



ASSESSMENT ON THE RATE OF DEFORESTATION ,AND ITS DRIVERS AT ZEQUALA
(CHUKALA) MOUNTAIN

BY

MEKONNEN YIRDAW BUTA

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WONDO GENET, ETHIOPIA

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HIGHLAND OF ETHIOPIA AT ZEQUALA (CHUKALA) MOUNTAIN*

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MEKONNEN YIRDAW BUTA

MAIN SUPERVISOR

Dr. MERSHA G/HIWOT

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ADVISORS' APPROVAL SHEET-I

This is to certify that the thesis entitled “Assessment on the Rate of Deforestation, and Degradation and Its Drivers at Central Highland Forests of Ethiopia at Zequala (Chukala) Mountain ” submitted in partial fulfillment of the requirements for the degree of Master of Science with specialization in Forest resource assessment and monitoring of the graduate program of the Department of Forestry, Wondo Genet College of Forestry and Natural resources, and is a record of original research carried out by Mekonnen Yirdaw, under my supervision, and no part of the thesis has been submitted for any other degree or diploma. Therefore, I recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the department.

Name of major advisor

Signature

Date

Dr.Mersha G/Hiowt

Name of co-advisor

Signature

Date

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We, the undersigned, members of the Board of Examiners of the final unprotected defense by Mekonnen Yirdaw have read and evaluated his thesis entitled “Assessment on the Rate of Deforestation, and Its Drivers at Central Highland Forests of Ethiopia at Zequala (Chukala) Mountain” and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirements for the degree of Master of Science in Forestry in Forest resource assessment and monitoring.

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TABLE OF CONTENTS

ASSESSMENT ON THE RATE OF DEFORESTATION ,AND ITS DRIVERS AT ZEQUALA (CHUKALA) MOUNTAIN.....	I
ADVISORS' APPROVAL SHEET-I.....	I
EXAMINERS' APPROVAL SHEET-II	II
ACKNOWLEDGEMENT	III
LIST OF TABLES.....	VII
LIST OF FIGURES	VIII
LIST OF ABBREVIATIONS.....	IX
ABSTRACT.....	X
CHAPTER ONE.....	1
1 INTRODUCTION	1
1.1 Back Ground and Justification.....	1
1.2 Statement of the problem.....	3
1.3 Objective.....	5
1.3.1 General objective	5
1.3.2 Specific objective.....	5
1.4 Research Question	6
1.5 Significant Of The Study	6
1.6 Scope of the Study	7
CHAPTER TWO.....	9
LITERATURE REVIEW	9
2.1 Forest cover and deforestation.....	9
2.2 Causes of Deforestation and Degradation	10

2.3 Effect of Deforestation and Degradation.....	12
2.4 Remote Sensing and GIS.....	14
2.5 Vegetation identification.....	15
2.6 Accuracy Assessment.....	16
CHAPTER THREE.....	17
MATERIALS AND METHODS.....	17
3.1 Back Ground and Location of the Study area.....	17
3.1.2 Population.....	18
3.1.3 Natural Resource.....	18
3.2 Data and Source of Data.....	19
3.3 Data Collection Techniques.....	20
3.3.1 Requisition of Satellite Image.....	20
3.3.2 Ground Truth Observation and Collecting Picture.....	21
3.3.3 Interview and Questionnaires.....	21
3.3.4 Secondary Data Collection Technique.....	21
3.5 Data Analysis.....	22
3.5.1 Image pre- processing.....	22
3.5.2 Image Classification and Mapping the Study Area.....	23
3.5.3 Accuracy Assessment.....	24
3.5.4 LULC_ Change Detection.....	25
3.5.5 Interview and Questionnaires.....	25
3.5.6 Secondary Data.....	26
4.3 Driver of Deforestation and Degradation of Forest of Mount Zeuqala.....	44

4.4 Effect of Deforestation and Degradation of Zequala Mountain Forest	46
CHAPTER FIVE	49
5. CONCLUSION AND RECOMMENDATION.....	49
5.1 Conclusion	49
5.2 Recommendation	51
REFERENCE.....	53
APPENDEX.....	58

LIST OF TABLES

Table 1: Image requested from internet.....	20
Table 2: Description of land cover classes distinguished in the study area.....	24
Table 3: Zequala mountain LULC supervised classification 2000.....	29
Table 4: Zequala mountain LULC supervised classification 2011.....	31
Table 5 : Zequala mountain LULC supervised classification 2017.....	32
Table 6:overall accuracy and kappa coefficient.....	33
Table 7: Zequala mountain from2000-2017 LULC.....	33
Table 8: Zequala mountain LULC change matrix.....	36
Table 9:summery of detection matrix.....	38
Table 10; (source) Hiruy Simie June, 2007.....	39
Table 11; deforestation rate in Africa.....	44

LIST OF FIGURES

Figure 1 Map of the study area.....	17
Figure2: Flow chart of the study.....	22
Figure 3 Zequalla mountain LULC 2000 map.....	28
Figure 4; LULC classification and map of the study area 2011.....	30
Figure 5: zequalla mountain LULC 2017 map.....	32
Figure 6: Zequalla mountain from2000-2017 LULC change graph	34
Figure 7: Zequalla at the top of the mountain where high and dense junipers dominant forest are found.....	40
Figure 8: The farmer on the top of mountain cultivating spices.....	44
figure 9: Degraded secondary forest of zeuqala mountain and the land around this forest, one side view.....	48
Figure 10: Growing Adulala woreda near this forest view from mountain.....	49

LIST OF ABBREVIATIONS

CC	Cubic Convolution
ETM	Enhance thematic mapper
FAO	Food and Agriculture Agency
FCC	False composite color
GPS	Geographic Position System
IPCC	Intergovernmental Panel on climate change
LULC	Land Use / Land Cover
MEFCC	Minister of Environment, Forest and Climate Change
MSS.	Multi spectral scanner
NASA	National Aeronautics and Space Administration
NIR	Near infra- red
REDD+	Reducing Emissions from Deforestation and forest Degradation
SWIR	Short Wave Infra-Red
UNFCCC	United Nations Framework Convention on Climate Change
LPGS	Level Product Generation System
UTM	Universal Transverse Mercator
VCS JNR	Verified Carbon Standard, Jurisdictional and Nested REDD
WGS	World Geodetic System
IPCC	International Panel Climate
FDRE.	Federal Democratic Republic of Ethiopia
USGS	United Stat Geology Survey

ABSTRACT

The aim of this study was to assess the rate of deforestation and its drivers at central highland of Ethiopia with special reference to zequala (chukala) mountain over the last 17 years (between 2000 and 2017). To investigate deforestation, LULC change of this area using satellite image data of Landsat loaded from internet and processed using GIS tools. Then the study area had been classified into four major LULC using satellite image of 2000, 2011 and 2017 and GIS tools, those LULC are water body, dense forest, farm and settlement, and degraded forest. After LULC classification, changes have been compared using data of image 2000, 2011 and 2017 to get deforestation magnitude within the given time. The results of supervised classifications of LULC change of these areas in 17 years from 2000-2017, those dense forests decline by 8.46 hectares, and disturbed forests decline by 1690 hectares and change to farm and settlement. In reverse, farm land and settlement increase by 1721 hectares within 17 years may be related with these LULC changes, water body decrease by 23.4 hectares. The main causes of this deforestation are expansion of farm land, exploitation of forest for fuel and charcoal production and also wild fire and lack of people's legal utilization decision authority on this forest is another cause of deforestation, and forest degradation at this study area. So, to minimize and stop deforestation and forest degradation, people should participate in utilization and decision and also the attitude of the people should be changed to be able for sustainable development of forest and utilization, specially farmers should adapt planting trees for their utilization and facilitate regeneration of this forest by stopping exploitation and use grass in the forest by cutting and carry system to feed their cattle, because cattle should not trample regenerating seedlings.

Key words;- Land use land cover, deforestation, forest degradation, Zequala mountain forest, remote sensing and GIS

Mekonnen Yirdaw. June, 2018

CHAPTER ONE

1 INTRODUCTION

1.1 Back Ground and Justification

Deforestation is the conversion of forest land from forest into other land uses such as agriculture, settlement, mining etc., with the assumption that forest vegetation is not expected naturally re grow in that area or the long-term reduction of the tree canopy cover below 10% .(Noriko, Hosonuma, et.al, 2012).According to the above description deforestation is change of land use from forest to other land use. In other cause, FAO,(2002) says that forest degradation is the reduction of the capacity of a forest to provide goods and services.

To study deforestation, assessing and investigating LULC-change using satellite image data and GIS tool is preferred method as Land use and land cover change (LULC) refers to human modification of the terrestrial surface of the Earth. This is because LULC is dynamic and data of satellite image taken at different period can show these changes.

As with many regions characterized by developing countries, the relationship between population growth and poor agricultural practices drivers of deforestation, loss of biodiversity, and habitat fragmentation specially at the local level, agricultural expansion, infrastructure development, overgrazing, and unrestrained fuel wood and timber harvesting directly impact forest degradation (Profor, 2012). This is because most of developing countries people live around forest depend on forest and forest product.

Deforestation can play a role in both global warming and cooling, and it also lead to reduction in biodiversity, disturbed water regulation, and the distraction of the resource base and livelihoods for many of world's poorest (William, 2003).

Depletion of forests and their degradation “are a threat to global ecosystem and diversity and have fundamental influence on the declining standard of living of many households.” (Els bogenetteau, *et al*, 2006).

According to world resource institute (2016) global tree loss reach recorded 29.7 million in 2016 which is 51% loss equal to an area of New Zealand. But in tropical Africa the previous deforestation during past century since 1900 was 55% decline to in average to 21.7% in 2016. But deforestation rate is different from place to place, so still in east and west Africa the deforestation rate is high reach up to 80%.(The conversion deforestation in tropical Africa 2016). From the above evidence deforestation in Africa as general show improvement but in some region still deforestation is a great problem.

Forest is very important for human being, it use for fuel wood and charcoal production, timber and construction material and by conserving soil and water, protect land from degradation and keep the fertility of the land to get good production and provide food for animals, it is source of medicine, food and home of fauna and floras (biodiversity). It regulates ecology and provide service.(ITTI 2000)

But this use full and determinant forest for human and all living things are deforested and degraded globally and locally as above indicated, in 2006 only in Ethiopia about 45,055km² forest land had been deforested and many forest degraded extremely.

Deforestation impact on sequestration of carbon ,as deforestation increase sequestration of greenhouse gas specially carbon decrease which cause increase of concentration of greenhouse gas in the atmosphere. This global and local deforestation problem what has been observed at the study area Zequala mountain as stated above.

There are many causes of deforestation and forest degradation in the world, some and mains of these, agriculture expansion ,urban construction development, mining and infrastructure (William,2003).The main cause of deforestation in tropical is expansion of farm land ,because of demand of farm land many forest land have been deforested and degraded and changed in to farm land(Gibbs *et al*2010).

Deforestation and forest degradation the problem clearly observed at the study area (mount Zequala) Just like tropical countries and other part of Ethiopia there are high deforestation and forest degradation in cause of agriculture land demand, and for fuel wood and charcoal production (Berhane and Agajie, 2006).

The major cause of deforestation is rapid population growth, which leads to an increase in the demand for crop and grazing land, wood for fuel and construction.(Million Bekele, 2001).

Deforestation and degradation of the forest is detected in land use land cover change, by latest, remote sensing data and GIS tool to analysis this data which collect information from the earth without direct contact with the object.

Information derived from remote sensing particularly in the form of land-use/land covers mappings, forest land changes and rate of deforestation is essential to detect changes, predict as well as monitor the results and useful for rational planning activities , (Majid, Humayun and Hellden ,2010)

1.2 Statement of the problem

Currently depletion of forests and their degradation “are a threat to global ecosystem diversity and have fundamental influence on the declining standard of living of many households.” (Els bogenetteau, *et al*, 2006).

Because trees are the most important component that help to create unique environment, they support various kinds of animals and plants by purifying and cooling the air and control the climate. Not only these, forest is home of wild life, source of drug and wood product and also gives ecological services by regulating weather and protection of erosion and siltation. However, forest is very essential for human being and also for all living things as described above, but deforestation and forest degradation are a current global challenging problem.

Deforestation is the removal of trees from lands covered by forests. It is caused by rapid population growth, settlement urbanization, farm expansion, grazing land demand, and etc(Noriko Hosonuma,el.al 2012).

Deforestation and degradation has negative impact on natural environment and human being. It decreases the capacity of forests to provide goods and services for human being globally in general, and particularly in developing countries. So forests should be protected and managed wisely and economically in sustainable manner as forest is raw materials for industrial product, source of energy and also provide many ecological service and also protect natural resources degradation. (Knox and Marston, 1998)

Deforestation has also been noted to contribute tremendously to long-term environmental consequences like global warming, biodiversity loss and soil degradation (Mahapatra and Kant, 2003, p.2) as well as increased poverty in forest fringe communities. Based on this analysis, deforestation posits a challenge for the practice of sustainable forest management, Accompanying with deforestation land degradation is high on national and international agendas. but still poses a large challenge at the global and local level, as is the case in Ethiopia. (Bongers, F., & Tennigkeit, T., 2010).

And specifically at the study area mount Zequala there is high deforestation and degradation of forest. Related to this there is degradation of biodiversity and soil fertility just a common problem in the world (global problem) that lead to desertification and poverty specially in developing countries. In this study area there is a limitation of information and the government bodies working at this woreda have good interest to conserve this forest, but shortage of information and knowledge gap to develop, conserve and utilize in sustainable manner. So why we needed to assess the magnitude and rate of deforestation and to find the driving force of this deforestation and degradation of the selected study area mount Zequala and to suggest possible solution to manage and minimize the problem.

1.3 Objective

1.3.1 General objective

To identify the trend of forest cover change and causes of deforestation and degradation of Zequala mountain and suggest possible solution

1.3.2 Specific objective

- To Identifying the trend and rate of deforestation
- To produce map of LULC change of three period 2000,2011 and 2017 to be able to investigate deforestation rate
- To investigate case and driver of deforestation
- To suggest possible solution

1.4 Research Question

This research was designed to answer the following questions:

- What is the pattern and rate of forest cover changes in Zeuqalla mountain
- What are the driving forces of forest cover changes
- What is the possible solution of deforestation and degradation for forest

1.5 Significant Of The Study

According to William (2003) and FAO (2015) the problem of deforestation has become a global issue .because deforestation has great impact on global warming and cooling and also all biodiversity and human life affected by deforestation and degradation.

.Based on this, in Ethiopia where most of the population depends on farming and animal husbandry The population is increasing rapidly and related to this cause of demand of farm land and grazing land, deforestation is expanding. Therefore, the study on deforestation and degradation of forest is very important.

This study therefore could have the following contribution to the concerned issue :-

- I. provides information about this local area concerning about deforestation problem to whom all interesting individuals, organization and governmental body to be able recognize and take measure.
- II. Indicates how the increment of population, urbanization and expansion of farm lands causes deforestation and helps to give awareness.
- III. To be able to provide information to whom interested body to plan and implement sustainable development and utilization of forest

- IV. Policy makers should know and understand the rate of deforestation and degradation of the remaining little forest to draft policy that enable to develop, protect and utilize in sustainable manner.
- V. May give Clue to other researchers who are interested to do further research on this area.

1.6 Scope of the Study

Deforestation and forest degradation is a global and local problem of this century, so to get solution for this problem primarily studding the magnitude and causes of this problem is necessary , especially in developing countries where there is shortage of information.

However this information of deforestation is necessary to all concerning individuals, organization and governmental bodies, and at different level (country, continental and global level) needed, it is not possible to study problem allocated in all place and level, because of limitation of time, budget and knowledge as the extent of the problem is so vast. So from this point of view this study limited at local level specially at zequala mountain forest.

The aim of the study was only on assessment of deforestation and forest degradation and it's drivers at Zequala mountain within the last 17 years (2000-1017) . In order to get deforestation rate, the study was concern examining the magnitude of LULC change of this mountain area .The study took place using satellite data and GIS tools to get deforestation and degradation rate by LULC classification method and by analysis of LULC change of different period. The land was classified in to , 4 major LULC, those are water body, dense forest, farm and settlement, and degraded forest.

In these classification settlement, farm land and small grazing grass land in the forest included in to agriculture land and took as one LULC class with agriculture land because scattered country side house and small open grass land in forest insignificant to identify.

The investigation of LULC change of this area is target to gate the magnitude and the rate of deforestation and forest degradation of this area. So, as deforestation effect all livelihood of human being this magnitude of deforestation known by this research gives awareness to all concerned individuals, government, organizations and clue to interested researcher to investigate more.

CHAPTER TWO

LITERATURE REVIEW

2.1 Forest cover and deforestation

Deforestation is the permanent destruction of forests in order to make the land available for other uses. Gorte and Sheikh(2010) And Forest degradation refer to redaction of the capacity of forest to produce goods and services (ITTO, 2002). Reduction of the capacity of the forest is destruction of ecosystem structure and function (ITTO, 2005)

Degraded forest land is former forest land severally damaged by the excessive harvesting of wood and or none wood forest product, by poor management repeated fire ,grazing and other disturbance or land use that damage soil and vegetation to degree that inhibits or severally delays the re-establishment of forest after abandonment (ITTO,2005)

Forest provide a wide range of ecosystem service ,produce oxygen which is very necessary for all living things and provide fresh water and regulate water regime, protect soil from erosion ,capture and store carbon help to reduce carbon risk , commonly in the tropic produce wood and none wood forest product (ITTO,2002)

Many people in the world whole in whole or partially depend on forest for their life. It is estimated that approximately 60 million indigenous people are wholly depend on forest (World bank,2004). Other than this for high degree of subsistence and income 350 million people depend on forest and similarly about 1.2 billion people rely on agro- forestry farming system (Secretariat of the convention on biological diversity, 2009)

The great problems are these use full forests are deforested and degraded extremely in the world, but it is observed the rate and extent of deforestation varies among continents, countries, regional and local boundaries (FAO, 2005, p. viii).

Specially in tropically developing countries where there are high biodiversity and this forest home of many biodiversity and has high value, the degree of deforestation and degradation is high. The most recent assessment of global rate of deforestation is approximately 13 million hectares per year (FAO 2005). At the same time, the net loss of forest has decreased since the last assessment, from 8.9 million to 7.3 million hectares lost per year (FAO 2005).

Only in Africa in the last two decades. Between 1990 and 2000, the continent lost about 52 million ha of forest, which accounts for 56 percent of the global reduction in forest cover (FAO, 2003, p.8). It is stated for that period, the continent experienced an average forest cover loss of 0.8 percent which was higher than the world average of 0.2 per cent (FAO 2005).

In a forest resource assessment of Ethiopia with in 1973_1990 the high forest of Ethiopia reduced from 54,410 to 45,055 km² land area 4.75 to 3.96% land area, this indicate that deforestation per year is 163000 ha (FAO, 2007)

2.2 Causes of Deforestation and Degradation

Causes of deforestation and degradation may be categorized broadly into anthropogenic and natural. In most cases the anthropogenic causes are often easily identifiable probably because of the increasingly recognition of human footprints on the earth's system (McCarthy, 2009). It is important to note the human drivers of environmental change (deforestation) vary in nature and scope but can be broadly grouped together as economic, conflict and governance, demographic, social and science and technology (UNEP, 2006).

Deforestation is rapidly increasing in tropical developing countries, the main reason of this is the increasing number of population cause demand of agricultural land and energy.

Also at this area the development of industry becoming one cause of deforestation and degradation , because when industrialization expand demand of land for urbanization and extensive farming increase.

From all of above indicated causes, agricultural expansion has been determined as the key driver of deforestation in the tropics (Gibbs *et al*2010). In addition to agriculture expansion demand of wood industry (logs exploitation) and high demand of energy are other causes of deforestation and humiliation. Because in Eastern, Western and Southern Africa, more than 90 per cent of rural households depend on fuel wood and charcoal, for their energy requirements (UNEP, 2006).

Commercial type of agriculture is the most important driver of deforestation, followed by subsistence agriculture. Timber extraction and logging drives most causes of the degradation, followed by fuel wood collection and charcoal production, uncontrolled fire and livestock grazing. (Noriko Hosonuma,el.al 2012).population growth and poor agricultural practices are not only drivers of deforestation, but also loss of biodiversity, and habitat fragmentation.

At the local level, agricultural expansion, infrastructure development, overgrazing, and unrestrained fuel wood and timber harvesting have direct impact on forest degradation(Profor, 2012).

In most of developing countries indigenous people livelihood linked in the forest recourse. But lack of participation, authority and power in utilization and regulation of forest policy. Because the state has taken authority to regulate the use of forest land, timber and other forest products, but in most cases it often lacks the authority and power to implement such regulations.

This is because the legal basis of such claims by the state often flies in the face of the rights of indigenous people and ignores their systems of tenure and rules of resources management

Because of this Illegal hunting and deforestation is expanding.(Adams, 2009)

2.3 Effect of Deforestation and Degradation.

The process of tropical deforestation may produce many negative effects of varied and mixed implications, but conventionally the long-term dangerous environmental consequences such as global warming, biodiversity loss and soil degradation which are often identified (Mahapatra and Kant, 2003, p.2). Related to these negative impact of deforestation on natural resource there are also negative impact on income of the people and the country. Because Ethiopia and the people live around the forest get many economical use from the forest directly by utilizing forest and none timber forest product.

According to FAO (2007) The natural forests of Ethiopia play a significant role by providing flowering plants all year round. Because of this use full forest, the country is the 10th largest honey and the 4th largest beeswax producer. From this point of view it is possible to estimate how much deforestation affect the economy of the people and country. Increased global warming, soil degradation and loss of biodiversity are renowned negative outcomes of deforestation. Quite apart from these, it is noted that deforestation is a known cause of poverty (Dery and Dorway, 2007, p.14). This is because increased deforestation can cause loss of livelihoods- through loss of assets- and increasing vulnerability to poverty (Owusu, et. al, 2011).

Globally tropical forests are the major carbon sinks. So the loss of tropical forests in many countries means the collapse of major carbon sinks and generation of more carbon dioxide which is a serious threat to global climate and atmospheric temperature distribution,(Gorte and Sheikh2010).

Related to deforestation and forest degradation in developing tropical countries account cause of increasing 18% to 20% of green gases(GHG) emission.(TEEB, 2010). For example in Ethiopia the major activities contributing to GHG emissions in forestry were deforestation for agricultural expansion, forest degradation for fuel wood, and limited formal and informal logging.(FDRE. 2011)

Deforestation and forest degradation could be causes of drought weather to local environment, because wind and temperature will increase because of deforestation. As wind moves the hotter, drier air, it tends to exert a drying effect on adjacent forest and agricultural lands. Trees and crops outside the denuded area experience heat and aridity stress which is not normal to their geographical locations (Getis et al, 2005).

Not only these but deforestation and degradation of forest causes of much declination of other natural resources those, declination of wild animals and degradation of biodiversity and soil fertility, depletion of underground water resource.(Knox and Marston, 1998) Those global and national problems are also major problems that observed at the study area. According to Hiruiy Simie ,(2007). The change in the micro-climate of the study area shows Severe erosion, deforestation, drought and extreme dryness, Loss of huge trees and Migration of wild animals .

2.4 Remote Sensing and GIS

Remote Sensing is the science and art of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area or phenomenon under investigation (Lillesand and Kiefer, 2000). From point of view of the above, remote sensing data had been utilized to investigate LULC change of the study area by requesting satellite image of different period of time.

GIS is a specific information system applied to geographic data and is mainly referred to as a system of hardware, software and procedures designed to support the capture, management, manipulation, analysis, modeling and display of spatially-referenced data for solving complex planning and management problems (Eastman, 2001). So Remote sensing(RS) data and Geographic information system(GIS) tools is very use full to asses and monitor the land cover change in the area in order to examine the rate of deforestation vast area with short time.

Remote sensing (RS) data source were used to generate information about the spatial and temporal change of forest cover in the interested area. People responsible for managing the Earth's natural resources and planning future development recognize the importance of accurate, spatial information residing in a digital data source. Most important layers of biophysical, land use/ land cover, and socioeconomic information in a GIS database are derived from an analysis of remote sensing data (Jensen, 2000). Multi-temporal analyses of surface properties are desired in order to monitor the various changes occurring at the Earth surface. Remote sensing is a unique data source ensure a systematic local, regional, and global coverage for a range of ground spatial resolution.

The examination of multi-temporal remote sensing data sets is often confined to simplified change analysis schemes.

More powerful procedures are offered by trend analysis techniques requiring quantitative or semi-quantitative input data (Elmore et al., 2000). Application of RS data to illustrate changes in land cover and particularly forest cover over time have been reported by many investigators (Coppin and Baur, 1996). Trend analysis can be employed to calculate numerous parameters that may be derived from time series of satellite data. A combination of different parameters reveals additional information, which is not easily comprehensible through other processing schemes.

• **2.5 Vegetation identification**

Vegetation can be identified using remote sensing and ground truth survey. Digital image classification is the process of assigning pixel to classes. Usually, each pixel is treated as an individual unit composed of values in several spectral bands. By comparing pixel to one another and to pixel of known identity, it is possible to assemble groups of similar pixels into classes that match to the informational categories of interest to users of remotely sensed data. (Jensen,1996),The radiation beyond red light towards larger wavelengths in the spectrum is referred to as infrared (IR).

We can identify vegetation type sand the stress state of plants by analyzing ‘near-infrared’(and ‘mid-infrared’) radiation much better than trying to do so by color. For example deciduous trees reflect more near-infrared(NIR) energy than conifers do, so they show up brighter on photographic film that is sensitive to infrared. Healthy vegetation has a high reflectance in the NIR range, which decreases with increasing damage caused by a plant disease.

The reflectance characteristics of vegetation depend on the properties of the leaves, including the orientation and the structure of the leaves canopy. The reflectance in the NIR range is highest, but the amount depends on leaves development and cell structure. In the SWIR range, the reflectance is mainly determined by the free water in the leaf tissue; more free Water results in less reflectance. (Enschede, Netherland, 2009)

2.6 Accuracy Assessment

After supervised classification accuracy should be assessed because it is not possible to know the accuracy of classification, as land of the classification might be very large. So to be accepted or reject classification at certain confidence level classification, accuracy assessments is relevant. Accuracy assessments has been done using confusion matrix calculation which is simple ratio after ground references have been taken. correctly classified pixel classes over total classified pixels times hundred, result percentage of accuracy. Accuracy is overall correctly classified percentage of pixels.

A confusion matrix shows correspondence between the classification result and a reference image. I.e., to create the confusion matrix we need the ground truth data, such as cartographic information, results of manually digitizing an image, field work/ground survey results recorded with a GPS-receiver,(Pavel Ukrainski ,2016)

There is not standards set a minimum accuracy threshold for classification except for the VCS JNR requirements that set a minimum of 75% for the forest and non-forest classes. However, it is worth noting that the classification overall accuracy of a LULC map does not necessarily give an indication in the uncertainty of a change map (The world bank technical report, 2015)

Two independent maps with high overall accuracies that are combined for change detection purposes, may lead to very high uncertainties. Olofsson et al. (2014).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Back Ground and Location of the Study area

The study area Zequala(chukalla) mountain forest is found at central part of the country south east of Adiss Abeba the capital city of the country 81 km far. Mountain Zequalla or Chukala is an extinct volcano in the Oromia region of Ethiopia. Situated in Liben Chukala woreda of the East Shewa Zone. The study area is located at 8°33'N 38°52'E and 8°33'N 38°52'E (Wikimedia , 2017)

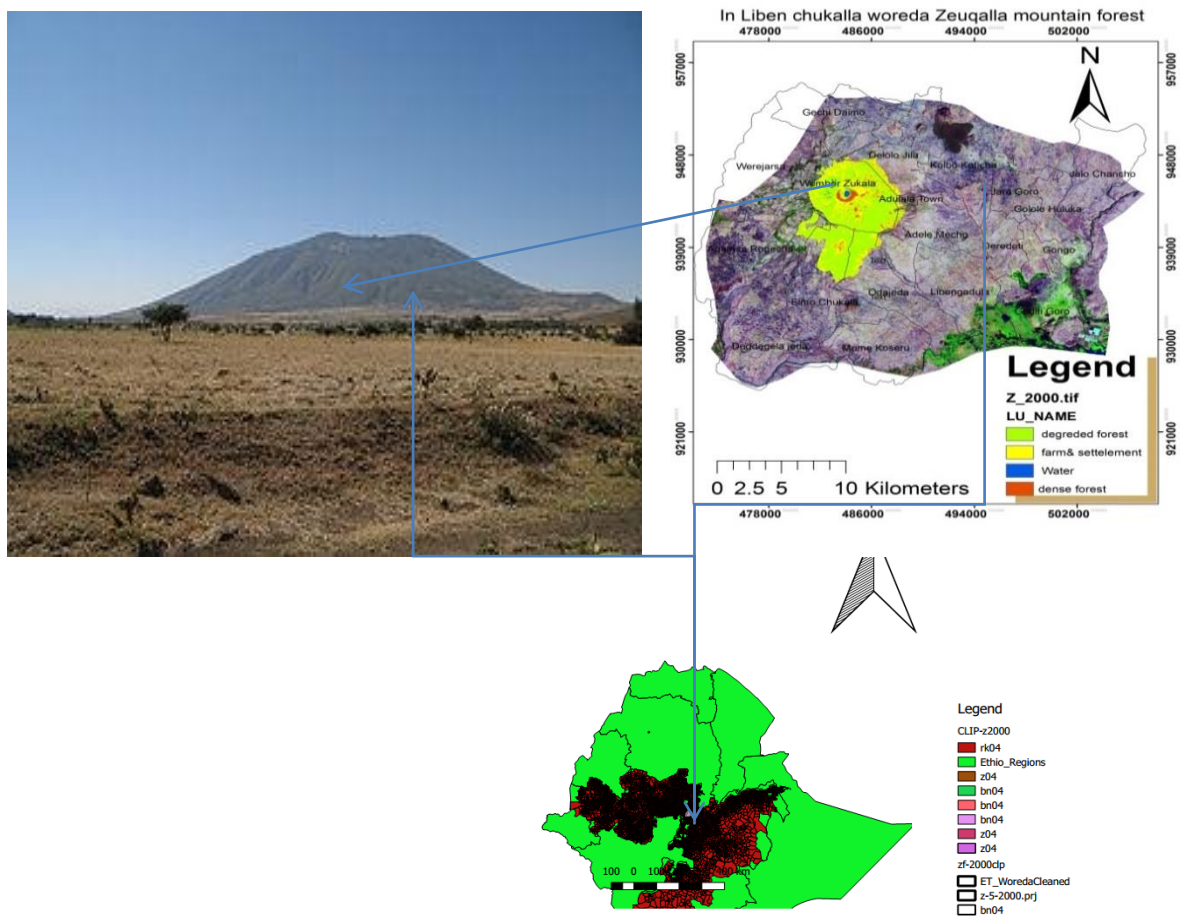


Figure: 2 Map of the study area

3.1.1 Climate and Topography

The climate of this area cove, according to Hurni ,1998 implemented a set of agro ecological zone, dry waynadega (1500-2300 meter above sea level) and moist dega (2300-3200 meter above sea level) , when go from the bottom to the top of zequala mountain the elevation of the area at the top of the mountain is 2989m above sea level and1720m at the foot of the mountain. The annual average maximum and minimum temperature is of 18⁰c and 6⁰c respectively, The annual average rainfall is731.3mm where the top of the mountain receives 808 mm average rainfall (Liben Chukala woreda agriculture office in day12/1/2018)

3.1.2 Population

The People live directly in the forest at the top and some middle of the mountain about 600 in number and majority of them are coming from different direction of the country; they are monk live together in Zequalla monastery (Gedam) ,and they had been coming to this area to give service to Abbo (Abone Gbremenfes kedus)Orthodoxy church. This mountainous forest is surrounded by 7 kebele . All the people live around this forest farmers plowing traditionally to produce crop and animals husbandry, their animals fodder from this forest (Liben Chukala woreda agriculture office)

3.1.3 Natural Resource

There is sufficient information about total area of the forest cover but there is no evidence of demarcation map or sketch map. The information from woreda rural land administration office reported that the total area of the water shad of this mountain is 960 hectors, gradually decreasing and fragmented.

Most of the forest are changing to agriculture land. The forest is studied now only covering mountain area. The Natural forest of zeuqala is estimated to be 6017 hectares according to woreda rural land administration. But there are not demarcation indicator sketch map on the top of mountain high forest dominate those are *Junipers procera*, *Olea africana*, *Hypericum revoluton*, *Hyginia abyssinica*, *Pittosporum viridiflorum*, *Maytenus obscura* and *Erica arborea*, covering the high altitude and middle of the mountain, money acacia species covering the bottom of the mountain.

Dodonaea viscosa dominant which cover large area of this remaining forest, because this indigenous tree well in a wide range of climates and soils. A pioneer species covering stony mountainous parts which is created by volcano eruption and disturbed and degraded area. *Dodonaea viscosa* widespread in Ethiopia in a variety of habitats, from reverie forest to rocky soils or arid marginal areas in Dry and Moist Kolla and lower Weyna Dega agro climatic zones in almost all regions, 1,000–2,700 m.a.s.l Useful trees and shrubs of Ethiopia (Azene Bekele-Tesemma 2007).

Many wild life hyenas, Bush pigs, Warthog, lions,(in rear) Leopards, jackals, Baboons, black and white Columbus monkeys and specially full of birds at the top of the mountain where there is a lake (woreda agriculture office in day12/1/2018)

3.2 Data and Source of Data

In this study primary and secondary data were used to answer the basic questions of the study, primary data source were satellite image from internet Google earth U.S.G.S. and people live in this area, data were collected using questionnaires and interview, and secondary data were collected from Woreda governmental offices specially Liben Chukala agriculture office .

3.3 Data Collection Techniques

3.3.1 Requisition of Satellite Image

By requesting remote sensing imaginary data from internet Google earth explorer USGS, Land sat satellite and using GIS tools to compute. It is possible to analyses and classify LULC area of interested of during a long time period and as a result to understand pattern of the changes (Fichera et al., 2012). So to get LULC change pattern of study area the following methodology used.

Images of 2000, 2011 and 2017 were requested and loaded from internet Google earth USGS, Land sat satellite, which could be requested freely without payment and relevant for land use land cover change assessment and also to identify deforestation rate and other land use change. Image requested from internet Google Earth Explorer - USGS Land sat_5 for image of 2000 ; land sat_5 for image of 2011;and landsat_8 for image of 2017 have been used to load. Those image from selected target area of the research. Selected images cover adequate land of study area, which are < 5% cloud cover.

Table 1: Image down loaded from internet USGS earth explorer

No	Type of satellite	Requesting time	Path	Row	Description
1	Landsat-5	March-2000	168	054	To get image Of 2000
2	Landsat-5	March-2011	168	054	To get image Of 2011
3	Landsat-8	March-2017	168	054	To get image Of 2017

Source internet Google earth USGS

As in the table indicated requested images of different period are on the same month to minimize the variation occurred on the ground by the variation of season. Because the data of land cover taken from satellite at dry and wet season of the same land use is not the same.

3.3.2 Ground Truth Observation and Collecting Picture

Ground truth observation took place to validate images had been classified according to LULC of the study area . It was carried out by field visit to get an overview of the study area and to identify validate this LULC classification. Transect walk starting from east to end of west study area had been taken to observe ground truth and pictures which show ground truth had been taken to validate satellite image.

During transect walk about 38 ground truth reference point recorded randomly using GPS and pictures which could able to represent LULC classification; water body, dense forest, farmland and degraded forest in day 11/2/2018. Sample of GPS reading of X and Y coordinate took and indicated on map of the study area(X and Y coordinate took indicated on appendix with table and the place on map of study)

3.3.3 Interview and Questionnaires

Interview and questionnaires presented to collect information about forest and its historical back ground, and the main causes of deforestation and forest degradation and what effect they are observed related to deforestation and forest degradation. The interviews were to 80 persons selected randomly but estimated would have better recognition and knowledge about this study area

3.3.4 Secondary Data Collection Technique

Secondary data have been collected from document found at the governmental office of Woreda cooperating with experts especially about the extent of deforestation and degradation of Zequala mountain forest

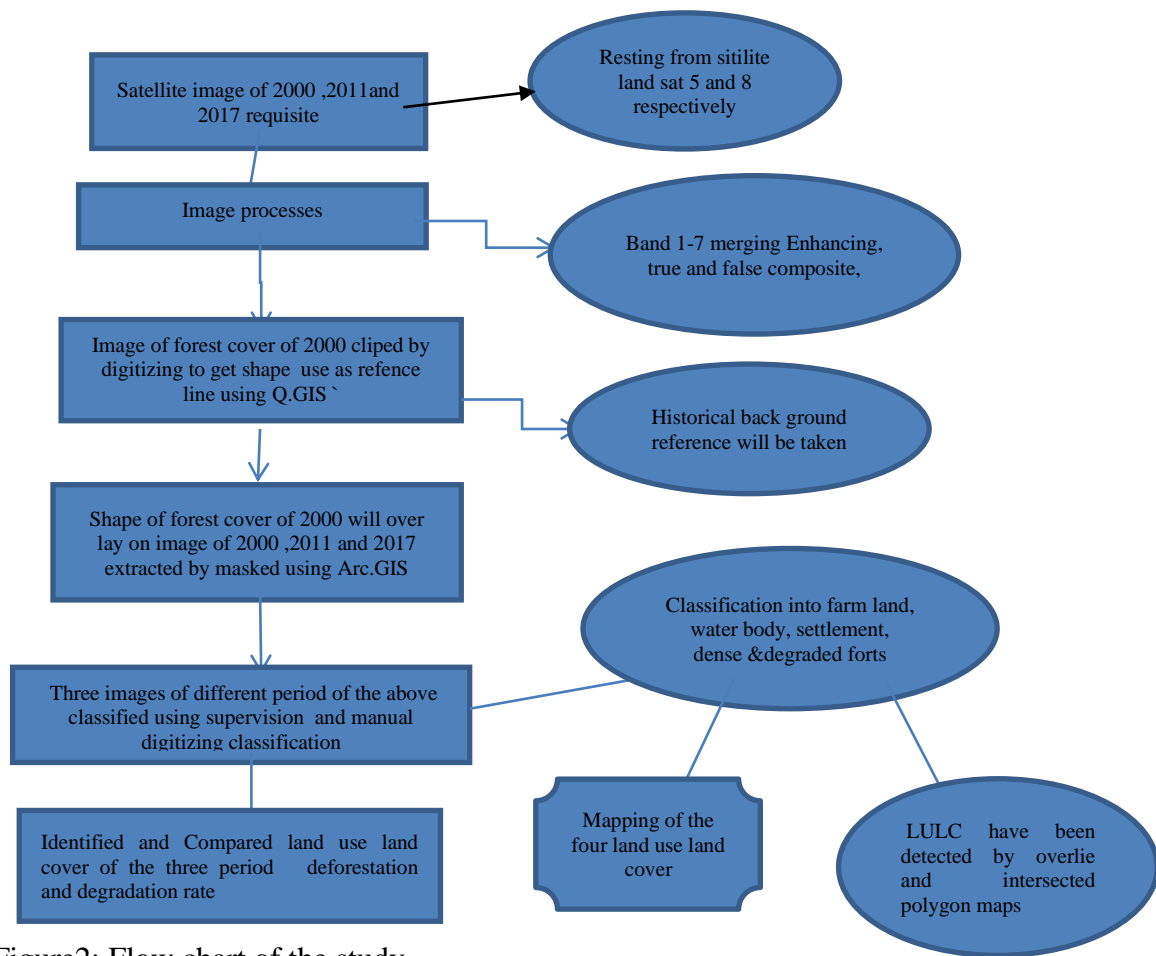


Figure2: Flow chart of the study

3.5 Data Analysis

3.5.1 Image pre- processing

Image preprocessing is to get clear visual of the image for the purpose it is needed. On time being the image requested is already pre-processed and corrected in geometric, radiometric and atmospheric correction. So in this research preprocessing needed is only image enhancement to get good visual and to identify the feature of the image clearly.

According to Faust, 1989, Image enhancement is the process of making an image more interpretable for a particular application needed

For this research purpose images have been composited (7bands have been merged), and enhanced True Color Composite (TCC) and False Color Composite (FCC). False color composition is to enhance true color, before it is visualized and classified to be more interpretable for the purpose image is applied.

3.5.2 Image Classification and Mapping the Study Area.

The shape of digitized forest area of image 2000 is lay over the image of 2000, 2011 and 2017 then the image of the 3 period extracted by mask use Arc GIS, after the extraction all three images have been classified by supervised classification, and classification was based on the statistics of training areas representing different ground objects selected subjectively by knowledge, experience and ground truth survey has been done. transect walk, starting from eastern of the mountain forest bisecting the mountain to western end of the mountain forest had been done to observe ground truth. During classification only four major land use land cover classes have been selected to investigate land use land cover change. Selected major land use land cover of this area are water body, high and dense forest Farm and settlement, and degraded forest. Description of land cover classes distinguished in the study area

Table 2 : Description of land cover classes distinguished in the study area

	Land cover class	Class description
1	Water body	Mainly creator lake on top and center of mountain and any land which is covered by water body
2	Dense forest	Area of land covered with densely populated trees that have height up to 40m, a crown cover more than 60% of upper strata and no open ground cover.
3	Degraded forest	Area of land covered with trees that have an open canopy cover in which the canopy cover of upper stratum is < 60 % and shrubs dominating the under canopy
4	Agriculture Settlement Land and open grass land	Land area that consists of a land area used for rain-fed and other forms of agriculture which is currently under crop, on preparation, fallow land ,grazing grass land and rural residential areas

From supervised classification land use land cover change map from image of 2000, 2011 and 2017 have been generated to visualized and identified deforestation and degradation. from the number of pixel of each image classes, the area of each land use land cover of supervised classification, and mapped land use land cover of the three period.

3.5.3 Accuracy Assessment

After supervised classification accuracy should be assessed because it is not possible to know the accuracy of classification, as land of the classification might be very large. So to be

accepted or reject classification at certain confidence level classification, accuracy assessments was relevant.

3.5.4 LULC_ Change Detection

LULC_ change detection has been took place using satellite image data, and then selected and demarcated the study area had been classified by processing using GIS tool to creating LULC_ change matrix table. To formulate LULC_ change matrix table, classified raster image of study area had been changed to polygon , then by over laying polygon of the two period (initial and final) intersection of LULC-change matrix had been created. In this study of Zeuqalla mountain deforestation and degradation, polygon of LULC of 2000 and 2011, 2011 and 2017 and 2000 and 2017 had been over lied and intersected to compare and identify indicated pair LULC_ change of the study area.

3.5.5 Interview and Questionnaires

The main objectives of the questionnaires to get the drivers of deforestation and forest degradations and effect of deforestation and forest degradation. As generals causes of deforestation and forest degradation have been known from question presented and answered by respondent. Also to get which deforestation and degradation causes the degree of impacts identified by the vote of respondent and then summarized to analyze . Questionnaires was presented for 160 persons from those 100 male and 60 females. From the respondents information above the main causes were identified and prioritized according to the vote of respondent

3.5.6 Secondary Data

Secondary data had been collected only from Liban Chukalla agriculture office about land use land cover change of mountain Zequala forest, and the information of this indicate that there were big dense forest previously but because of fire burning, expansion of agriculture land and production of charcoal and fire wood exploitation, this forest is decline and also degraded. According to their information there are many measures have been taken to protect and conserve this forest , one measure that have been taken, the farmers live at the center (top of the mountain) forbidden to produce crops instead cultivating spices and vegetable to get income. Because of this deforestation of high forest found at the center of the mountain decreasing to some extent, so the area of dense forest increasing detection matrix reading by the information from natural expert coinciding with to data of remote sensing processed using GIS tools

CHAPTER FOUR

4. RESULT AND DISCUSSION

The total land cover of the study area is 5925.78 hectares and Land use/land cover classes of the study area were categorized in to four types; these are: water body, dense forest, degraded forest and farmland and settlement. The forest in the study area has been divided in to dense forest and degraded forest on field verification. The intension was to separately identify the natural dense undisturbed forest with disturbed by human forest. The three periods (2000, 2011 and 2017) of land use/land cover classification map of the study area is presented in the (figure 3, 4 and 5). of the result showed that the land cover of 2000 is dense forest, degraded forest and farm and settlement land is 28.4% 0.6%, 66% and 28.4% respectively (Table:3). In this study LULC of the 2000 is considered as the base line to investigate the deforestation rate of the are

4.1 LULC classification map of the study area

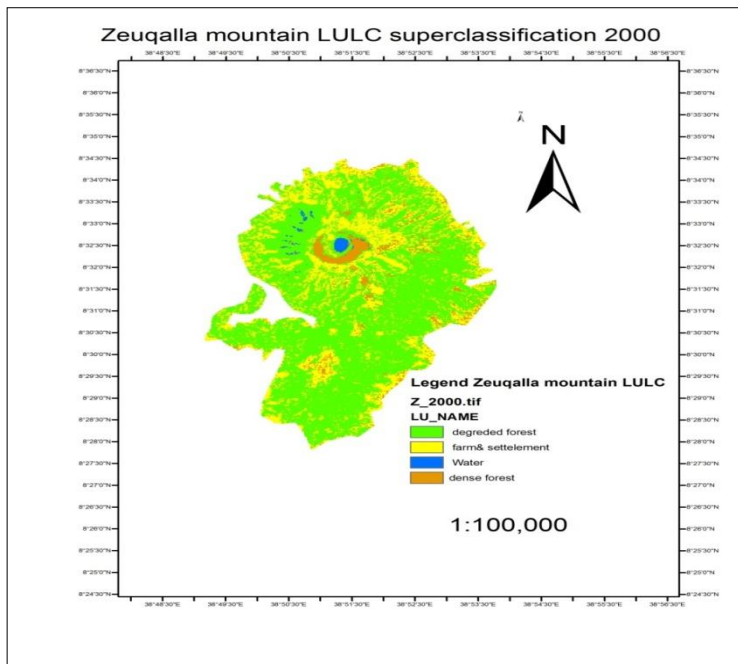


Figure: 3 LULC map of

Table: 3 Area of LULC types of 2000

No/	LULC classes 2000	Area in hectare	Area in %
1	Water body	35.64	0.6%
2	Dense forest	292.14	4.9%
3	Farm and settlement	1684.17	28.4%
4	Degraded forest	3913.83	66.0%
Total		5925.78	100

From the land use and land cover map interpretation of 2011, the areal coverage of the study area are, water body, dense forest, degraded forest and farm and settlement land 0.3%, 4%

50% and 44.7% respectively (Table:4). In LULC of 2011 rate of deforestation in both dense forest and degraded forest -19.4% and 22.8% respectively and farm land and settlement increase 57.3% after 10 years

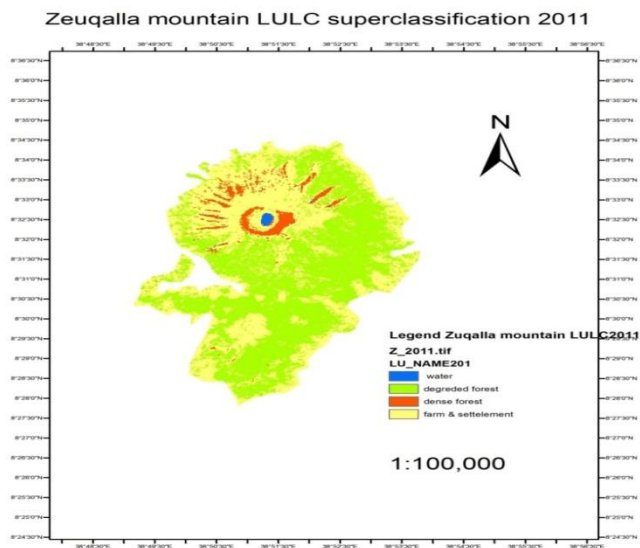


Figure 4; LULC map of 2011

Table: 4 Area of LULC class of 2011

No	LULC type 2011	Area in hectare	In %
1	Water body	20.25	0.3
2	Dense forest	235.35	4
3	Farm and settlement	2649.15	44.7
4	Degraded forest	3021.03	50
Total LU		5925.78	100

From the land use and land cover map interpretation, of 2017 the areal coverage of the study area are, water body, dense forest, degraded forest and farm and settlement land 0.2%, 4.8% 37.5% and 57.5% respectively (Table:5). In LULC of 2017 rate of forest change in both dense forest and degraded forest 20.5% and- 26.4% respectively and farm land and settlement increase 28.5% after 7 years. At this period dense forest increase from 235.35 hectares to 283.68 hectares which and also decreasing from the previous deforestation rate and related to this increment of farm land and settlement decreasing during this date

Zeuqalla nountain LULC supervised classification 2017 map

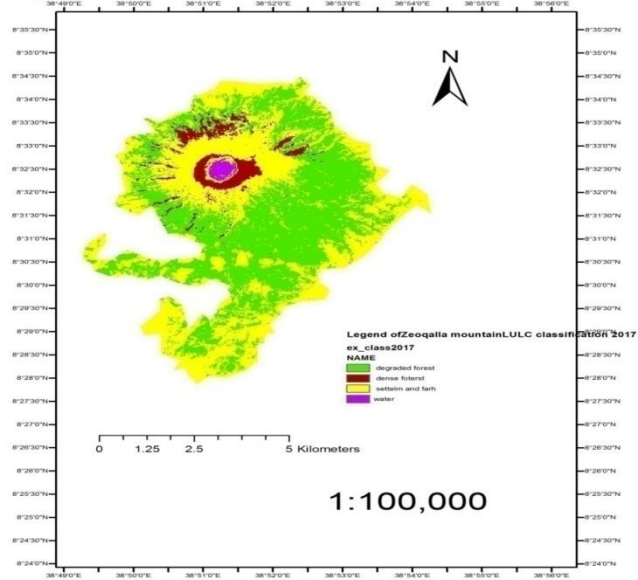


Figure 5: LULC map of 2017

Table 5: Area of LU LC type 2017

No.	LULC type 2017	Area in hectare	Area in %
1	Water body	13.23	0.2
2	Dense forest	283.68	4.8
3	Farm and settlement	3405.06	57.5
4	Degraded forest	2223.81	37.5
Total LU		5925.78	100

Table :6 the overall accuracy and kappa coefficient of the three image consequently

Image	2000		2011		2017	
1	Overall accuracy	kappa coefficient	Overall accuracy	kappa coefficient	kappa coefficient	Overall accuracy
	75.8	66	82.8	77.5	81.8	75

Table 7: Summery of LULC change 2000-2017

No I	LULC classes	2000 in hectare	2011 in hectare	2017 in Hectare	LULC change 2000&2011 b/n	LULC change 2011&2017 b/n	LULC change 2000&2017 b/n
1	Water body	35.64	20.25	13.23	-15.39	-7.02	-22.41
2	Dense forest	292.14	235.35	283,68	-56.79	48.33	-8.46
3	Farm and settlement	1684.17	2649.25	3405.06	965.08	755.81	1720.89
4	Degraded forest	3913.83	3020.67	2223.81	-893.16	-796.86	-1690.02
	Total	5925.78	5925.78	5925.78			

II	LULC classes	2000 in hectare	2011 in hectare	2017 in hectare	LULC change b/n 2000&2011 in%	LULC change b/n 2000&2017 in%	LULC change b/n 2000&2017 in%
1	Water body				-43.2	-34.7	-62.9
2	Dense(intact) forest				-19.4	20.5	-2.9
3	Farm & settlement				57.3	28.5	102.2
4	Degraded forest				-22.8	-26.4	-43.2

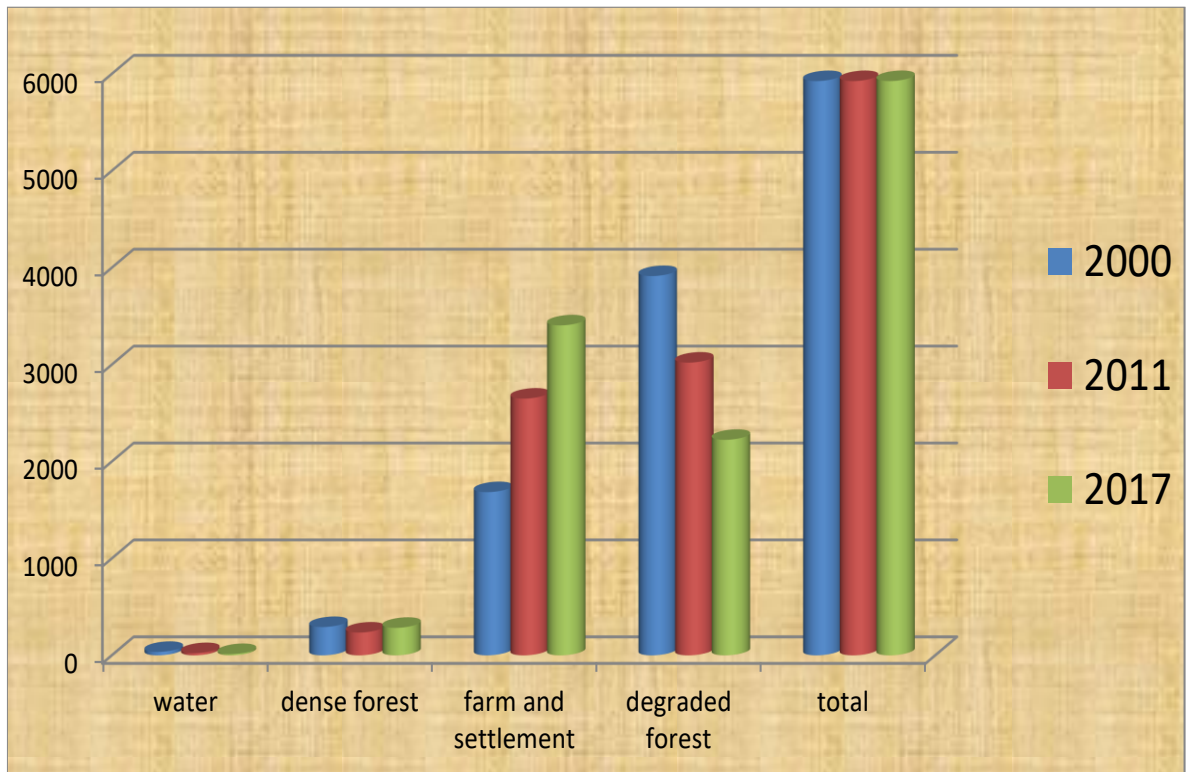


Figure 6: Graph of LULC change 2000-2017

4.2 LULC change detection

the extent, rate and trend of land use land cover change of the study area has been analyzed and presented for two distinctive periods 2000-2011, 2011-2017 and for entire long-term period (2000-2017) by digital change detection overlying the two classified consecutive land use land cover maps of the study years to investigate mainly deforestation rate.

➤ Change between 2000 and 2011

The major cover changes observed during this period had been the reduction in the area of both forest categories, dense and degraded forest when gain and loss balance had been compared from detection table.

Water land decreasing from 35.8 to 20.3, dense forest from 292.1 to 235.4 and degraded forest from 3913.9 to 3021 hectare respectively, but farm land and settlement increase from 1684.2 to 2649.2 hectares (Table:8 the first .one)

➤ Change between 2011 and 2017

At this period deforestation decreasing than previous time, dense forest increase from 235.4 to 283.7 hectares and degraded forest decrease from 3021 to 2223.8 hectares, water body decreases from 20.25 to 13.2 hectares and farm and settlement increase from 2649.2 to 3405.1 hectares.

Table: 8 Zequala LULC change Detection matrix table

Zeugallal mountain LULC -change matrix between 2000 and 2011							
LULC_2000							
Table;8a	LULC	Waterbody	Dense Forest	Farm and Settlement	Degraded Forest	Total	change in%
LULC_2011	Waterbody	15.8	0.6	0.1	3.7	20.3	-43
	Dense Forest	15.4	71.5	19	129.5	235.4	-19
	Farm and Settlement	4.4	155.6	1104.5	1384.7	2649.2	57
	Degraded Forest	0	64.4	560.6	2396	3021	-23
	Class Total	35.6	292.1	1684.2	3913.9	5925.9	

Zeugallal mountain LULC -change matrix between 2011 and 2017

LULC_2011							
Table:8b	LULC	Water body	Dense Forest	Farm and Settlement	Degraded Forest	Total	change in%
LULC_2017	Waterbdoy	13.1	0.2	0	0	13.2	-35
	Dense Forest	1.5	104.9	75.7	101.6	283.7	21
	Farm and Settlement	2.5	45.1	1936.2	1421.3	3405.1	29
	Degraded Forest	3.2	85.2	637.3	1498.1	2223.8	-26
	Class Total	20.25	235.4	2649.2	3021	5925.8	
Zeuglal mountain LULC -change matrix table between 2000 and 2017							
LULC_2000							
Table ; 8c	LULC	Water body	Dense Forest	Farm and Settlement	Degrade d Forest	Row Total	change I n%
LULC_2017	Waterbdoy	13.2	0	0	0	13.2	-63
	Dense Forest	7.7	83.6	53.9	138.4	283.7	-3
	Farm and Settlement	9.4	150.7	1209.9	2035.2	3405.1	102
	Degraded Forest	5.3	57.9	420.4	1740.2	2223.8	-43
	Class Total	35.6	292.2	1684.2	3913.8	5925.8	

Table :9 LULC detection matrix summery table from200-2017

change detection of 2000_2011			change detection of 2011_2017			change detection of 2000_2017			change detection of the three period			
LULC	unchanged	loss to	gain from	unchanged	loss to	gain from	unchanged	loss to	gain from	balance 2000-2011	balance 2011-2017	balance 2000-2017
										gain-loss	gain-loss	gain-loss
water body	15.8	19.8	4.4	13.1	7.2	0.2	13.2	22.4	0	-15.4	-7	-22.4
Dense Forest	71.5	220.6	163.9	104.9	130.5	178.8	83.6	208.6	200	-56.7	48.3	-8.6
Farm and Settlement	1104.5	579.7	1544.7	1936.2	713	1468.9	1209.9	474.3	2195.3	965	755.9	1721
Degraded Forest	2396	1517.9	625	1498.1	1522.9	725.7	1740.2	2173.6	483.6	-892.9	-797.2	-1690
Total	3587.8	2338.0	2338.0	3552.3	2373.6	2373.6	3046.9	2878.9	2878.9	0.0	0.0	0.0

LULC change in percent and annual change												
change detection of 2000_2011			change detection of 2011_2017			change detection of 2000_2017			change detection of the three period			
LULC	inisial LULC	loss /gain/ change in %	inisial LULC	loss /gain/ change in %	inisial LULC	loss /gain/ change in %	inisial LULC	loss /gain/ change in %	annual change in%	annual change in%	annual change in%	
	1	2 3(2/1*100)	4	5 6(5/4*100)	7	8 9(8/7*100)	2000_2011	2011_2017	2000_2017			
water body	35.6	-15.4 -43.3	20.3	-7 -34.5	35.6	-22.4 -62.9	-4.3	-4.9	-3.7			
Dense Forest	292.1	-56.7 -19.4	235.4	48.3 20.5	292.1	-8.6 -2.9	-1.9	2.9	-0.2			
Farm and Settlement	1684.2	965 57.3	2649.2	755.9 28.5	1684.2	1721 102.2	5.7	4.1	6.0			
Degraded Forest	3913.9	-892.9 -22.8	3021	-797.2 -26.4	3913.9	-1690 -43.2	-2.3	-3.8	-2.5			

Within 17 years water body decreasing 22.4 hectares this 63% decreasing, and dense forest decrease 8.6 hectares which is 5.5 % this dense forest land better conserved than others, area of degraded forest which is changed to other land use is 1690 hectares which is 43.2% of this land changed to other land use.

Farm land is the only land use which show increment of 1721 hectares and 102 hectares of forest deforested annually . When compared loss and gain of forest in this study there is high deferent balance change between 2000 and 2011 period, dense forest loss 220.6 hectares and gain 163.9 hectares, gain to loss ratio is 0.74, degraded forest changed to other land use (loss) 1522.9 hectares and gain (increment) is 725.7 this gain to loss ratio o.48 ,Ethiopian forest gain loss ratio study 2000-2013 show that 0.43 (JNFCCC 2016)

From2011_2017 dense forest of Zequala mountain 130.9 hectares loss and 178.8 hectares gain this is gain to loss ratio is 1.37 this show that dense forest well conserved and generated during this time.

But according to (Hruiyi 2007) studied deforestation of this area by demarcating 5135.98 hectares taking as initial LULC, comparing aerial photo of 1965 and 1971 and analysis LULC change to get deforestation rate. He estimated the deforestation of 2008 after 27 year, indicate that the water body is unchanged starting from 1965 to 2008 which is covering 40.58 hectares and dense forest below zero change -38.13 in 2008.

But in this research on ground survey and satellite image data processed using GIS there is about 284 hectares intact forest and 2223 of degraded forest present still now, but according Hiruy Simie,(2007) there is only 216.58 hectares of degraded forests in 2008

LULC	1965.00	1971.00	change in%	annual change	change in 2008	estimat LULC 2008
water body	40.58	40.58	0.00	0.00	0.00	40.58
dense forest	140.24	107.81	-32.43	-5.41	-145.94	-38.13
farm and settlement	1618.83	2218.49	599.66	99.94	2698.47	4916.96
degraded forest	3336.34	2769.11	-567.23	-94.54	-2552.54	216.58
total	5135.99	5135.99	0.00	0.00	0.00	5135.99

Table.10 (source) Hiruy Simie June, 2007. Resource degradation and unsustainable livelihood practices in and around Mt. Zequala.

The forest of the mountain Zequala declining from time to time by deforestation and degradation. Within seventeen years about 1721 hectares of forest have been changed in to farm land and settlement. This forest is surrounded by seven farmer association kebel and one kebele at the top and center of this mountain forest.

Mountain zequala formed by volcano eruption and at the top center there is crater lake and high forest of junipers species dominated forest surrounded the lake, only this forest is not disturbed forest, except this forest other forest which cover large and major area of the mountain is disturbed and degraded extremely as majority remnant forest of high land forest of Ethiopia (Kidane Mengistu, 2002).

The people live around the forest exploit for charcoal production, fuel wood plow materials and a also use as grazing land. Also wildfire burn occurring within unknown interval make it degraded and suppress its regeneration and rehabilitation.



Figure 7: Zeuqala at the top of the mountain where high and dense junipers dominant and remnants primary forest are found (source, photo by researcher Saturday/January/13/2018)

Dense forest of this mountain from 2000 to 2011 within 10 year decreasing 5.68 hectares per year, but between 2011 and 2017 deforestation of this forest decreasing and improvement of regeneration. Area of dense forest increase from 235.35 to 283.68 hectares. this mean this forest increase 48.3 hectares within 7 years.

According (Abele,2014) intact forest area surrounding the crater lake is estimated to 197 ha.

The research time of author Abele was three year before this research in 2014. In this research the area of dense forest is 283.68 hectares the different is 14 hectares .This improvement has been after the government give attention to natural resource, specially forest of the country, and the people live around this forest forbidden to plow the land for crop production and restricted only to produce cabbage and spices with in limited area.

As information from people live for a long time around this mountain has been given, there was high dense forest before about 30 years, but most of the forest area degraded because of charcoal production and fuel wood collection and wild fire ignited unknowingly by people producing charcoal in the forest. Degraded forest of Zequala Mountain has been change into farm land and settlement by deforestation, as result in supervised classification above obtained correlated with information gathered from key people. The area of this degraded forest is very large than others land use, but it is deforested extremely and changed to other land use specially to farm land . From 2000 to 2011 within 10 years this degraded forest of 3913.9 hectare decline to 3021 hectare this mean -892.9 hectare of secondary forest has been change to farm land, in this cause annual deforestation rate is 89.3 hectare. Within seven year from 2011 to 2017 this secondary degraded forest area declining from 3021 to 2223.81 hectare.

This indicates that 797.2 hectare deforested within seven years and annual deforestation rate is 113.9 ha, most of this forest change in to farm and grazing land , when deforestation rate compared with the previous 10 years , 24.6 hectare increasing annually. According to the information has been earned by interview from people and agriculture office of Liben chukala worda, declination of deforestation because of the awareness given to the people by the government body and penalty has been given to the people by punishment, has been tried to control and minimize deforestation.

Forest area of Zequala mountain on time being degraded and deforested extremely, total forest land change to other land use, that the largest degraded forest which was cover an area of 3913.83 hectare decline to an area cover of 2223.81 hectare whit in 17 years. From 2000-2017 which is degraded forest change to none forest land use is 1690 hectare.

This indicate that in average annual deforestation rate is 99.4 hectare, which mean 2.54% annual reduction of this forest. So, if the deforestation rate continues by this rate the remaining forest will completely disappear within 22years. Also dense forest on top of mountain also decreasing from 292.14 hectare to 283.68hectare, so 8.64 hectare forest land decreasing from 2000-2017 within 17year which is annually 0.5 hectare declining, in this situation if deforested is continue it will disappear within 558 years, Comparatively the protection and conservation of dense forest is better.

Because on this forest worda administration protect well this forest, the farmer live in top of mountain near this dense forest forbidden not to expand agriculture land ,even not to produce crop, instead of this the farmer growing vegetable and spices. Because of this the deforestation of high forest at the top of the mountain is protected better than other area (middle and bottom of the mountain).

According to woreda administration program, the people live on top of the mountain at the center of the mountain will be settled out of this forest to conserve and protect this forest.

As the information obtained from satellite image which is processed using GIS tool ,southern part of the mountain forest area called. Ilmo chukala within 2000 to 2017 highly deforested and degraded than other area ,because this area is less mountainous than other place and better for plowing ,from this point of view and observation on mountainous land forest is better conserved as the this land is not convertible for cultivation.

Related to this 35.64 hectare of water decline to 13.23 hectare within 17 years from 2000-2017 ,which is 22.41 hectare of declination and 1.32 hectare annual reduction. So if declination of this water continue by this rate it will disappear within 10 year.

In Africa as general according to FAO (2005). global forest assessment ,highest deforestation rate and highest annual forest area changing countries of Africa indicated below in the table

From the table above information analysis, deforestation annual rate of zequala very competing with the countries which are recorded in high deforestation rate in Africa indicated by FAO in2006. In this area annual deforestation rat is 2.54% which is equal to annual deforestation rat of Benin which has fifth rank in Africa in deforestation (2.5%(65) (Table:11). Even this deforestation rate minimized by great protection of woreda administration and other government body

Table 11: deforestation in Africa

Burundi	5.2%(90)	Sudan	589(0.8%)	
Togo	4.5%(20)	Zambia	445(1.0%)	
Mauritania	3.4%(10)	Tanzania	412(1.1%)	
Nigeria	3.3%(410)	Nigeria	410(3.3%)	
Benin	2.5%(65)	DR Congo	319(0.2%)	

[Source *Global Forest Resources Assessment 2005* (FAO, 2006)]

The farmers live on the top of the mountain forbidden to expand farm area and plough land for crop production except cultivating spice and cabbage, and also they can not to expand the land for production of crop this measure has been taking to protect and conserve this remaining forest, so to some extent the measures have been taken minimize deforestation and degradation of this area.



Figure 8: The farmer on the top of mountain cultivating cabbage and different spices instead of crop production to protect deforestation. (source, photo by researcher Saturday/January/13/2018)

According to woreda agriculture office and natural resource development and protection team the measure have been taking place to conserve the remaining forest and protect mountain and hilly land degradation of the area. May be because of this measure have been taking place between 2011 and 2017 period area of dense forest at the top of mountain increasing when satellite image analyzed using GIS tools

4.3 Driver of Deforestation and Degradation of Forest of Mount Zeuqala

Deforestation and degradation of forest of mount zeuqala almost similar the problem in east Africa. Agriculture expansion for crop production and livestock grazing is the main cause of deforestation (FAO, 2010).

Zequala mountain forest is one of the remnant large forest in Liben chukala woreda not only in this woreda but in East Shoa administration zone.

So many farmers get their traditional farming wooden tools from this forest and most of the people live around this mountain forest use it as supplementary economic income by charcoal and fuel wood selling, and other very poor and jobless young use this forest as the main means of their income. To 160 respondents, questionnaires were presented to identify the main causes of deforestation and degradation ,all of this respond that they use this forest for energy supple agriculture traditional plow material and constrictions materials ,to construct house and fence. According to those respondent not only the people live around this forest use it, as this forest the only forest found at Liban chukala woreda people comes from far and use this forest.

As the information collected from 160 respondent randomly selected from 8 kebele and 20 respondent from each kebel and, closely related with this forest, according to their respond most causes of deforestation are agriculture land expansion, forest exploitation for fuel wood and charcoal production and wild fire respectively.

Respondents express that, for the question presented to them the cause of deforestation, thos land demand for agriculture expansion, forest exploration for charcoal production and fire wood demand and wild fire damage, 106(66%), 28(17%), 26(17%) respectively. Charcoal production and fuel wood exploitation is not only for their utilization, but they get means of their income specially for job and land less young's.

Also causes of forest degradation according to vote of respondent , by Charcoal production and fuel wood exploitation 50%, by wild fire damage 40% and by agricultural activities 10% (wooden plow material exploitation and live stoke grazing), these are by protecting and suppresses regenerating species aggravate degradation.

One of the young go to the forest to collect fire wood interviewed why he is participate in deforestation. He said that << I am very sorry for the disturbance and degradation of the forest but I need means of life and very interested to participate in soil conservation and seedling plantation to compromise for the deforestation and degradation but I cannot stop charcoal production and fuel wood collection because I have not means of life > Wild fire also one of the main cause of deforestation and degradation, when farmers producing charcoal fire is ignited and burning forest many times and harm regenerating forest. Fire was the main cause of degradation and deforestation by damaging regenerating seedling sapling, and big tree.

Because of generating trees have been cut for deferent utilization before it mature and becoming big tree and the seedling trampled by livestock, restoration of this forest becoming difficult. Other cause of deforestation is luck of people power and decision on this forest and owner sentiment , because as owner ship of this forest is government all decision and utilization done alone by government body, this make difficult to conserve and protect this forest in sustainable manner. The people lives around this forest utilize it only by wood exploitation for charcoal production and fuel wood ,they do not other use of forest to gene ret their income because lack of knowledge. So this lack of knowledge and participation in this forest decision one causes of deforestation.

One respondent say that for the question what do you fill for deforestation and forest degradation << what the use of this forest for me if it is how mach dense and beautiful it use only for the government, even it is harm full for my crop because wild life migrate to this forest and damage my crop>> from this point of view the farmer is not happy for the regeneration of this forest.

From 160 respondent 86(54%) of them is not happy for regeneration of this forest the main causes is wild life damage their crop and 50(31%) of them interested for regeneration of this forest 24(15%) respondent do not have define idea. From this point of view lack of knowledge, awareness and participation and decision of the people live around this forest one causes of deforestation.

4.4 Effect of Deforestation and Degradation of Zequala Mountain Forest

Deforestation and degradation of mount zeuqala has many effect on natural resource and environment, also on the lively hood of the people around this area.

Because of this mountain deforestation and degradation, there are degradation of soil and farm land at the bottom of the mountain and also degradation of forest land (figure:12).

High degradation of land is occurred because of deforestation and forest degradation. Because on bare land infiltration of the soil is poor. So why erosion and flood is formed during the rainy season, because of runoff water and erratic rain fall ,declination of production and reduction of productivity of the land and also gully is formed because of erosion and land degradation (Hiruiy Simie,2007)

Because of deforestation, wild life declining, in number and diversity, water resource also declining. Within 17 year from 2000 to 2017 water body declining from 35.64 to 13.23hectar and annual declination of 1.32 hectare. Also water springs found on this forest mountain, have been reduced, and dry when long dry season, for example water of spring, Burka karsa and kataba was big, decreasing and dry when dry season long. This degraded forest surrounded by 7 farmer association, because of this it is deforested in all direction for agriculture land expansion on the boundary of the forest.



Figure 9: Degraded secondary forest of zeuqala mountain and the land around this forest, one side view (source Author Saturday/January/13/2018)

Near to this forest area there is a fast growing Adulala woreda town (figure:13), because of this growing town population are increasing and related to this demand of fuel wood and land are increasing, these increment of demand impact on this forest.



Figure10: Growing Adulala woreda town (source, photo by researcher Saturday /January/13/2018)

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The following could be concluded base on this study. The objective of this study is to assess the magnitude of deforestation and its driving force at Zequala mountain by analyzing LULC - change of the three periods using satellite image of 2000,2011 and 2017. The satellite image of the three period indicated requested from internet Google earth USGS And loaded, then after enhancement classified in to 4 LULC classes using GIS tool, those LULC class are water body, dense forest, farm land and settlement and degraded forest. To assess the driving force of deforestation questionnaires had been presented to the farmers live around this study area and secondary data collected from governmental office specially from agriculture office. From these classification of the three period LULC change, raster maps of LULC of the three period had been produced. To extract and analysis the result of LULC change to get deforestation rate of the three period raster maps change to vector maps and two vector maps which are interested to compare the change overlaid and intersected to create detection matrix table. From detection matrix table read within 10 years (2000-2011), the result of LULC change was , dense forest, water body , and degraded forest is declined in 56.79 ,15.39 and 893.16 hectares respectively. Farm land increases in 965.1 hectares which is 96.5% annual increment. Also water body declining by 43.2% within 10 years but it need other study whether the declination of this water related with deforestation or forest degradation, within 17 years, and 1684.17 hectare of farm land increase to 3405.06 hectares.

This mean 1720.89 hectare of forest change to farm land which is annual deforestation of this area is 101.2 hectares per year in average within 17 years. So if deforestation and degradation continues by this rate the remaining forest will disappear within 22 years all in all. The main cause of this deforestation is demand of agricultural land expansion , exploitation of forest for fuel wood and charcoal production and fire burning, and causes of forest degradation are mainly exploitation of forest for fuel wood and charcoal production and agriculture expansion insignificant causes.

Demand of agriculture land increase because, jobless young need land for their means of life to produce crops and also exploit forest to produce charcoal to sell in the market and get income, not only jobless need land but additional land is needed by farmers have their own farm land. Growth of town without development and growth of industrialization near this forest ,specially growth of Adulala town, causes increase number of population increase interest settlement land, and also increasing price of fuel wood and charcoal, these reason aggravate deforestation and degradation of this forest. This forest is the only forest found at this area which use as source of traditional plowing wooden materials. So all farmers from far and near exploit this forest for plowing material is other causes of forest degradation lead to deforestation gradually.

Generally when observed this highly degraded forest area there are regenerating species like Dodonia, Junipers and Oleahigh regenerating on this area ,but because of human interference and exploitation regenerating trees cannot mature and reach to high forest as previous and primary forest.

The main cause of this regeneration disturbance is agricultural land expansion , exploitation of forest for fuel wood charcoal production and plowing wooden materials, for house and other construction materials and also fire burning and livestock trampling impact on regenerating seedling. Because of deforestation and forest degradation on this area there are degradation of the land and declination of productivities of the soil and also many wild animals and water body decline in quality and quantity in this area.

5.2 Recommendation

Zeugala mountain forest is one of the main forest from remaining little central forest of Ethiopia, so these forest should be protected , conserved and managed well before disappear. Because this forest is found at the central part of the country where there is highly industrialized and has been polluted when compared with other part of country.

To protect ,conserve, manage and utilize this forest ,it should be owned firmly by one organization for example oromia forest and wild life enterprise. this organization should include this forest under its concession and just like other forest area (Cilimo, Belete Gera and Bale forest) and participatory forest management should be applied. People live near this forest should participate in protection management and utilization and on any decision of this forest

The people live near to this forest have high demand of forest to use or utilize and selling at market to get income. But the interest of the people very poor to plant tree for their utilization. So attitude of the people should be changed, because they should not deforest and degrade this forest for their utilization and mean of income, instead of cutting tree from this forest they should adapt planting tree and use their own forest to get income and utilize by developing small scale of their own forest.

Also so being this degraded open forest has good regenerating capability, if there is not negative impact interference there will be good regeneration. One of the interference has negative impact is cattle grazing in the forest on patch of open land, during rainy season trampling the regenerating seedling. So to protect this problem the people should also use grass in the forest by cut and carry system to feed their cattle and to get income should adapt producing none timber forest product like honey by adapting bee keeping activity.

Also so being this forest near to the capital city of the country and historical place Abbo church established 500 years ago found at the pick of the mountain ,if ecotourism is opened on this area good opportunity for the people live around this forest to get job, specially for jobless younger, and if the people have got job will stop participate in deforestation and degradation for their mean of life, commonly the awareness had been given to the people is not continuous until the attitude of the people changed. So continuous awareness should be given to the people for the future.

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APPENDIX

zeuqalla mountain supervized classification accuracy assesement					2000		
Count of ground_tru	Column Labels						
Row Labels	water	dense forest	farm&sette	degreded fores	Grand Total	user's accuracy%	
water	10	3			13	76.92	
dense forest		14	4	2	20	70	
farm&sette			18	3	21	85.71	
degreded forest		8	3	30	41	73.17	
Grand Total	11	26	25	35	95		
producer's accuracy %	90.91	53.85	72	85.71			
over allaccuracy %							75.8

Over all accuracy=(10+14+18+30)/(13+20+21+41) =(72/95)*100=75.8%

Kappacoeffi=((72*95)-(11*13)+(26*20)+(25*21)+(35*41))/((95²-

(11*13)+(26*20)+(25*21)+(35*41)

=6840-2623/9025-2623=4217/6402=66%

Kappa coefficient = 66%

zeuqalla mountain forestarea supervision clasification 2011 accuracy assesement							
Count of ground_thr	Column Labels						
Row Labels	water	dense forest	farm&settele	degreded forest4	Grand Total	user's accuracy%	
water	17				17	100	
dense forest	2	31			33	93.94	
farm&settele			23	13	38	60.53	
degreded forest4			3	25	28	89.29	
Grand Total	19	33	26	38	116		
producer's accuracy%	89.47	93.94	88.46	65.79			
over all accuracy%		17+31+23+25	96	96/116*100	82.76		

Kappacon=((96*116)-(19*17)+(33*33)+(26*38)+(38*28))/((116²-

19*17)+(33*33)+(26*38)+(38*28)Kappa confident=77.5

2017 zeuqalla mountain LU land cover supervised classification accuracy assesement						
Count of ground_tru	Column Labels					
Row Labels	water	dense fores	farm&settel	degredeed fo	Grand Total	user's accuracy
water	17				17	100
dense forest		22		5	27	81.48
farm&settelement		1	35	14	50	70
degredeed forest				16	16	100
Grand Total	17	23	35	35	110	
producer's accuracy %	100	95.65	100	45.71		
over all accuracy %			17+22+35+16	90	90/110*100	81.82

$$\text{Kappacoff} = \frac{(90 \times 110) - (17 \times 17) + (23 \times 27) + (35 \times 50) + (35 \times 16)}{(110^2 - (90 \times 110) - (17 \times 17) + (23 \times 27) + (35 \times 50) + (35 \times 16))}$$

$$(17 \times 17) + (23 \times 27) + (35 \times 50) + (35 \times 16))$$

Kappa coefficients=75%

No	LU land cover type	2000 in Hectare	2011 in hectare	2017 in hectare	LULC change b/n 2000&2011	LULC change b/n 2000&2011	LULC change b/n 2000&2017
1	Water body	35.64	20.25	13.23	-15.39	-7.02	-22.41
2	Dense forest	292.14	235.35	283.68	-56.79	48.33	-8.46
3	Farm and settlement	1684.17	2649.25	3405.06	964.98	755.91	1720.89
4	Degraded forest	3913.83	3020.67	2223.81	-893.16	-796.86	-1690.02
	Total	5925.78	5925.78	5925.78			

Annual average change of LULC

NO	LULC type	Annual change in hectare	Change in% Of 17 years	Annual change in % in	description
1	Water body	$-22.41/17=-1.32$	$-22.41/35.64*100=-62.88$	$-62.88/17=-3.7$	decreasing
2	Dense forest	$-8.46/17=-0.5$	$-8.46/292.14*100=-2.9$	$-2.90/17=-0.17$	decreasing
3	Farm and settlement	$1720.89/17=101.23$	$1720.89/1684.17=102.18$	$102.18/17=6.01$	increasing
4	Degraded forest	$-1690.02/17=-99.41$	$-1690.02/3913.83=-43.18$	$-43.18/17=-2.54$	decreasing
	Total land				5925.78



Water body and dense forest at top of mountain (source, photo by researcher Saturday/January/13/2018)



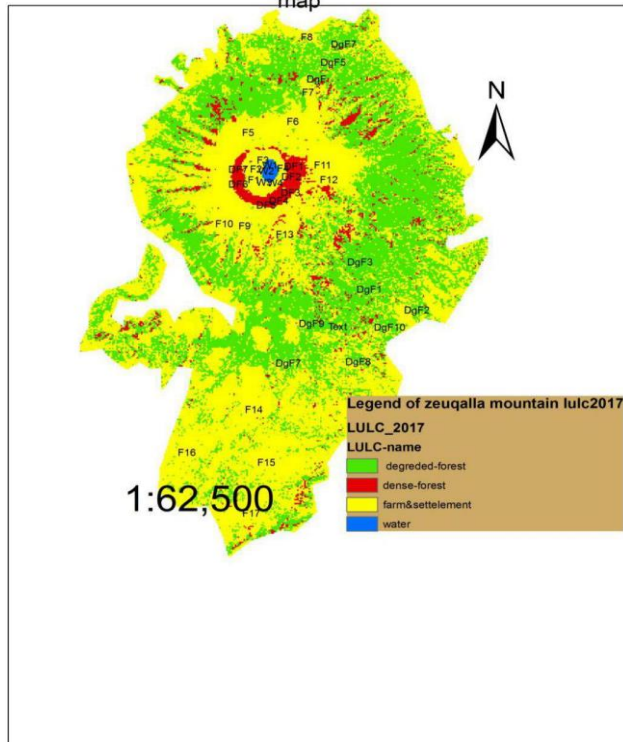
Degraded forest LULC(the area cover the major LU study area (source, photo by researcher Saturday January /13/2018)

Table 9; Zeuqala LULC classification ground reference taken using GPS coordinate reading

LULC ground reference	X-coordinate	Y-coordinate	Remark
Water body=w			LULC in hectares
W1	484058	994438	For water body LULC 13.23
W2	483979	9944307	
W3	483938	944052	
W4	484164	944033	
Dense forest=Df			
Df1	484564	944874	For Dense forest LULC 283.68
Df2	484827	944129	
Df3	484494	943805	
Df4	484551	943245	
Df5	483991	943527	
Df6	483410	944000	
Df7	483386	944324	
Farm land=f1			
F1	483718	944103	For farm land and settlement LULC(this include grass land and open small patch
F2	483911	944103	
F3	483767	944547	
F4	484328	944364	

F5	483606	945088	land found in forest) 3405.06	
F6	484552	945361		
F7	484825	946091		
F8	484844	947293		
F9	483301	943188		
F10	483113	943118		
F11	485166	944440		
F12	485295	944124		
F13	489380	942889		
F14	483728	938980		
F15	483990	937752		
F16	482847	937972		
F17	483712	936578		
Degraded forest=DgF				Degraded forest 2223.81
Dg F1	486158	941600		
Dg F2	487116	941164		
Dg F3	485988	942110		
Dg F4	485034	946355		
Dg F5	485378	946727		
Dg F6	485610	947127		
Dg F7	484463	939913		
Dg F8	485898	940012		
Dg F9	484931	940865		
Dg F10	486557	940774		
Total			5925.78	

Zeugalla mountain LULC classification ground reference point map



Questionaries

1. What did this forest look like before 20 years ?
2. Is there land of forest changed to farm land ?
3. Other than deforestation for farm land for what purpose people cut tree ?
4. From where people get fire wood and charcoal for utilization and seal ?
5. Have not people their own trees to utiliz if not why they are not plant tree ?
6. What are the effect of deforestation and forest degradation on your environment ?
7. How much wild fire effect forest ?
8. Effect of deforestation and forest degradation on natural resource eg. On water body, soil productivity , wildlife and biodiversity

Questionnaires	Main cause of deforestation and degradation			
Are there deforestation and degradation	Yes	No	I don't know	Total respondent
No of respondent	80	0		80
What are the main cause of deforestation	Respondent for three causes			
	Agriculture expansion	Charcoal production and fuel wood exploration	Fire	Total respondent
No of respondent	106	28	26	160
In %	66	17	17	100
What are the main cause of degradation	16	80	64	160
In %	10	50	40	100



Land degradation because of deforestation and degradation (source,photo by researcher Saturday January/13/2018)