THE APPLICATION OF REMOTE SENSING TECHNIQUES IN DETERMINING EROSION POTENTIALS (A CASE STUDY OF MINNA AREA)

BY

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DECLARATION

This is to certify that I Mohammed Bello (M.Tech/SSSE/864/2001/2002) declare that I carried out this work titled: **The Application of Remote Sensing Techniques in Determining Erosion Potentials (A case study of Minna Area)**, is part of the requirements for the award of M.Tech. in Remote Sensing Applications of the Department of Geography, School of Science and Science Education, Federal University of Technology, Minna.

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CERTIFICATION

This is to certify that this project was originally carried out by Mohammed Bello (M.Tech/SSSE/864/2001/2002) and approved as meeting the requirements for the award of a Master of Technology degree in Remote Sensing Applications of the Department of Geography, Federal University of Technology, Minna Niger State, Nigeria.

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DEDICATION

I dedicate this project to my entire family and all environmentalists.

ACKNOWLEDGEMENT.

I wish to express my gratitude grant by the Almighty Allah for given the wisdom and strength to write this project, my project supervisor Dr. M. T. Usman for help an coordination through out the project. It was with his constructive criticism and suggestions that guided me to the success of this project.

My special thanks goes to the entire staff of the Department of Geography, School of Science and Sciene Educaiton, fEderal University of Technology, Minna for offering me useful discussion and suggestions especially Dr. Shaba Halilu and Mr. Salihu.

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ABSTRACT.

This study utilizes application of Remote Sensing Techniques to determine erosion potentials in Minna townswhip area, the problem of erosion in Minna is a common sight especially during the wet season. Due to the topography of Minna area, where the land slopes from highland in the west to a lowland to the east, the place has witnessed severe flooding in the past. However, the problem has presently been minimized with the construction of huge flood channels within the town.

Erosion within the Minna area is mainly caused by human activities. In this study, remote sensing techniques with the use of the Idrisi 32 software package, the SPOT 1995 image was used to determine erosion potential areas.

The image which had to be geo-referenced was classified into 5 distinct land use classes. There are; water body, thick vegetation, settlement/built up area, sparse vegetation and rock outcrops. With the importing of Minna topographical map SW 1:50,000 the DEM was acquired. This DEM was the bases of deriving the slope gradient or topographic factor. From the analysis, 3 classes of high moderate and low values were identified.

Erosion was found to occur in all the classes, however the high classes had the high erosion potentials. The erosion sites were delineated from the topographical map of Minna SW.

Finally, it was determined that areas with highest slopes are very prone to soil erosion and that remote sensing is a viable tool in the study of erosion potentials.

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CHAPTER ONE

INTRODUCTION

1 SOIL EROSION

Soil erosion is the removal of part of the soil, or the whole soil, by the action of wind or ater. It s a natural process, but due to man and his activities the process has been greatly celerated. This is done through the clear felling of forest on steep slopes for either farming or her forms of urban development. The instance, sediment derived from eroded fertile soil can transported down stream. This is how Ethiopia helps to sustain Egyptian agriculture (Wild 95).

Natural erosion, which has occurred throughout the history of the earth from the time, cks were first, exposed to the influence of the atmosphere, has helped in shaping the land rface and forming sedimentary rocks from weathered rocks and soils (Wild 1995). This has lped in the formation of fertile soil. Erosion has affected the environment, which is more tensive than damage at the site from which the soil has been lost. Loss of soil from hill opes increases the surface run-off of water, which leads to flooding in the lower part of the tchments area during rainstorms.

Water erosion on hill slopes has widened valleys and produced colluviums on the foot opes and aluminum in valley bottoms. The rate at which natural erosion occurs depend on the getation cover of the land surface, if slope and climatic condition. Because of its variability the average value, natural erosion may have little relevance to a particular site in a particular ear. Its order of magnitude is useful in providing the baseline from which to asses accelerated osion.

Wind blows sand damages the crops, can block water and can bury buildings. The fine rticles that are carried into the atmosphere from haze intercept sunlight and can cause respiratory problems in humans. The particles may also act as nuclei for the formation of aerosols which affects chemical processes in the atmosphere.

The extent of erosion is most severe after the removal of the protective cover of the vegetation by tree feeling, cultivation or as a result of drought. This loss of vegetation cover increases the rate of surface run-off of water, thereby limiting crop growth and affecting soil and water conservation.

Water erosion is more pronounced in the tropics especially on steep slopes due to the heavy rainstorms. In South East Nigeria, soil erosion caused by rain has been the major ecological disaster affecting the region (NALDA 1996), to over 30m of arable land lost annually as a result of the menace (NALDA 1996). Erosion can, however, vary greatly from one year to another depending on the severity of rainfall or drought.

Water causes soil erosion mainly by:

a. The impact of raindrops on the soil surface.

b. Its flow between rills and in channels down slope.

It also causes landslides on steep slopes where soil over lying materials of low permeability becomes saturated with water from rain or overland flow. A landslide can cause devastation when the whole soil, together with vegetation and buildings slides downhill.

When the channel of the run-offs is sufficiently shallow to be covered over by cultivation they are called Rill. They are called Gullies when they are too deep to be covered by normal cultivation (Wild 1995). Once a gully is formed it quickly becomes deeper and wider because of the scouring action of water in turbulent flow. As the gully deeper, the up slope head becomes unstable and collapse the retreat of the head wall.

Erosion in Minna has affected the environment through loss of soil from hill slopes, which increases the surface run-off of water that leads to flooding in the lower part of the town during rainstorm. Due to the unstable structure of the soil, clearing of land as earth excavation has accelerated the erosion process by 60% (NALDA 1996).

.2 AIM AND OBJECTIVES

The aim of this study is to access the overall soil erosion in Minna town and its ıfluence on the land use. To achieve this aim the following objective will be considered:

a. Identifying and delineating erosion sites.

b. With the aid of remote sensing techniques, classifying the observed soil erosion to degrees of severity.

c. Recommending measures based on the findings for in solving the problem of soil erosion in the area.

3 DESCRIPTION OF THE STUDY AREA

Minna, the capital of Niger State, is located in the northern Guinea Savanna belt of geria. It lies on latitude 9" 30' north. It has Bosso Local Government Area (LGA) to the rth, Gbako LGA to the east, Shiroro LGA to the west and Paikoro LGA to the South. It also s the prominent River Chanchaga flowing through it to the south, Bosso and Tagwai Dam. g. 1.1)

.1 CLIMATE

From available records, the climate of Minna just like other areas within the Guinea anna belt is characterized by a single maximum rainfall pattern with about 600-700cm of ıfall annually. The relative humidity generally rises to over 70% during the wet season.

The seasonal change is greatly controlled by the annual migration of the inter-tropical one of convergence (ITZC). This is where the wet moisture laden tropical maritime air mass ssociated with southwest Trade winds meets the dry dust laden tropical continental air mass ssociated winds from the northern subtropical high pressure belt in the Sahara.

The tropical maritime air mass comes in from the Atlantic ocean where it picks up oisture and enters the country from southwest. The air mass is warm and wet and prevails the untry with its peak in July. This period is commonly known as the wet season or planting ason where there is plant and vegetation growth.

On the other hand, the dry tropical continental air mass brings cool dry dusty winds lled Harmatan. This occurs between November and March when the relative humidity is low d vegetation growth is decreased as the soil is dried out.

a. **RAINFALL**

The main annual rainfall in the study area ranges between 1,200mm and 1,400mm (NALDA 1996). Most of this is received during the rainy season. The striking feature of the rainfall distribution pattern is that at least 20 -30% may be expected in the month of September alone which is the month of maximum rainfall with 300 - 360mm.

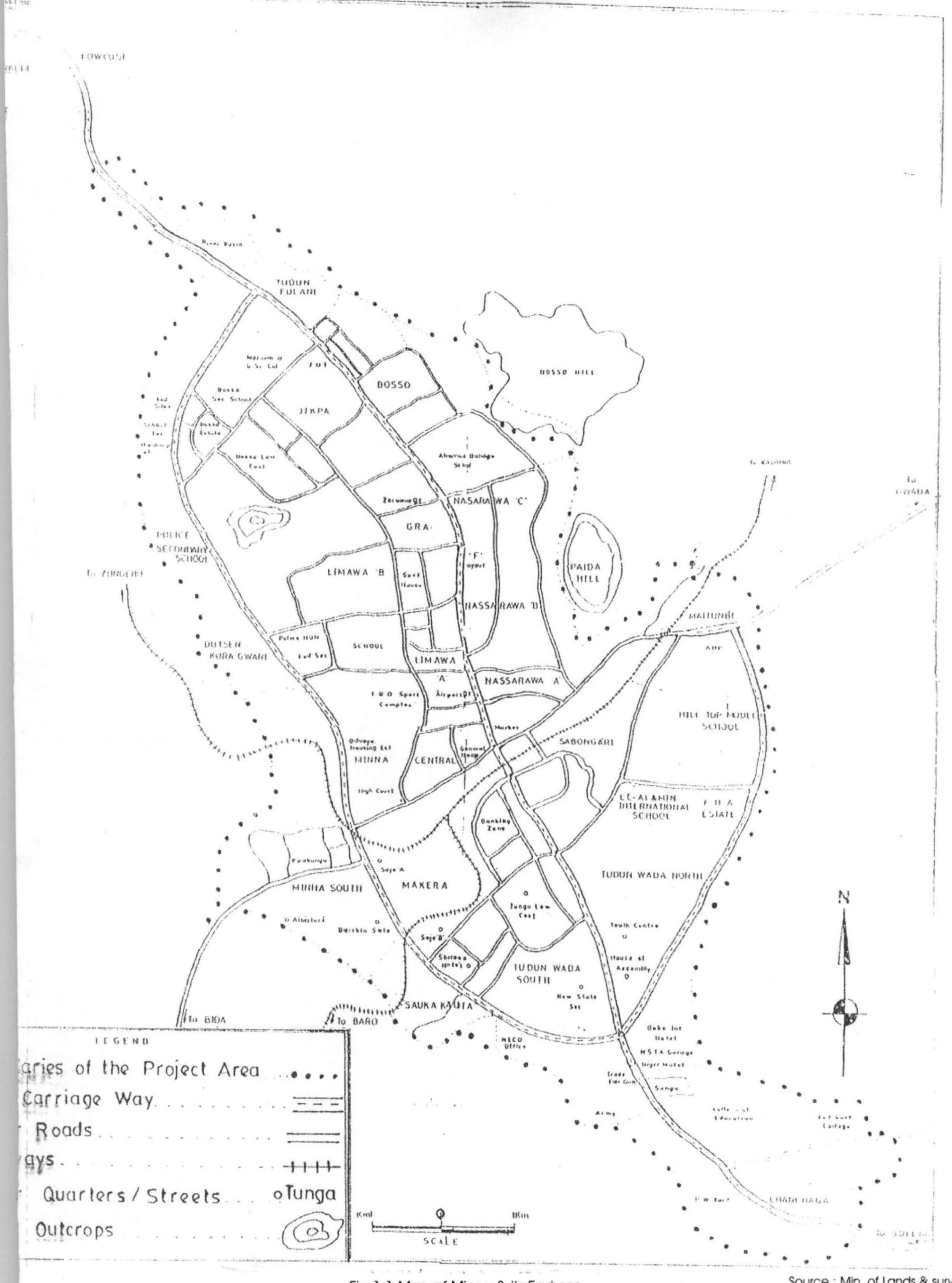

Fig 1.1 Map of Minna & its Environs

Source : Min. of Lands & survey
Niger State.

b. **TEMPERATURE**

The temperature of Minna is greatly influenced by the season. During the wet rainy season temperatures are at their lowest this is because of the cloud cover. The month of August having the lowest average of between 24°-25°C. Also during the dry harmatan season night temperatures fall to about 24°C. Maximum temperature could be as high as 37°C during the month of March and April.

1.3.2 TOPOGRAPHY

The area west of Minna town is generally very hilly with the highest peak reaching 500m above sea level. The eastern part of Minna is generally flat land liable to flooding. There are many streams and Rivers that flow through Minna area, some of these are Rivers Chanchaga, Suka, and Sanki all flowing from west to east. The channelizing of some of the rivers and streams within Minna town has helped to reduce the severe flooding previously being experienced.

1.3.3 GEOLOGY AND SOIL

The geology of Minna is made up of base complex rocks with colluvial material of the basement complex rock occupying various slope position in the landscape. On the upper slopes, very gravely shallow soils over saprolite consisting of reddish brown to purple red energized mica schist are common.

The major land form is that of out crop of granite gneiss, a few small outcrop of ironpan are included and occur in close proximity to the rock outcrops. There are patches of organic matter fairly scattered around the lower scopes and river valleys. This organic matter is at various stages of decay (NALDA 1996). Also the shallow to very shallow well drained soil position on colluvial/alluvial materials on the lower slope are subjected to severe gully erosion at the edge of the major rivers and streams.

1.3.4 VEGETATION

The distribution of this guinea savanna vegetation type is determined by natural and human activities such as drought, floods, bush fires, demographic pressure, farming mining activities and other forms of urbanization.

According to Keay (1960), the guinea savanna is classified into:

a. The isobar line woodland with the woody species occupying in almost pure stands, on a considerable this standing out clearly against surrounding vegetation.

b. Diospyros forest with an almost complete canopy, the occurrence at which is capable of stimulating scientific enquiry.

The vegetation apply thick along the river valleys due to the constant moisture content at the soil Other areas with little vegetation undergrowth are exposed to the break up of the soil which are subsequently transported by run-off the trees found here are mainly deciduous one that shed their leaves in the dry season to control evaporation and transpiration and are the Afzehe, Africana, Acacia complex barking Africana/Deterium. (Musa 1978). During the dry season the landscape appears barren and dark which is as a result of the clearing of the vegetation. With the on set of the raining season, the vegetation turns green once again.

1.3.5 LAND USE

Like most of urban cities and towns in Nigeria, Minna's inhabitants engage in mostly white - colour jobs. However mining and farming in the outskirts of the town are common. The activities of inhabitants, particularly earth excavation has contributed significantly towards erosion, especially along the river channels. The clearing of vegetation for urban development has denied the land of its vegetation cover, such that the soil becomes liable to erosion during rainstorms.

1.4 JUSTIFICATION OF STUDY

The damage caused by erosion in Minna if not checked will go beyond the financial control of both the local and the State governments. Just as the other form of land degradation in Nigeria, there is an urgent need for government to have a scientific approach in dealing with such disasters.

The environmental condition in the study area is much favourable for soil erosion. The activities of Minna farmers, earth excavators, developers and the general public all contribute significantly to soil erosion. Because of the potential dangers of soil erosion on man and his environment, employment of Remote Sensing Techniques is required to highlight the dangers of erosion risk areas. This study is expected to go along way in examine and solving the problems associated with erosion.

1.5 SCOPE AND LIMITATIONS OF STUDY

The scope of the study is limited to the Minna metropolitan area. Though there are other factors that can determine erosion potentials, such as rainfall, soil types, vegetation cover, and conservation practices, this work is limited to the slope factors. This is as a result of difficulty in acquiring rainfall and soil data which are major factors determining erosion. Also due to the topography of Minna town where mountain ranges stretch from north to south on the western part of the town and the lowland on the east parallel to the mountains. This type of topography is effected by slope erosion and flooding.

1.6 ORGANISATION OF THE THESIS

The thesis is divided into five chapters in all. The first chapter presents an introduction to the study highlighting the statement of research problem, aim and objective, justification of study, scope and limitations of study. Chapter two focuses extensively on the relevant and related literature of similar studies and touches on the history of remote sensing and other satellite images.

Chapter three discusses the methods of carrying out the study, such as the collection of materials, image interpretation, field investigation, mapping of features from imagery to form overlays and classification units and also the computation procedure.

Chapter four presents the analysis of the data, results and discussions.

Finally, chapter five presents the discussion, summary of the major findings, suggest possible solutions and make necessary recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Remote sensing is the science and art of obtaining information about the earth's physical creatures through the analysis of data acquired from a platform that has no contact with the object or features on the ground.

The information derived this way, depends on the reflected, emitted or transmitted electromagnetic energy that radiates from the objects/features. The electromagnetic energy is recorded in either photographic or non-photographic form. The variation in energy are detected and recorded depending on the detected signals.

Remote Sensing is rarely the end-all and be all, it is often but one step in a much larger process. Its application to land degradation assessment is of considerable interest to humanity, s it affects the existence of man. The emphasis is on its uses with a clear definition of the roblem and the elements necessary to solve that problem. For instance, mapping projects often equire the identification and quantification of land cover. The decision to use remote sensing ata should be driven by clearly defined requirements and regulated by resources, software, ardware and the ability to employ them.

There are numerous of remote sensing, images. These include the Aerial photography, de Looking Airborne Radar (SLAR), Earth Resources Satellite, land set. 1-7, and SPOT hich has sun-synchronous and semi-recurrent orbit. In the panchromatic mode, a single riable band with 10 by 10m pixel is produced. In the multi-spectral mode, images with 20m 20m fixed is produced of each of the 3 band, 0.05pm (green) 0.61μm to 0.68μm (red) and 74μm to 0.89μm (near infrared).

The recurrent period is 26 days normally, but 4-5 days if observed with oblique pointing. A scene of HRV has a nadir coverage of 60x60km and an oblique coverage of 81 x 81 km at maximum looking angle of 27°.

SPOT imagery is used for a wide range applications such as mineral estimation of crop conditions, estimation of forest losses, land use planning, identification of pollution and tracking of forest fires. According to Halilu (1999), SPOT has provided a photographic, geologic and cartographic capabilities that was unknown to other satellite systems in the past. It is able to record causes passes of over laying imagery from two stations for a base height relationship and stereoscopic models. It is has also be permanent sources for geographic information that has the added advantage of offering stereoscopic views and excellent geometric accuracy.

2.2 SOIL ASSESMENT

In his work, Akinyede (1990) shows how a variety of remote sensing imageries such as Landsat thematic mapper (TM), SPOT SLAR and Aerial photographs were used to collect terrain data. In his studies, potentials of images were discussed, and in areas with marked topographical variations, SLAR was seen to be useful to morphological mapping. Also the aerial photos brought out a characteristics of erosion and slope features. Surface moistures characteristics and identification of geological boundaries were got from satellite images.

Soil erosion assessment, though a capital intensive and time consuming exercise, has a number of parametric models developed to predict soil erosion of drainage basins. Yet, the Universal Soil Linear Equation (USLE) (Wischmeir and Smith 1978) has proved to be the most widely and cost effective empirical equation for estimating annual soil loss from agricultural basins. While conventional methods yield point based information, remote sensing applications make it possible to measure hydrological parameters on spatial scales. While Geographical Information Systems (GIS) integrate spatial analytical functionality for spatially distributed data (Rinos 2000).

In Slovakia, Mitasova and Hofierka (1993) carried out a study to test the method of identification and mapping of spatial of features. The pattern of soil degraded by water erosion was undertaken by means of integration of slope classes. Three classes were identified as low, moderate and high slope erosion risk areas. They concluded that the combination of topographic map and remote sensing is very impressive and highly reliable.

In his work, Ilyas (1997) employed aerial photographs in conjunction with topographical map to determine the gully erosion in Ankpa area. The first requirement was to establish the extent of the erosion, which was traced directly from topographical map and details between the demarcated area were transferred to a tracing overlay. A base map was drawn to the scale of 1-50,000. And on each of the aerial photographs, all the length and ground depressions were mapped and all identifiable land-use features indicated. Furthermore, the erosion map was superimposed on the land use map to show the land use factors on erosion in the area.

In another study by Ginther (1985), infrared force false colour photography was used to monitor slope instability. He concluded that soil cover, morphology and drainage can be easily assessed using infrared false colour photos. He observe that tonal differences in vegetation in relation to hydrology conditions of the soil makes the assessment easier.

In the Hinalayan valley Yadav et al (1999) show that erosion is the major problem to weak structure and the of the locals on the forest and other naturals resources will further amplify the problem. Remote sensing holds great promises in this regard as it allows models to be applied over wide area. The study incorporated data product of different nature to achieved the desired objectives. Topographical map of 1-50,000 was used for the preparation of the base map. Soil erosion was recognized as a major problem arising from unscientific agriculture, agricultural intensification and land degradation.

In assessing slope erosion, SPOT imagery in conjunction with the digitized topographical map of Usuma Dam in Abuja area was used (Halilu, 2000) to get the DTM of the study area. Using the software called Idrisi, the surface area, aspect, slope degrees and gradient images were thematically integrated and used to delineate various areas based on their homogeneity, which forms the 3 classes. Based on the classes that were identified as potential erosion risk areas, the Wischmeir Empirical Nomograph was use to find the slope contribution. Three classes were identified as low, moderate, high slope erosion risk areas based on this formula using the DTM.

2.3 MONITORING LAND DEGRADATION

The destruction increases for the likelihood of flooding as narrow channels eventually widens as a result of run-off processes. The study and identification from the remote sense data gives a lot of information about erosion as it indicates decreased run-off due to interception and evaporation, increased infiltration, and increased stream flood due to decrease evapo-transpiration and interception. Also the stream side vegetation slow down flood water passage and retard stream back erosion due to root binding (Edward 1992).

Satellite images have now proved to be a more viable tool for studying vegetation character as against a conventional area photograph (Vink 1992). Satellite sensors are capable of detecting many change in physiognomic characteristic of vegetation through spectral radiation measurement. The visible infrared band on satellite multi-spectral sensors allows the monitoring of the greenness of vegetation, since vegetation is a high absorbent in the visible part of the electromagnetic spectrum. Vegetation is low absorbent in the infrared band due to chlorophyll, water content and scattering as result of the internal spongy methophyll layers of the plants (Halilu 1993).

Landsat image in band 5 appears to be very useful for mapping and interpretation of vegetation while radar is less suitable for it (Jeje 1986). As vegetation becomes stressed, its ability to absorb light as chlorophyll is decreased. The spongy metasophyll layers decreases the reflectance of near infrared radiation (Harris 1987).

Also, Vogelmann (1990) identified forest damage NOAA-AHVRR data. The high and low damage side of broad leave trees were easily separated using both NDVI and short wave infrared data. The NDVI also allow excellent separation medium and low damages.

2.4 IDENTIFICATION OF LAND USE

Land system mapping from imegerys such as landsat and SPOT may prove more useful than contour maps for general planning, particularly for a very large region at a time (Verstoppen 1977). Abdulkadir (1993) used enhanced classification approach from landsat MSS data set of 1975-1984 in accessing natural and man induced changes in land use in semi arid environment of northern Nigeria after the construction of Bakolori Dam.

Omojola and Soneye (1993) used landsat MSS image in landuse/landcover classification. This was achieved by calculating the percentage of area covered by landuses such as river settlement vegetation and agricultural land.

CHAPTER THREE

METHODOLOGY

1 DATA COLLECTION

The data for this study was acquired from various sources. These include materials om Library, Literature of past work done, text books, topographical map of Minna SW, Land-;e map of Minna and environs, soil and geological map of Niger State and SPOT 1994 satellite ıage. The topographical map of Minna SW 1: 50,000 was scanned and digitized to get the TM to be used with the SPOT image of the study area. The scanned topographical map ovided the Z coordinate required for the DTM, essential for the slope length/gradient and grees. The X and Y coordinates were derived from the contour of the topographical map; the ap showing study is shown in appendix 1.

2 SPOT IMAGERY

The SPOT satellite image for the study area is of Multispectral High Resolution Visible RV) instrument with 3 bands of red green and blue. As follows:

Red	0.5-0.59µm
Green	0.60-0.68µm
Blue	0.79-0.89µm

In identifying the image, vegetation is highest in the red band and relatively high in the nfrared than the green band. Water reflect higher in infrared, while bare soil is higher in the red lower in the near infrared and medium in the green.

The image underwent both geometric and radiometric corrections. These are basic corrections and calibrations that are made to achieve as faithful representation of the earth surface as possible which is fundamental for digital image processing. Using the Idrisi 32 software, the image was geo-referenced. This geo-reference is some times referred to as the resampling which involves registering and the image to universally recognized coordinates such as longitude/latitude or Universal Transverse Mercator (UTM). In this 'case' the coordinates for this image is based on the UTM 32n. The re-sampling involved identifying the X and Y coordinates of pairs of points that represent the place within both the old and the new coordinates system. Five coordinate points were taken with the assistance of the global positioning system (GPS). With the software the relationships between the new and the old coordinates were derived. Figure 3.1 shows the raw SPOT image showing Minna and environs while Figure 3.2 shows the geo-referenced carved out image of Minna area.

3.3 CARVING OF THE STUDY AREA

The study area was carved out using the Erdas software package. The area which includes, the mounting raging the east of Minna town and the flood plains to the SW, which has Minna town, located at the centre. Figure 3.3 shows the orthographic view of the image. Some 487 columns and 645 rows cover this carved out area respectively. Since the Idrisi software only accepts one band at a time the columns and rows were saved as new images in 3 separate bands.

3.4 IMAGE PROCESSING

This involves the analytical design for restoration, enhancement and the interpretation of digital data was derive from the SPOT satellite image. The image processing was done in the Idrisi software since the image does not process the software in the composite form. Therefore, the image had to be disbanded into red green and blue bands which the software accepts Figure 3.4 shows the disbanded images.

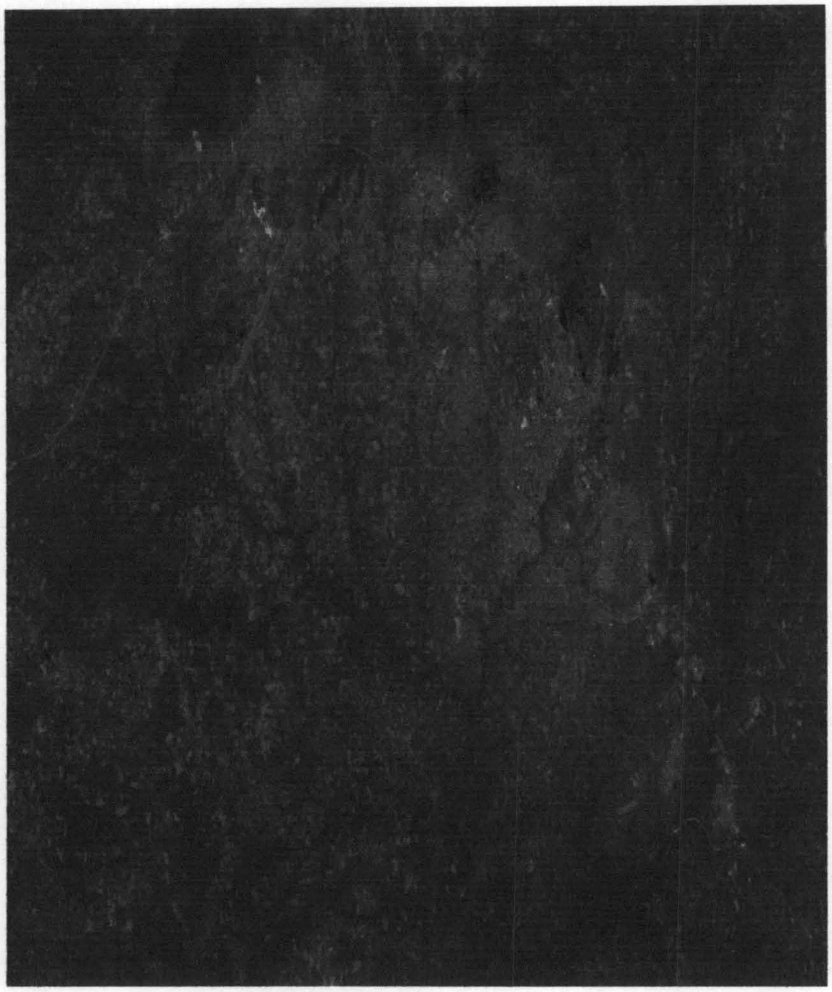

Fig. 3.1: Raw Image of Minna Area

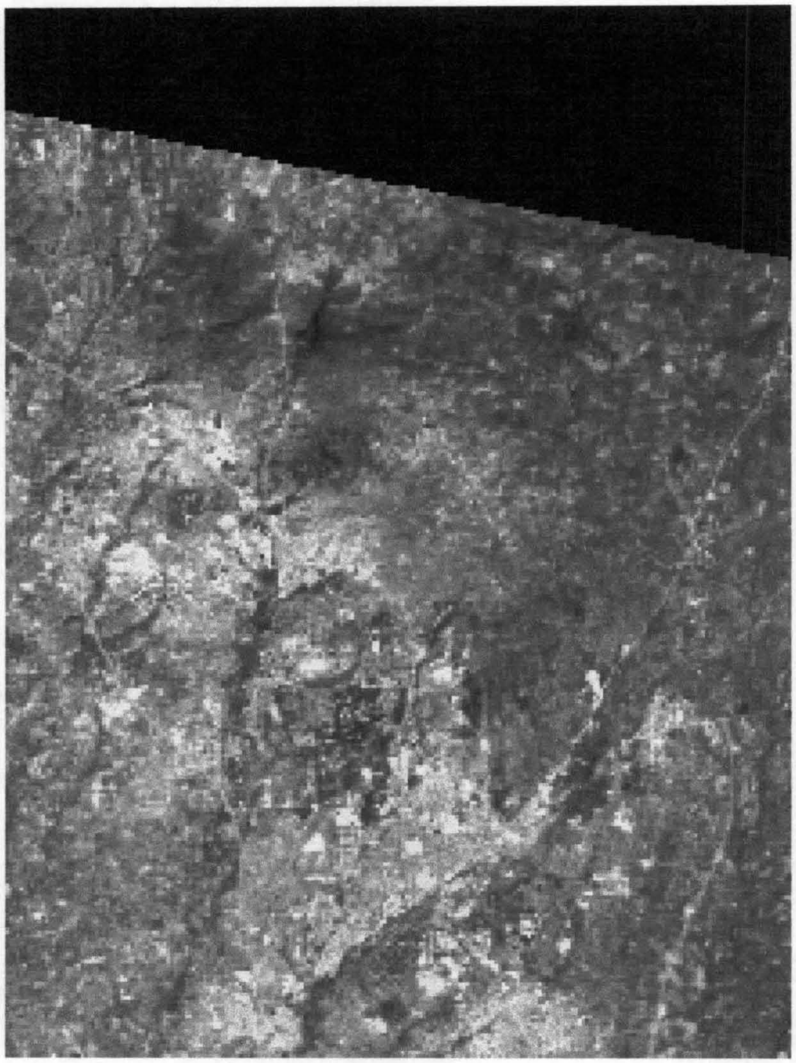

Fig. 3.2: Geo-referenced Image of Minna Area

3.4.1 IMAGE COMPOSITE

In order to create an image composite, the following procedure was used with the software (Idrisi 32). **ANALYSIS-IMAGE PROCESSING-COMPOSITE.** Figure 3.3 Orthographic view the colour composite works well in the study of landscape and vegetated surface as it contains Idrisi palettes form colour indices 220-235. It is only when this image composite is carried out that the unsupervised classification can be done using the 8-bit colour composite function on the Idrisi software (Figure 3.5).

.4.2 IMAGE EDITING

This was done on colour composite in other to eliminate confusion that may arise in the assification of the image as 2 or more figures may share the same signature. However the ırsor enquiry was use to get various digital identification numbers.

4.3 UNSUPERVISED CLASSIFICATION

The 8 bit composite image was used for the unsupervised classification as shown in ure 3.5 that was used for ground truth the point indicated in figure 3.6. This type of ssification is known as cluster the procedure used is known as cluster and the procedure used ANALYSIS-IMAGE PROCESSING CLUSTER.

The process was in the broad generalization level and set to maximum of 10 clusters in ıe qualitative 256 palette option. This gave rise the image in figure 3.7.

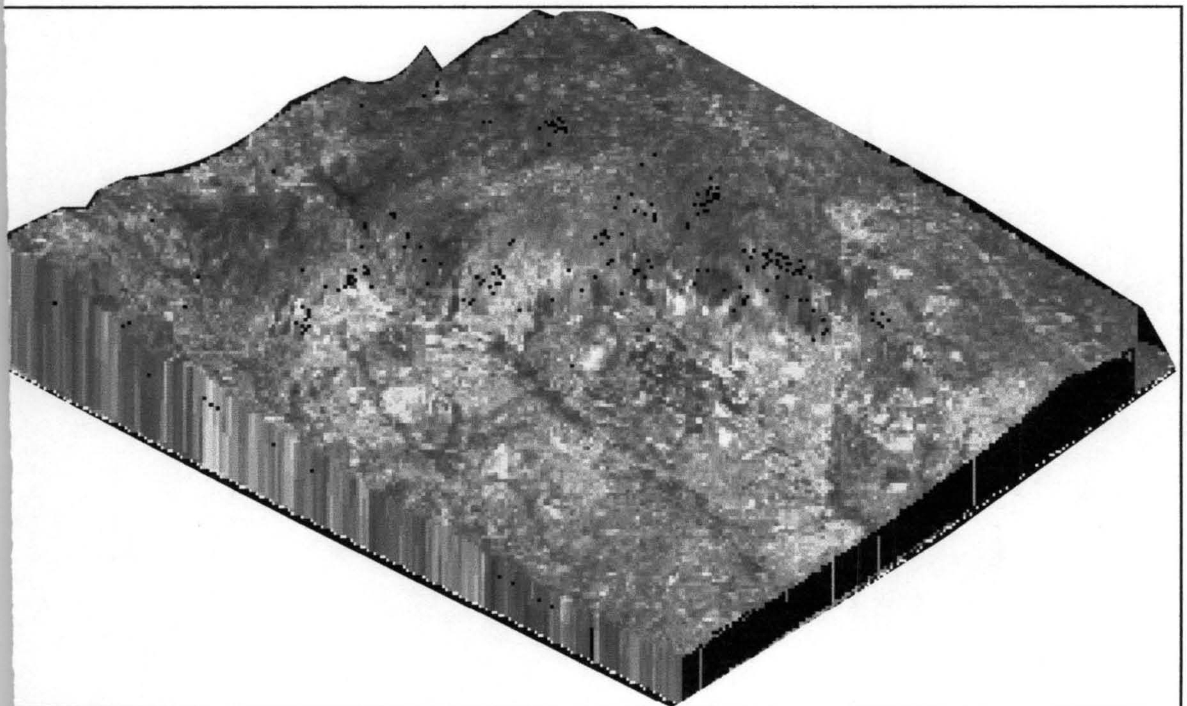

Fig. 3.3: Orthographic View at the study area.

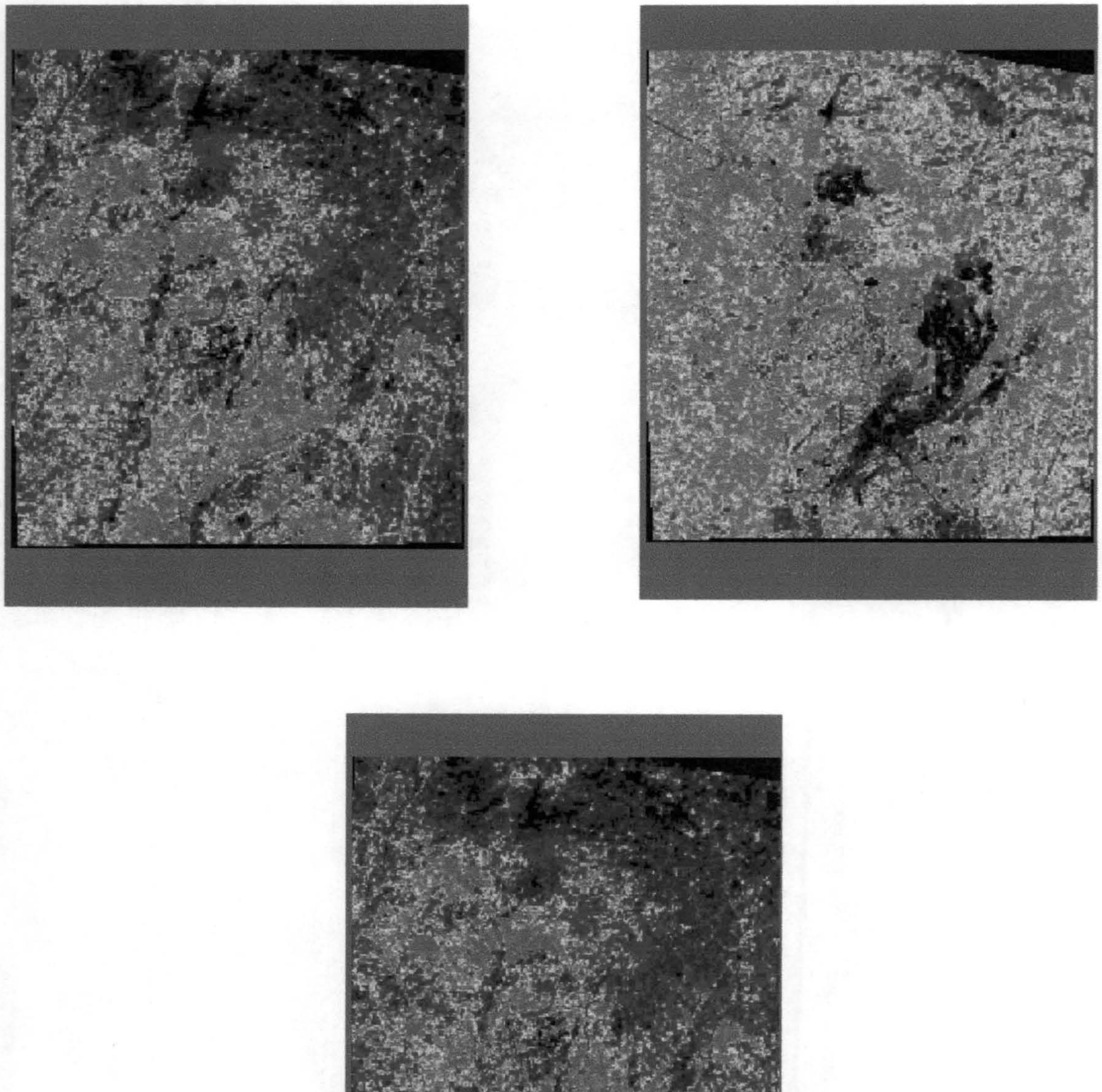

Fig. 3.4: Disbanded images, Red, Green and Blue Bands

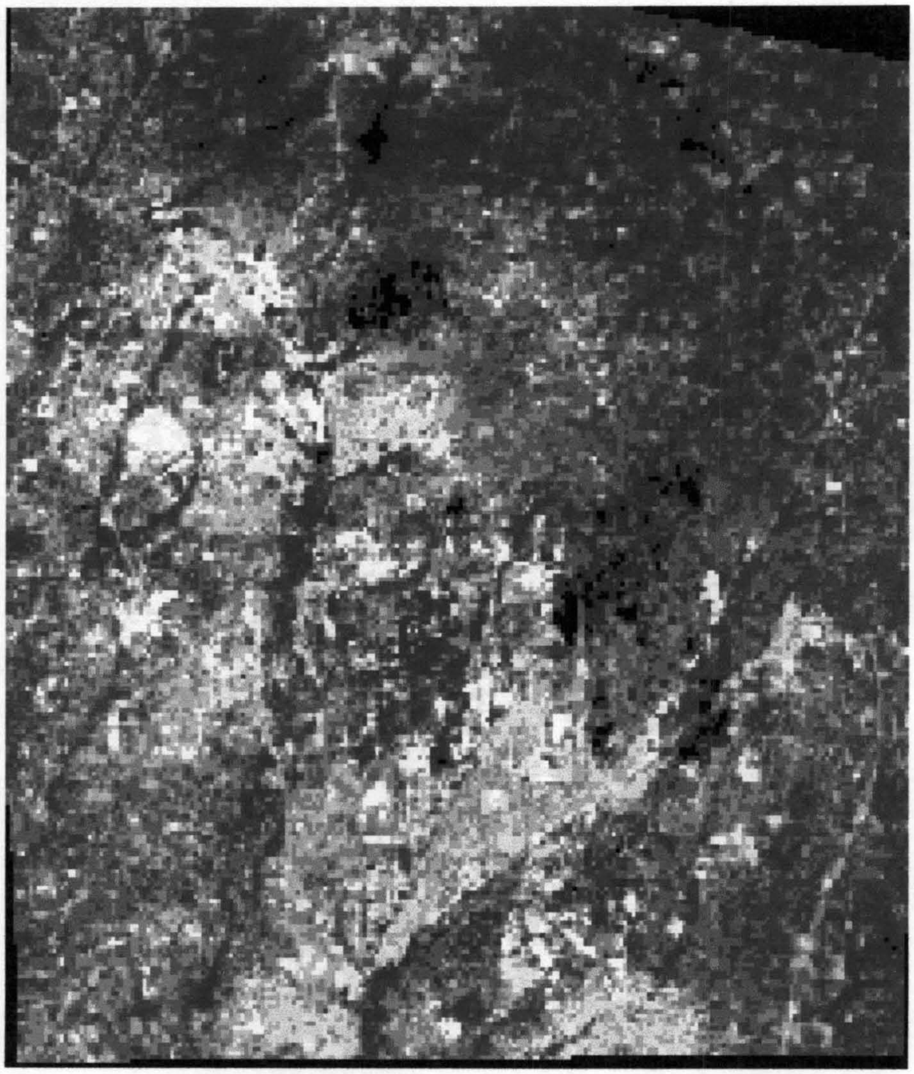

Fig. 3.5: The Composite Image of Minna.

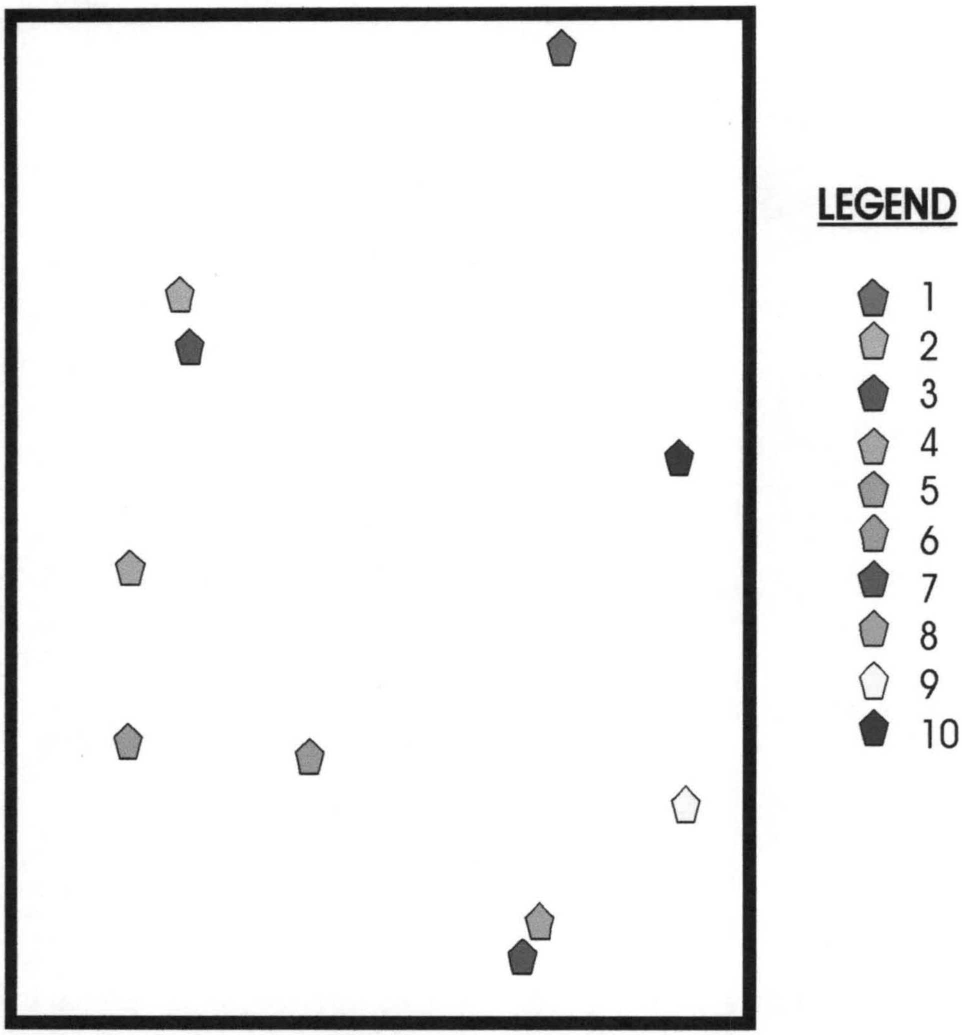

Fig. 3.6: Random Sample Points.

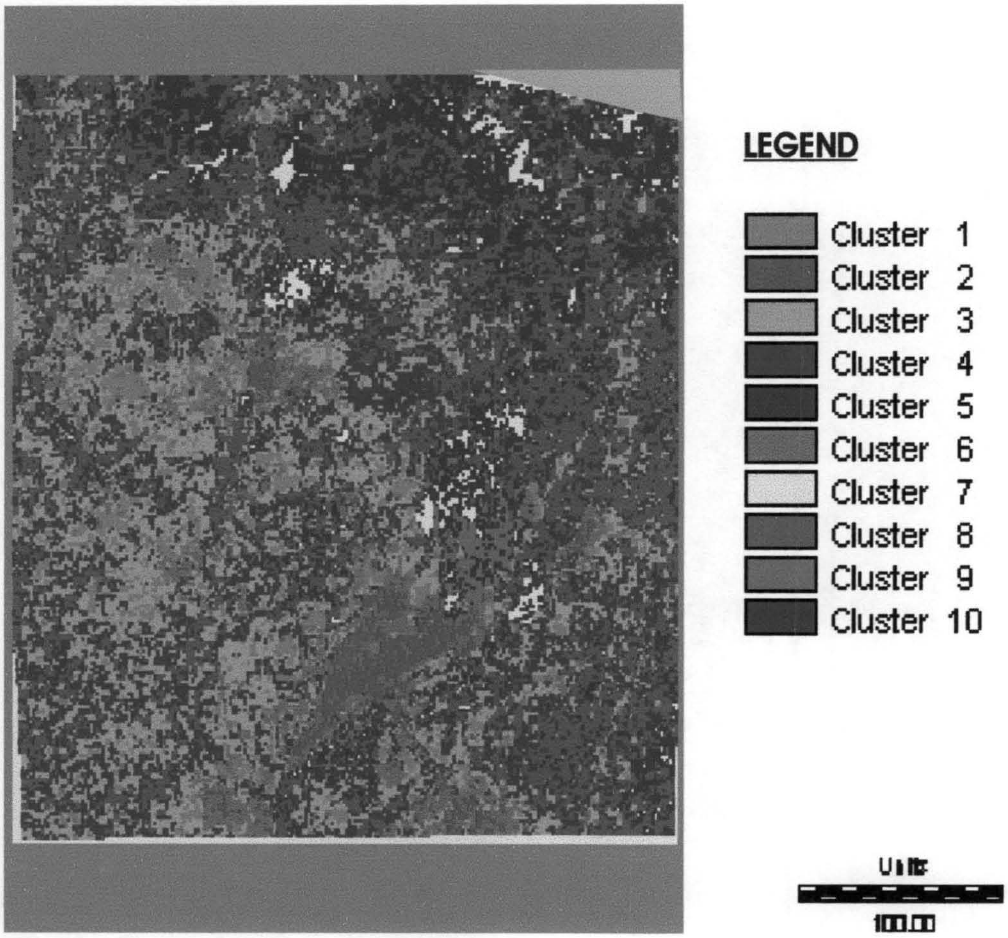

Fig. 3.7: Unsupervised classification.

1.4 SUPERVISED CLASSIFICATION

Unlike the supervised classification where the computer uses its discretion to carry out : classification, the supervised classification involved 3 steps. First, the was the carving out area to be digitize known as training sites, then was the creating a signature and finally the s choosing one from the 3 classifier option of which are:

Minimum distance (Mean distance)

Parallel Pipe (Piped)

Maximum like level

SELECTION OF TRAINING SITES

Using the digitizing icon identifier number, the first object is selected and entered with polygon option and vector file selected. This process was carried out till the end of itization. However, features of the same type were given the same identified numbers (ID).

CREATION OF SIGNATURE FILE

The training signature site is done through the command sequence: ANALYSIS-AGE PROCESSING-MAKE SIG and the various signatures were entered for corresponding

CLASSIFICATION

Under the classification, MAXLIKE is chosen because it is more accurate than the other 2 options.

A total of 5 was used for this classification which are:

i. Water Body

ii Thick Vegetation

iii Settlement/Built up areas

iv Sparse Vegetation

v Rock out Crops

Base on this 5 land use classes, the pixel value for each training was derived using: ALYSIS-DATA BASE-QUIERY AREA.

The pixel values for each of the training sites 3 are shown in Table 3.1

Table 3.1: Pixel Value for Training Sites

Symbol	Classes	Pixel No
A	Water Body	268
B	Thick Vegetation	15568
C	Settlement/Built up Areas	42246
D	Sparse Vegetation	56154
E	Rock out Crop	12155

5 GENERATION OF DIGITAL TERRIM MODEL

Topographical map of Minna SW was brought in through: **FILE IMPORT DESK UBLISHING, FORMAT TERRAIN** and with the assistance of digitize one after the other which is from the highest point to the lowest using REFORMAT – Raster/Vector conversion – ineras for shading the contours to produced the height as shown in figure 3.8.

Since slope potential factor is to be considered the DEM was used to derive the slope potentials for the study area based on the individual training sites as shown in figure 3.9.

COMPUTATION OF SLOPE VALUES.

The topographic factor (Slope % and length) or LS was applied using the Wischmeir ıith (1978) formula:

$$\frac{65.4 * S^2}{S^2 + 10{,}000} + \frac{4.56 * S}{\sqrt{(S^2 + 10{,}000)}} + 0.65 \Bigg] \left[\frac{L}{72.5}\right]^m$$

= Topographical Factor (Slope % and Length)

= Slope Length, (m x 0.3048)

= Slope percent

= Exponent dependent upon slope steepness (0.2 for slope<1%, 0.3for slope 1 to

for slope 3.5 to 4.5% and 0.5 for slope>5%).

ı the formula and using the DEM for the slope value, 3 classes were identified as Low, e and High erosion potentials. The results of the computation were analysed and d in the next chapter.

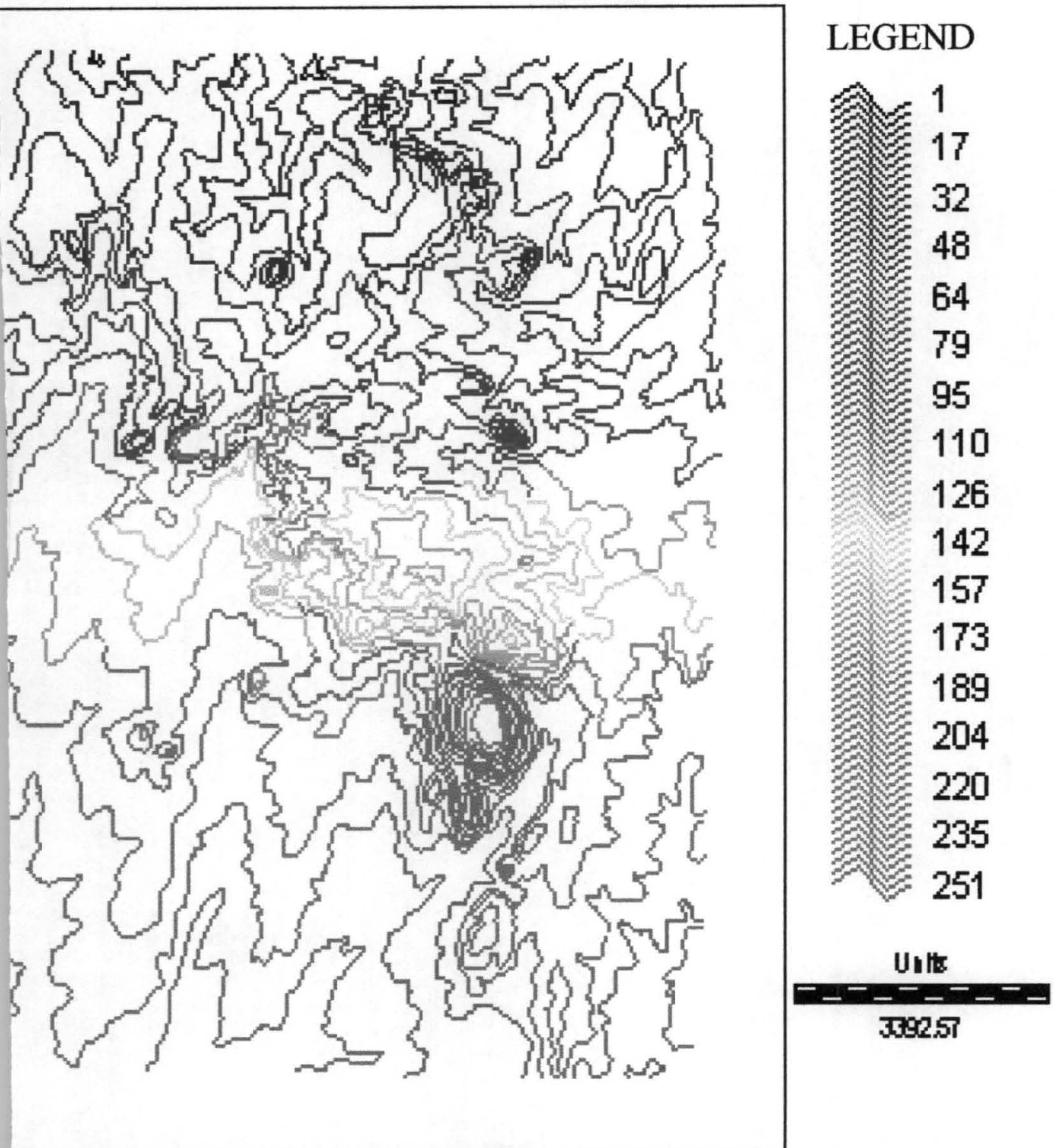

Fig. 3.8: Diugitized contoured Map

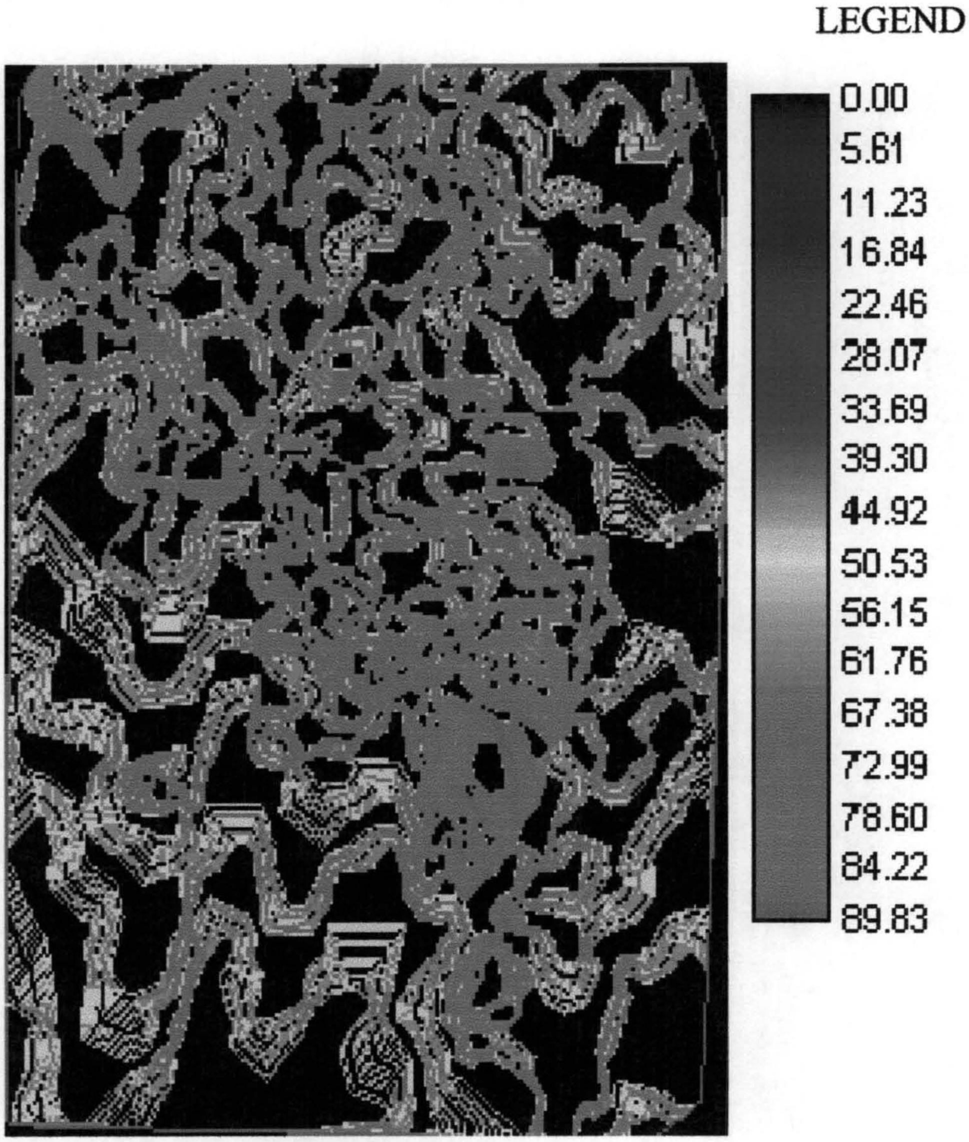

Fig. 3.9: Surface slope map.

CHAPTER FOUR

PRESENTATION AND DISCUSSION OF RESULTS

INTRODUCTION

This chapter presents the results of analysis of the images and data of the study area. Factors that have erosion potentials are singled out in raster images and represented in form.

GENERAL CLASSIFICATION OF IMAGES

The satellite images is classified into 5 land-use classes as shown in figure 4.1. this formed the basis for the classification of the land-use for the study area. Below is the howing the general classification.

Table 4.1 General Classification

cation	Land-use Category	Symbol	Digital No	Area %	Ranking
	Water Body	A	80	2.2	5
	Thick Vegetation	B	51	17.6	3
	Settlement/Built up area	C	164	35.8	2
	Sparse Vegetation	D	94,150	36	1
	Rock Out Crop	E	240	8.2	4

Open ground or sparse vegetation covers 36% and is first in the ranking of the land-use. area can be influence by erosion due to the lack of proper cover of the soil. Also due to the an activities such as mining, earth excavation, felling of trees and grazing of animals, soil become bare and liable to erosion. Areas covered mostly by sparse vegetation are mostly in

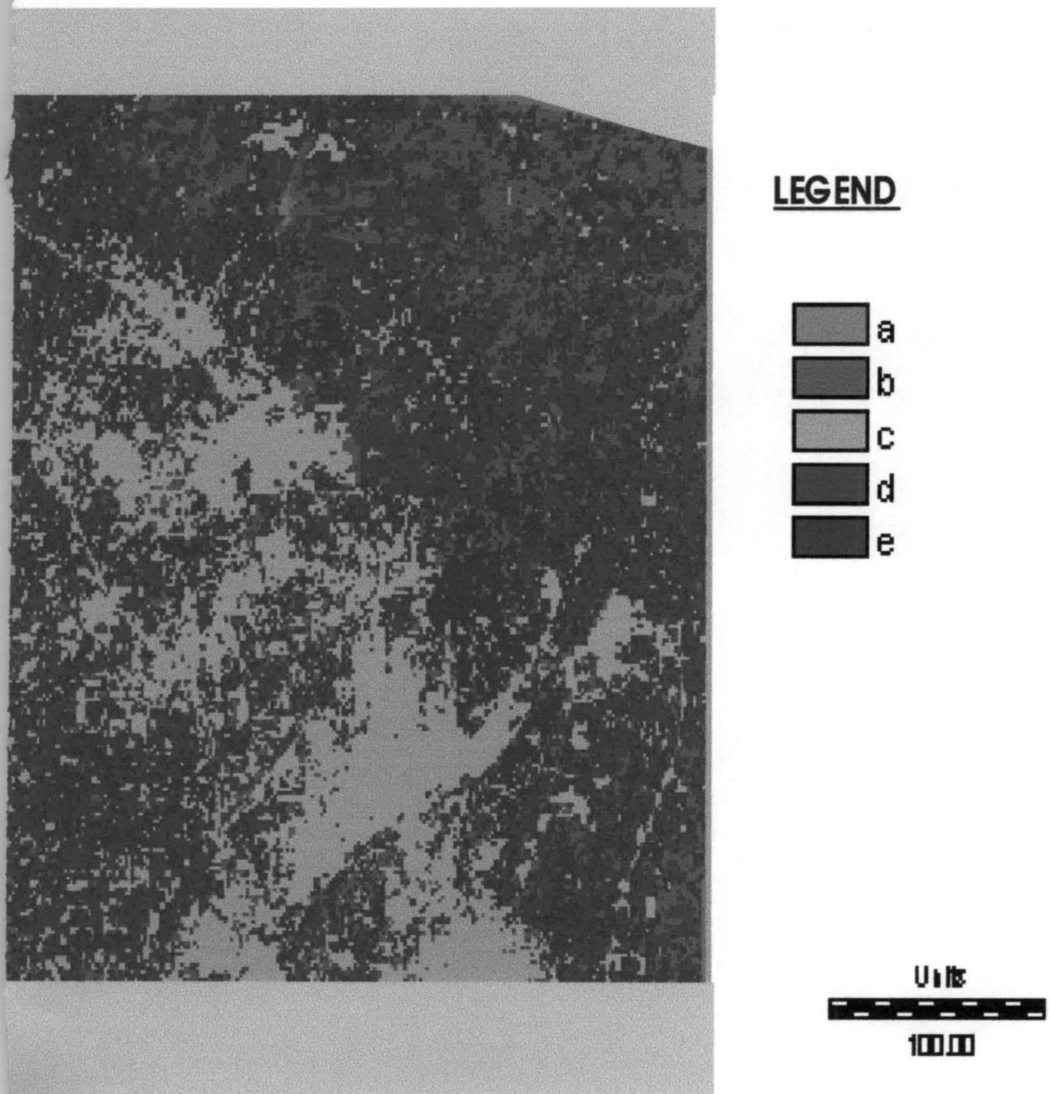

Fig. 4.1: Supervised Classification Image

central and south eastern section of the study area. This areas are just at the foot of the ges of high grounds in the north west of the study area.

Settlements and Built up Area account for 35.8% of the total land cover of the study ı. Though this area has little erosion potentials. However, erosion is visibly noticed along stream and river banks that flow from the north west to the south east. The erosion activity ; has been greatly reduced due to the construction of giant water channels drains from the ı lands that control flooding of the area during the heavy down pour. The thick vegetation stly located in the north east and along stream and river valleys account for 17.6% of the l cover. The thick vegetation protects soil against the major erosion activities.

The Rock outcrops unit that constitute up 17.6% of the total area has virtually no sign of ion. However due to the high altitude and slope run off from there greatly affects erosion vities below the hills and rock outcrops. Also due to the steepness of the slopes and the ocity of the water moving down eroded soils are washed away. The highland ranges in na are at an average of 1000m above level and he in the past accounted for the serious ding in the town during the rainy season. Water bodies within the study area only cover just in the total land-use. One should not be surprised at the low value, as this is a result of the ge taken during the dry season (February), when most of the rivers are dried up. However ı the images, areas in the North West and along the river channels are potential water ies. Bosso Reservoir located at the northern part of the image is on the high ground with ion activities limited to the banks of the reservoir. From the ground truth it was evident to w that the activities of earth excavators around the reservoir have greatly contributed to the sion of the banks.

3 RESULTS OF EROSION POTENTIAL CLASSES

Based on the formula for the calculation of a topographical factor (slope % and length), e following result was determined.

NO	SLOPE VALUE	SURFACE %	DEGREE	SLOPE LENGTH (M X 0.3048)	LS
1	0.00	-	-	-	-
2	5.61	0.79	0.2M	0.06096	0.000001768
3	11.23	1.59	0.3M	0.09144	0.00005460
4	16.84	2.38	0.3M	0.09144	0.00007966
5	22.46	3.17	0.4M	0.1219	0.0001851
6	28.07	3.96	0.4M	0.1219	0.0002339
7	33.96	4.76	0.4M	0.1219	0.0002891
8	39.30	5.55	0.5M	0.1524	0.0005450
9	44.92	6.34	0.5M	0.1524	0.0006467
0	50.53	7.14	0.5M	0.1524	0.0007583
1	61.76	8.73	0.5M	0.1524	0.001005
2	67.38	9.52	0.5M	0.1524	0.001140
3	72.99	10.31	0.5M	0.1524	0.001283
4	18.60	11.12	0.5M	0.1524	0.001438
5	84.22	11.90	0.5M	0.1524	0.001594
6	89.83	12.69	0.5M	0.1524	0.001807

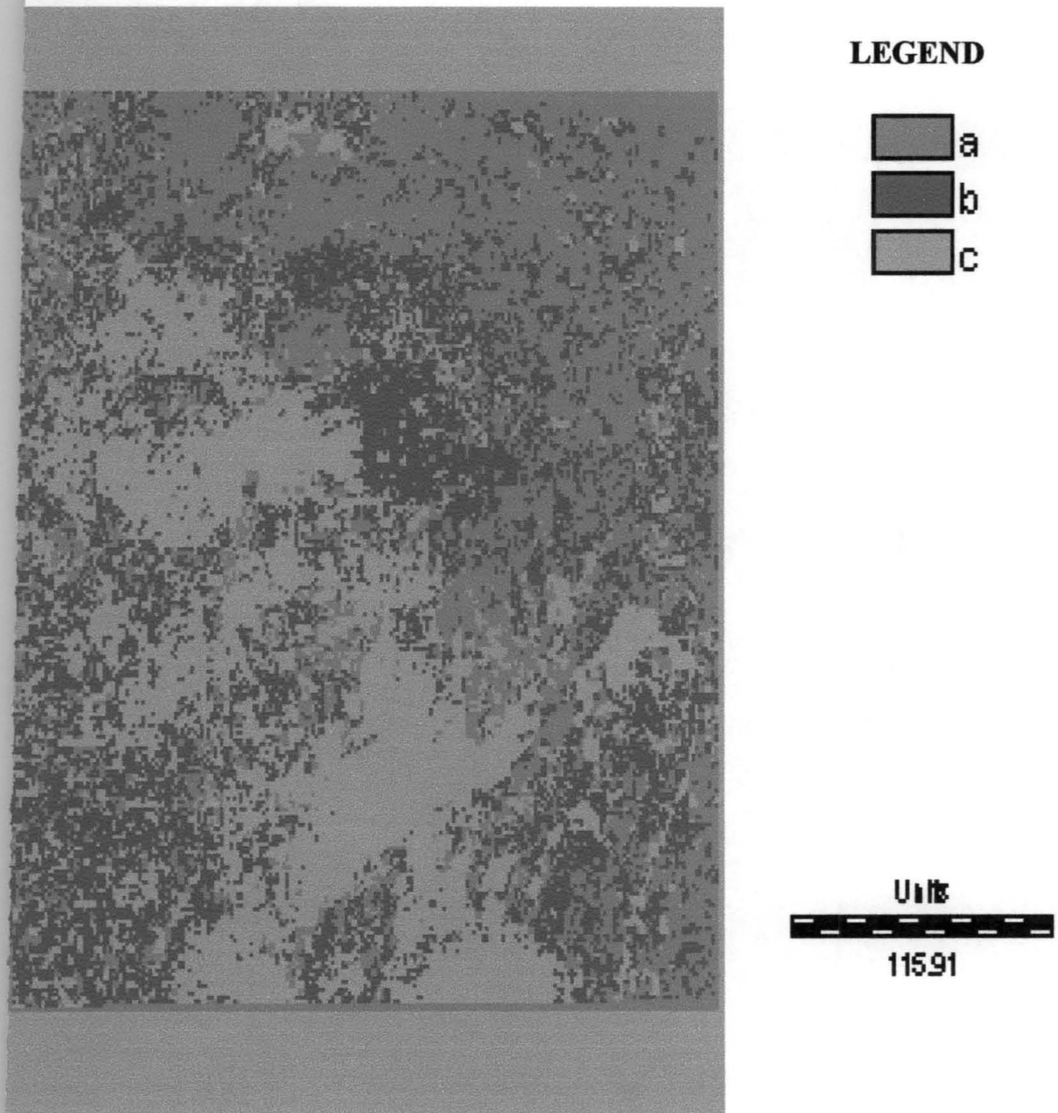

Fig. 4.2: Erosion Classes

The topographical factor yielded 3 classes of erosion potentials as illustrated in Table and figure 4.2

a. High Slope Area.

b. Moderate Slope Area

c. Low Slope Area

Table 4.2: Slope Erosion Potential Classes

Classes	Low	Moderate	High
pe %	0.79%	6%	13%
a Covered	36%	29.5%	34%
a Covered (M^2)	41030	33188	38354
	0.000001768	0.0005450	0.001807

From the analysis, the slope factor shows that areas on higher altitude have very greater pe gradient than relatively lower areas. Based on the 3 classes, high erosion potential areas ve about 13% slope gradient. From Table 4.2, 34% of the study area is classified as high sion potential areas. This area is concentrated on the high ground and is currency thickly getated, but with the exposure of the vegetation to mans activities the area will be high sion risk the moderate risk areas have about 6% gradient and 0.00305450LS and covers .5% of the total area. The area is mostly made up of bare and open soil, used for farming and azing. The low slope erosion risk area is located in the built-up areas and flood plains which vers 36% of the study area. See also Figure 4.3.

4 **DISCUSSIONS**

From the foregoing result, it is apparently clear that remote sensing technique could be plied in determining erosion risk areas. The slope factor as analyzed in fig. 4.2 shows that the :a having high altitude has higher erosion potentials. 4.2 shows the delineated potential sion all the classes. The moderate and low potential areas based on the slope factor both w current sign of erosion but have lesser influence of factor in determining the erosion ential as the case may be.

In addition, the influence of human activities on the land enhances erodibility of the land ecially in areas where slope gradient is higher.

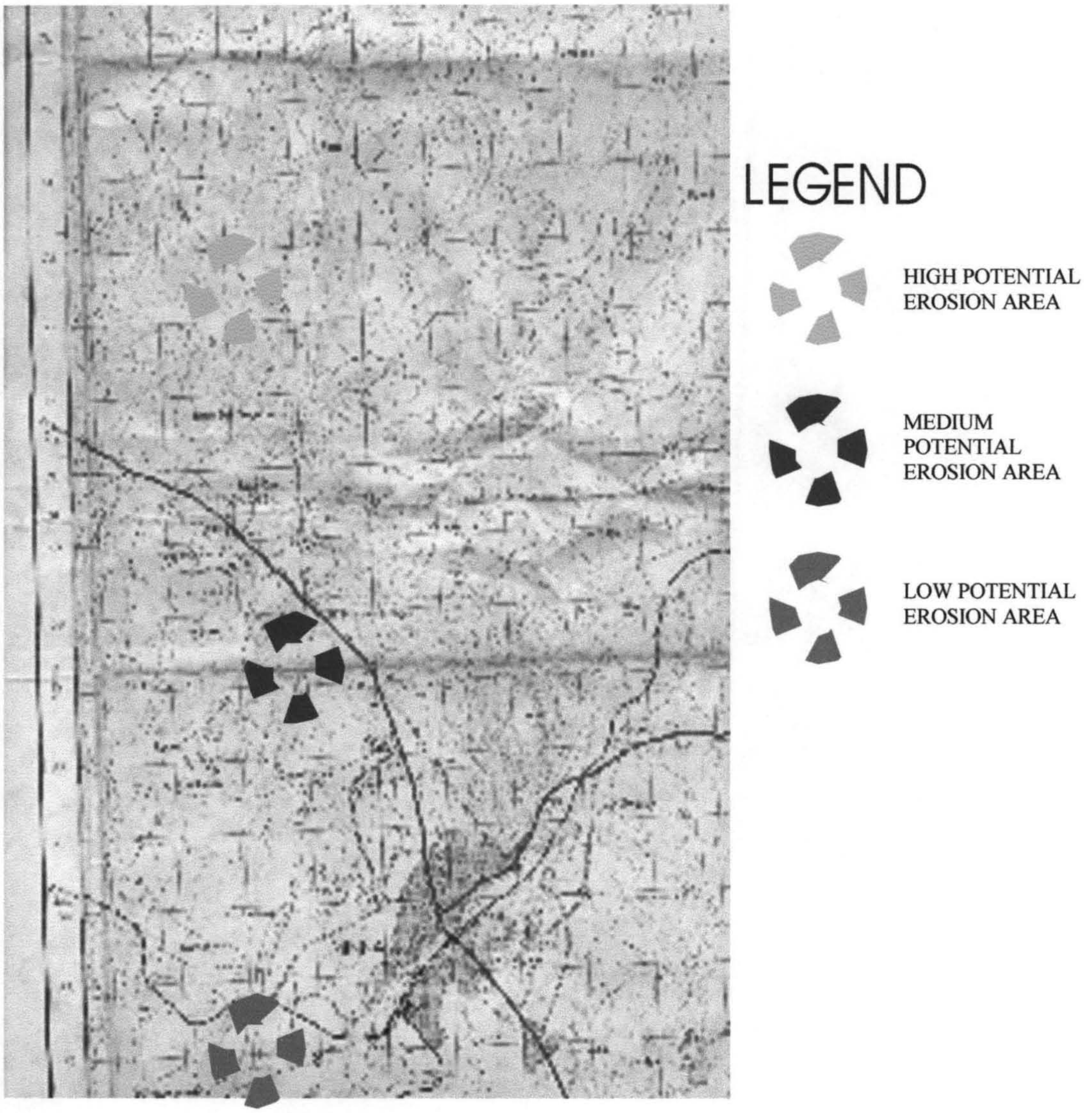

Fig. 4.3: Delineated Erosion sites

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

SUMMARY

The results of this study can be summarized as:

Areas with sparse and open vegetation have a largest area coverage of the various land This can be attributed to the influence of human activities such as farming, grazing and forms of land degradation.

Areas with high slopes have high erosion potentials. But due to current thick vegetation an be seen in figure 4.2), the activities of the erosion is not extensive. However, with the ities of man such as deforestation, farming, grazing and earth excavation, if not checked, rea will be highly vulnerable to erosion. The canalization of the run-off has curtailed on within the township of Minna.

CONCLUSION

The application of remote sensing is a viable tool in the study of erosion potentials, as it allows the assessment in the inaccessible areas and is cost effective.

) Remotely Sensed data allows for the accurate definition and quantification of objects on the ground would lead to accurate classification. With this, remote sensing result are more reliable than the traditional method of analysis. It could be concluded that human activities have greatly influenced erosion in high and moderate slope areas.

3 RECOMMENDATIONS

In future, further research on the study of land cover changes could be employed using emote Sensing data sets to assess the level of Erosion Potentials in Minna Are. There changes ıch as the human activities and other natural changes must be critically examined.

The following recommendation are made for the sustainable development and contract erosion within Minna Area.

i) The result of the study be used for conservation planning in the face of erosion threat to high slopes areas as a results of man's activities.

ii) That various factors be used in the study of erosion potentials for further work, in line with the present study. The application of remote sensing and integration of GIS techniques be used as it is a more reliable and accurate means of identifying erosion potentials.

iii) Massive a forestation should be carried out in areas where the land is left bare, especially on the high slope areas.

iv) Proper conservation practice and education on the risk of erosion should be imparted to the local inhabitants in order to discourage land degradation.

v) Further research be carried out on the erosion potentials of Minna Area.

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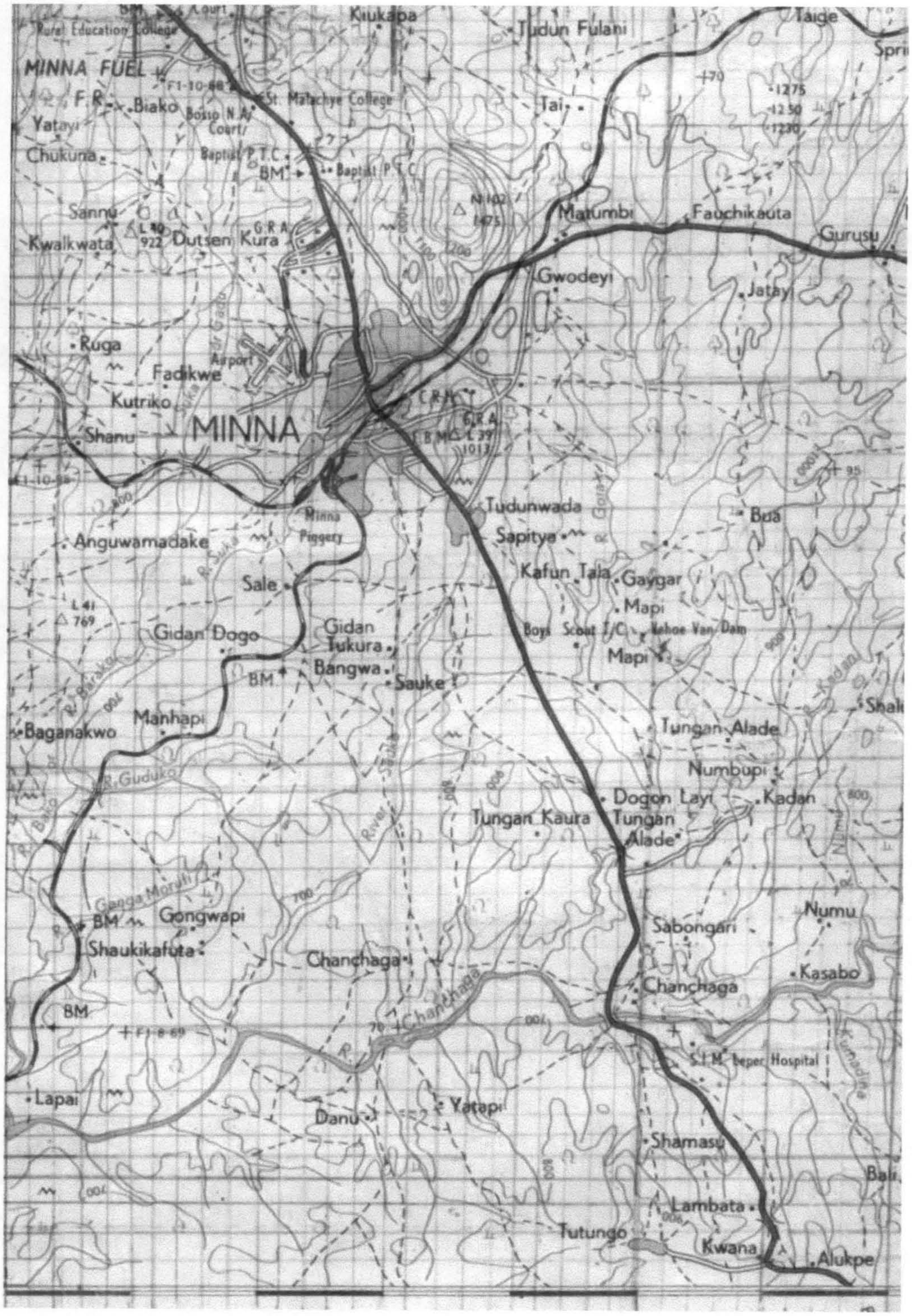

APPENDIX 1: MINNA SW 1:50,000 TOPO MAP

APPENDIX 2: DEM

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