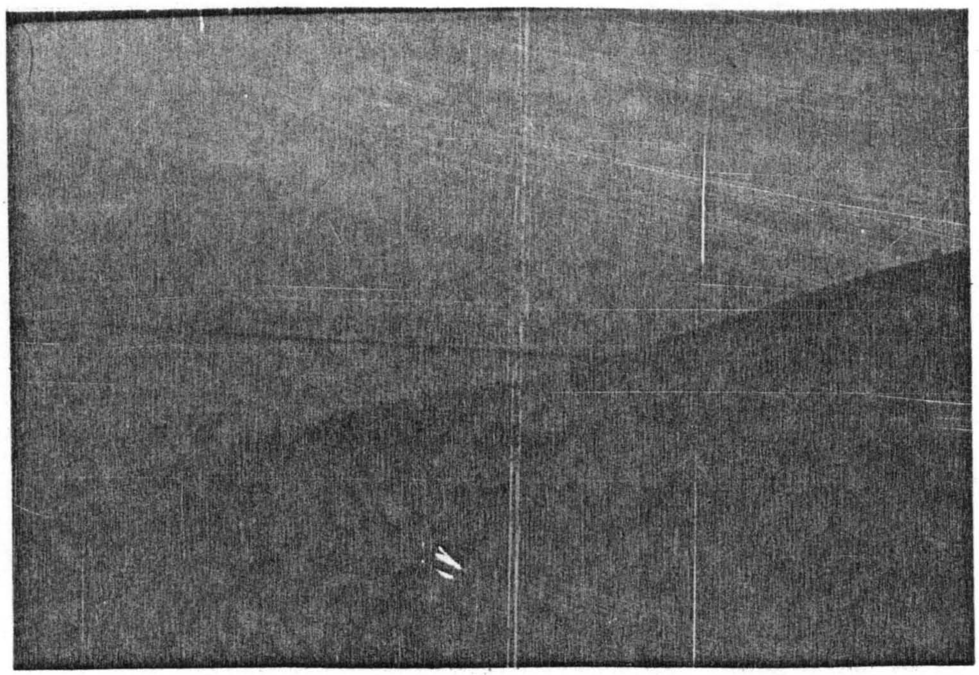


Plate 5.4 Goronyo Dam Showing the crest

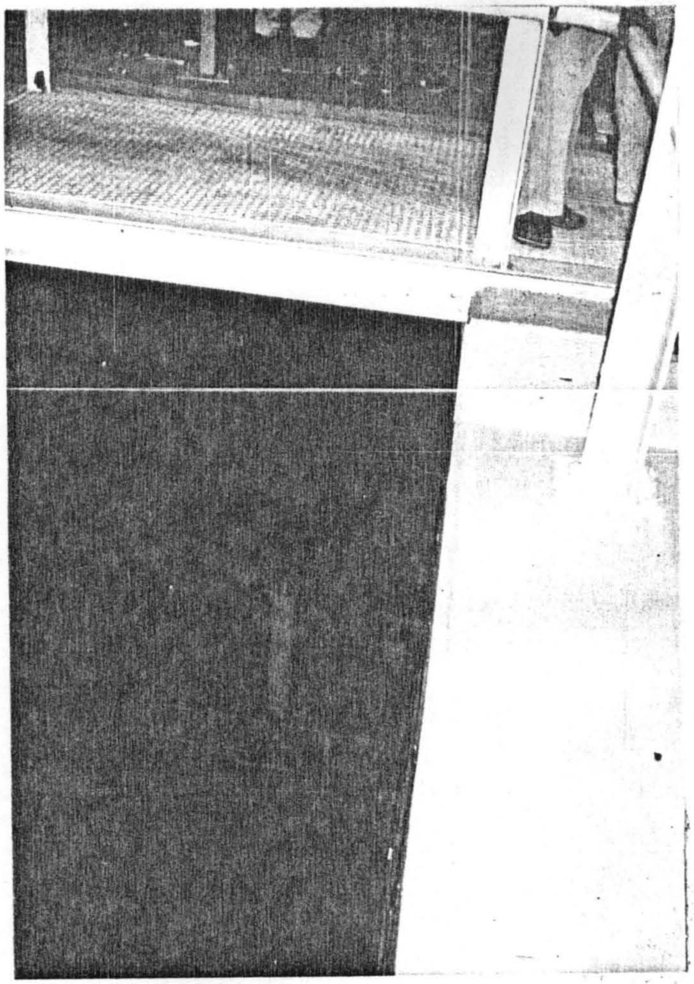


Plate 5.5 Goronyo Spillway on the Bridge

for presenting water flowing back into the reservoirs. This may cause problems in the long run because it was found that areas around the reservoir stand the risk of being submerged if proper care is not taken . This is because the reservoir releases water during the rainy season to prevent the submersion of the reservoir. This causes serious flooding of the villages and farmland downstream.

Plate 5.4 shows the spill way on the bridge, this is where the water is released which causes flooding. This has serious implication because of the washing away of the top soil which leads to less fecility in the soil and the upstream fadama land is lost due to flooding.

Farmers downstream comfirmed that the land that was used previously for intensive dry season fadama cultivation is now less activated or even fallow. They are now unable to grow even rice which used to be the staple product there. The land is now being used for millet which is normally grown on poorer land.

The farmers complained bitterly about their livehood being tampered with. They lost their land during the construction of the dam and the new ones allocated to them are not very fertile.

The new settlement are so far from the market that many farmers refuse to go and those that still have their lands are reluctant to allow friends use the land for fear that the land is being over exploited already because of population explosion.

The new settlement do not have very good roads leading to the market therefore even if the farmers have their products ready to be sold, it will be difficult to get them across to the buyers. The roads are so bad and cars are reluctant to ply them.

Settlement did not appear on the Imagery because most of the buildings are made up of mud and their roofs are either mud or thatched. This makes it difficult because spectral characteristics of the roof will be the same as that of the soil. This shows the rate of development that the Goronyo has attained. Although there are a few buildings with zinc, they did not appear on the Imagery due to the fact that the spectral resolution of LANDSAT MSS could not get all the required information. Landsat thematic mapper would have been able to pick more information.

There are a few tarred roads in Goronyo but they did not show on the Imagery due to the inability of the satellite to pick such information.

The traditional activities of most of the people is mainly subsistance farming, herding and craft manufacturing. The Hausa's do the farming and craft manufacturing while the fulani's take care of herds. Agricultural practice vary from intensive permanent farming in the fadama to once a year cropping in the upland areas. The farms are usually small from 0.2 ha to 0.9 ha in the fadama while the average upland is about 0.53 ha. Around the river, certain species growing epecies are concentrated e.g. Acacia Nilotica. Grasses are scanty and that is what the herd feed on. This also helps to cause deterioration in the vegetation because the few grasses are being eaten up and leaving the soil bare and without any form of protection. The few grasses showing in the imagery is attributed to the fact that the imagery was acquired during dry season and the semi - arid nature of Goronyo.

The laterite surface occupies a lot of space in the imagery. This is due to the nature of the basement complex rocks that make up what is on the surface if the soil. Sandy surface occupies a lot of the area. There are areas of dry channels of rives and erosional outwash plains.

Digital classification has on edge over visual interpretation due to the fact the digital classification has the capability of identifying 255 colours while the human eyes can only distingush 7 colours. This will make classification easy because the colours showing each landuse can easily be identified and the spectral signature of the colours will be the same allover . Identification in visual intepretation is sometimes difficult because the eye cannot function as well as the computer.

Computer classification is extremely fast and easy to do unlike the visual classification that is tasking and takes time.

Computer overgeneralised vegetation and grassland. This is due to the spectral value of vegetation and grasses being high. This can easily be corrected by further field work and with the visual interpretation.

For a good job to be done, one needs digital, visual and field work.

CONCLUSION

5.2 The main objective of this project is to study and map out the landuse of Goronyo and to find out the differences between result obtain by visual and digital interpretation of the landscape. The result seen is that bare surface occupies most of the landcover of the area. This is bacause of the characteristic of rain system and the effect of man on land. These has caused a lot of damage to the area most especially in the aspect of agriculture.

The dam was constructed to aid the farmers in irrigation of crops so that more crops yield will be realised instead of waiting for the few months of rainfall. The construction has cause so many problems that were not envisaged before the construction farmers have therefore lost their land and the land given as compensation is not good enough. There is an increased pressure on the agricultural land which will lead to further degradation of the land. The land that are unsuitable or not good enough for farming are used for agricultural purposes leading to further land degradation.

The farmers who lost their land and refused to move to new settlement have no skill thereby increasing number of unskilled labours. The few farmers who are concentrated on a small piece of land also cause further deterioration of the land due to overcultivation of the land. The surface of land is already showing the wear and tear i.e. signs of dessication and desertification.

The upland area stands the risk of being exposed to desertification. This is because the water that is released from the rservoir washes away the topsoil of the area making the land to lose its fertiliy.

The farmers are unable to market their produce because of inaccessibility to market and bad roads and they are forced to concentrants on small areas.

In conclusion, remote sense techniques can be said to have contributed to landuse mapping. The way in which landuse can be mapped and easily shown practically is by this method. Combination of digital and visual interpretation makes the landuse classification easier.

Landsat MSS was used by enhancing colour composite which helped to clearly map out the landuse of Goronyo. Visual interpretation is a good compliment of the digital classification. Work done using remote sensing will increase the awareness of the significant role it play in environment and resource problems. It will help to demonstrate the values that areas have.

The limitation found with visual interpretation is that it is time consuming and the eyes cannot distinguish as many colours as the computer. The advantage of computer lies with its ease, speed and accuracy based on spectral signatures and the colours. In this project, the computer overgeneralised vegetation and grassland. It is therefore advisable to use both digital and visual methods in interpreting data.

Problems encoutered is the unavailability of software used for interpretation. The spatial resolution of **LANDSAT MSS** used could not get all the information required. With ***LANDSAT*** **THEMATIC** mapper a more detailed result may have been acquired. The value of landuse mapping cannot be overemphasised. This will help to make proper monitoring of the environment leading to better utilization of land. The effect of land misuse will not be felt immediately but in the future generation. It is better to leave a good legacy for the future generation.

5.3 RECOMMENDATION

The use of land by people or equipment needs to be properly managed. It has been found that land deteriorates due to misuse. Remote sensing can put a stop to all these by proper monitoring of the environment since requisite information can be provided quicker. With remote sensing, it is easy to have an inventory of a place and thus will guide the understanding of the landuse of the area. Remote sensing can be used in identifying areas suitable for dry forming so that better utilization of the land can be achieved.

Farmers that were re-settled on Goronyo should be encouraged by compensating them adequately. Incentives such as seedlings, tarred roads should be made available. The government should also make buses available so that they ply roads leading to markets.

The Government needs to monitor the situation downstream so that it does not get out of hand, Remote sensing data should be acquired constantly so that there will be information on the landuse which will help to alleviate any production problems.

A detailed study should be carried out upstream so that it does not lose its land to desertification and release of the water from the dam should be monitored properly.
A higher resolution data integrated with geographic information system (GIS) will increase the utility of satellite remote sensing.

Remote sensing data should be acquired regularly so that there will be enough data to be used in doing effective monitoring of our environment. This will help to reduce the deforestation of the land and help in evaluating or assessing the landuse of an area.

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