

GIS AND REMOTE SENSING IN LAND USE LAND
COVER CHANGE DETECTION IN FINCHAA
VALLEY AREA, EAT WOLLEGA

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Master of Science in GIS and Remote Sensing.***

BY
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**ADDIS ABABA UNIVERSITY
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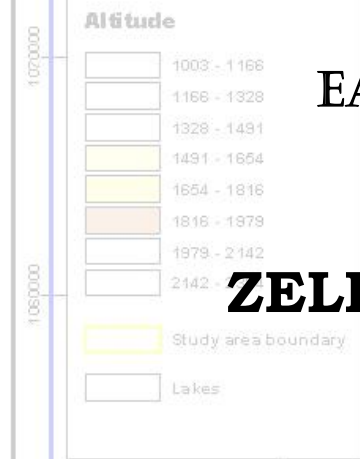
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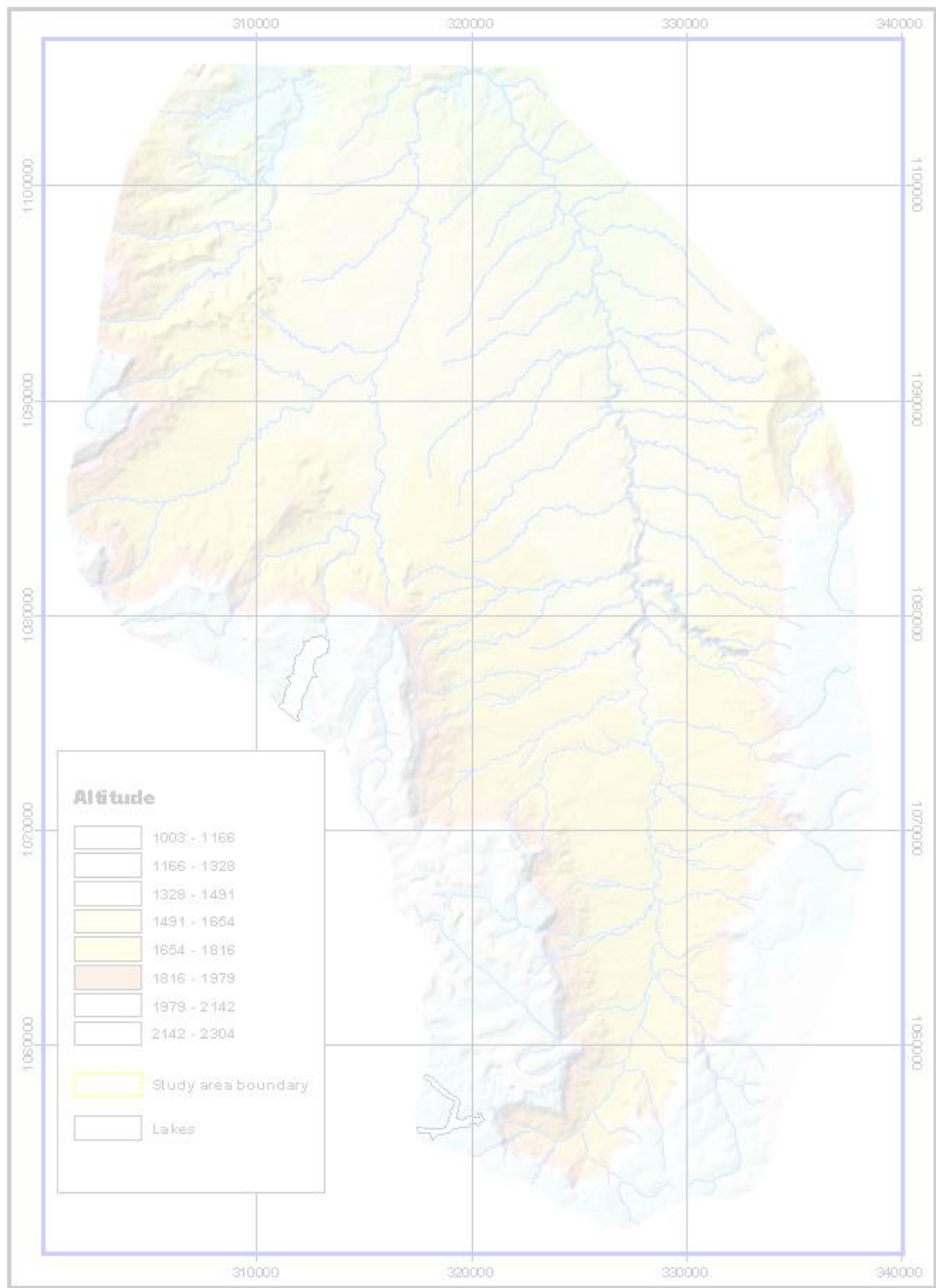
DEPARTMENT OF EARTH SCIENCES
 ADDIS ABABA UNIVERSITY
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JUNE 2005
 Title: **DIGITAL ELEVATION MODEL**
 PROJECTION UTM ZONE 37N Scale 1 : 250,000



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List of abbreviations

GIS	Geographic Information Systems
FSF	Finchaa Sugar Factory
ADB	African Development bank
FEDPD	Forestry and Environmental Protection Department
DEM	Digital Elevation Model
GPS	Global Positioning System
UTM	Universals Transverse Marketers
RGB	Reed Green Blue
Ha	Hectares
NDVI	Normalized Difference Vegetation Index

Abstract

This study assessed land use/ land cover change of Finchaa valley area by integrating GIS and Remote sensing techniques in Finchaa valley area in between 1973 and 2003. The study compared four different techniques: image differencing, rationing NDVI image comparisons and post classification Comparisons. Image differencing and rationing proved not suitable for the study area. NDVI is found better for visual comparisons with its mean values. Post classification comparison is proved the best method for the study area.

The result of the analysis indicates that generally vegetation cover is decreasing attribute to increase in crop land with accelerated rate of change, the development of mechanized state farm in between 1972 and 1986 and agroindustrial development since 1991 at accelerated rate of change with its related infrastructures but collapse of state farm in the valley. The change is directly related to socio-economic activities, fire and poor environmental management and inseparably connected to one another. From observation the change has negative implications on the environments particularly on land, vegetation and animal diversities. Therefore the ill environmental management strategy should be re evaluated to protect to protect vegetation cover and to keep the development sustainable.

armed with modern equipments and accelerated with the coming of Finchaa agro-industrial development from 1990 on wards. (Zelege, 2003) also supported this idea using the same method. Report on soil survey in Finchaa valley (Girma, 1995) indicated that this removal of vegetation in the Valley might threaten the sustainability of the industry (Finchaa sugar Factory) by removal of the quality topsoil ideal for agriculture. During the appraisal of Finchaa sugar project, African Development Bank (ADB), also anticipate and relate vegetation degradation on the steep slope of Finchaa valley with the population pressure that come with the opening of Finchaa sugar factory and point out that these leads to the risk of erosion as immediately followed by increased runoff within the plantation, over flooding and land slide that can threaten the life of the industry cited in (ANUTECH pty 1994). In response to the suggestion forwarded by ADB, Forestry project for Finchaa valley was proposed by (ANUTECH pty Ltd, 1994) but failed to achieve its esteemed objective directed to plant multi-purpose species in degraded areas by erosion, protect indigenous vegetation, propagate indigenous plants in the area and to plant about 2200 hectares of firewood plant and distributing free fire wood from 1999 on wards so as to keep the surrounding as well as the valley settlers from disturbing the natural vegetation all vanished in air (Zelege, 2003). These reports although, not targeted at land use/land cover changes analysis, readily tried to identify problems related to land use/land cover changes in the area. But no tangible solutions and remedies were suggested in these reports. Thus, this research seeks to address the above inadequacies by attempting to study the pattern, rate of change, quantify and map these changes by using GIS and remote sensing techniques. And thereby make a brief remark of the implications of this change on land, fauna and flora and to forward suggestions.

1.2 Objective of the study

General objective

- To assess land use/ land cover change using GIS and remote sensing techniques

Specific objectives

- To compare different land use land cover change detection methods by integrating GIS and remote sensing and selecting suitable technique
- To map and quantify land use/ land cover change and its rate over 30 years (1975- 2003)
- To describe causes and implications of land use land cover change in the study area
- To quantify change with respect to slope

1.3 Methods and materials of the study

1.3.1 Materials

A. Satellite images: In this study multi temporal Landsat images were downloaded from global land cover facility website and used. The images are summarized in (table1.1).

Satellite	Sensor	Pixel size	Date of acquisition
Land sat 1	MSS	80m by80m	December9,1972
Land sat 5	TM	28.5m by28.5m	January28,1986
Land sat 7	ETM+	30 m by 30 m	March8,2003

Table1.1; Different years of satellite image descriptions

B. Other GIS data layers

- Topographic map with scale of 1:50,000 from mapping agency of Ethiopia
- Climatic data from Finchaa sugar factory weather station
- Photographs

C. Facility and soft wares

- Arc GIS 8.3,Arcview 3.2,Cartalinx 2.0,ENVI 3.5,IDRSI 32
- GPS and photograph Camera

1.3.2 General Methods

The general study approach is presented in Fig; 1.1

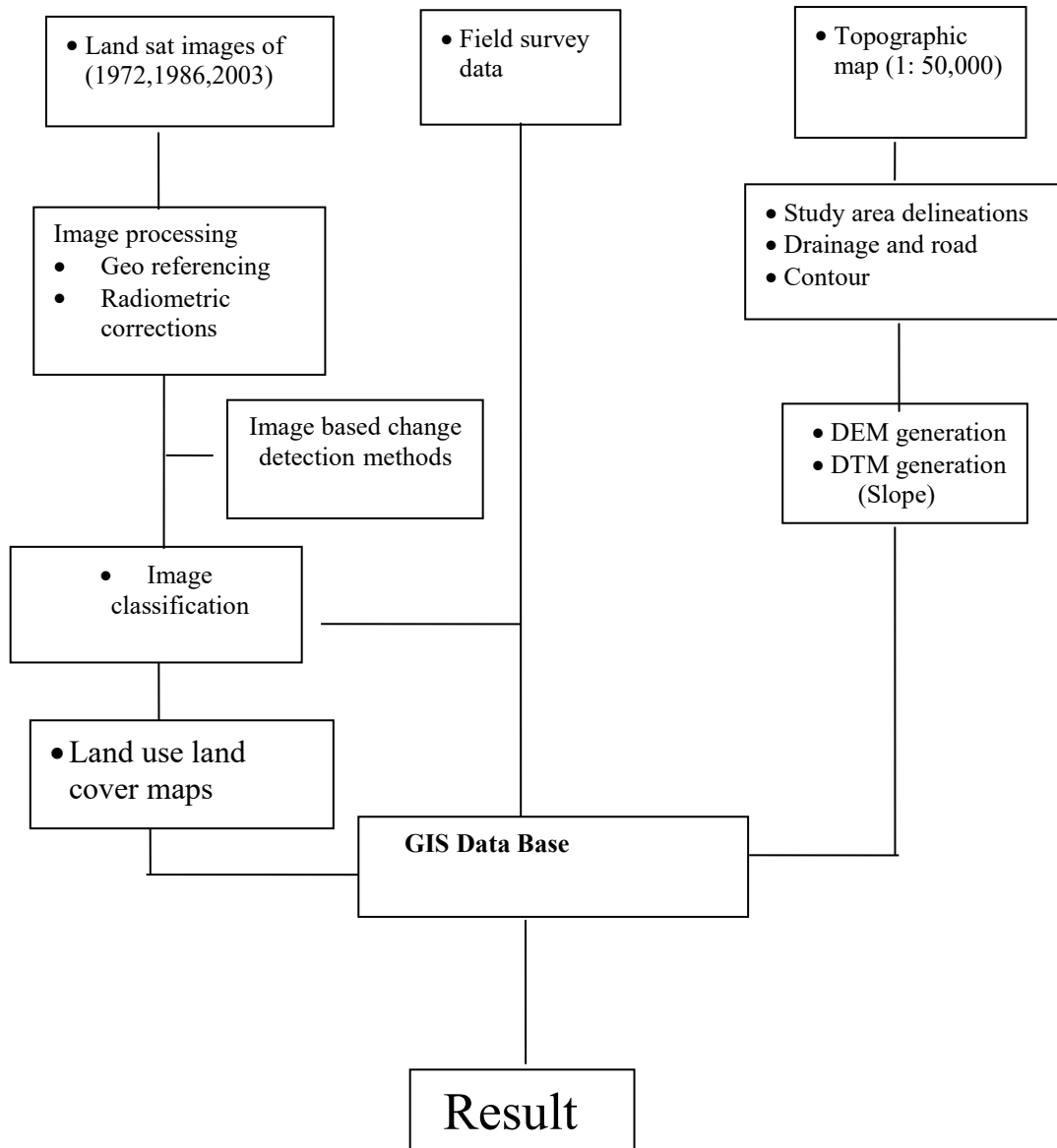


Fig 1.1; General study approach

CHAPTER TWO

2 Description of the study area

2.1 Location

The study area, Finchaa valley area, is located in Abay basin, Horro- Guduru area Eastern Wollega, Western Ethiopia. The valley is partly in Horro, partly Abay Chomen and partly in Guduru. Astronomically the area lies within the coordinates of $9^{\circ} 30'$ to 10° north and $37^{\circ} 15'$ to $37^{\circ} 30'$ east to the North West of Addis Ababa at a distance of 332 kilometer. The study is about 1364.5188 square kilometer. For this study, the area is not restricted to the valley only, but includes part of the surrounding highlands. The area can be accessed from Addis Ababa, through the main road in the northwest direction by passing through Ambo and Gedo towns (fig 2.1).

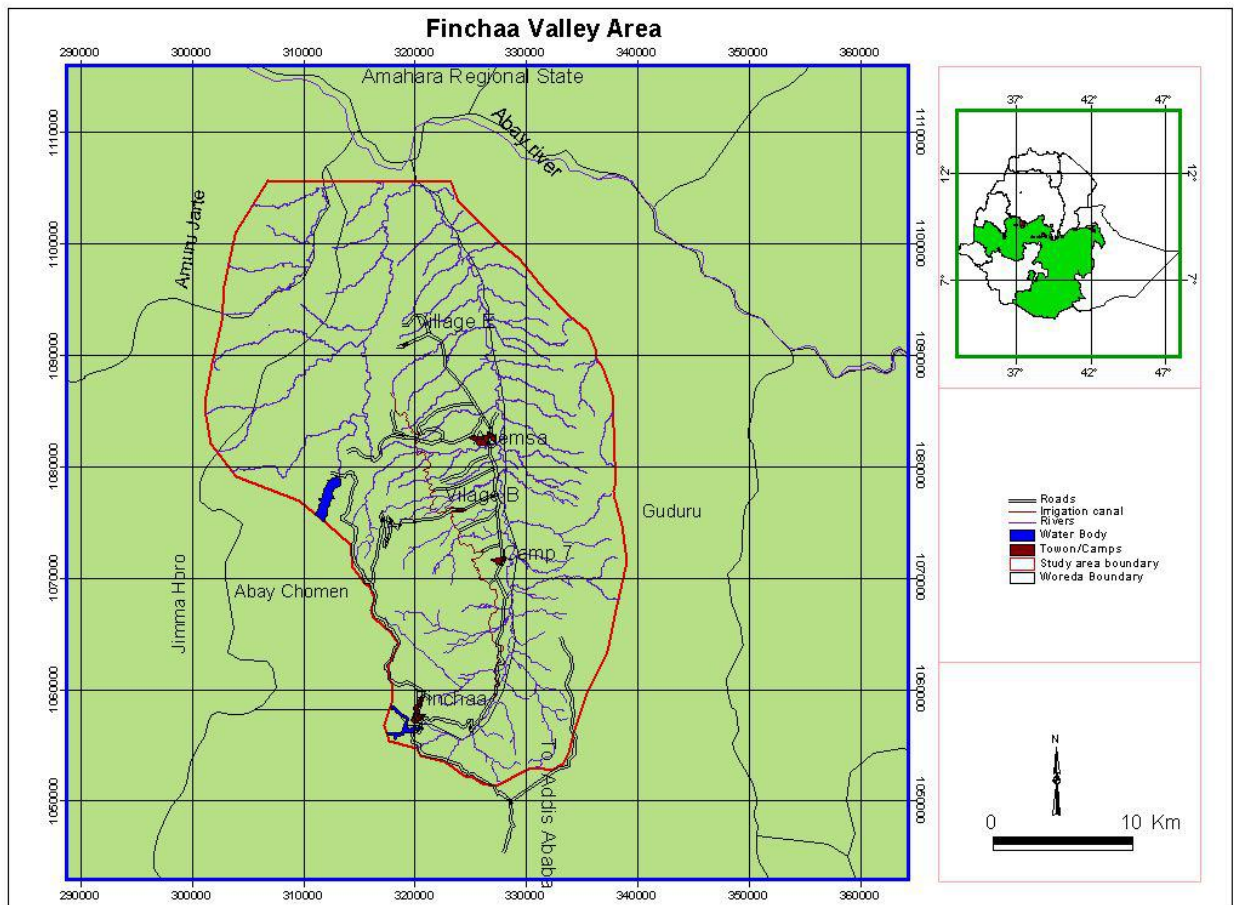


Fig 2.1 Location of the study area

2.2 Topography

The valley is fenced by the escarpment of height 700 to 850 from the bottom of the valley in the east, south and west and it is open in the north direction. The bottom of the valley is undulated with south north inclination. The topographic map is presented using hill shade map (fig2.2).

2.3 Geology and soil

In the study area, two major types of soil are identified namely luvisol and eutric sols with their sub divisions as presented in(fig,2.3).Most of them are formed from the accumulation of cluvial and alluvial deposits of the surrounding escarpment where as some of them are derived from the basement complex rocks. The luvisol are red to reddish brown color and the vertisols are heavily black. All of them are characterized with PH value of 4.5 to 6.5, from extremely acidic to nearly neutral (Girma, 1995). Addegrat sand stone is the dominant geological unit in the study area. (Figure2.4) depicts different geological unit of the study area.

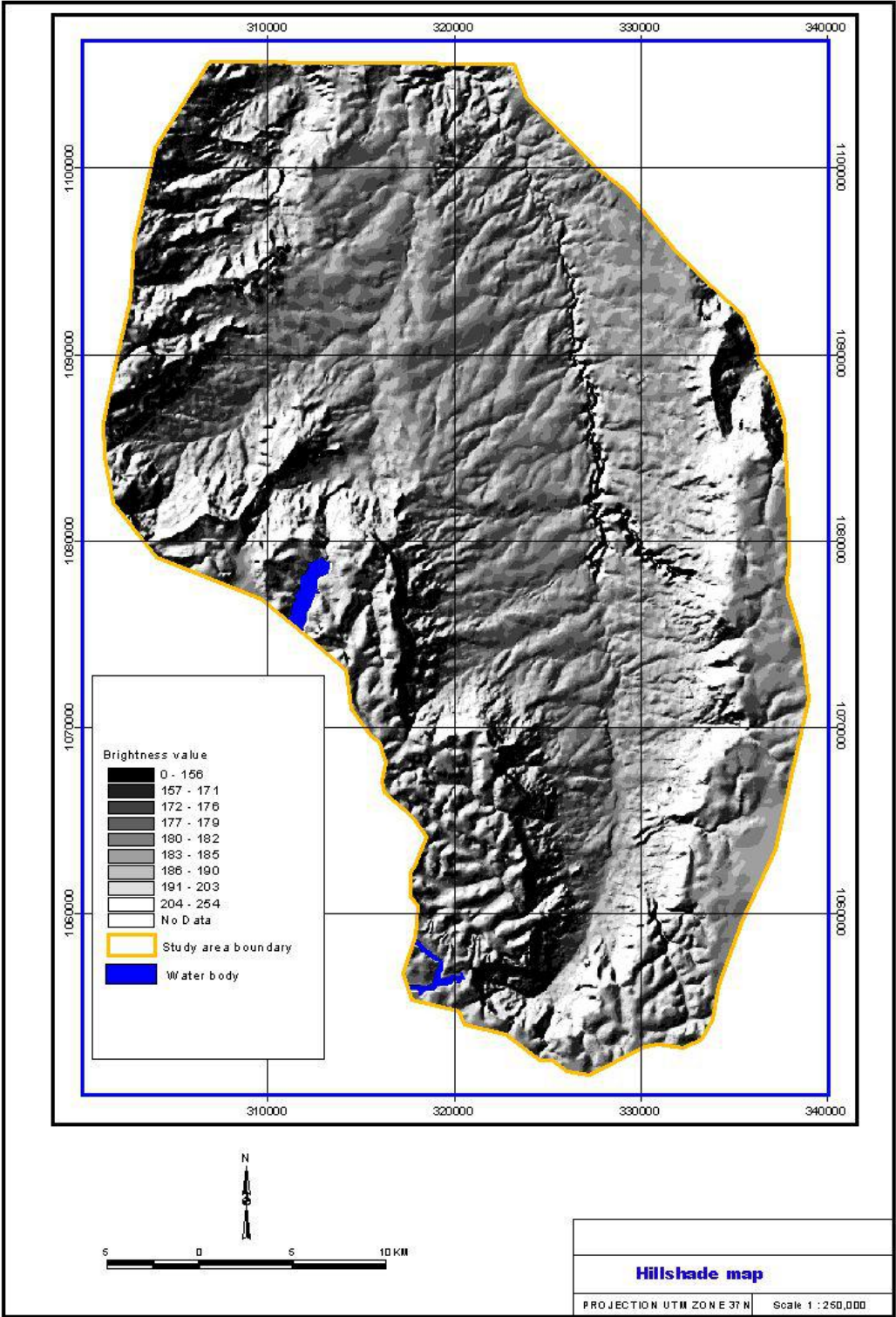


Fig 2.2 Hill shade map of the study area

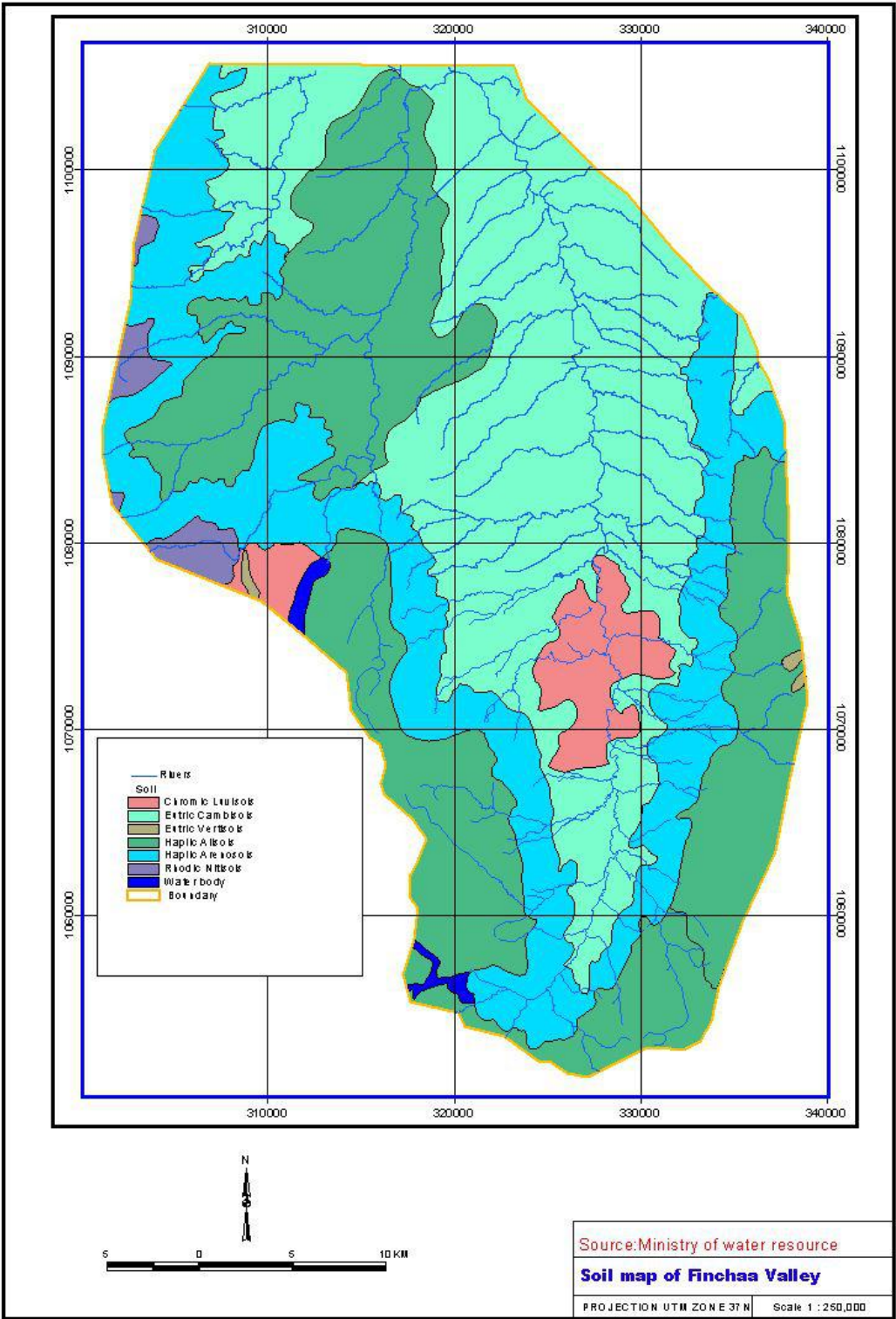


Fig 2.3 Soil map of the study area

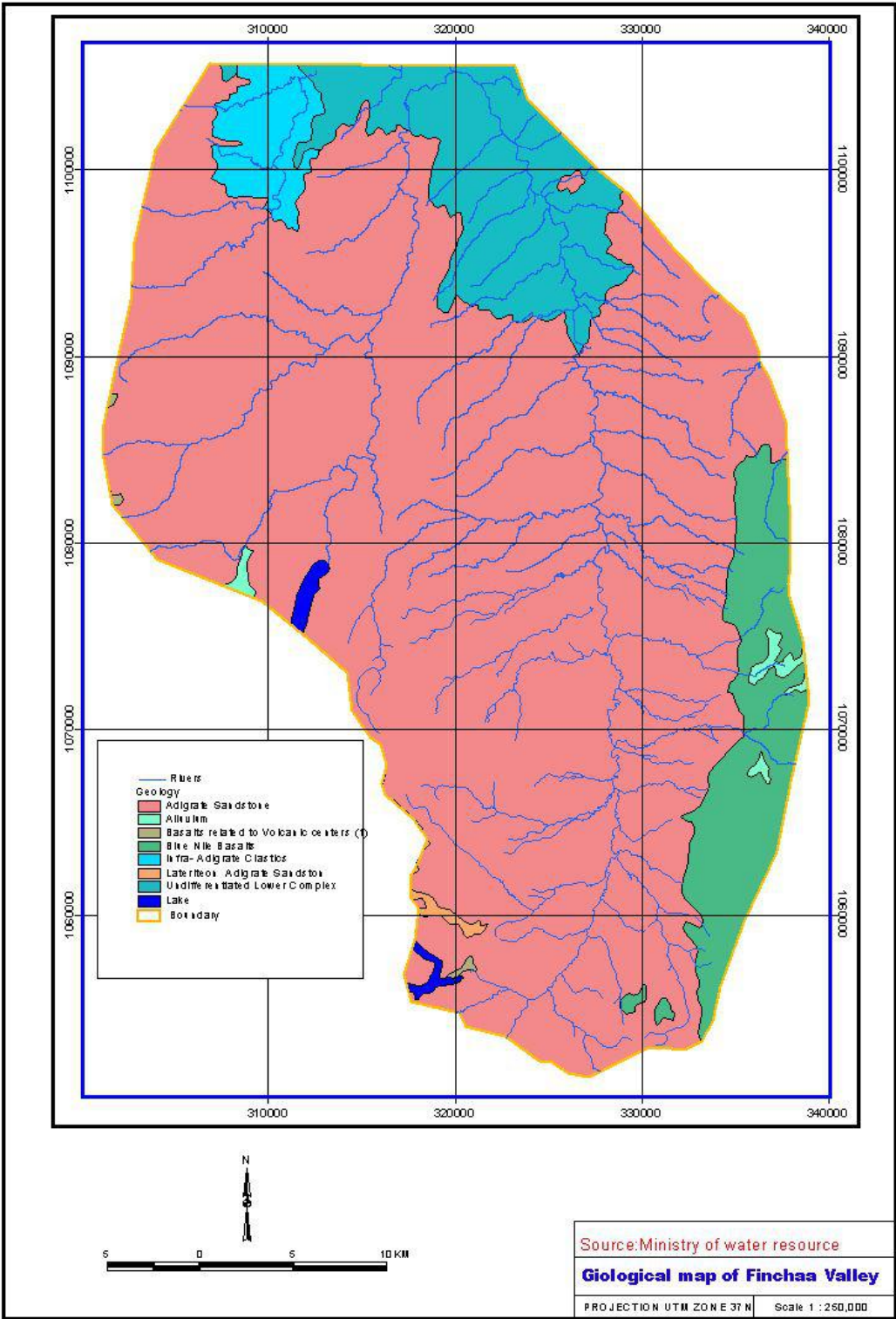


Fig 2.4 Geological map of the study area

2.4 Climate

On average, the maximum and minimum daily temperature of the area is 30.6°C and 14.5°C in their order. March (34°C) is the hottest month followed by April (33.8°C) and February (33.4). Where as July and August are cool months with 26.6°C and 26.2C, respectively. About 63% (804 mm) of annual rainfall is obtained during summer season with the highest rainfall in July (333.6mm). The annual sum of evapotranspiration is 1503mm. Evapotranspiration exceeds rainfall from mid-September to mid-June where as from mid-June to mid-September rain fall becomes 2.6tims of evapotranspiration(Finchaa Sugar Factory research center metrological station and Table2.1).

Weather data(1979-2004)

Description	Moths												Remarks
	Jan	Feb	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	
Maximum temperature	32.1	33.4	34	33.8	32.5	29.8	26.6	26.2	27.7	29.3	30.6	31.4	26 years avg.
Minimum temperature	11.8	13.8	16.7	17.5	17.2	16.3	15.7	15.6	14.8	13.2	12.2	11.4	" " "
Rainfall(mm)	3.14	6.26	31.6	54.6	106	216.09	333.6	269.8	182.2	85	8.2	7.49	" " "
pan evaporation mm/day	7.7	8.8	9.1	8.9	7.9	6.2	4.8	4.5	5.3	6.2	6.8	7	" " "
Sunshine hrs/day	8.7	8.9	8.4	8.2	8.8	7.6	5.4	5.3	7.5	7.4	8.8	9.2	14 years avg.
wind speed km/hr day	3.3	3.9	4.1	4	4	3.6	3.2	3.3	3.2	3.1	3.1	3.2	15 " "
Wind speed km/hr night	3.1	3.1	3.4	3.2	2.9	2.7	1.9	1.7	1.9	2.3	4	3.2	" " "
Relative humidity% Max.	74	62	65	71	83	93	96	96	95	92	87	82	" " "
Relative humidity% Min	25	21	23	26	32	47	61	63	56	42	31	27	" " "
Soil temperature at 5cm depth	27.7	30.7	32.5	32.6	31.1	28.3	25.1	25.1	26.7	28.4	27.7	27.1	" " "

Table 2.1 Long year weather data of Finchaa valley

Source: Finchaa sugar Factory research Center, Metrological Station

2.5 Population Socio Economic setting (historical)

2.5.1 Population

Only population of the valley is considered here since population data of the surroundings woredas are not organized in such way I delineated my study area. Within 15 years the population of the valley increased from 2243 in 1991 to 26130 in 2005. The figure indicates only permanent settlers

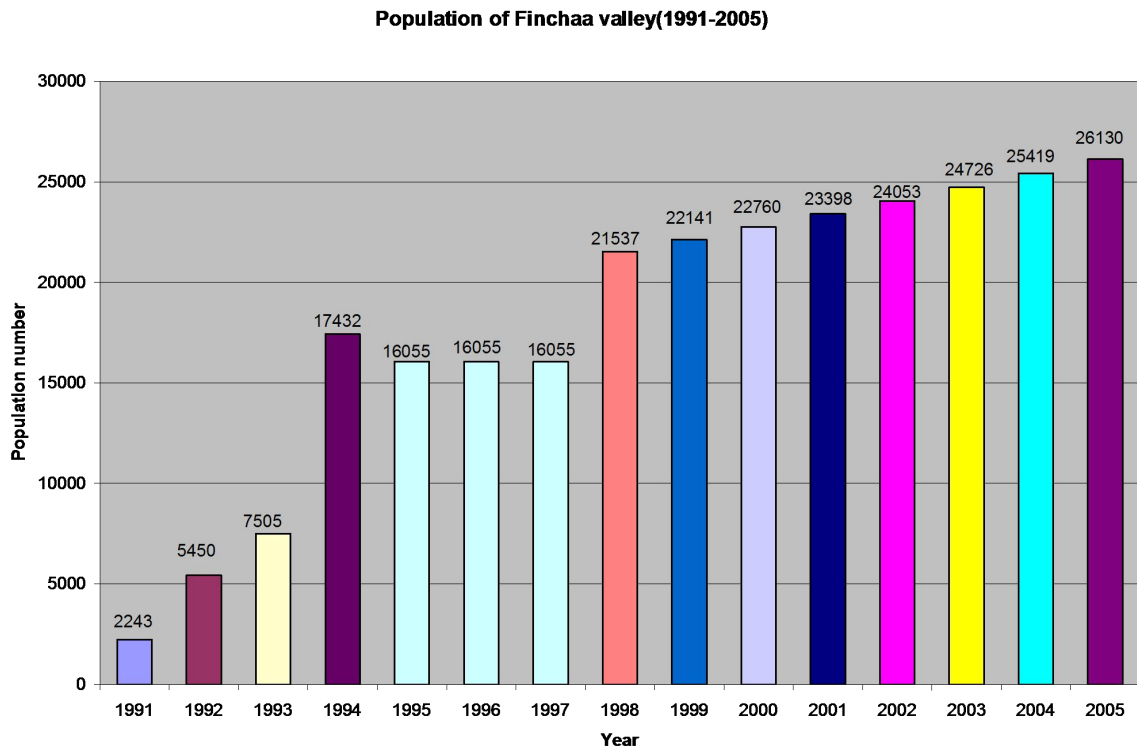


Fig 2.5 Population of the study area (ANUTECH pty 1994)

2.5.2 Socio Economic setting (historical)

Historically, it is difficult to know exactly when the valley was settled. However, according to oral traditions, there were indigenous inhabitants in the valley engaged in activities like herding of cattle, production of crops like maize, sorghum, and cotton using traditional materials like hoe. Hunting and collection of wild honey were also other activities. Around 1920s (Worku, 1994) the prevalence of draught and famine on the surrounding highland forced people to migrate to the valley. In the valley, they were living by hunting, collecting wild honey and plant fruits for survival. Through time the number of people increased in the valley and they became also rich. The presences of Hora (mineral water) Sorgia, Sonsa, Omachoo, Abaya etc. in the valley were found suitable for cattle production. But after certain years due to prevalence of trypanomiasis and malaria, both the indigenous and the migrated people left the valley and settled permanently on the surrounding high lands. Even after they left the area, people come to the valley to collect wild honey, hunt wild life, and cultivate maize and cotton. And they also bring their cattle to Hora to drink their cattle for fattening. In 1975 state farm was established with its associated infrastructures like roads settlements clinic, school and so on. During this period a relatively large number of people migrated to the valley from different parts of the country in search of employment opportunities in the state farm. The state farm was equipped with modern agricultural equipment's like tractors. The state farm was producing maize, sorghum, sunflower etc. beside this, people were engaged in traditional irrigation's around Finchaa River and its tributaries. Using this, they have been producing vegetables like cane green paper, cabbage, onion, tomato, etc. Also people were producing maize, sorghum, millet nug etc by clearing forest. Furthermore, cutting trees for charcoal production, fire wood, poles timber become sources of income. The state farm was also clearing vegetation for expansion of agricultural land and for other construction.

In the mean time, after two years of the opening of the state farm, in 1977, Finchaa valley was selected as an imperative area for sugar cane production and has been under study until 1988. In 1988, the state farm stopped its activity and the land was over handed to Ethiopian Sugar Corporation. The corporation started its activity since 1991. And production of white sugar started in 1998. This period was a land mark for social, economical and environmental changes in the valley.

CHAPTER THREE

3 Data processing

3.1 *Satellite image processing*

3.1.1 Geometric correction

Geometric distortions occur because the imagery is representing the curved surface of the Earth in two dimensions. In order to prepare two or more satellite images for an accurate change-detection comparison, it is crucial to geometrically rectify the imagery (Townshend et al., 1992; Macleod and Congalton, 1998; Kwarteng and Chavez, 1998).

The accuracy of the georeferencing also affect the accuracy and the result of change detection results (Lillesand and Kiefer, 2000; munyati, 2000). For Landsat, for instance, TM imagery acceptable RMS error is approximately 0.5 pixels for change detection (Townshend et al., 1992; Yuan and Elvidge, 1998; Lunetta and Elvidge, 1998). To minimize impact of Misregistration on the change-detection results, geometric registration, as I did it, is here under.

The year 2003 image was rectified to the UTM-37north coordinate system by first degree polynomial transformation using 12ground control points obtained from the topographic map at scale of 1:50,000 with RMS error of 1.5. Nearest neighborhood interpolation resembling method was employed to determine the pixel value of new rectified image with pixel size of 30m by 30m. The year 1986 TM and 1972 MSS images were co-registered to the year 2003 image by using first degree polynomial transformation technique. The RMS error was 0.45 and this acceptable for Land sat images as described in the abovementioned paragraph. The resembling was the same to that of 2003 image.

3.1.2 Radiometric Correction

To use images of different dates for change detection analysis, they must be radiometrically corrected (Mas 1999).

Radiometric errors are caused by different atmospheric conditions. Variations in the angle of solar illumination, and changes in sensor calibration (Du et al 2001) again result in radiometric

error. This in turn makes difficulty in making use of images of different years for change detection propose, for it may end up producing false changes. There are absolute and relative image normalization methods to correct images for radiometric distortions. Absolute radiometric correction is very complex and requires quality ground information, but is usually unnecessary for detecting changes in land cover features (Mas 1999). Relative radiometric normalization minimizes radiometric differences between images (Yang and Lo 2000). This method does not produce images without atmospheric error; instead it tends to produce images with the same atmospheric error.

However, whatever the two normalization methods may be, it is found difficult to normalize images employed in this study. We can't use absolute normalization for the images are in the form of archive, all necessary information are not available. Moreover, it is potentially difficult to obtain ground information such as ground reflectance measurements which is important for absolute normalization. Relative normalization considers targets which never change over time like sand duns, geological objects, dark forest, and deep clear water body etc.and if there is change in reflectance of such objects that is assumed to be induced owing to atmospheric changes (Eckhardt et al., 1990). But attempts to get target with constant reflectance on these images proved futile. Indeed, considerable numbers of scholars established that, in some areas, targets with constant reflectance do not exist (Du et al., 2001; Du et al., 2002).

Consequently, some of the intended methods such as band subtraction ratio, NDVI for subtle change detection, are difficult to implement in these study. This forced me to focus on post classification, comparison to see major changes for the same method couldn't identify subtle changes like aforesaid methods. For post classification change detection, where multiple images are classified independently and the maps are compared to identify changes, atmospheric correction is necessary to a lesser degree (Foody et al., 1996). However, NDVI is used for simple comparisons of vegetation changes and aid classification.

3.1.3 Image interpretation and Image Classification

That interpretation and analysis of remote sensing imagery involves the identification and measurement of various targets in images in order to extract information about targets is beyond doubt.

In this study interpretation and classification was carried out in such away that first false color composite (432 in RGB order) of Land sat ETM+ of 2003 had been prepared and taken to the field. In the field it was cross referenced Using Germen GPS 48 with ground features and some of features were also delineated in the field. In some cases different features appeared to be similar in reflectance. This could be best exemplified by bare land and crop land. On contrary, some have different reflectance but still they are of the same features, bush/shrub land for example. Apparently this owes a readable impact on the classification accuracy particularly supervised classification, as my laboratory attempt depicts with 55% accuracy for 2003 image. Because of this fact I preferred manual on screen digitization to automatic classification. Manual classification system is irreplaceable for accuracy yet it is time consuming. More to the point, false color composite of images of each year (fig 3.1, 3.2 and 3.3) were selected using ENVI 3.5 software. For 1972 MSS image color composite of Band 3, 2 and band 1 RGB respectively were selected. In the same way, for years 1986 TM and 2003 ETM+ color composite of Band 4, 3, 2 RGB were used in their order. Then the composites were linearly enhanced in order to increase visibility. Finally they were exported to Arc Gis and manually digitized on screen in to different land cover class (fig 3.4, 3.5 and 3.6).

A panoramic assessment of spatial arrangements of tonal variation such as size, shape texture, pattern, and contextual element (association) ,used for interpretation to classify, as discussed in Lillesand and Kiefer (2000) are here under.

To begin with, tone refers to relative brightness or color in an image .It is a fundamental element to distinguish variation among features. Variation in tone allows shape size, texture and pattern of objects to be distinguishable

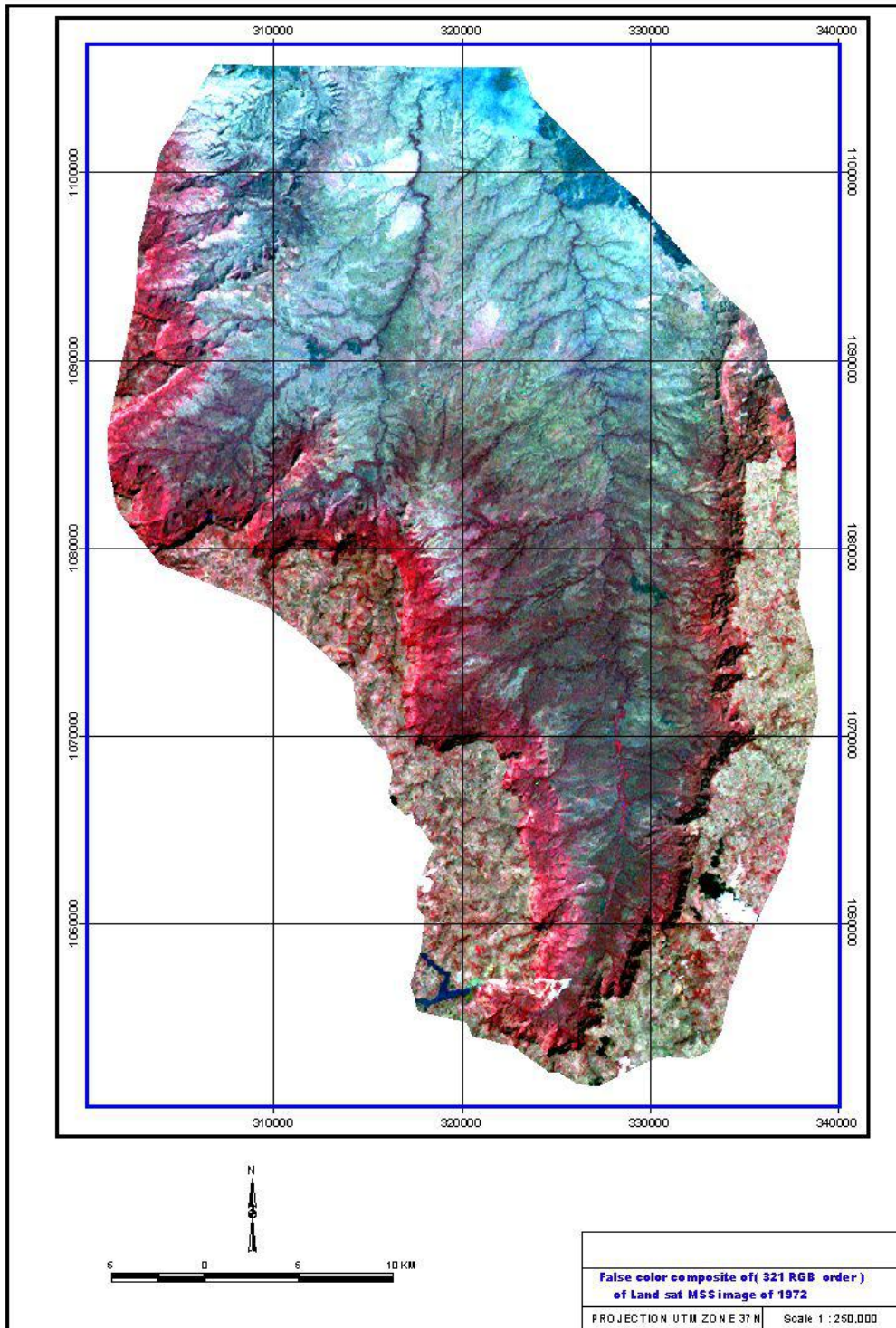


Fig 3.1 False color composite (432RGB order) map of Landsat MSS image 1972

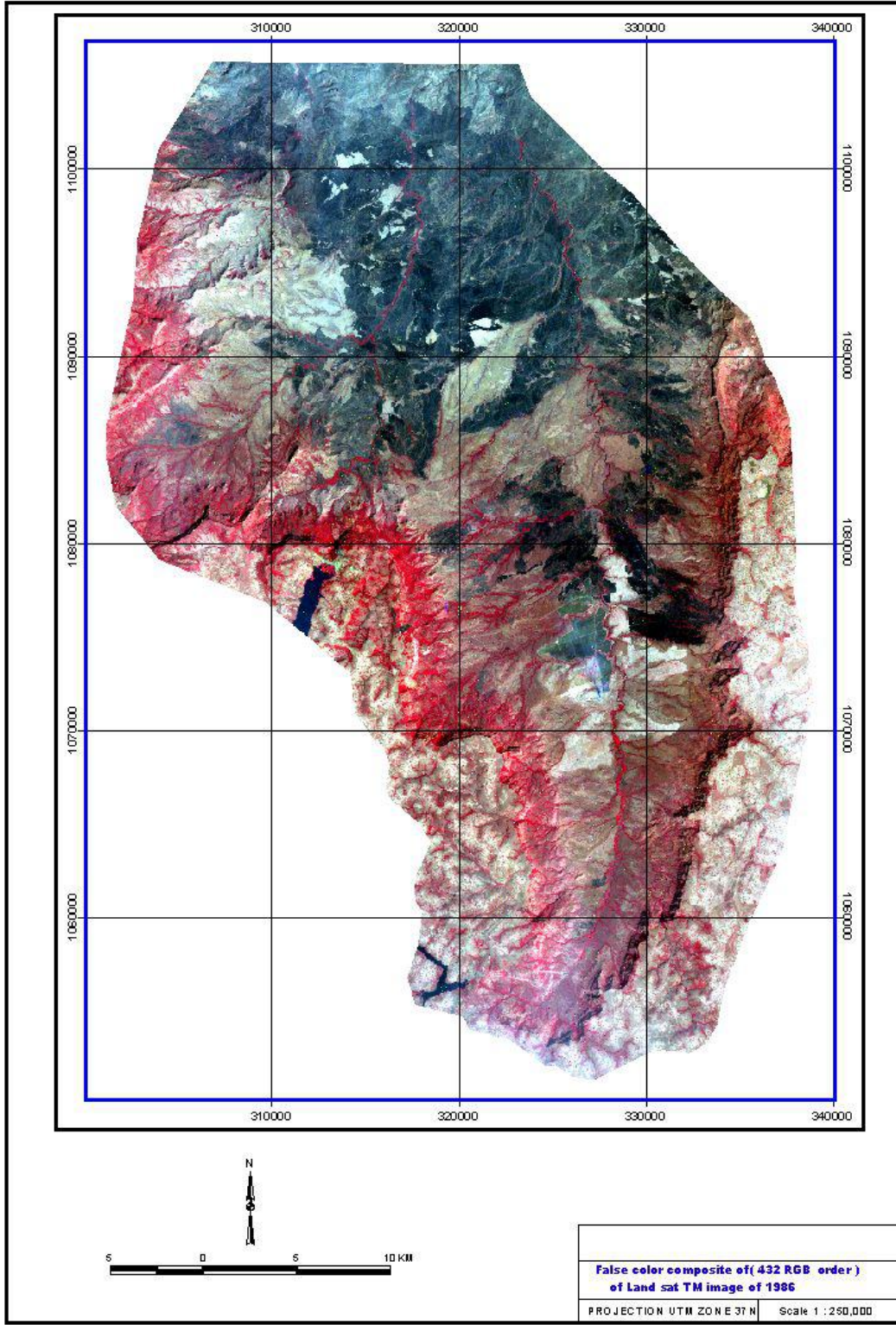


Fig 3.2 False color composite (432RGB order) map of Landsat Tm image 1986

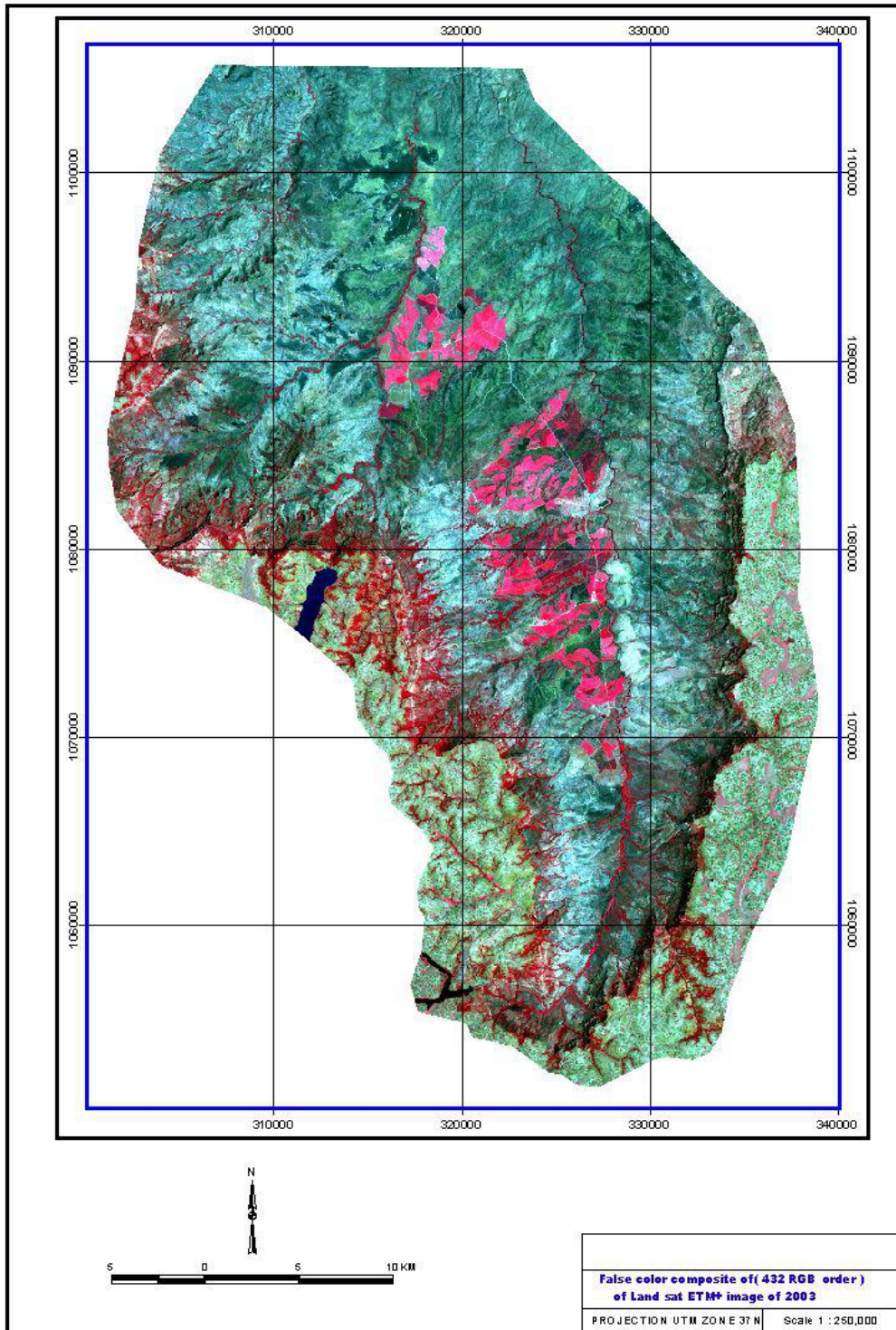


Fig 3.3 False color composite (432RGB order) map of Landsat ETM+ image 2003

Shape refers to general form, structure or outline of targets. It is a distinctive clue for interpretation.

Size is a function of scale. It is important to relate size of features to other feature in the scene and as well as absolute size to aid interpretation of targets in the scene. Quick approximation of target would lead to real interpretation of the target quickly.

Pattern refers to the spatial arrangement of visually discernable objects. Typically an orderly repetition of similar tones and textures will produce distinctive and ultimately recognizable pattern.

Texture is to the arrangement and frequency of tonal variation in particular areas of an image. Rough texture would consist of a speckled tone where the gray level changes abruptly in small area where as smooth texture very little tonal variation. Smooth textures are most of often the result of uniform even surfaces such as fields and grass lands.

Association on its part takes in to account the relationship between other recognizable or features in proximity to the target of interest. The identification of features that one would expect to associate with another features may provide information for identification of features.

Land cover type	Interpretation element used	Indicative color and distinguishing characteristics		
		MSS of1972	TM of1986	ETM+ of 2003
Water Body	Size, Texture	Blue and smooth	Blue and smooth	Blue and smooth texture
Marsh Land				
Grass Land	Size,patern,texture	Grayish red,smoothand reputedly occurring	Grayish red, smooth and reputedly occurring	Grayish red, smooth texture and reputedly occurring
Crop Land	Pattern, size,	Whitish patched with red color	Whitish patched with red color	Whitish patched with red color and black color
Sugar Cane Plantation	Patern,size,shape			Light red color and regular arranged
Town/Camps	reflectance		White	White
Eucalyptus plantation				Delineated in the field
Riverian Trees	Associotion,Shape	Dark red along river banks	Dark red along river banks	Dark red along river banks
Shrub/Savanna/Bamboo	Texture,patern	White, smooth Patched with grey green color		
Open Wood Land	Texture Pattern	Coarse Textures Green patched by white and red color	Coarse Textures Green black patched by white and red colors	Coarse Textures Green patched by white and red color
Forest	Reflectance		Dark red	Dark red
Bush/Shrub	Position, reflectance	Light red patched with white gray color, river side, road side and rigs	Light red patched with white gray color, river side, road side and rigs	Light red patched with white gray color, river side, road side and ridges
Grass/Bare land	Texture,size reflectance			Bright white to grey
Bushed Grass Land	texture	Medium texture and whit	Medium texture and white	
State Farm	texture, shape pattern	Grey, Smooth, regularly arranged		
Degraded Forest	reflectance		Light red patched with grey color	

Table 3.1 Interpretation keys

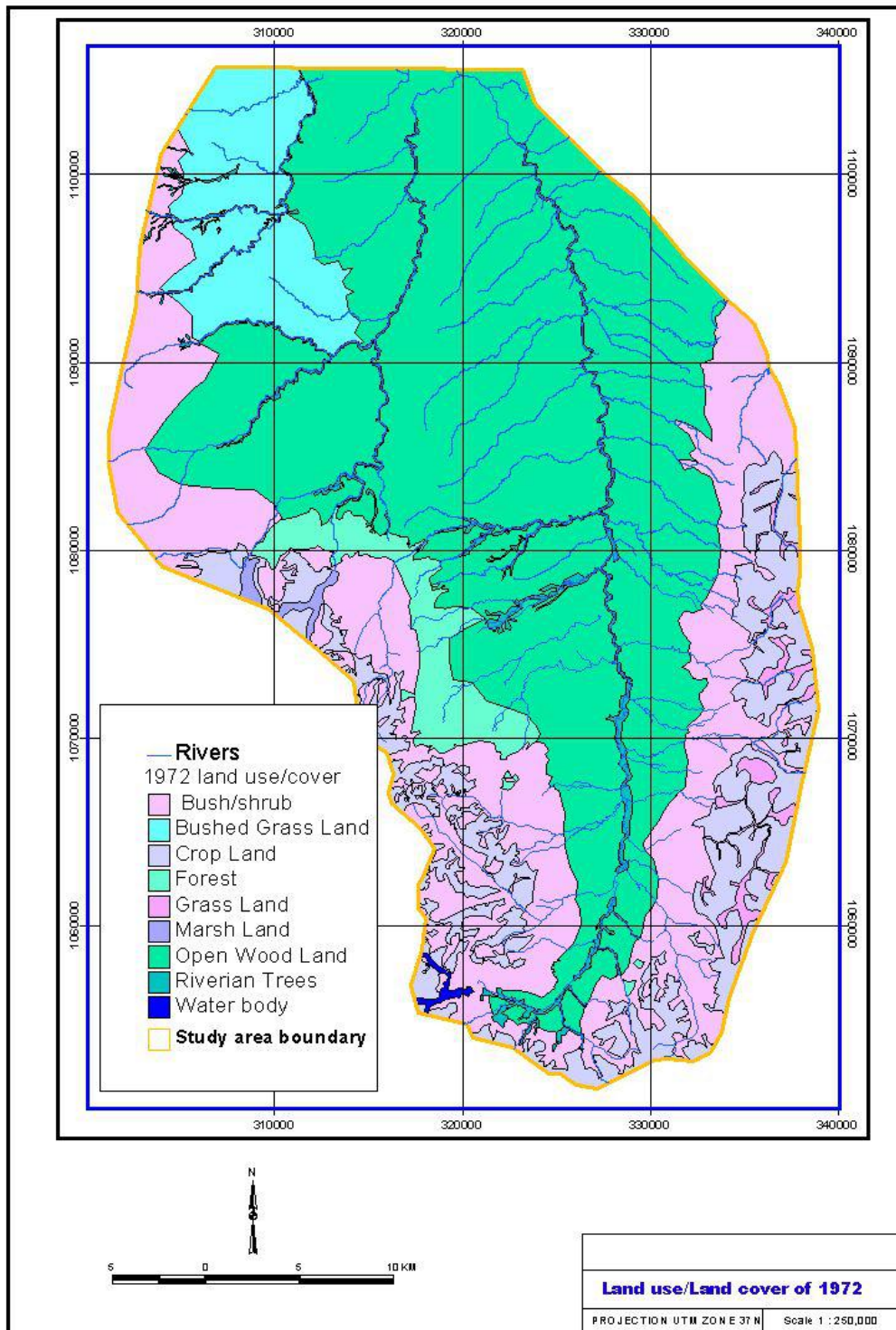


Fig 3.4 Land use/Land cover map of 1972

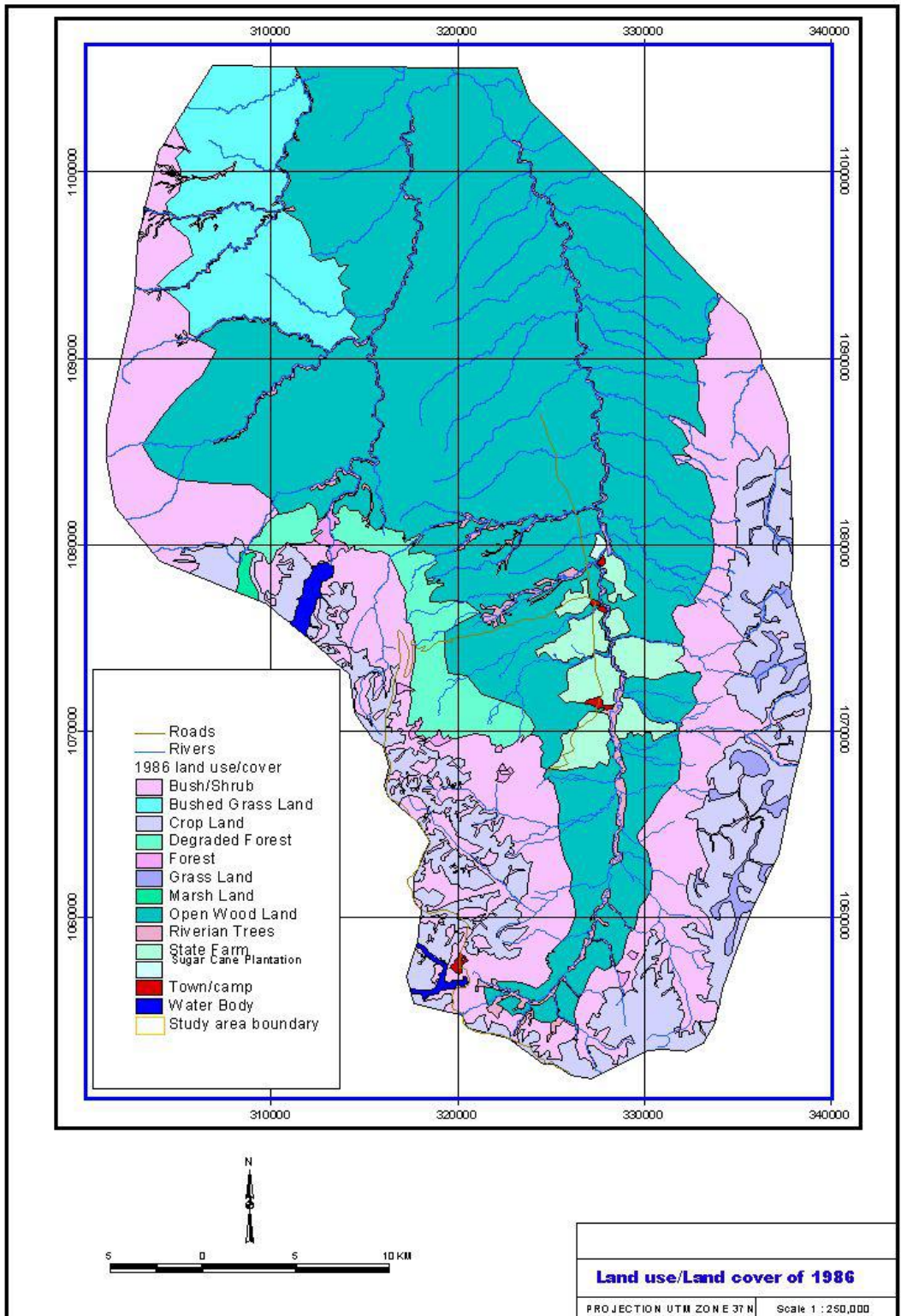


Fig 3.5 Land use/Land cover map of 1986

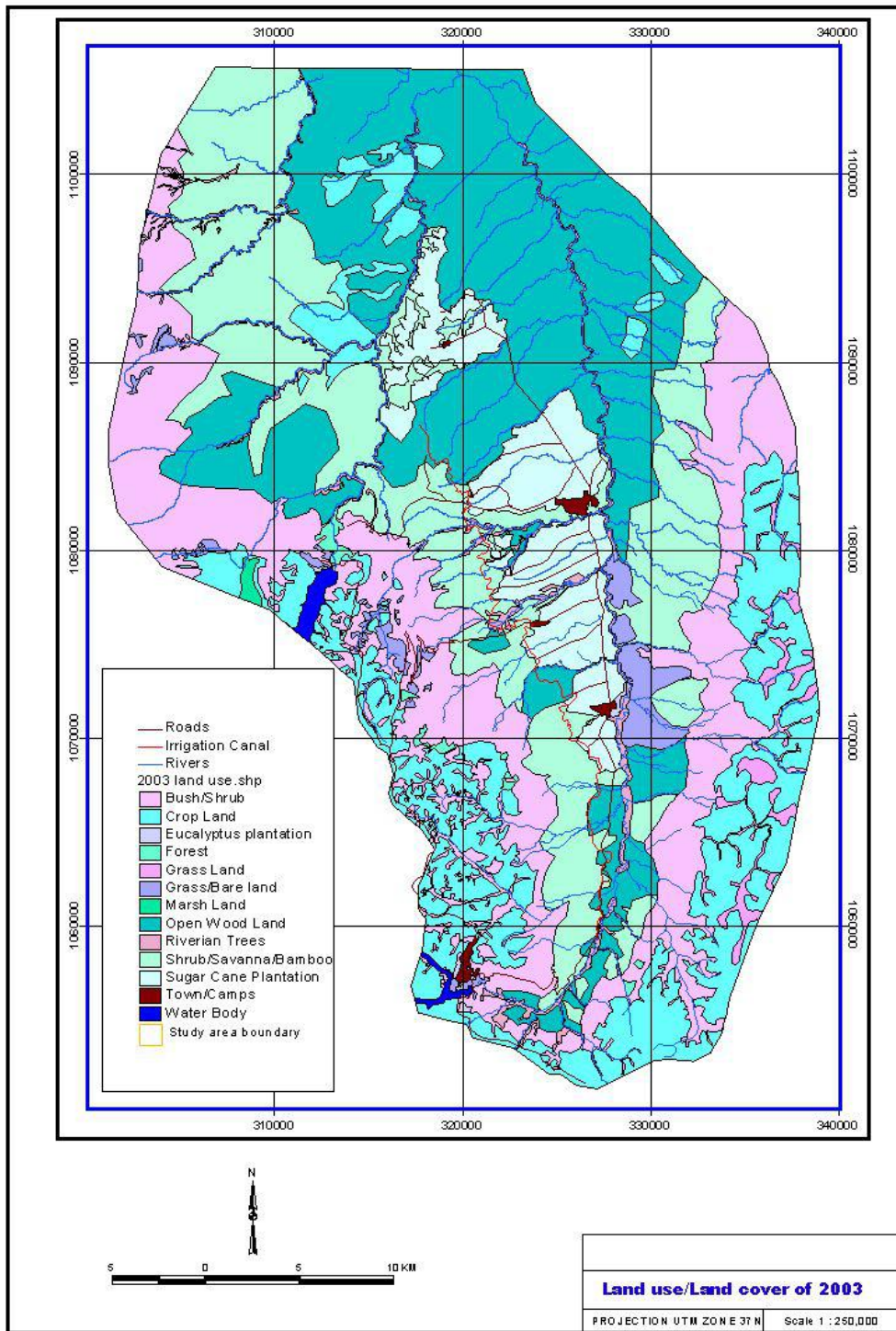


Fig 3.6 Land use/Land cover map of 2003

3.2 Other GIS Data Layer Preparation

3.2.1 Digitization of contour, drainage and boundary of the study area

Contours, drainages, roads and study area boundary are derived from topographic map of 1978 at scale of 1:50,000. Each topographic map was digitized separately to cartalinx spatial data builder software by using table digitizer. From each sheet six ground control points were digitized to register the topographic map to Utm-37north with RMS error of less than 3. Then contours with 20meter interval, drainages (rivers and lakes), and boundary of the study area were digitized and edited, and finally exported to arc view GIS software for further use.

3.2.2 Derivation of DEM and slope map

The digitized contours were used for DEM preparation by exporting Arc Gis-Arcifo8.3 as per demand of the subject. There, using Arcscen extension the DEM was prepared. The DEM is displayed using hill shade for it depicts more the topography of the area (fig2.2). Slope map was derived from DEM. The slope map in turn was used for vegetation change analysis (fig 4.5)

CHAPTER FOUR

4 Change Detection and Results

Obviously, there exist varieties of change-detection techniques ranging from visual comparison to detailed quantitative approaches (Wick ware and Howarth, 1981). Nonetheless; the complexities of natural characteristics of geographical territory cause difficulty to develop general method.

In this study four methods of change detection were assessed and a suitable method among them was selected.

4.1 *Image Differencing*

This method is simple and widely used method for detailed quantitative change detection. It involves subtracting a digital number of values from certain date of specified band from the digital number value of the same pixel in the later date. The subtraction results in positive and negative where change has occurred and zero where no change has occurred (Jensen 1996). The brightness values of the differenced images can be graphed usually following normal distribution where the brightness values that have not changed are located at the tails of the distribution (Singh 1989)). Accordingly, the change can be determined (indeed on the basis of the graph) by placing critical threshold between change and no change depending on standard deviation from the mean. But putting threshold is subjective (Jensen 1996). This method is advantageous in identifying subtle changes where as it is impossible to see from to changes and subjective to identify changes. This has been unsuitable for the theme under study and the reason is elaborated below.

4.2 *Image Rationing*

Image rationing is similar to image subtraction except that it uses division function and results are presented as grater than 1 and less than 1 where change has occurred and 1 where no change has occured. The changes are separated from those of no change in the same way as in the case of image subtraction.

The two methods, image rationing and differencing, were tried in this study but was found unsuitable. Evidently, the images are of different years, months and of different sensors (table1.1). From this it can be understood that these images were taken with different atmospheric conditions, sun angle, look angle of the sensor and etc. On the other hand, avoiding these differences, either absolutely or relatively, appears fruitless attempt, as reasoned out under section 3.1.2, regarding the study area. Evident is also the fact that images used in change detection should be normalized for atmospheric errors before change analysis unless the result of the change could be false (Yang and Lo 2000; Mas 1999). My study area is also by no means exceptional.

4.3 NDVI Image Comparisons

One of the most common vegetation indices is the normalized differencing vegetation index (NDVI). This technique was developed for identifying the health and vigor of vegetation and for estimating green biomass (Hayes and Sader 2001). The absolute value of the result will be between zero and one. The greater the amount of photosynthesizing vegetation present, the brighter the pixel will be (Jenson 1996). NDVI is calculated using the following equation:

$$NDVI = (NIR - RED) / (NIR + RED),$$

Where NIR = the near infrared band response for a given pixel,

RED = the red response

In this research the NDVI was used to get an over view of the vegetation biomass change over these periods for it indicates the amount of green vegetation which is important for land cover identification. The NDVI is calculated by using the above formula in Idrisi32 software. The result obtained ranges between 1 and -1. After production of three different NDVI images all of them were converted to 0-255 scale as presented on (fig 4.1, 4.2 and 4.3) Then statistics of each of The NDVI images were calculated (in table 4.1)

Type	Year		
	1972	1986	2003
Mean	90.2641	83.6036	77.6413
Standard dev.	69.2279	66.036	63.4556

Table 4.1 NDVI statistics

The statistics and visual observation of the NDVI images over the period show those decrements in vegetation biomass. The NDVI was used only for visual comparison and to aid classification. It is without atmospheric correction so that the result could be due to the addition of atmospheric conditions. As it can be visually compared the amount of green vegetation is falling .Nevertheless, on the 2003 NDVI images the center of the valley exhibit green vegetation. That is irrigated sugar cane plantation.

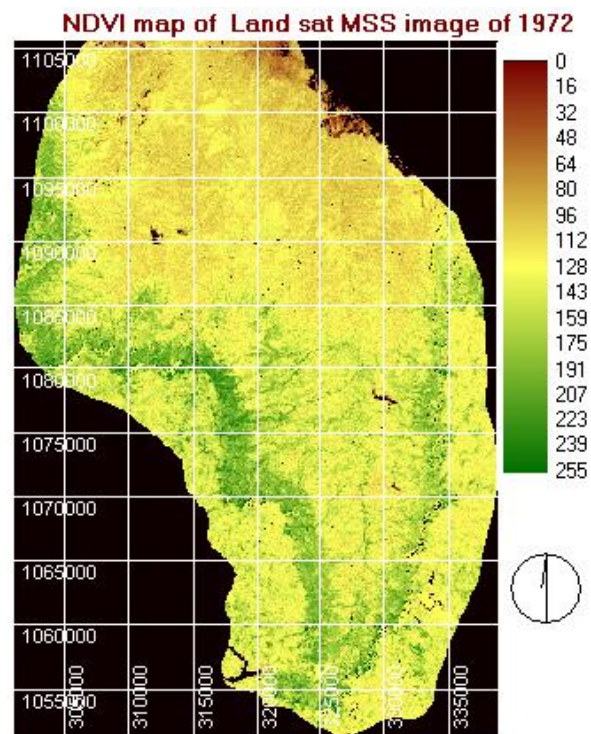


Fig 4.1 NDVI image map of 1972

NDVI map of Land sat TM mage of 1986

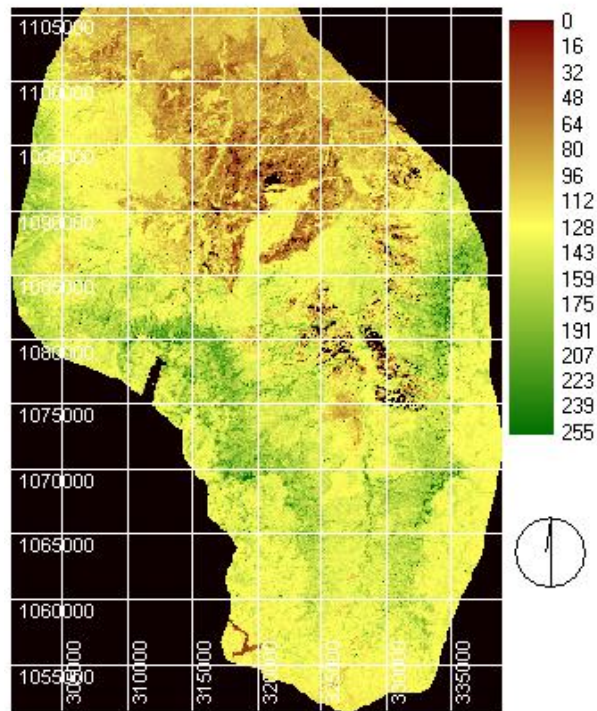


Fig 4.2 NDVI image map of 1986

NDVI map of Land sat ETM+ image of 2003

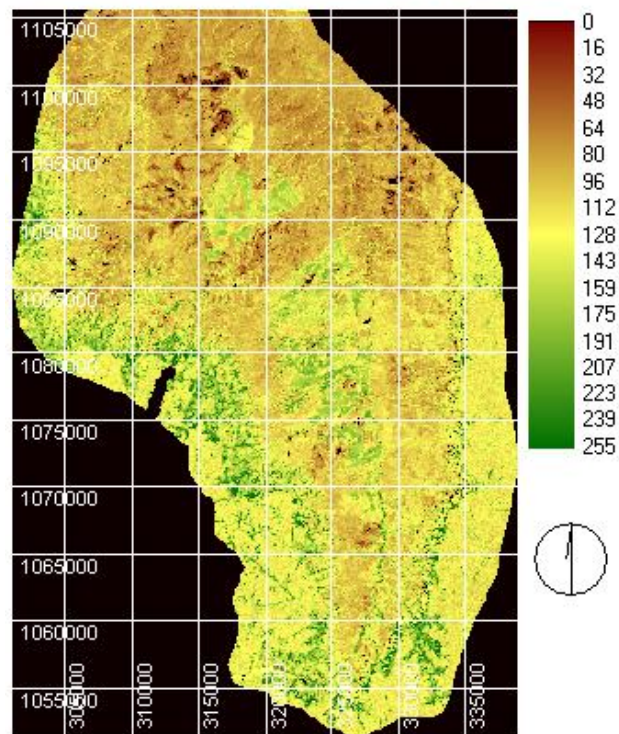


Fig 4.3 NDVI image map of 2003

4.4 Post Classification Comparisons

This method avoids problems encountered, in image rationing and subtraction, and needs both images to be individually rectified and classified before they can be compared pixel by pixel (Jensen 1996). This method provides to and from information and results in a base map that can be used for the subsequent year. It identifies where and how much change has occurred. However, producing change map on the method under discussion requires more guarantees and the ultimate change classification is only as accurate as the product of multiplying the accuracies of each individual classification (Howarth and Wickware 1981).

However, in the subject, the two aforementioned change detection methods use full for detailed quantitative results failed because of the difficulty of atmospheric corrections. Yet atmospheric correction is necessary only to a lesser degree for post classification change detection where multiple images are classified independently and the maps are compared to identify changes (Foody et al., 1996). Here is a sounding reason for selection of Post classification comparison as suitable for the study area.

The classified maps were rasterized and compared on pixel by pixel and the change matrixes was made showing the magnitudes and direction of the changes. The change matrix is presented (in table 4.2 and 4.3).

Land use Land cover Change matrix in between 1972-1986

Land use/cover of 1986	Land use/cover of 1972										
	Bushed Grass Land	Grass Land	Marsh Land	Crop Land	Water body	Bush/shrub	Open Wood Land	Forest	Riverian Trees	Total	
Sugar Cane Plantation	0	0	0	0	0	0	62.91	0	0	62.91	
Marsh Land	0	0	182.88	0	0	0	0	0	0	182.88	
Grass Land	0	1383.03	0	0	0	0	0	0	0	1383.03	
Bushed Grass Land	9486.81	0	0	0	0	0	0	0	0	9486.81	
Town/camp	0	0	0	0	0	50.49	86.22	0	0	136.71	
State Farm	0	0	0	0	0	0	3484.35	0	0	3484.35	
Forest	0	0	0	0	0	0	0	466.02	0	466.02	
Degraded Forest	0	0	0	0	0	0	0	4336.74	0	4336.74	
Open Wood Land	0	0	0	0	0	0	67225.32	1.98	0	67227.3	
Riverian Trees	0	0	0	0	0	0	0	0	2838.51	2838.51	
Water Body	0	0	186.93	162.72	167.85	16.92	0	0	0	534.42	
Crop Land	0	29.16	76.14	14544.27	23.4	1905.48	0	0	0	16578.45	
Bush/Shrub	0	0	2.7	0	4.41	29724.12	0	2.16	0	29733.39	
Total	9486.81	1412.19	448.65	14706.99	195.66	31697.01	70858.8	4806.9	2838.51	136451.88	

Table 4.2 Land use/land cover change matrix of 1972 and 1986

Land use Land cover change matrix in between 1986-2003															
Land use/cover of 2003	Land use/cover of 1986														
	Land_cover	Sugar Cane Plantation	Marsh Land	Grass Land	Bushy Grass Land	Town/camp	State Farm	Forest	Degraded Forest	Open Wood Land	Riverian Trees	Water Body	Crop Land	Bush/Shrub	Total
	Water Body	0	0	0	0	0	0	0	0	0	0	534.42	0	0	534.42
	Marsh Land	0	182.88	0	0	0	0	0	0	0	0	0	0	0	182.88
	Grass Land	0	0	1383	0	0	0	0	0	0	0	0	0	0	1382.94
	Crop Land	0	0	0.09	753.12	0	0	0	0	2436.9	0.81	0	16577.82	2905	22674.24
	Sugar Cane Plantation	62.91	0	0	0	28.08	1703	0	0	8063.4	5.76	0	0	0	9863.19
	Town/Camps	0	0	0	0	79.02	21.87	0	0	185.85	0	0	0	80.64	367.38
	Eucalyptus plantation	0	0	0	0	13.23	45	0	0	0	0	0	0	86.4	144.63
	Riverian Trees	0	0	0	0	0	0	0	0	0	2838.51	0	0	0	2838.51
	Shrub/Savanna/Bamboo	0	0	0	8733.7	0	257.5	0	58.86	19777	0	0	0	1139	29966.22
	Open Wood Land	0	0	0	0	0	0	0	0	35667	0	0	0	0	35666.73
	Forest	0	0	0	0	0	0	466	0	0	0	0	0	0	466.02
	Bush/Shrub	0	0	0	0	0	231.2	0	4218.93	712.89	0	0	0.54	24612	29775.6
	Grass/Bare land	0	0	0	0	13.05	1226	0	58.95	384.3	0	0	0.09	907	2589.12
Total	62.91	182.88	1383	9486.8	133.4	3484	466	4336.74	67227	2845.08	534.42	16578.45	29731	136451.88	

Table4.3; land use/land cover change matrix of 1986 and 2003

Land use /land cover(1972-2003)

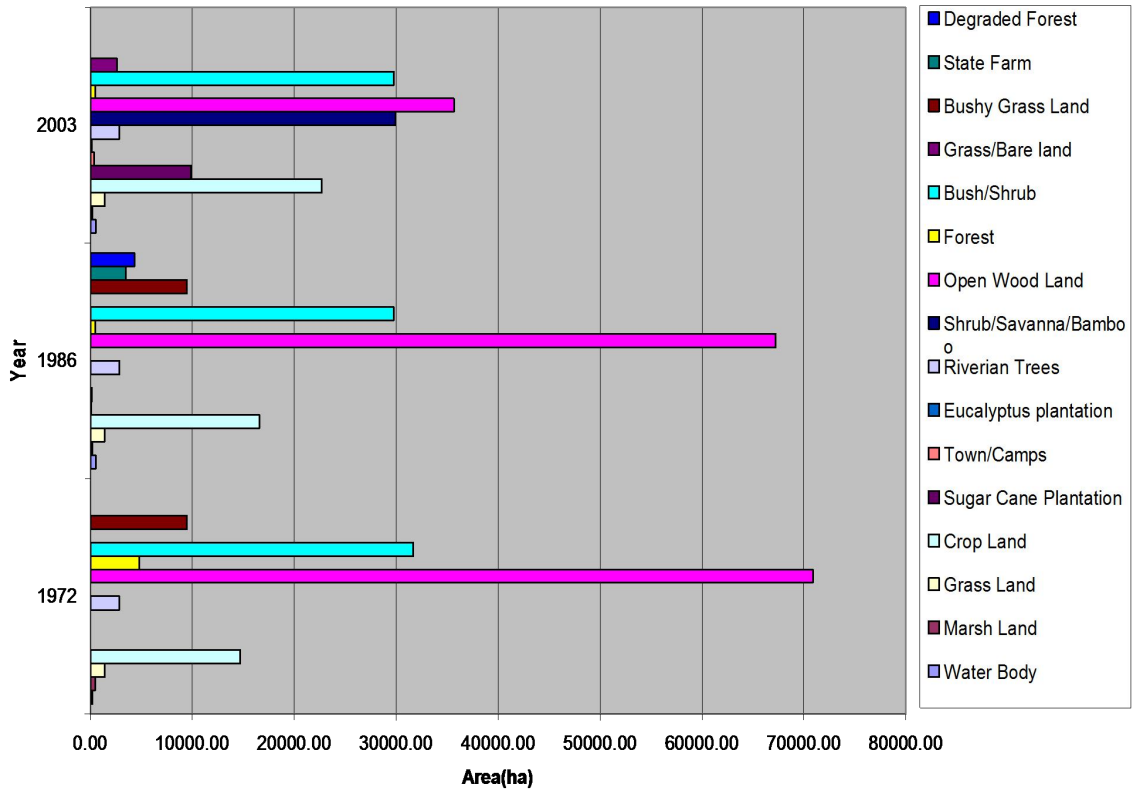


Fig 4.4 land use lands cover class (1972-2003)

4.5 Change analysis with respect to slope

Change analysis respective to slope has certain importance to deduce the implication that hat land use /land cover change may have. The analysis of land use land cover change in the study area was under taken in Arc Gis spatial analysis simply by cross tabulating. For discussion purpose I only Forest, Open wood land, Bush/shrub and crop land were considered. The analysis depicts results presented on tables (4.4, 4.3, 4.5, 4.6and4.7. What the result meant shall be discussed under the discussion part.

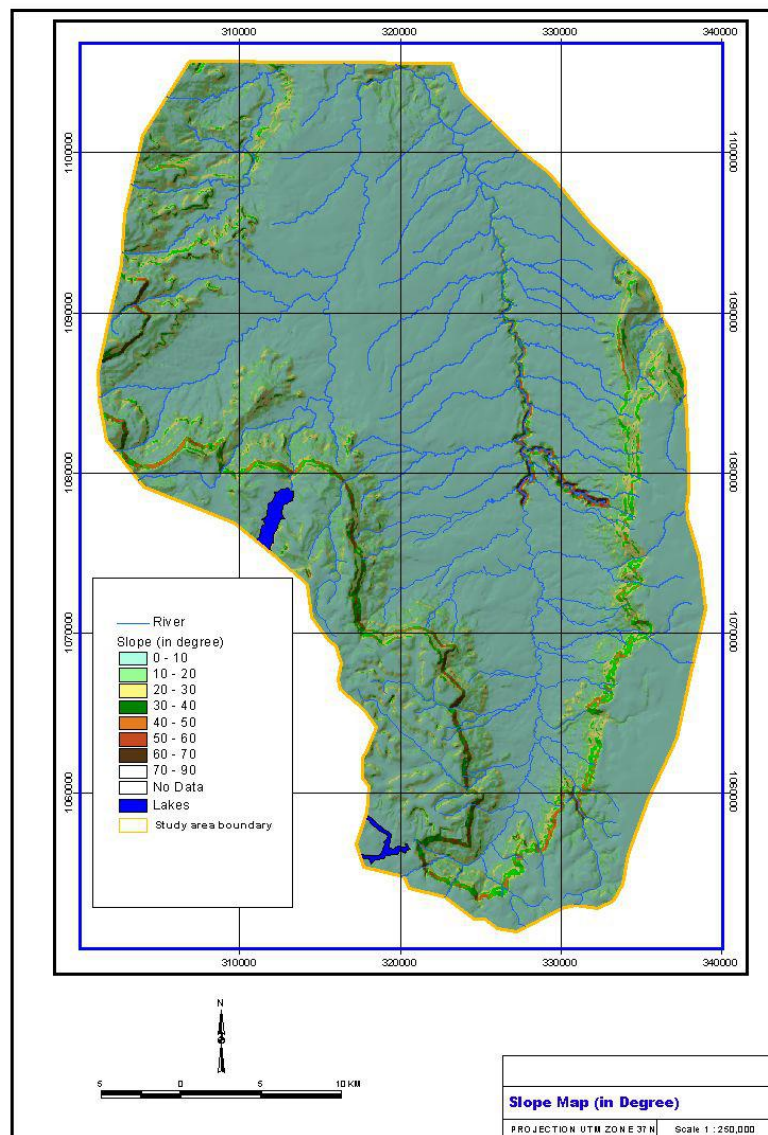


Fig 4.5 Slope Map (in degree)

Open Wood Land change With respect to slope(1972-2003)					
Slope Class	Years				
	Year			Change	
	1972	1986	2003	1972-1986	1986-2003
0 - 10	63301.59	59752.71	31365.63	-3548.88	-28387.08
10 to 20	4900.5	4856.49	2807.91	-44.01	-2048.58
20 - 30	1621.08	1608.39	999.45	-12.69	-608.94
30 - 40	612.36	600.21	358.2	-12.15	-242.01
40 - 50	242.1	232.02	102.87	-10.08	-129.15
50 - 60	132.84	122.49	34.2	-10.35	-88.29
60 - 70	52.38	49.68	2.07	-2.7	-47.61
70 - 90	5.31	5.31	0	0	-5.31
Total	70868.16	67227.3	35670.33	-3640.86	-31556.97

Table 4.4 amount of open wood land change on slope class

Bush/shrub Land Change with respect to slope(1972-2003)					
Slope Class	Year				
	Year			Change	
	1972	1986	2003	1972-1986	1986-2003
0 - 10	13891.86	12332.43	11700.18	-1559.43	-632.25
10 to 20	9396.72	9088.11	9260.73	-308.61	172.62
20 - 30	4645.62	4577.31	4804.74	-68.31	227.43
30 - 40	2336.67	2314.44	2468.79	-22.23	154.35
40 - 50	1067.04	1065.78	1160.64	-1.26	94.86
50 - 60	340.2	338.94	365.58	-1.26	26.64
60 - 70	16.38	16.38	15.3	0	-1.08
70 - 90	0	0	0	0	0
Total	31694.49	29733.39	29775.96	-1961.1	42.57

Table4.5 amount of Bush/shrub land change on slope class

Forest change with respect to slope(1972-2003)					
Slope Class	Year				
	Year			Change	
	1972	1986	2003	1972-1986	1986-2003
0 - 10	1768.59	65.43	65.43	-1703.16	0
10 to 20	1642.77	135.72	135.72	-1507.05	0
20 - 30	770.67	108.45	108.45	-662.22	0
30 - 40	365.49	77.49	77.49	-288	0
40 - 50	190.35	54.27	54.27	-136.08	0
50 - 60	65.97	21.51	21.51	-44.46	0
60 - 70	3.15	3.15	3.15	0	0
70 - 90	0	0	0	0	0
Total	4806.99	466.02	466.02	-4340.97	0

Table4.6 amount of Forest change on slope class

Crop land expansion with respect to slope(1972-2003)					
Slope Class	Year				
	Year			Change	
	1972	1986	2003	1972-1986	1986-2003
0 - 10	12984.75	14417.01	19689.39	1432.26	5272.38
10 to 20	1292.4	1630.98	2259	338.58	628.02
20 - 30	320.76	395.1	547.47	74.34	152.37
30 - 40	88.92	112.23	147.69	23.31	35.46
40 - 50	17.82	19.08	24.3	1.26	5.22
50 - 60	2.79	4.05	6.3	1.26	2.25
60 - 70	0	0	0.09	0	0.09
70 - 90	0	0	0	0	0
Total	14707.44	165784500	226742400	165769792.6	60957900

Table 4.7 amount of Crop land expansion on slope class

Rate of land use land cover changes

The rate of change was calculated for each land use land cover using the following formula:

$$\text{Rate of change (ha/year)} = (A-B)/C$$

Where A = Recent area of land use/ cover in ha.

B = Previous area of land use/ cover in ha.

C = interval between A and B in years

The result is presented using table and graph (Table7)

CLASS	YEARS			RATE OF CHANGE	
	1972	1986	2003	1972-1986	1986 -2003
Water Body	195.66	534.42	534.42	22.58	0.00
Marsh Land	448.65	182.88	182.88	-17.72	0.00
Grass Land	1412.19	1383.03	1382.94	-1.94	0.00
Crop Land	14706.99	16578.45	22674.24	124.76	338.66
Sugar Cane Plantation	0.00	62.91	9863.19	4.19	544.46
Town/Camps	0.00	133.38	367.38	8.89	13.00
Eucalyptus plantation	0.00	0.00	144.63	0.00	8.04
Riverian Trees	2838.51	2845.08	2838.51	0.44	-0.36
Shrub/Savanna/Bamboo	0.00	0.00	29966.22	0.00	1664.79
Open Wood Land	70858.80	67226.76	35666.73	-242.14	-1753.34
Forest	4806.90	466.02	466.02	-289.39	0.00
Bush/Shrub	31697.01	29733.39	29775.60	-130.91	2.34
Grass/Bare land	0.00	0.00	2589.12	0.00	143.84
Bushed Grass Land	9486.81	9486.81	0.00	0.00	-527.05
State Farm	0.00	3484.35	0.00	232.29	-193.58
Degraded Forest	0.00	4336.74	0.00	289.12	-240.93

Table4.8; Land use/land cover class and change rate (1972-2003)

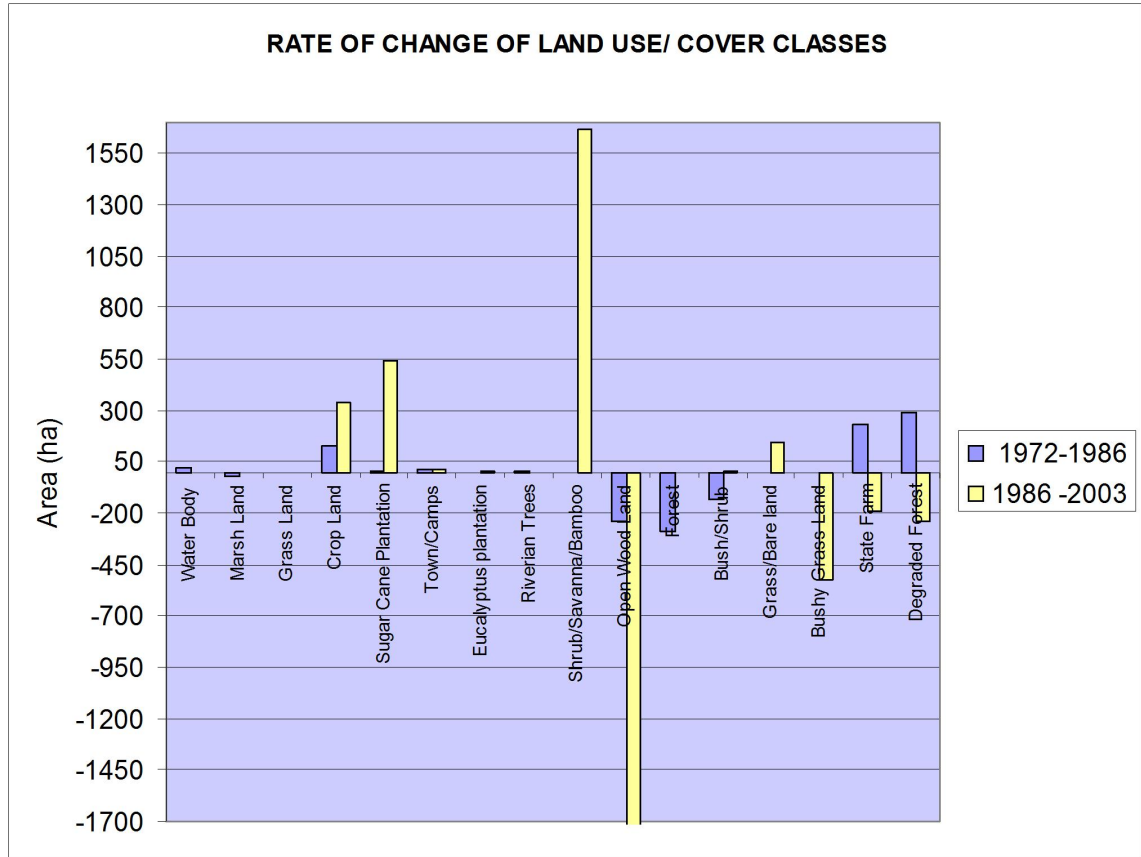


Fig4.6; Land use land cover change rates (1972-2003)

4.6 Discussions

This study assessed land use/ land cover change of Finchaa valley area by integrating GIS and Remote sensing techniques. Four different techniques are used, namely image differencing, rationing, NDVI and post classification comparisons. Image differencing and rationing is proved unsuitable for the study area. The reason is difficulty to avoid the atmospheric differences in the variety of data of images which may possibly generate false result. It is apparent from the study that the NDVI image comparisons were found better than the two above mentioned ones and employed for visual comparison. The NDVI images presented on fig4.1, 4.2 and 4.3 when compared visually depict decrement in vegetation. This is attested by mean value of NDVI (in table 4.1) which indicates decrements in vegetation as time went on. Although it fails to show subtle changes, post classification method was found suitable. On the basis of post classification

comparisons the result is discussed in this section of the paper almost certainly paying due emphasis on major changes.

Three of the classified land use/ land cover classes are presented on fig 3.4,3.5,3.6 showing 9, 13 and 14 land classes in 1972, 1986 and 2003 respectively. Between 1972 and 1986 three new classes of land use has emerged; namely state farm, sugar cane plantation and towns/camps. The establishment of the state farm on 3484.35hectars of land and 62.91hectares of sugar cane plantation were totally at the expense of open wood land. 133.38hectars of towns and camps were built on open wood and bush/shrub lands. Between 1986 and 2003 the land coverage of sugar cane plantation had enlarged to 9863.19hectars of land with rate of 544.46 hectares/year on wood land and on the deserted state farm largely as presented on (table4.2 and 4.3). This development noticeably indicates rapid dynamics of economic progress at expense of vegetation cover.

More to the point, crop land had increased increasingly from14706.99 hectares in 1972 to16578.45 in in1986 (table 4.2) with rate of 124.76hectars/year (table 4.8 and fig 4.6) and further increased to 22,674.24 hectares (table4.3) in 2003 with accelerated rate of change 338.66 hectares/ year (table 4.8 and, fig 4.6). The extension in crop land was by large at the outflow of bush/shrub land in between 1972 and 2003.But between 1986 and 2003 the expansion was at the outlay of other land cover type such as bushed grass land and wood land in additions to bush/shrub land. The expansion of crop land between1986 and 2003 into the heart of the valley, as can be seen on the (fig4.3) which were absent between 1972 and 1986(fig4.2) could be directly related to the establishment of Finchaa agro-industrial development for it increased accessibility in establishing infrastructures and the increments of settlers in the valley (cause of the change is described in reasonable detail in chapter 5). On the contrary, open wood land decreased from 70858.80 hectares in 1972 to 67226.76 hectares in1986 with-242.14 hectares/year rate of change and further decreased to 35666.73 in 2003 with rate of 1753.34 hectares/year. The change was induced by the transfer of open wood land to state farm by 3484.35 hectares, to towns/camps by 86.22 hectares and to sugar cane plantation by 62.9 hectares between 1972 and 1986.In between 1986 and 2003, 8063.37 hectares of open wood land was converted to sugar cane plantation, 19776.7 hectares was to shrub/savanna/bamboo, 2436.93 hectares was to crop land and 712.89 hectares was to bush/shrub land and the rest can be seen from (table 4.2 and 4.3).

Similarly, Forest was reduced in size from 4806.90 hectares to 466.02 hectares between 1972 and 1986 with rate of -289.39 hectares/year. But no change in forest coverage between 1986 and 2003. Rather the degraded forest was changed to other class of land use/ land cover as evidenced on (table 4.3 and fig 3.6). In the same way bush/shrub land decreased from 31,697.01 hectares to 29,733.39 hectares between 1972 and 1986 with -130.91 rate of change hectares/year.

In this same period 1905.48 hectares of bush/shrub land was transformed to crop land; 50.49 hectares to bushed grass land and to water body. The transformation of 16.92 hectares of bush/shrub land to water body was caused by the construction of Finchaa hydropower dam and Amerti dam which in turn resulted in the back flow of water. Buzayew and Strike (the fourth coming; 2005) analyzed in detail the impact the back flow of water caused by the constriction of Finchaa hydropower dam on the upper catchments of Finchaa water shade. In the year 1986 and 2003, on the contrary, bush /shrub land show increment from 29733.39 to 29775.60 hectares respectively with rate of 2.34 hectares per year. The reason was attributed to the conversion of 712.89 hectares of woodland; 4219 hectares of forest land and 231.2 of hectares of state farm to bush/shrub land (table 4.3). The development of bare/grass land was seen clearly in between 1986 and 2003 with total area of 2589.12 hectares.

With respect to rate of change, sugar cane plantation, crop lands, Bare/grass and town/camps are increasing. Bush/shrub showed negative rate of change (1972-1986) but positive in between 1986-2003). Where as wood land, and forest are decreasing alarmingly (fig 4.6 and table 4.8). This figure indicates that the variation in the land coverage was owing to increment in economic activities.

With respect to slope, the amount of change is so significant in the case of forest, open wood land, cropland and bush/shrub compared to the other class. The change on gentle and low slopes is obviously expected for it is important for agricultural activities. But what is feared is change on steep slopes. As can be seen (table 4.4) the amount of loss of Open wood land is increasing on steep slopes as time went on significantly. But in the case of bush/shrub land is increased positively between 1986 and 2003 on slope class 10 to 60 degree (table 4.5). That is because of the conversion of wood land and other class to bush /shrub land between the specified years

(Table4.3).Forest also exhibit the same change with no change between 1986 and 2003.The enlargement in crop land largely between 0-10 slop class, but with the passage of time it is also increasing on steep slopes.Forexample, in between 1972 and 1986 crop land on 74.34 hectares on 20-30 degree of slop increased to 152.37 hectares between 1986 and 2003 on the same slope (table4.7).The lose of vegetation and expansion of agriculture on such on such steep slop defiantly has negative implications on land. It triggers erosions, slide and etc.

CHAPTER FIVE

5 Causes and Implications of Land use Land Cover Change

5.1 Causes of Land use Land/cover change

This section presents causes of land cover change in the study area. The causes are directly related to such underlying factors as socio-economic activities, fire and poor environmental management and inseparably connected to one another. Each of these factors is discussed here under.

1. Fire

In the study area, fire can be taken as the main cause of vegetation degradation. Fire is not occasional phenomenon in this specific area. It is seasonal phenomenon which exists every year from December till early April (the beginning of rainy season). Accredited elders of the society state that, fire is initiated by local wild honey collectors, hunters, lumber producers, fire wood collectors and pole sellers to increase accessibility. Other informants, too, affirm that is also naturally caused. Moreover Incense collectors around Abay River are always torch fire. Most of the time, the fire comes from the north direction, low land, and gradually expands to the other directions. The dry savannah serves as fuel. In this Months fire reaches every place except river sides and on the tip of the escarpment and nearly all vegetation in the valley are burnt. This process eliminate of all florals, and leads to erosions of the top soil ideal for agriculture at the start of the rain. During rainy season savanna and fire resisting plants (plants with tick trunks) regenerate.

2. Economic Development in the Valley

Socio-economic development in the valley has passed through traditional economic activity before 1975 trough state farm in between 1975 and 1991 and agro-industrial development from 1991 onwards. But this by no means refers to ceasing of the traditionally surviving earlier farming, instead it expanded.

A. Pre-1975

Before this year there were indigenous inhabitants in the valley. The dwellers involved in activities such as herding cattle, collecting honey, and farming using traditional tools like hoe, axe and etc. Through this traditional farming they produce cotton, millet, maize, tef, nug, and sorghum and so on. In 1920s, the surrounding highland people were migrated to the valley due to drought prevalence in the high land. These people engaged in activities the same to the indigenous people. Both the migrant and the indigenous people have been torching fire to increase access in the valley for honey collection, charcoal production, hunting, timber collection and etc. This activity is still practiced. However, during this period the destruction of natural vegetation was not significant due to the fact that the number of population per unit area is very minimal. But it was found difficult to see any human activity like farming on Landsat MSS image of 1972. Only forest fire can be interpreted. This is one farm land can be mixed with fired places and it is difficult to differentiate both of them. Another reason is, according to the local elders, there are no settlement and significant farming in the valley in 1972. Death of cattle due to the prevalence of Trypanosomiasis (gandi) and death of people due to malaria pushed the settlers out of the valley before this year. The indigenous as well as the migrants were permanently settled on the surrounding highlands. However they go to the valley for wild honey collection, hunting timber collection and etc. even after they left the area.

B. Between 1975 and 1991

In 1975 state farm was established equipped with modern farm equipments such as tractors. This period can be taken as the beginning of high vegetation degradation in the valley. The state farm cleared vegetation for farm land, road construction, settlement and etc. This is clearly interpreted from Landsat TM image of 1986 (fig 3.5). In this period relatively huge number of people migrated to the valley from the nearby high land and other places either to work in the state farm or to provide services for the workers. Camps were built; activities which have been before 1975 increased alarmingly because accessibility was increased. Traditional irrigations along Fincha River and some of its tributaries are expanded in the valley, and this is a new development appeared with the state farm. The state farm stopped its activity and over handed to Fincha Sugar Industry Development in 1991.

C. Since 1991

From 1991 onwards the land was over handed to Finchaa sugar factory. The effect of the industrial development can be approached in two different ways.

- The factory cleared vegetation to construct infrastructures such as roads irrigation canal (43.3km), bridges, settlement and expansion of cane fields. In addition, the factory makes use of fire wood to produce quick lime and to start the processing plant. Furthermore; they fire cane to increase sucrose content and to accelerate harvesting process. But some times such fire escaped from cane field and fire vegetation. This is one obstacle to the forestry program in the valley. For instance in 1995/96 a total of 13.5 hectares of eucalyptus plantation burnt due to such fire (Department of cane plantation of FSF).
- On the other hand the opening of the industry attracted many people from the nearby high lands and from other parts of the country either to work in the factory or to give service like selling of prepared food, shopping, etc. This situation leads to 'illegal settlement' expansions in the valley. The life of all people settled in the valley is dependent on the valley vegetation for construction and fuel wood. The increment in population in the valley and the increment of returning lorries and cars to Addis to load sugar, increased the cost of fuel wood; charcoal and etc. Because of this some daily laborers do not want to work in Finchaa sugar factory for they can generate better income from sell of timber, charcoal and the like. In 1993, for example, about 50 individuals were collected from forest and employed in FSF to stop them from deforestation activities, but after a week, they left out of the work and back to their former activities (Zelege, 2003). This fact was feared by African development bank during the appraisal of Finchaa sugar factory cited in (ANUTECH pty 1994).

3. Legal and Illegal agricultural activities in the valley

Individual farming is not a recent history in the study area however; the intensity is accelerated recently. Before years the farming was not at large scale. It has been practiced by settlers in the valley and some farmers' from surrounding high lands probably for two reasons: due to the nature of the soil no need of adding fertilizer to the land and they will not pay land tax (personal

communication, 2005). On the contrary, at this time, a huge number of individual local investors are licensed to land around Nedi River on the western bank of Finchaa River by Jarte woreda. On the eastern of Finchaa River bank farmers are licensed to land around Hami and the like rivers by guduru woreda. All of these investors, except one company are, using oxen as means of production. They produce Sesame. According to the discussion with some factory managers and environmental department, the valley is totally under the concession of Finchaa sugar factory. But on contrary the woredas claim as the land is their property on these localities. And this is known to the regional investment bureau.

4. Failure of forestry and environmental protection programs

During the state farm there was no as such strict environmental management practice except timber collectors, charcoals producers... were caught by police men and penalized. But with the establishment of Finchaa agro industrial development, by the recommendations of African Development Bank (ADB), during the appraisal of Finchaa sugar factory, Department of Forestry and Environmental protection was established as one of the factory departments to keep the environment sustainable (ANUTECH pty 1994).

In reference to this recommendation, the forestry program has been started under the supervision of department of cane plantation in 1991 until the establishment of forestry department in 1994. In 1996 with the addition of environmental protection as one component, the department is renamed as Forestry and Environmental Protection Department (FEPD). Both Forestry and Environmental Protection components are working towards the same goal with interrelated different area of activities.

The environmental protection group has committee which consists of Forestry and Environmental Protection Department (FEPD) of FSF, and police force, agricultural development office, administrative office of the surrounding highland woredas. Their main objective is creating awareness among people through teaching; distributing seedlings for the surrounding highland people and penalizing the low breaking people (FEPD). But they haven't ever taught people to create awrnass. The seedling they distribute also is localized and not satisfactory. For example,

between 1996 and 2002 they distributed 236432 seedlings for 284 individuals, but there is no supervision with regard to the survival of the seedlings (FEPD).

The forestry program has two main objectives:

1. Planting multipurpose species such as *eucalyptus camaldus* spp. on shallow, eroded soils particularly on slopes and galleys (ANUTECH pty 1994).
2. Distribution of free fuel wood for valley settlers. It was scheduled in such a way that 2200 hectares of *eucalyptus camaldus* spp should have been planted within five years (1994-1999) by planting 500 hectares per year and 200 hectares in the last year. According to the plan free fuel wood distribution should have started since 1999 (ANUTECH pty 1994), but not yet started. Up to 2005 the program planted less than 200 hectares of survived *eucalyptus camaldus* spp (FEPD). This figure indicates that within 11 years they planted less than a year plan according to the proposal. The failure of the proposal could be due to the following reasons.

A. Prevalence of termite in the valley. Termite is serious on red soils than on black soils in the area. But the *eucalyptus* plantation is on red soil since the black soil is devoted for cane plantation. For instance, in the year 2000, on one plot about 83607 seedlings planted on red soil, 79.53% were attacked by termite (FEPD of FSF) whereas on other plot (black soil) 2809 seedlings only 14.7% was attacked by termite.

B. Indigenous plants are ignored, but there are species which can even survive on termite mounds.

C. Local conditions were ignored during proposal to plant *eucalyptus* species. The recommendation was made based on the comparisons between Bako and Finchaa valley by considering soil, rainfall and altitude without considering other factors such as termite.

D. Fire. The survived *eucalyptus* plantations are attacked by fire every year.

E. Lack of budget and both skilled and non skilled labor hinder the program not to work according to the plan.

5. The construction of Finchaa hydropower dam in 1973

Buzayehu and strek (forth coming) assessed the impact of Finchaa hydropower dam on land use land cover using GIS and remote sensing techniques. It is explained as the construction of the dam led to creation of lake, which takes the land of farmers. This resulted in forced migration of settlers to hillsides with their cattle. There, the new settlers cut tree for construction, clear forest and bush land for agricultural land and grazing also there. Consequently, settlers' vicinity to the valley is forced to cut trees on the steep slopes of the valley escarpment for construction and farm tools. And also started such economic activities, hunting wild life and wild honey collection in the valley.

From all these arguments it can be deduced that there is inter action in between the surrounding high lands (inward) and the valley (out ward) shrinking the vegetation cover.

5.2 Implication of land /use land covers change

Land use/ land cover change has several implications on land climate wild life and etc.The study area experienced several changes with land use land cover change. The implication of land use land cover change was described based on observation.

- 1. Implication for land:** The removal vegetation obviously has implication on land. In the study area areas affected by erosion are observed (fig5.1).The impact Erosion is hazardous particularly during the start of rainy season for the land is nearly bare because of the prevalence of fire during dry season. As can be observed from (fig5.2) the escarpment is totally bare. And at the same time the high lands are dominated by uncovered crop lands. Hence, during the start of rainy season, the flood come from the high land is distractive for the valley. It seems on the other hand the valley get benefit from the deposing of soil eroded from the highland (it needs to be studied). But to the level of this study, the impact is justified by; Gravels and small stones are frequently deposited around and under brigs and cause over fellow of water and course transportation problem. Land slide on the escarpment also an other example on (fig5.3)

occurred in the summer of 1998. Gullies are observed along river banks, sugar cane fields and in crop fields during field work.



Fig5.1 Photograph showing land affected by soil erosions (Zelege, 2005)



Fig5.2 Photograph showing escarpment of Finchaa valley affected by fire (Zelege, 2005)



Fig5.3 Photograph showing land slid on escarpment of finchaa valley (Public relation of FSF, 1998 Cited in Zeleke, 2003)

2. Implications for wild animals

Vegetation is home for wild animals. In the study area local elder's wittiness that Finchaa valley endowed with such animals Lion, Elephant, Wolf, Boars, python.and so on. Due to the prevalence of a given animal, names of places were adjoining to that particular wild animal. A typical example could be 'Gogoldas' which is located near to the main town of FSF was termed as house of lions (Manna leencaa).

But according to elders and hunters, these animals are not frequent in the area now. Elephant was totally disappeared and the rest are being drained out of the area. These are not only due to vegetation degradation but also the agro industrial development hunt these animals for they attack sugar cane plantation. For instance in the year of 2001/2002 the authorized persons by the industry killed about 412 baboons (department of cane plantation of FSF, 2002).In additions, the irrigation canal is one which claims the life of many wild animals. It takes place

when wild animals get in to the canal either to drink water or to cross it but failed to get out of it. In 2002 about 46 animals including Baboon, smaller antelope, Boar and hyena were founded dead in the irrigation canal (Irrigation department of FSF).Fig45.4 shows that smaller antelope victim of the incidence.



Fig5.1 Photograph showing smaller antelope in Irrigation Canal (Public relation of FSF, 2000)

1. Implication for plant species and other biodiversities

In the study area important plant species are disappearing. Fore example; 'Wadessa' (*Cordia africana*) which has been the most important tree for lumber production in the area is now observed around villages only. Three wood work shops were visited during field work and there was no lumber from this tree species and the next important tree species 'Muka booke' (*entada abyssina*) is also decreasing, according to the wood workers. Micro organisms which are attached to vegetations, important in keeping soil fertility are lost with removal of such vegetation.

CHAPTER SIX

6 Conclusion, and recommendations and suggestions

6.1 Conclusion

This study assessed land use/ land cover change of Finchaa valley area by integrating GIS and Remote sensing techniques. Remote sensing in providing information with regarded to land use land cover and GIS for analysis (change detection) are Best methods for the study area. With respect to methods, four different techniques are compared, namely image differencing, rationing. Image rationing and image differencing are proved not suitable for the study area. NDVI is found better for visual comparisons and post classification comparison is proved the best method for the study area.

Based on NDVI mean value and visual comparisons vegetation biomass is generally decreasing.

Based on Post classification comparisons, All Vegetation type's covers are generally decreased with accelerated rate of change except forest and bush/shrub in between 1986 and 2003 no change and increment respectively. Enlargement in crop land, Bare/grass, and agro industrial expansion is increased with accelerated rate of change at the expense of other vegetations. The lose of vegetation on steep slops and enlargements of croplands on the same slop is increasing as time went on with its implication on land. The causes are directly related to such underlying factors as socio-economic activities, fire and poor environmental management and inseparably connected to one another. The change has negative implications on land and other biodiversities.

6.2 Recommendations and suggestions

Suggested further studies

- Satellite images with high resolution/Air photos should be experimented to detect subtle changes in land use land cover change in the study area
- Study on soil erosion and flood hazard with its implication on industrial development in Finchaa valley.
- Study on social change.

Recommendation

- The strategy of department of forestry and environmental protection should be re evaluated by giving emphasis on:
 - Implementations
 - Labors
 - Local community
 - Budget allocations

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