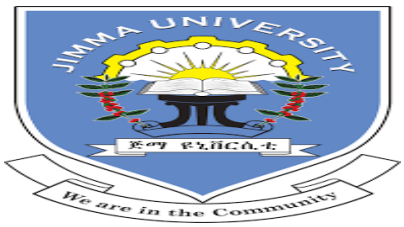

JIMMA UNIVERSITY

COLLEGE OF SOCIAL SCIENCES AND HUMANITIES

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

MASTER THESIS

ON

POTENTIAL ECOTOURISM SITES SELECTION USING MULTI CRITERIA EVALUATION WITH GEOSPATIAL TECHNIQUES:

THE CASE OF MENZ GERA MIDIR DISTRICT, NORTH CENTERAL ETHIOPIA

BY

BAYKEDAGN TAYE SHENKUT

A THESIS SUBMITTED TO SCHOOL OF GRADUATE STUDIES OF JIMMA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIRIMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN GEOGRAPHIC INFORMATION SYSTEMAND REMOTE SENSING

JIMMA

2017

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DECLARATION

This study is my original work; it is not copied and has not been submitted or presented for any academicals or other awards in any stages and university or institutions. All the sources and materials have been duly acknowledged as well.

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ACKNOWLEDGEMENTS

For the success of this work, many individuals and institutions have contributed a lot. First, I would like to thank the 'Almighty God' for giving me the life, patience, wisdom and who made it possible, to begin and finish this work successfully.

Next, my sincere appreciation and gratitude also goes to my advisors Mr. Dessalegn Obsi and Mr. Sintayehu Legesse for their valuable guide, endless support and comments in revising the work critically from the first stage up to the final. Individually, I would like to express my thanks to Mr. Dessalegn Obsi for his earnest guidance and careful training about reference and material utilization and to Sintayehu Legesse for his cooperation in sharing his knowledge and in giving reference materials during this study.

I would like to extend my gratitude to Ministry of Education and Jimma University for giving the Opportunity to study my master's degree in GIS and RS. I would like to forward my sincere thanks to all respondents from Menz Gera Midr Woreda governmental offices that cooperated with me in providing genuine data. Specially, I am highly grateful to Menz Gera midir agricultural and rural development office and to the district administration office for providing me the transport service and material like GPS and toposheet of the study area.

I am also grateful to Mr. Tale Lema and Tessema Mtikie, Menz Gera Midr Woreda Agricultural Office; Mr. Mulugeta, Menz Gera Midr Woreda Administration Office; Mr. Getacher Menz Gera Midr Woreda Culture and Tourism Office for their cooperation during my data collection.

I sincerely thank my beloved families, especially my father Mr. Taye Shenkut and my mother Ms. Beletu Ayele for them endless care and love, and sisters, brothers and relatives. You are all the reason for my success.

Finally, I thank you all my classmates, friends and colleagues who put a drop of contribution in any ways in my study.

Table of Contents

Content **page**

List of Tables

List of Figures

Abbreviations

AIANTA	American Indian Alaska Native Tourism Association
AHP	Analytic Hierarchy Process
ARDO	Agricultural and Rural Development Office
ASTER	Advanced Space borne Thematic Emission and Reflection
CSA	Central Statistics Agency
DEM	Digital Elevation
EMA	Ethiopian Mapping Agency
ERDAS	Earth Resources Data Analysis System
ETMP+	Enhanced Thematic Mapper plus
FAO	Food and Agriculture Organization
FCC	False Color Composition
GCP	Ground Control Points
GDP	Gross Domestic Product
GIS	Geographic Information System
GPS	Global Positioning System
Ha	Hectare
KM	Kilometer
LULC	Land Use Land Cover
M	Metere

MCE	Multi criteria evaluation
MCDM	Multi Criteria Decision Making
MoCT	Ministry Of Culture and Tourism
OLI	Operational Land Imager
RS	Remote Sensing
SRTM	Shuttle Radar Topography Mission
TIRs	Thermal Infrared Sensors
USGS	United State Geological Survey
UTM	Universal Transverse Mercator
WLC	Weighted Linear Combination

Abstract

Geospatial techniques are being applied in different part of the world (especially developed nation) in so many spatial related issues ranging from manual analysis up to real-time analysis in number of discipline including ecotourism.However, in case of Ethiopia their application too minimum. Ecotourism is expressed as when ecotourists are attracted to a given geographic area (i.e. space). Therefore, space is an elementary part of ecotourism activities. This spatial relevance make geospatial techniques preferable environment in this issue in order to identify the available ecotourism resources and to manage tourism activities in line with the issue of sustainability by considering different parameters. Hence, the aim of this study is to identify potential ecotourism sites in Menz Gera midir district. To this end, three criteria and five factor maps are identified, namely: landscape/land use land cover map, topography (elevation and slope map) and accessibility (road and river map). Those identified factor maps first ranked based on the expert opinion, and then the weight of influence to each was computed by pair wise comparison technique that is one of AHP method. The image classification was operated in ERDAS imagine software using supervised Image classification method. Its overall accuracy and kappa coefficient was 84% and 0.80. The result showed that11, 75.6, 13 and 0.06% is highly, moderately, marginally and not suitable area. Therefore, this study proved that the district has good ecotourism potential that can help to maintain sustainable development and the application of geospatial techniques integrating with MCE useful for ecotourism site selection. Additionally, this study may also serve as a base for comprehensive planning and complex studies in the future by incorporating additional criteria and factors.

***Key word**: Ecotourism, potential, factor, criteria, geospatial, MCE, FAO*

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the study

According to Aregawi (2016), tourism is one of the fastest growing industries that provide services and sales of goods for visitors who came from outside of the destination area for a period of more than 24 hours and less than one year. Ecotourism is one of sub branch in the field of sustainable tourism. Ecotourism's perceived potential as an effective tool for continuous improvement of development is the main reason why developing countries are incorporating it in their economic development and conservation policies. It maintains development in the community by providing different alternative sources of livelihood to local community that is more sustainable (Kiper, 2013). In recent years, Ethiopian government has formulated a series of policies for promoting national development, particularly implemented sustainable programs (Ebisa, 2016). Ecotourism is also one of the identified environmental friendly and sustainable programs.

According to Daniel (2009), Human beings starting from Romantic period have been experiencing in traveling to wilderness for the intrinsic nature of the experience. He also defined Ecotourism; as traveling to relatively condensive natural area with the particular objective of studying, appreciating, and enjoining the scenery and its wild plants and fauna, as well as any existing socio-economic or socio-cultural manifestation. Therefore, from this we understood that identifying LULC resource and potential ecotourism site a primary issue to maintain sustainable tourism development and to keep ecotourist interest by fulfilling everything in ecotourism destinations.

There is strong relationship between land cover and ecotourism. Once we identify LU/LC, we can easily know the potential resource, habitat for wild life, a pleasant place where people trust to visit, to manage and monitor the overall tourism activities, and to fulfill ecoturist interest. According to The Canadian Centre for Remote-Sensing, land

cover means that, the actual surface cover on the ground. It may be vegetation, urban infrastructure, water, bare soil. Other and, land use refer as any economical or social benefit that we gate from that actual land cover. Therefore, identifying, mapping and delineating land cover is crucial for global as well as national or regional monitoring studies, resource management and planning activities.

As Rahman (2010) clearly stated, the application of geospatial techniques have play an important role in ecotourism planning. Because these technologies are considered to act as effective tools for storing, manipulating and analyzing a great variety of spatial related data with huge attributes. However, on the contrary way he also argues that the application of this technology in ecotourism research has been minimal though it has been discussed in the tourism literature for over a decade. Similarly, Daniel (2009) in his ecotourism potential site selection study stated that, GIS has been widely discussed in environmental and resource management applications and has important role in ecotourism though it is not applied widely in this issue.

According to Aregawi (2016) and Daniel (2009), the attractions of ecotourism are primarily based on the natural environment and ecotourism differs from nature based tourism in that nature based tourism is just travel to natural areas, but ecotourism provides local benefits; environmentally, culturally and economically. For instance, while a nature based tourist may just goes only for zebra watching. Whereas an ecotourism goes zebra watching with local guide, stays for some times in a locally operated eco lodge, and contribute to the local economy and community. Ecotourism is therefore, a type of tourism that focuses on local cultures, wilderness, and adventures; a travel to destinations where the scenery, flora, fauna and cultural heritage is the primary attractions. So delineating potential ecotourism sites by considering land escape (land use land lover)**,** topography (elevation and slope) and accessibility (distance from roads and river) as criteria/ factors in Menz Gera midr district is thus helpful in tourism planning, guiding and expanding the tourism industry.

Land and its resources can be detected, mapped, managed and analyzed using remote sensing and geographic information system (GIS) techniques in conjunction with the secondary and ground truth data. Mapping helps to identify areas where environmental

and natural resources are critically located and to pass appropriate decision (Simmons, 2007).

Therefore, here the researcher has able to apply geospatial techniques in potential ecotourism site selection in the study area. Most Ethiopian research writers in ecotourism regard are highly concerned on the available local resources and select the factor and criteria based on the situation. Again, they try to relate ecotourism with urban area (like Ermias (2015) urban tourism potential of Hawasa; Suryabhagavan (2015) identification of potential ecotourism site in Hawasa town and Daniel (2009) potential ecotourism site in Addis Ababa and surrounding area). However, according to Dorobantu & Nıstoreanu (2012), among different reasons that separate ecotourism from mass tourism, it is rural based and need reduced development of tourism facilities where as mass tourism is urban based and need intensive development of tourism facilities. So, based on those facts conducting research on rural district is logically relevance. That is why the researcher selects this topic and area.

1.2. Statement of problem

As Tewodros (2014) idea, Ethiopia's wealth in cultural and natural tourism assets gave it strong potential as a tourism destination. In another way, Daniel (2009) stated that despite the strong potential that Ethiopia endowed, in terms of tourism revenue the country is rated among the lowest in sub-Saharan country. As Gomeje (2014) also, the Ethiopian highland areas are rich in endemic species of plants, birds and mammals. However, as Yilma et al (2016), Ethiopia's mountains are almost untouched in any ecotourism activities.

The problem behind the sector's poor performance has not been studied in a comprehensive way (Yabibal, 2010). For Less Developed Countries like Ethiopia the fundamental challenge is maintaining sustainable development and improving the standard of living dramatically. To achieve this promoting ecotourism is the one. Despite its increasing importance in every aspect however, ecotourism has attracted relatively little attention in the empirical literature (Meseret, 2011).

The ecotourism potential of the study area not yet mapped. So far, some researchers like Aregawi (2016), Amogne (2014), Yilma et al (2016) and Daniel (2011) tried to assess the ecotourism potential site in different part of Ethiopia by using qualitative approach dominantly. However, though their result and findings were good it lack visible decision support map. Therefore, the researcher rational behind the proposed study was the spatial dimension of ecotourism. In addition, there is lack of scientific literature that deals about the ecotourism potential in the district.

As Alemayehu (2006), more than 80 % of the data used by managers and decision maker are spatial related. However, due to lack of geospatial and related techniques mismanagement of resources is a common problem. For example, in 2016 the district tourism and cultural office was planned to give a short-term basic computer and GIS training at least for two staff member of the office with the collaboration of volunteer institute or university. However, it is not achieved as proposed. This makes the tourism planning spatially poor and lack the issue of comprehensiveness. Till now, they were not adapting incorporating spatial planning while the annual or seasonal tourism planning preparation without expecting the tourist number and the amount of income that would be collected. Ecotourism planning has also a spatial complexity and it requires reliable and up to date information about the resources and their distribution over space by considering different criteria and factors. Hence, the aim of this study was to identify the ecotourism potential sites in Menz Gera midr district, geospatial techniques with MCE method were applied.

Moreover, having resources by themselves do not mean earning benefits unless we identify the potential site scientifically to promotion and exploit efficiently, and to maintain sustainable development in every aspect.

1.3. Objectives

1.3.1. General objective

The main objective of this study is to identify potential suitable ecotourism sites in Menz Gera Midir District using geospatial techniques.

1.3.2. Specific objectives

- To create LULC map of the study area
- To identify determinant ecotourism suitability factors.
- To formulate ecotourism suitability criteria.
- To identify the potential ecotourism sites in the study area.

1.4. Research questions

The following research questions would be answered in this study.

What is the distribution of Menz Gera Midir district land use and land cover?

What are the main ecotourism suitability determinants?

Which criteria need to map the potential ecotourism site based on those factor maps?

Which part of the area has high ecotourism suitability?

1.5. Significance of the study

As Kushwaha (2008) presented clearly, GIS has been applied in so many fields like geography, forestry, urban development and planning and environmental studies. Similarly, tourism has been a subject of interest to geographers, economists, business, environmental planners, anthropologists, and archeologists. Therefore from this we can understood that both GIS and tourism share a common characteristic, that is, both cross the boundaries of disciplines and application areas. Maps of travel routes and general information about the areas to visit are used in selecting the destination and in planning travel and stay. Therefore, as objective this study set producing potential ecotourism site in the identified district. RS is one of the primary source of remote data (spatial and temporal) and GIS also has extremely powerful tools for creating new data from existing data and is often referred to as a decision support system. Therefore, the integrated application of GIS and RS in this study would provide supportive information to any concerned bodies that need spatial support decision system, from any multidiscipline tourism planer to ecotourist and guiders. Moreover, it will serve as a benchmark for other

researchers who are interested to conduct study on similar or related issues in the study area especially to know the trend of spatio-temporal ecotourism trend by applying. Finally, this study will contribute to our common understanding about the role of geospatial techniques and MCE for achieving such like spatial related suitability analysis and modeling.

1.6. Limitation of the study

In addition to identifying the potential ecotourism site in the district, assessing the general ecotourism potential of the district by comparing it with other areas, districts, zones etc could be better. However, there is no available information about their ecotourism potentiality. Due to this spatially this study is limited only at Menz Gera midir district, north Shoa zone, Amhara region. The concept of ecotourism is new at global to some extent and national level, and this type of ecotourism suitability research has been conducted first time at the study area. Therefore, the questionnaire was to some extent difficult for the participant experts to rank those questions were composed of technical words of criteria and factors for ecotourism site selection. Here, the researcher tried to direct them. Therefore, the result would not be as such objective.

1.8. Organization of the study

This study has five chapters. The first chapter deals with the background of the study, statement of the problem, significance of the study, objectives of the study, research question and limitation of the study. Chapter two covers review of related literature. The third chapter presents description of the study area and method and materials of the study. Chapter four describes about data analysis and presentations. Chapter five in turn deals with conclusion and recommendations.

CHAPTER TWO

2. LITRATURE REVIEW

2.1. Concepts and Definition of Ecotourism

However, the origin of ecotourism and its concept is not certain, since 1965, the pillar and principle of responsible tourism, the so called ecotourism have been identified. Namely: minimizing environmental impacts, respecting host cultures, maximizing benefits to local people, and maximizing tourist satisfaction (Buchsbaum, 2004). Similarly, Tewodrose (2010) also forwarded that the concept of ecotourism is one of ambiguity and dispute. There is no universal and common definition for ecotourism, nor is there a certifying agency. The concept of ecotourism mainly focused on, the inclusion of nature-based attractions, interpretation of the environment, learning experiences and ecosystem management and conservation; as secondary attractions, it also includes respect of indigenous or local cultures. In short, it is concerned with the maintenance and sustainable development of the natural environment by implementing low impact tourism and concerned with the benefit of local communities by generating revenue (Daniel, 2009)

For the definition of ecotourism, there is no clear-cut agreement between different individuals and organizations. Its terminological and conceptual meaning and uses is end by disagreements, confusion, and propaganda (Weaver, 1999). Buchsbaum (2004) by referinig different litreture argue that, there are different types of ecotourism: such has “hard vs soft”, “deep vs shallow” or “active vs passive” ecotourism. Therefore, it can be argued that, because there are different types of ecotourism, they cannot be grouped into one categorical definition. Even though ecotourism lacks a universal definition, there are many well recognized definitions forwarded by different parties and that have formed a clear picture of its core principles, which are shown in table 1.

Table 1: Deferent definition of ecotourism

Source	Definition
International Ecotourism Society (2004)	Responsible travel to a certain natural environment with the conservation ant promotion of it and sustains the benefit of local people.
Kipper (2013)	Ecotourism means that different things to different peoples. The general term encompasses nature-based, adventure, soft adventure, and cultural tourism. He also defined as; it is a unique subset of the general tourism industry in which particularly concerned on the recovery or maintenance of natural ecological systems through tourism.
Joshi (2011)	Ecotourism is travelling to relatively clear natural areas with specific objective of studying, admiring and enjoying scenery and existing features.

While there are varieties of definitions for ecotourism, each with a unique perspective and still in its infancy as global or national phenomena; however, there is considerable agreement that ecotourism must be beneficial to local communities and have a positive effect on protecting the environment. Since ecotourism is contextual, therefore, in this study it is defined as a travel to a given unique geographic area by considering the issue of sustainability, local benefit and promotion of attractive sites.

Ecotourism is a relatively contemporary issue and has emerged since the late twenty century that has dramatically captured the attention of many people and stakeholders from a variety of backgrounds (Amogne, 2014). Ecotourism has great roles in the community's development by providing alternate source of livelihood to local community that is more sustainable. It also play infinite role in resources conservation, especially biological diversity, and maintains sustainable use of resources, which intern can bring ecological experience to travelers, conserve the ecological environment and gain socio economic benefit (Kiper, 2013). Similarly, Malin Hoyme (2016) suggested that beside many Ecotourism benefits to local environments, economies and

communities, it is often used as a marketing instrument in order to promote tourism businesses related to nature. Therefore, Ecotourism believed as an effective tool for sustainable development; developing countries are trying to considering and including it in their economic development and conservation strategies (Stem et al., 2003).

2.2. Type of ecotourism

According to Amogne (2014), generally tourism as an economic activity is hard to define but easy to recognize. Therefore, as Daniel (2009) study, it is only part of the whole idea of sustainable development and it can be broadly divided as mass tourism and alternative tourism. The term mass tourism is widely used for pre-scheduled tours for group of peoples and it is entertainment oriented usually offering higher degrees of comfort and convenience regardless of any environmental effects (Erkan Sezgin and Medet Ylal, 2012). Mass tourism leads to high concentrations of people in relatively small area and in such cases; tourism often appears to be less of blessing and more of blight. Moreover, there is the danger of tourism killing tourism. Alternative Tourism on the contrary, seeks to face mass tourism from the opposite side. This involves smaller number of people as well. Furthermore, as Daniel (2009), alternative tourism has five types. These are:

Nature tourism; it involves travels to unspoiled areas to experience and enjoy nature. It is highly concerned on the utilization of natural resources in a relatively undeveloped state, including scenery, topography, water features, vegetation and wildlife.

Adventure tourism is nature tourism with a kick. This requires physical experience or skill and involves a degree of risk taking. For example, rock climbing, mountaineering and Snorkeling.

Wildlife tourism; it involves a travel to observe wild and game animals; like birds, mammals and fish in their native habitat. This includes both consumptive and non-consumptive use of wild animals. For example, visit to parks and bird watching.

Agricultural/Rural tourism is a newly emerging form of tourism where farmers offer many opportunities for tourists to find experiences closely connected with agricultural practices. For example, horseback riding and home stays.

Ecotourism can include all the above types of tourism. In addition to recreation, ecotourism should result in strong benefits to environmental conservation and the local people as well. Its activities also broadly grouped into marine ecotourism and land based ecotourism (Kiper, 2013). The marine ecotourism involves activities that are exercised associated with water bodies like sailing, yacht, power cruising and sea kayaking tours. The land based ecotourism activities also incorporate bicycle touring, mountain biking, horseback trail riding, hiking, backpacking, trekking, freshwater river rafting, canoeing and kayaking and winter tourism (back country /tour skiing, dog sledding, snow shoeing). Generally, the aim of ecotourism is to increase experiences by encouraging activities such as long-distance walking, camping, boating, hunting, sightseeing, swimming, cultural activities, bicycling, observing wildlife and nature, skiing, visiting historical places and horse riding among others.

2.3. Principles and elements of ecotourism

As Daniel (2009) clearly stated, ecotourism is often concerned with a specific tourism activity in a specific area and it is associated with natural areas on land. It also includes cultural and educative component. However, not all ecotourism has a cultural component. Therefore, from this, we can understand that identifying the available land use resources and ecotourism potential area in the given area is necessary.

As Blamey (2001) suggestion, two major components contributed to the establishment of ecotourism. First, ecotourism is linked to the environmental movement of the 1970's and 1980's. Second, there was a great dissatisfaction with mass tourism due to its overdevelopment, environmental pollution, and the invasion of culturally insensitive and economically disruptive foreigners. The result of this positive environmental awareness and dissatisfaction by mass tourism led to an increased demand for ecotourism.

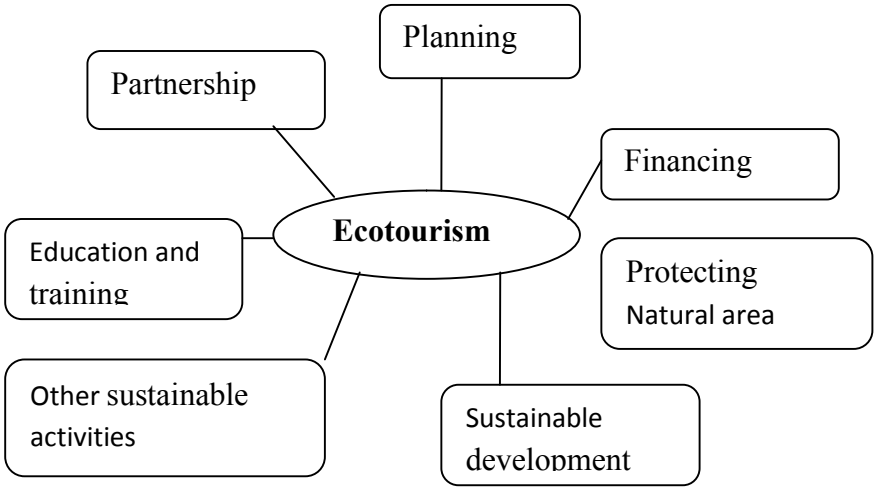


Figure 1: Figure 2.1: Essential elements for ecotourism. Source:Kipper (2013

Table 2: Principles for sustainable tourism

1.Using resources sustainably	The conservation and sustainable use of existing natural, social, cultural resources are crucial to makes long-term business sense
2. Reducing over consumption and waste	Minimization of over-utilization and waste avoids the costs of restoring long-term environmental damage and contributes to the quality of ecotourism activities.
3. Maintaining Biodiversity	Maintaining and promoting natural, social, and cultural diversity is curtail for continuous sustainable ecotourism development and create a resilient base for the economy.
4. Integrating ecotourism planning	Ecotourism development should be integrated into a national and local strategic planning framework and which undertakes environmental and social impact assessments.
5. Supporting local economies	Ecotourism should supports a wide range of local economic activities and takes environmental costs and values into account both protects these economies and avoids environmental damage.

6. Local communities participation	Participation of local communities in the ecotourism activities not only benefits them and the environment but also maintain tangible quality for ecotourism development.
7.Consulting stakeholders and the public	Consultation between the ecotourism projects with any stakeholder is essential if they are to work alongside each other and resolve potential conflicts of interest.
8. Training Staff	Personnel training can integrates sustainable ecotourism into work practices, along with recruitment of personnel at all levels, improves the quality of the ecotourism product.
9. Marketing tourism responsibly	Marketing also provides tourists with full and responsible information increases respect for the natural, social and cultural environments of destination and maintain customer satisfaction.
10.Undertaking research	Continuose research and monitoring using effective data collection and analysis is essential to solve problems and bring benefits to tourism industry and consumers in particular and to national or global economy in general.

Source: adopted from (Blamey, 2001)

2.4. Criteria for ecotourism suitability

Ecotourism contains natural areas, wildlife, and traditional cultural features. The suitability of an area for ecotourism is highly determined by the availability of natural attractions. Additionally, other attractions for ecotourism are protected areas. National parks, wildlife reserves, scientific reserves, natural monument, managed nature reserve, and protected landscapes, resource reserves, natural biotic areas and multiple use management areas are some examples of protected areas (Daniel, 2009).

Amogne (2014) in his study tries to point out some major characteristics of ecotourism by referencing different materials. Travel to natural destinations should always involve minimize the negative impacts, builds environmental awareness, brings economic benefits to local communities and generate revenues to local community living adjacent

to protected areas, local participation in decision making and planning, and increasingly relies on infrastructure that has been developed sensitively in harmony with the environment. For ecotourism site selections, there is no uniform standard in over all procedure of the operations; rather it is apply based on the nature, situation of a given geographic area. For example, according to Daniel (2009) study, in urban area may concern on the available socio-economic infrastructures, in other area the center of discussion may be the available natural and cultural aspects.

2.4.1. Landscape/LULC

Landscape represents the distribution and variation of features in a given geographic area (Suryabhagavan.k, 2015). The land cover is taken as one major parameter that affects the suitability ing in the case of study area. Land use is the way in which, and the purpose for which, human beings employ the land and its resources. Examples include farming, mining and logging. Whereas, land cover is the physical state a surface. The term originating referred to the type of vegetation that covered the land surface, but has broadened subsequently to include human structures, such as buildings or pavement, and other aspects of the physical environment, such as soils, biodiversity, and surface and ground water. Land Use /Cover mapping is useful for resources management, land use planning, land evaluation, and land use/ land cover change detection etc (Alemayehu, 2006). In order to make sample collection and classification process easy, LULC nomenclatures (identification) are required to create and define the possible LULC classes first (Zewdu, 2011).

Farmland: Agricultural land for the purpose of this study defined broadly as land used primarily for production of food and areas that is considered as irrigation areas etc. Shrub land in this study defined as land where the potential natural vegetation is predominantly shrubs and scatter trees. Forest In this study the vegetation includes natural vegetation and individual and public wood lots and roadside tree planting. Grass and pasture: in this work includes open field with grass and land used for grazing purpose. Bare land: bare land includes bare soil, rocky land that includes Exposed soils, unmaintained land.

Table 3: LULC description

LULC	Their suitability for ecotourism
Farm Land	It can be used for agro-forestry scheme, land reclamation, for agricultural use or rural ecotourism activities development.
Forest	Highly important for ecotourism and sustainable environment. It can serve as main ecotourism attraction.
Bush Land	An area which contain attractive birds, endemic mammals like chilada baboon and red fox, it have high aesthetic value in any ecotourism activities.
Grass And Grazing Land And	Is an area of grazing land and area where contain local and migratory birds can entertain and, any endemic and herbivorous animal found.
Bare Land	It can serve for a source of construction purposes and infrastructure development but Currently not suitable for ecotourism

2.4.2. Topography

Topography can be defined as recognition of physical properties and morphological status of a study area by considering different physical criteria. It also shows the differences in altitude and surface structure of any part of the earth. It also refers to various landforms (physical features) which represent the external shape of a place. For this study, elevation and slope is considered.

2.4.2.1. Elevation

Elevation, also called, altitude is the height of a place above and/or below a reference datum, such as mean sea level. Altitude, like latitude, acts through climatic conditions to exert a major influence upon the distribution and abundance of living things (Daniel,

2009). Topography influences the distribution of different natural resources, fauna and flora distribution. This intern has a direct relationship in ecotourism activities. For example, some ecotourist prefer to have a journey to high land area and to enjoy and appreciate. The other also prefers to go the low land and to show the available interesting resources and feature. Therefore, including elevations map as a factor, when preparing ecotourism suitability for a certain area become viable. There are different types of DEMs: such as TIN, contour and GRIDDED.

2.4.2.2. Slope

Slope represents the gradient of an area expressed either in % or in degree. It is computed as the vertical increase divided by horizontal increase. Slope can also be classified as gentle and steep slopes. Those experiencing little variation are gentle slopes and those experiencing extreme variations are steep slopes (Geremew, 2015).

2.4.3. Accessibility

Accessibility simply refers to the relative ease by which the location of activities can be reached from a certain area. According to Kudeep Pareta (2013), accessibility is the prerequisite for ecotourism development. Ecotourism needs fair connectivity over land. One travels from point of origin to the destination in pursue of tourism related activities. This is possible by road connectivity Good road network connectivity with proximity or nearness to scenic beauty (Like River and other natural resources) depicts a high suitability. It provides facility for easy and faster movement. In a terrain where other mode of transport cannot built, road provide the most convinces means of transport.

2.4.3.1. Road

Roads are considered as the tourism industry arteries. This system makes a communication line between destination, accommodation and natural attractions. The existence of roads in the nature leads to rupture in the landscape and reduce the apparent values for tourists.

2.4.3.2. River

Water bodies are ideal for ecotourism as they provide recreational spaces. They can be developed for tourism related activities. For example, river and riverfronts can be developed in to active sport and water based recreational site like white water rafting, fishing, and swimming and different bird watching activities.

2.5. Application of GIS and RS in ecotourism site selection

GIS and remote sensing integrally can provide useful information about the monitoring of land resources in a given geographic area at different scale. GIS has capacity and gives the opportunity to observe land use changes, visualize them, monitor them, and even forecast them (future scenario). Remote sensing also gives the ability to exquisite and extracts data through the space or air borne sensors for a real world, resulting in multispectral, multi-resolution, and multi temporal data, which is used for the creation of land use maps in every field. Like urban expansion detection, forestry, ecotourism etc (Herold, Scepan& Clarke, 2002).

GIS is a tool for making and using spatial information. It applies the power of computer to pass and answer geographic questions. Remote sensing can be defined as any process whereby information is gathered about an object, area or phenomenon without being in contact with it. Our eyes are an excellent example of a remote sensing device. Moreover, most of the time it is considered as a major source for GIS with other geo information technologies like GPS.

Therefore, the integration of those geospatial technologies can be used in ecotourism as a decision supporting tool for sustainable ecotourism planning, impact assessment, visitor flow management, and potential tourism site selection. However, GIS use RS and other geo information technologies as a data sources to perform a given operation.

The fundamental use of GIS is to collect data, perform spatial analysis, map economic values, and most importantly, GIS can combine the figure information that reflects the geographical features together with various types of attributes. The spatial analysis tools of GIS has been widely used in several ecotourism related studies, and has been proved

its efficiency to some ecotourism related issues including explore conflicts, examine impacts, and development planning. In addition, the features of remote sensing and aerial photography also widely used in the ecotourism management, primarily to see the changes in land use/land cover, from time to time, to see the impacts of activities in the given geographic area. Furthermore, some advantages offered by GIS and remote sensing also support the effort to predict and finding the potential and safe area to be developed in the future (Blamey, 2011). Kushwaha (2008) also clearly explain the nexus between GIS and its application on ecotourism by relating different spatial ecotourism activities with GIS capabilities as follow.

Table 4: Capability of GIS

Capabilities of GIS		GIS Basic Question	Ecotourism Applications
1	Location	What is at?	Tourism resource inventories
2	Condition	Where is it?	Identify most suitable location for ecotourism development
3	Trend	What has changed?	Measure ecotourism impacts
4	Routing	Which is the best route?	Visitor management/flows
5	Pattern	What is the pattern?	Analyze relationships associated with resource use
6	ing :	What if…?	To assess potential impacts of ecotourism development

According to AIANTA (2014), GIS have so many advantages to both ecotourists and for the ecotourism development authorities. For ecotourists, it help to visualize tourists site, to identify the available resources in the area they went, to organize valuable information in GIS (like videos, photos, procurers and selective information), to accesses information easily over the internet (web based GIS) and interactive maps that respond to user queries. It has also some advantages for development authorities to manage customers and toknow from where they coming from, to plan regional marketing, to infrastructure development, transportation, utilities, zoning and planning for new site selections.

2.6. Image classification and reclassification for LULC mapping

According to Genemo (2012), GIS and remote Sensing based research focusing on image classification has attracted the attention of many researchers and conducted using different classification methods and techniques. Image classification is the process of assigning pixels of continuous raster image to predefined land cover classes based on the information obtained from the district agricultural office. This process is complex and time consuming and the result of classification is probably affected by various factors (e.g. nature of input images, classification methods, algorithm, etc). In order to improve the classification accuracy, therefore, selection of appropriate classification method is required. This would also enable the researcher to identify each thing successfully. Thus, image classification at pixel level could be supervised or unsupervised. In case of unsupervised method, input from the researcher is very limited like specifying the number of clusters and labeling the classes. In this condition, the output may not be effective as the desired objective, especially for such like site selection study.

Therefore, for this study using another method is appropriate; i.e., supervised image classification method. This approach considers groups of pixels and the geometric properties of image objects. It separate the images into homogenous regions based on neighboring pixels' spectral and spatial properties. It is based on maximum likelihood classification. It is one most common and popular method of classification in remote sensing, in which a pixel with the maximum likelihood is classified in to the corresponding class (JARS, 2001).

From the various data sources used in GIS, remote sensing using satellites provide one of the most important. Image classification refers to the computer-assisted interpretation of remotely sensed images. There are two general approaches to image classification: supervised and unsupervised. They differ in how the classification is performed. In the former case, the software system delineates specific land cover types based on statistical characterization data drawn from known examples in the image (known as training sites). whereas, in case of unsupervised classification, clustering software is used to uncover the

commonly occurring land cover types, with the interpreter's providing analysis of those cover types at a later stage (Simmons, 2007).

Reclassification operation also commonly performed in Arc GIS software environment. It is a process of rearranging entities or values in to new group or categories. This process help full for replacing value based on new information, grouping entities, reclassifying values to common unit of measurement like suitability analysis. Identifying, mapping and delineating land cover and land uses are important for global as well as regional or national monitoring studies, resource management and planning activities. It also establishes the baseline from which monitoring activities and suitability can be performed and provides the ground cover information for base line thematic maps in every spatial related study (Daniel, 2009).

2.7. Multi-criteria decision making and GIS

A decision can be defined as a choice between alternatives, where the alternatives may be different actions, locations, objects, and the like. For example, one might need to choose which area is the best location or perhaps identify which areas will be best suited for a certain activities.

According to Ronald (2011) opinion, MCDM provides a number of techniques and procedures for structuring decision problems, and evaluating and prioritizing alternative decisions. Multi criteria Decision Making (MCDM) problems typically involve criteria of varying importance to decision makers. The derivation of weights is a primary step in clearing the decision maker's performance preferences. A weight is a critical step in eliciting to an evaluation criterion that indicates its importance relative to other criteria under consideration (Alemayehu, 2006).

According to Samo Drobne and Anka Lisec (2009), GIS functionality can play a crucial role in a multi criteria decision-making process. MCDM also required to select feasible alternatives and to rank them with respect to the decision-makers' preferences. This method has become important tool to pass rational decisions on an assessment of multiple decision criteria.

MCDM problems involve criteria of varying importance to decision makers and information about the relative importance of the criteria is required. This is usually obtained by assigning a weight to each criterion. The derivation of weights is a central step in defining the decision maker's preferences. As Zulaikha Hana Mohd and Uznir Ujang (2016) stated, Usually researchers make decision process by applying GIS that recognized as a decision support system which can analyze, design, evaluate and prioritize alternative decisions to ecotourism development.

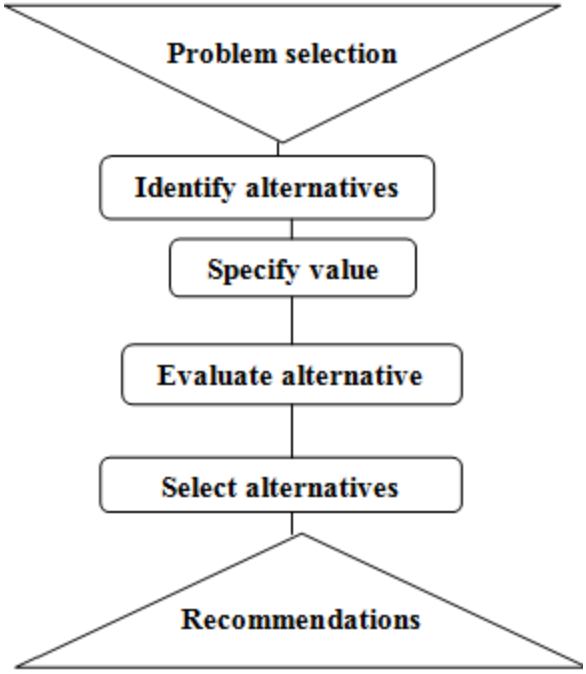


Figure 2: Framework for decision making (based on Samo Drobne and Anka Lisec, 2009)

2.8. Multi criteria evaluation

Multiple criteria evaluation is commonly use the Analytic Hierarchy Process (AHP). It is an important technique to analyses land suitability that developed by Thomas L.Saaty (1980). It also helps to capture both subjective and objective view of a decision and it is a measurement theory through pair wise comparisons in making a decision between alternatives and criteria needed to earn the scale of priorities. Decision making involves multi criteria evaluation (MCE). It used to rank and select the priority for the alternatives of a decision (Samo Drobne and Anka Lisec, 2009).

Then, make the weight normalization and calculate the consistency ratio (CR).

CR = CI/CR..... (1)

Consistency Ratio (CR) equal Consistency index (CI) /Random Consistency Index (RI).

$$CI = \frac{\lambda - 1}{N - 1} \text{.....} (2)$$

Where λthe average value of the consistency vector and N is *is* the number of criteria. The random index is the consistency index of the randomly generated pair wise comparison matrix and depends on the number of elements being compared.

Table 5: Random consistency ratio

N	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45

The scale values vary from 1 that indicates equal importance of criteria in the pair wise comparison matrix to 9 represents extremely importance of criteria in the pair wise comparison matrix. Finally, Consistency Ratio (CR) checks the accuracy of weighting process. When its result is less than 0.1, confirms accuracy of given weights otherwise, If CR larger than > 0.10, then the value of pair wise need to be repeat again in evaluation process until get the acceptable value of CR which is smaller than < 0.10 for suitability analysis.(Zulaikha Hana Mohd and Uznir Ujang, 2016).

Table 6: Scale for pair wise comparison

Scale	**Description**
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance
2,4,6 and 8	Intermediate values

2.9. The important of multi criteria evaluation in ecotourism development

Criteria/factors are needed to evaluate and measure decision making process. Decision maker can choose one or more methods from several methods to determine the weight of each factor like ranking, rating and analytic hierarchy process. For decisions making on ecotourism using AHP method factors like slope and aspect is significant for ecotourism development and could not be neglected. Other criteria/factors accessibility (river and road distance) must be considered with regard to the natural area. Therefore, to manage those criteria/factors using multi criteria evaluation make the final decisions effective and efficient (Zulaikha Hana Mohd and Uznir Ujang, 2016).

CHAPTER THREE

3. MATERIALS AND METHODS

3.1. Study area description

3.1.1. Physical description

Location

Menz is the popular name of the area and Gera Midir District is one of the districts of north Shewa zones of Amhara National Regional State. The capital of Menz Gera-Midir is Mehal Meda which lies about 265 kms NE of the national capital Addis Ababa by road and 135 Kms North of Debre Birhan; the capital of north Shewa zone. Geographically, it is located between 10°15′9′′ N to 10°30′15′′ N and 39°24′5′′ E to 39°45′′37′E (Ayele et. al., 2015). Menz Lalo Midir borders Menz Gera on the south on the southwest by Menz Keya Gebreal, on the west by the Qechene River, which separates it from the Debub Wollo Zone, on the north by Geshe Rabel, on the Northeast by Antsokiyana Gemza, and on the east by Efratana Gidim. The administrative center of this district is Mehal Meda. The district also has 21 villages (20 rural villages, and 1 administrative town) (Adisie, 2016).

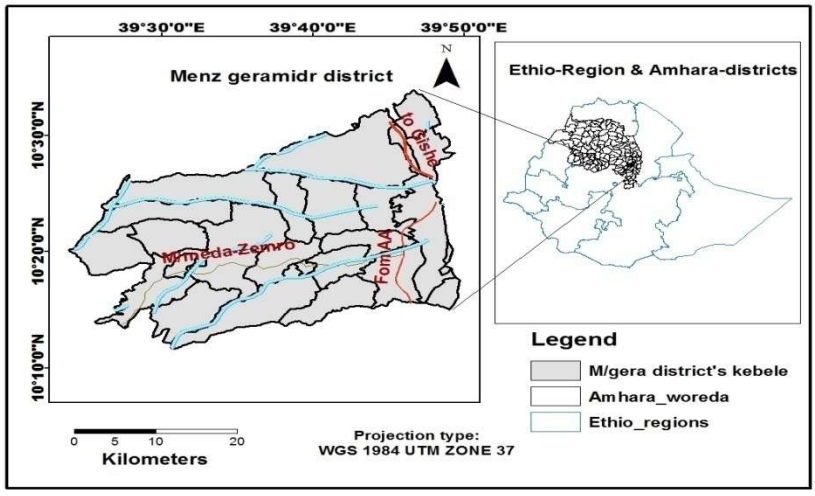


Figure 3: Map of the study area**.** Source: (Ethio_GIS, 2017)

Topography

The District has an altitude range from 1663-3564 m.a.s.l. Flat areas constitute 38%, mountain constitutes 25%, rugged areas constitute 23%, where as valleys and water covered area constitute 13% and 1% respectively of the total area of the district.

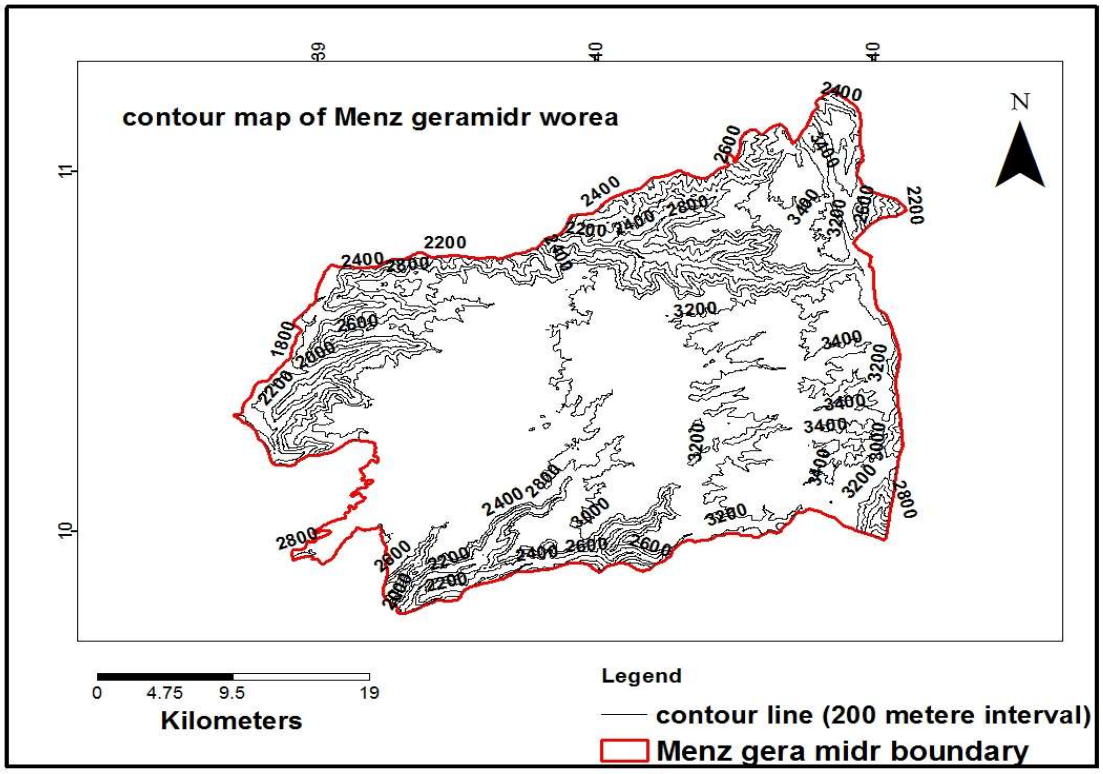


Figure 4: contour map of the study area. Source: (generated from ASTERDEM)

Climate

Agro-ecologically, the district is classified as alpine, temperate, sub-tropical and tropical. However, from these agro-ecological zones temperate and sub -tropical take more share than other does. The rainfall pattern of the district is bimodal; unpredictable in nature and its distribution most of the time extends from June to August. The equatorial Westerly's and the Indian Ocean air streams are the sources of rain for the study area at different times of the year. Though showers of light rain can occur in any month of the year, but informal there are two main rainy seasons, between June to September and minor rainy season in February, March and April. The annual rainfall at Menz Gera Midir district

ranges from 1200-1600mm. The annual humidity ranges from 55.18% - 80.90% (Ayele, 2015).

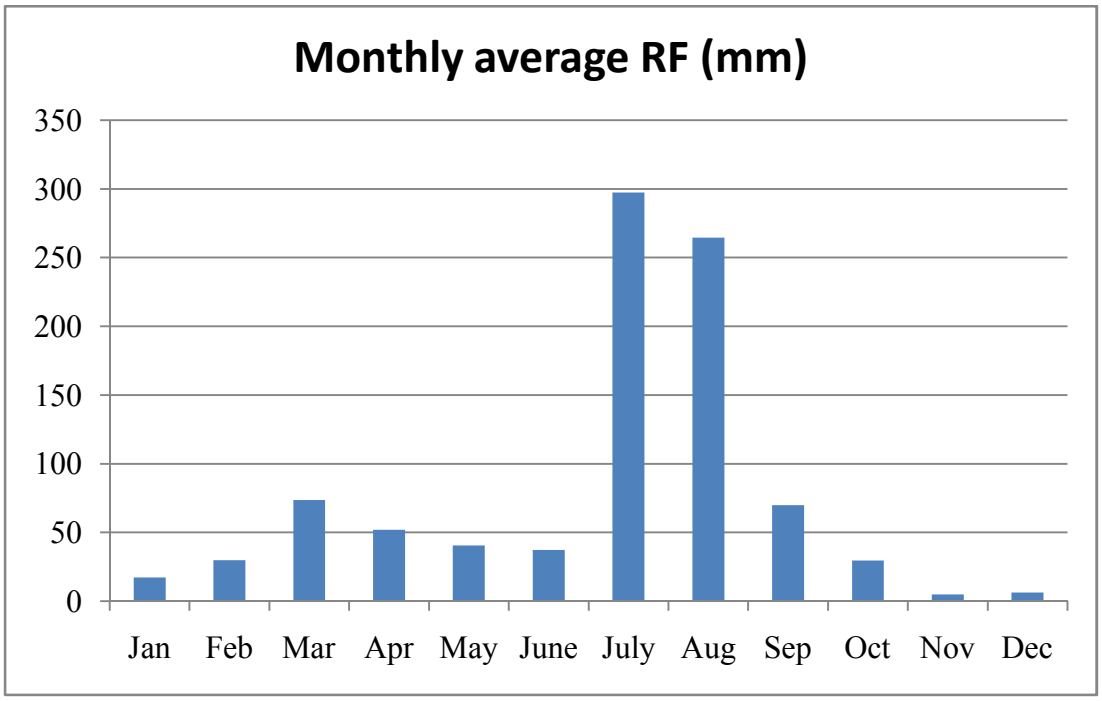


Figure 5: Annual average rainfall of the study area

Source: the district agricultural and rural development office (2017)

The mean annual temperature of the area is 12.3ºc. Mild day temperatures and cold night temperatures characterize the area. During the dry season (December to January), the temperature would rise up to 21˚C at daytime, but it falls to 7˚C at night. In the wet season, at the day time temperature is 12˚C while a night temperature is 3˚C. The area is characterized by high humidity in the wet season and low humidity in dry season (Ibid).

Table 7: Annual average temperature and rain fall

No	Month	Min To	Max To	Average TO (^{o}c)	Ave. RF (mm)
1	Jan	6.21	18.02	12.115	17.26
2	Feb	7.03	18.61	12.82	29.76
3	Mar	7.2	18.55	12.875	73.53
4	Apr	7.37	18.33	12.85	52.03
5	May	7.62	18.2	12.91	40.55
6	Jun	7.39	19.25	13.32	37.35
7	Jul	7.51	17.31	12.41	297.41
8	Aug	7.54	16.37	11.955	264.48
9	Sep	7.5	16.95	12.225	69.81
10	Oct	6.49	16.45	11.47	29.58
11	Nov	5.52	17.16	11.34	5
12	Dec	6.05	17.7	11.875	6.28
	Total	83.43	212.9	148.165	
			Mean Annual value	12.3^{o}c	900.6 mm

Source: the district agricultural and rural development office (2017)

Fauna and flora

Since the study area is located in central high land of Ethiopia commonly characterized by mountain vegetation. Like Guassa grass, Euryops-alchemila shrubland and Erica moorland, Carex monistachia, Carex fisheri, Hydrocotyle mannie and Kniphofia foliosa. Menz Gera midir district is containing the endemic mammals of Ethiopia, including the Ethiopian Wolf (Canis simensis), Gelada (Theropithecus gelada): this is the only living member of the once widespread genus Theropithecus and only found in the highlands of northern Ethiopia, the Abyssinian hare (Lepus starcki) and other potential mammal and bird species(Gomeje, 2014).

Soil and geology

Most part of the study areas are the result of tectonic movement during Oligo- Miocene. At present, the area consists of 15-26 million years old Miocene Thyolitites, basalts, and 20-26 million years old Oligo-Miocene Tarmaber basalts and Phonolites (Gomeje Amessie, 2014). According to the data (shape file) obtained from the district agricultural and rural development office, the study area has a number of soil type classes which are found in different places and agro ecologies of the district. However, the common soil types are grouped under five classes. Namely: cambisols, leptosols, nitosols, regosols and vertisols. Among these soil type cambisols has a lion share in the study area. It is a common soil type in most central part of the district.

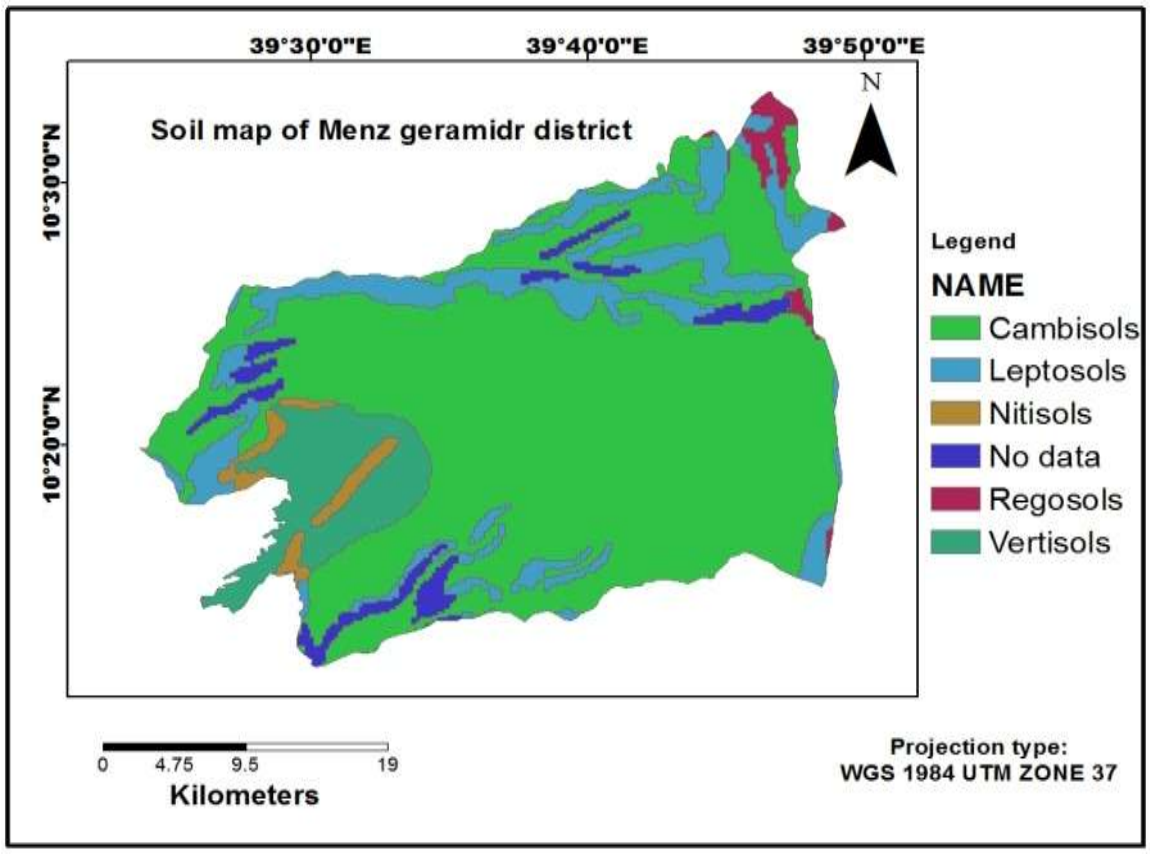


Figure 6: Map of common soil type's distribution in the district

Table 8: Common soil type distribution

NAME	Area (ha)	%
Cambisols	77228.73	70.5
Leptosols	15084.9	13.8
Nitisols	2 046.33	1.87
Regosols	1693.8	1.5
Vertisols	9065.43	8.27
No data	4421.07	4.03

As it is clearly indicated in table 7 and figure 6, the dominant soil type in the study area is cambisols that accounts for 70.5 % and 77228.73 hectare of the total soil type. It is then followed by leptosols and vertisols, which accounts for 13.77 % and 15084.9 hectare and 8.2 % and 9065.43, hector of the total soil type respectively. All other soil types, on the other hand, account for a minor %age share and coverage.

Cambisols: Characterized by Absence of appreciable quantities of illuvial clay, organic matter, Al and Fe compounds. They make good agricultural land and they are applied in a wide range of vegetation types. Cambisols with high base saturation in the temperate zone are among the most productive soils on earth more acid cambisols, although less fertile; are used for mixed arable farming and as grazing and forestland.

Leptosols: They are very shallow soils developed over continuous rock and they are soils that are extremely gravelly and/or stony. They develop on mostly land at high or medium
altitude and with strongly dissected topography. Have a resource potential for wet-season grazing and as forestland. The excessive internal drainage and the shallowness of many leptosols can cause drought even in a humid environment.

Nitisols: - They are deep, well-drained, red tropical soils with diffuse horizon boundaries and a subsurface horizon with more than 30% clay and moderate to strong angular blocky

structure elements that easily fall apart into characteristic shiny, polyhydric .(nutty) elements. They are red or reddish brown clay soils with antic subsurface horizon of high aggregate stability. Nitisols are rich in Fe and have little water dispersible clay. The deep and porous solum and the stable soil structure of nitosols permit deep rooting and make these soils quite resistant to erosion. The good workability of nitosols, their good internal drainage and fair water holding properties are complemented by chemical (fertility) properties that compare favorably with those of most other tropical soils. Nitisols also have relatively high contents of weathering minerals, and surface soils may contain several % of organic matter, in particular under forest or tree crops. They are amongst the most productive soils of the humid tropics.

Vertisols: They are churning, heavy clay soils with a high proportion of swelling clays. The climate vegetation is savannah, natural grassland and/or woodland. These soils have considerable agricultural potential, but adapted management is a precondition for sustained production. Tree crops are generally less successful because tree roots find it difficult to establish themselves in the subsoil and are damaged as the soil shrinks and swells to establish themselves in the sub-soil and are damaged as the soil shrinks and swells.

Regosols: this soil type has low productive capacity because of minimum humus (organic) content, has salty nature and consist disintegrated rock.

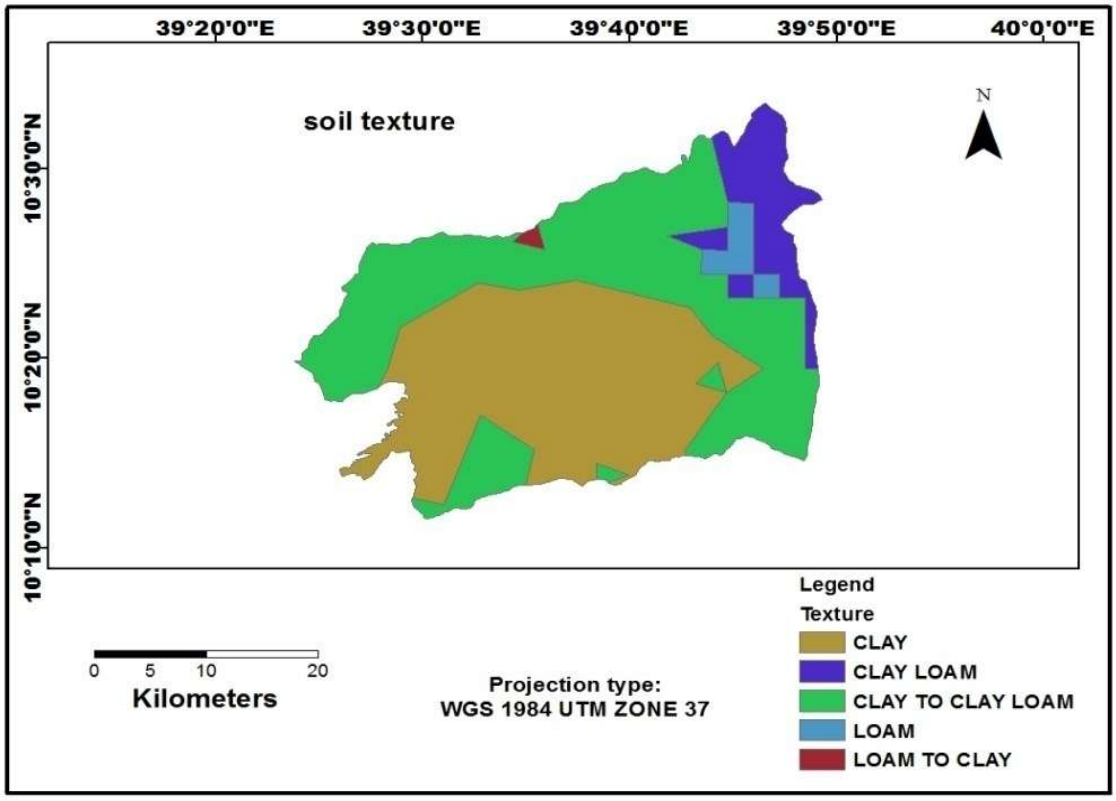


Figure 7: common soil texture in the district

Table 9: Soil texture distribution

Name	Area (ha)	%
Clay	47218.77	43.1
clay loam	9986.49	9.11
clay to clay loam	49363.83	45.06
Loam	2647.35	2.41
loam to clay	323.82	0.29

Source: Menz Gera midir district agriculture office

As it is indicated in table 8, clay and clay to clay loam type take a lion share; 43.1 % and 47218.8 hector and 45 % and 49363.8 hector in the study area. The third rank is belongs to clay loam texture type; account around 9 % and it followed by loam and loan to clay; account 2.4 and 0.2 % respectively.

3.1.2. Socio economic description

Demography

Total population of the district is estimated to be 128,068, from these 68,863 male and 59,205 females (CSA, 2007). Around 88% of the district's human population resides in rural areas. The district's population density is estimated to be about 115 person /sq.km. The majority of the population of Menz Gera Midir district is Amhara ethnic group, and the dominant religion is Ethiopian Orthodox Christian, around 99.9 % (Mulu Zegeye, 2012)

Economic activities

Almost all peoples in Menz Gera district are basically engaged on both crop production and livestock rearing. Crop production is a major economic activity of the communities. Barley, beans, wheat, peas and vetch are among different type of crops that are growing in the district commonly. Vegetables like carrot, cabbage, beat root, Swiss chard, etc are the common one and highland fruits like apple varieties (Pear Ana) are also grown in the district. The major challenges to crop production in the district include frost, an erratic rain fail, rugged topography and soil erosion. Livestock rearing also the second major livelihood options for almost all rural communities of the district. It is the source of food, income, cloth, social prestige, and sources of natural fertilizer (compost to the soil). Livestock also important means of plough, harvests, transportation for agricultural activities and human beings. Livestock population of the district is expected to be composed of 48,923 cattle, 16,790 equines, 175,856 sheep and goats, 50,778 chicken and 3,199 beehives. These all activities and things (resources) make the district mosaic of everything in addition to the community attractive culture and unique natural features (ARDO, 2017).

History

For a first time Menz is mentioned in the Glorious Victories of Amda Theydon (who ruled in the early 14th century), where it is called *"Manzehel"* and again it is mentioned

in the Royal Chronicles of Ba'eda Maryam this small province came to form the center of the self administrator Ethiopian state of Shewa. Negasi Krestos, a leading warlord of Menz province, extended his power to ward south by conquest, proclaimed himself ruler of Shewa, and defeated all of his opposite. Menz afterwards retained its identity as a sub region of Shewa. During the reign of Haile Selassie, Menz was incorporated into the province of Shewa (Huntingford, 1989).

Culture and Tourism

Menz Gera midir district peoples have their own fine culture, history and hand crafts. Their traditional villages, which are containing hubs of two storey-thatched houses, are unique in photogenic and architectural interest. Unlike other part of Ethiopia, spinning wool is an age-old tradition in the district. Until recently, the main cloth is woolen blankets, locally known as "*Bana* or *Zietett"*, worn as protection against the severe cold climate. Wool also contributes to the household economy as a readily marketable product. The local people also produce a traditional "*Burnous"* (long cloaks) which was one of the most preferable cloths by former shewa and Ethiopia kings and till now it used to advertize the manifestation of Ethiopian culture (tourism and culture office, 2017).

The study area comprises a number of natural and socio-cultural ecotourism potentials. Some of the natural attractions include parks, rivers, forests, bush and shrub lands, attractive grasslands, and mountains and unique landscapes. Endemic and unique species like *Guassa sar* (Festuaca abyssinica), red hot poker (kniphofia foliosa), *Jibra , koso, Asta* etc are from flora aspect and from fauna aspect also the district contains different endemic mammals, including the Ethiopian wolf (canis simensis), Gelada baboon (theropithecus gelada), Abysinian hare (lepus starcki) etc are again another attractions found in the study area. Other potential animals species to observe on the district different part includes spotted hyena, golden eagle ,augur buzzard (locally *Gedie*), jackal, leopard, serval cat and a number of bird species including globally endangered bird species like Ankober serine (serinus ankoberensis).

The district also has different religious and socio-cultural tourism potential site like Firkuta kidane mihiret monastery, Arbara medhanalem, cultural artifacts and tradition. All these and other attractive feature are some of tourism attraction site in the study area.

Table 10: Number of tourist vs income

Time (2016)	Local		Abroad	
	No of tourist	Income (birr)	No of tourist	Income (birr)
1st quarter	58	400	21	17200
2nd quarter	31	8700	78	4748.8
3rd quarter	11	4475	59	28125
4th quarter	121	2200	50	15100
Total	221	15775	208	107910.8

Source: tourism and culture office (2017)

As clearly indicated in the above table (table 9), the revenue that the district gained from tourism activity in the year 2016 is 123685.8 (the sum of local and abroad). It is relatively too smallest amount. From this 15775 ETB was from local tourists and 107910.8 was from foreign tourists. For this, the district tourism and culture bureau identified some problems. The major problem is absence of effective promotion at local, national and global level. For this absence of integrated human and capital resources are the challenges. Even low or no collaboration of any concerned bodies in the seasonal or annual tourism planning process also make the district low beneficiary from this environmental friendly sector.

3.2. Method

The GIS based suitability analysis method as the multi-criteria evaluation was used in this study. The various software were applied in this study for data acquisition, design, analysis and presentation of the final research results: ARC GIS 10.3 for map making and different analysis like mapping, reclassification and accuracy assessment; ERDAS IMAGINE 9.2 also employed for satellite image processing and classification; in this case Land sat 8 (OLI multispectral bands) have been used. This sensor has some improvement than others previous landsat series sensors like increased spectral information content, good geodetic accuracy, minimum noise, reliable calibration, the addition of a panchromatic band (15 meter resolution), and relatively high spatial resolution of the thermal band. The spectral bands of OLI (i.e. 1-7 and 9) are similar with the former landsat 7's ETM+ sensor, but there are some difference which have been added in OLI. The data quality (signal to noise ratio) and radiometric quantization (12-bits) of the OLI and TIRS is higher than previous land sat instruments (8-bits for TM and ETM+). Furthermore, to make the study up-to-date, the researcher also used 2017 image of the study area (raw 53 and path 168). DEM visualization for processing ASTER data, Global Positioning System (GPS) for ground control points and to record the collected data Microsoft office extensions like word, Microsoft excel were employed. Input data for this study were collected and obtained from different sources.

Table 11: Data sources

Data type	Source	Use/application
Landsat 8 (OLI, 30 m)	USGS	LU/LC map
ASTER data	GLCF	Slope, elevation and river map
Toposheet	ARDO	Road map
GPS data , Questionnaire and Digital Photo	Field survey	Accuracy assessment, ranking, and attractive photo

3.3. Data collection and tools

To get the relevant information's which have been helped to achieve the established objectives; GPS data, questionnaire and own observation would be employed. GPS data collection has been applied to operate accuracy assessment on classified land use land cover map of the study area; one of the factor map, it was classified and produced by applying supervised classification method in ERDAS imagine 2010 software.

Based on the information obtain from the district agricultural and rural development bureau and experts opinion about the variety of LU/LC in the study area, random 97 GPS points are taken. If the source image is up-to-date and acquired recently, it is possible to take GCP by executing field survey. However, to perform accuracy assessment on outdated imagery, finding a high resolution image which have been acquired at the same or closer time as reference is recommended than using GCP. Because in real world everything and features could not exist without changes at the time pass away. To collect reference data random sampling technique is best technique than other for relatively small and accessible area. In this case, all feature classes have a probability to select and the collected data could be more representative for accuracy assessment.

Questionnaire on the other hand has been distribute to 12 purposefully select key informant experts working on tourism, agriculture and land administration and environmental issues found in the district offices of Menz Gera midir, Mehal meda town. As Daniel Alemayehu (2011) idea, purposive sampling technique applied primarily when there are a limited number of people that have expertise in the area being researched. Therefore, since the issue (ecotourism) is new, environmental and tourism experts are to some extent believed to be experienced. Hence, the researcher chooses the sample based on whom they think would be appropriate for the study. The questionnaires were systematically compiled and analyzed to determine the rank of land use land cover classes and factor maps based on their suitability to ecotourism. The expert involvement in this process is needed to convert subjective relative importance of a given criteria in to linear set of weight. Field observation also applied for identifying and understanding potential ecotourism site and for recording information about different natural features

and site through simple observations by seeing their characteristics that are located in the district. The field observation also supports the researcher at the time of determining the scale of importance for factor maps using pair wise comparison technique.

3.4. Data analysis

This study was conducted using mixed approaches (qualitative and quantitative) data interpretation mechanisms. However, as the desired objective the quantitative approach is the dominant one. As clearly stated in Ermias (2015) study, applying qualitative and quantitative research design make the study and its resolute more sounder and better in quality especially for tourism related researches. In this study, the quantitative research approach employed to measures and quantifies laboratory data, the qualitative design approach was used for field observation, and other data obtained from different sources.

3.4.1. Image classification

Mapping of Land use land cover was done using a 2017 Landsat 8 image. Land sat 8 has 11 bands which are desired for different detection purposes. However, almost all of the bands from the previous landsat series are still incorporated, there are only two additional bands, such as the costal blue band water penetration or aerosol detection and the cirrus cloud masking and other applications (Kevin butler, 2013). For this study only the multi spectral bands (1-7 and 9) which are recorded by the landsat 8 OLI sensor are layer stacked in ERDAS imagine 9.2 software. The RGB combinations of different bands are also different in their areas of analysis. for example 4, 3 and 2 is natural color;7, 6 and 4 is false color; 5,4 and 3 is color infrared (for vegetation); 6,5 and 2 is for agriculture, etc. In this study, however, only bands 7, 6 and 4 (i.e. false color) were used. (See in appendix section, image of the study area in FCC with GCP's taken from the field).

There are a number of LULC classification scheme that are applied at global, continental, national and regional levels. For the seek of this study, the researcher simply selected and modified the descriptions of some of the LULC classes by considering the LULC diversity of the study area based on the information obtained from agricultural office of the district and field observation. Therefore, five major LULC nomenclatures: Farmland,

forest, Bush land grassland and grazing land and bare lands were used to produce the final LULC map of the study area.

3.4.2. Accuracy assessment

In order to determine classification accuracy, it is necessary to determine if the output map meets, exceeds, or does not meet certain predetermined classification accuracy criteria. One of the most commonly technique applied to assess classification accuracy is the use of an error matrix (sometimes called a confusion matrix). Currently, accuracy assessment is considered as an integral part of any image classification. This is because image classification using different classification algorithms may classify pixels or group of pixels to wrong classes. The most obvious types of error that occurs in image classifications are errors of omission (producer accuracy) or (user accuracy) commission (Zewdu, 2011).

Therefore, for this study the overall, user's and producer's accuracies and the Kappa coefficient were calculated from error matrices table. The error matrix was obtained from reference data (ground control point (GCP)) with the help of arc GIS 10.3 software accuracy Assessment operations; data management extensions (extract value to points, frequency and pivot table). Then, further automatic calculations were operated under micro soft 2007 extension, excel. Under the classification process by using landsat 8 image of the study area, there was a challenge of misclassification of one LULC into another due to a relative poor spatial resolution of the images and similar spectral response of different features (e.g. agricultural lands with bare field, grassland with cropland plots i.e. with agricultural lands). Therefore, to minimize this challenge the researcher executed field observation and random ground truth data collection using GPS form well known sample sites to arrive at the reasonable validation statistics. The study assessed the image classification accuracy by using 97 random GCP for all land use classes (22, 17, 22, 14 and 22 for farmland, forest, bush land, grassland and bare land respectively). The ground truth points collected during field observation for selected sample sites are presented under the appendix section.

Overall Accuracy

This is computed by dividing the total correct number of pixels (i.e. summation of the diagonal to the total number of pixels in the matrix (grand total)).

Overall Accuracy = $\sum$ Xii/N..... (3)

Where, Xii = Number of correctly classified pixels, or the diagonal value and

N= entire number of pixels in the matrix.

Producer's Accuracy

This refers to the probability of a reference pixel being classified correctly. It is also known as omission error because it only gives the proportion of the correctly classified pixels. It is calculated by dividing the number of correctly classified pixels in the class category by the total number of pixels of the category in the reference GCP data.

User accuracy

This presents the probability that the pixels in the classified image of the study area represent that class on the ground. The actual value to each class was calculated by dividing the total number of correctly classified pixels in the category by the total number of pixels on the classified data.

Kappa Coefficient

To compensate the difference in classification accuracy assessment, thought it lack practical applications in reality (Robert Gilmore Pontius Jr & Marco Millones, 2011) calculating the kappa coefficient is common in earlier studies (Daniel, 2009; Daniel, 2011; Zewdu, 2011 and Genemo, 2012). The Kappa coefficient, which measures a classification agreement, can also be used to assess the classification accuracy. It expresses the proportionate reduction in error generated by a classification process compared with the error of a completely random classification (Congalton, 1991).The kappa coefficient (K) is calculated using the information obtained from error matrix table (tables 12) and the following formula given by Congalton.

$$K = \frac{N\sum_{i=1}^{r} X_{ii} - \sum_{i=1}^{r}(X_{i+} \times X_{i+1})}{N^2 - \sum_{i=1}^{r}(X_{i+} \times X_{i+1})} \quad \text{..... (4)}$$

Where: r = is the number of rows in the matrix; Xii = is the number of observations in rows i and column i (along the major diagonal); Xi+ = the marginal total of row i (right of the matrix); Xi+1 are the marginal totals of column i (bottom of the matrix); N is the total number of observations.

3.4.3. DEM data and toposheet analysis

Slope map, elevation map and river map of the study area were generated from 30x30 meter ASTER DEM (North 10 and east 39) which was downloaded from USGS. Then by using arc GIS 10.3 software, a layer map for each prepared using the spatial analysis extension; surface for slope and elevation map, and hydrology for river map. The other factor, road map also generated from the toposheet of the study area using digitizing operation. Finally, all factor maps were reprojected to Adindan_UTM_Zone_37N and reclassified based on their suitability using "project" and "Reclassify" functions of arc GIS 10.3.

3.5. Multi- criteria evaluation

It is one of a GIS based multi criteria decision making process and practiced by defining goals, determining and standardizing criteria/factors, determining weight for each factors, aggregating the factors and by validating (Ronald, 2011). For this study, AHP technique is applied to perform multi criteria evolution as much as possible. It is also one of the common multiple criteria decision making methods.

3.6. Criteria and factor selection

To evaluate ecotourism suitability, five factor maps namely; Land use land cover map, Elevation map, Slope map, road map and river map were considered. These factor maps were selected based on their relevancy to the study area and by referring different related literature on the issue. Then these factors were first ranked and reclassified based on

questionnaires prepared for these purpose. The questionnaire was distributed to experts working on Tourism and land and Agricultural office of the district. Then ranking for those Land use Land cover class and factor maps was computed based on the statistics derived from the results of the questionnaire. According to Tewari (2010) in ecotourism site selection natural resources are higher than cultural resources. It is mainly because natural features with great uniqueness are more attractive to ecotourists. That is why the researcher mainly concerned on natural and physical feature of the study area. As far as their suitability degree concern, LU/LC with forest and vegetation is most suitable than other; higher elevation and slope, minimum distances to river and road highly suitable for ecotourism and vice versa. By considering this, they would be reclassified.

As the FAO guidelines for land evaluation clearly stated in Bunruamkaew (2012) potential ecotourism site identification study, the identification of suitable land classes based on different factors are presented as follows: a) Land suitability orders reflect kinds of suitability: S (Suitable) and N (Non suitable). b) Land suitability classes that reflects the degrees of suitability: S1 (highly suitable), S2 (moderately suitable), S3 (marginally suitable), N (not suitable). Therefore, these degrees of suitability classes have been applied in this study for analyzing land evaluation for ecotourism potential in the study area. As to be able to create realist binary classification in to “S” and “N” is not enough, more precise break is needed (Helmut Filtre et.al, 2013).

3.7. Weighted overly analysis

In some potential ecotourism site selection studies, key informant experts are involved in attractive site determination and factor map ranking (like Geremew t and Leul (2015), Bunruamkaew (2012), Daniel (2009), Ermias (2015), Suryabhagavan (2015) and other. That is why the expert participation is needed on this section.

Regard to factor maps, weight for each factor maps are assigned based on their relevance by the researcher. For this, the researcher used a pair wise comparison that is one of AHP method. Then, the prioritized factor maps (or simply factors or criterion) from highest to lowest would be arranged according to their suitability value for ecotourism. The value was derived from pair wise comparison matrix which has been computed in excel. The

process of converting data to such numeric scales is most commonly called standardization. Standardized factors are combined by means of weighted linear combination method; that is, each factor is multiplied by a weight, with results being summed to arrive at a multi-criteria solution (i.e. ecotourism potential site map).

Then finally, the ecotourism potential map is produced by using the logical formula given by Ronald (2001) in Arc GIS weighted overlay extension tool.

$$S = \sum WiXi \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where; S is suitability map

$\sum$ is sun

Wi is weight of factor and

Xi is Criterion score of factor i

3.8. Data quality assurance and accuracy assessment

Regard to the questionnaire concerned, necessary adjustment has been made to improve the questions. As far as the accuracy assessment of LULCmap concerned, by using the collected GCP the producer accuracy, user accuracy, over all accuracy and kappa value could be calculated. To determine the final value of rank and weight of each factor, pair wise comparison method is employed. To measure the degree of consistency in factor's weighting process the consistency ratio has been calculated to check whether the operation is fit the general rule of thumb or not.

3.9. Ethical consideration

Under the overall stage of this study, all research and copyright ethics are considered. In addition to the ethics on human subject's acknowledgement of data generated by others and appropriate citations of scholarly research outputs, books, websites, and any other related documents in order to assure intellectual and scientific integrity of the research/researcher has been considered.

Methodology

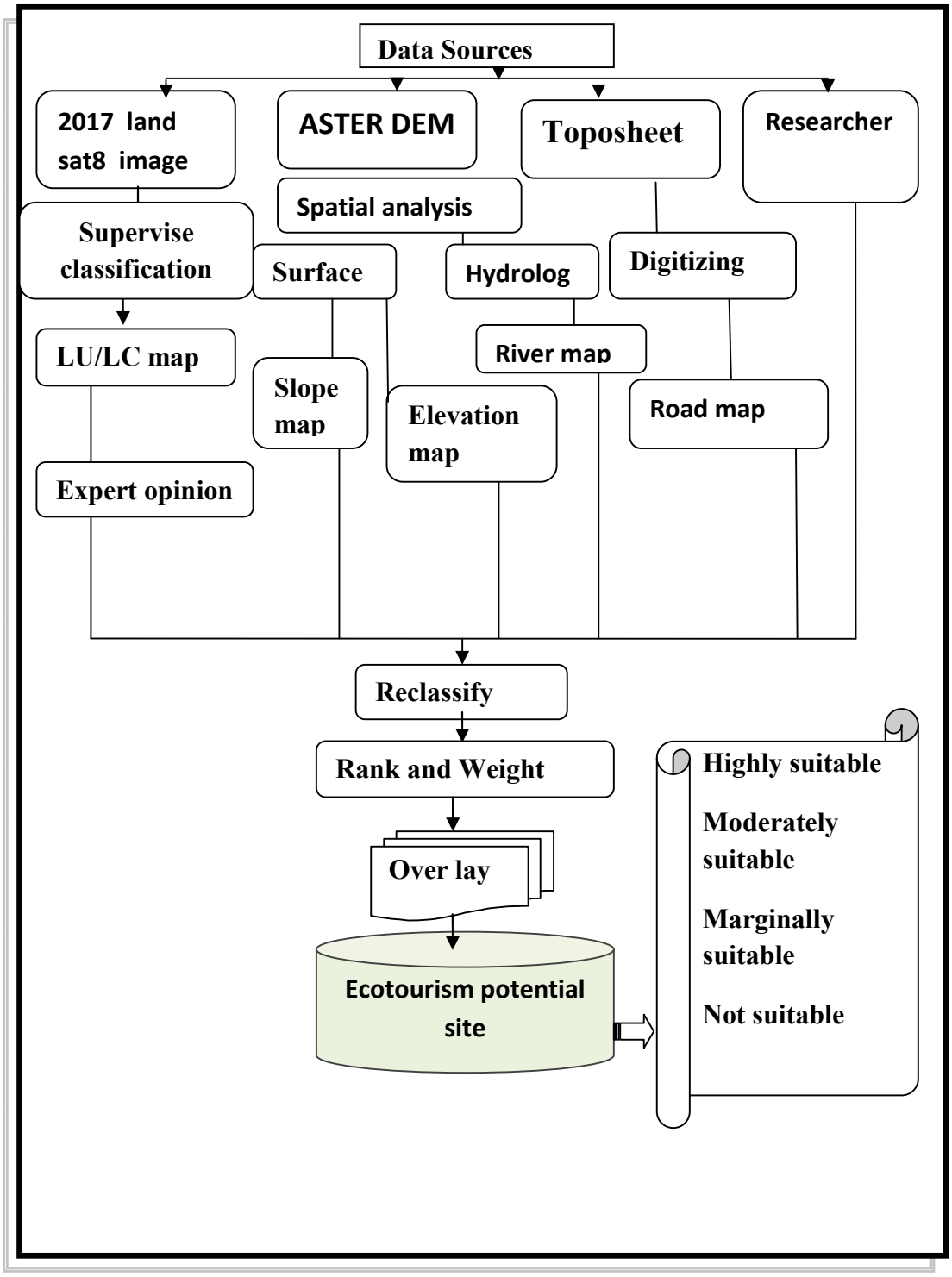


Figure 8: Research flowchart

CHAPTER FOUR

4. RESULTS AND DISCUSIONS

This chapter deals about the major findings of the study. Therefore, in this section an attempt has been made to offer detailed presentations and interpretation on factors /criteria for ecotourism suitability by using standardized remote sensing and GIS (geospatial) techniques.

4.1. Landscape/LULC

By considering the LULC diversity of the study area based on the information obtained from agricultural office of the district and field observation, using supervise classification method it was classified in to five major classes. Namely: Farmland, forest, Bush land grassland and grazing land and bare lands.

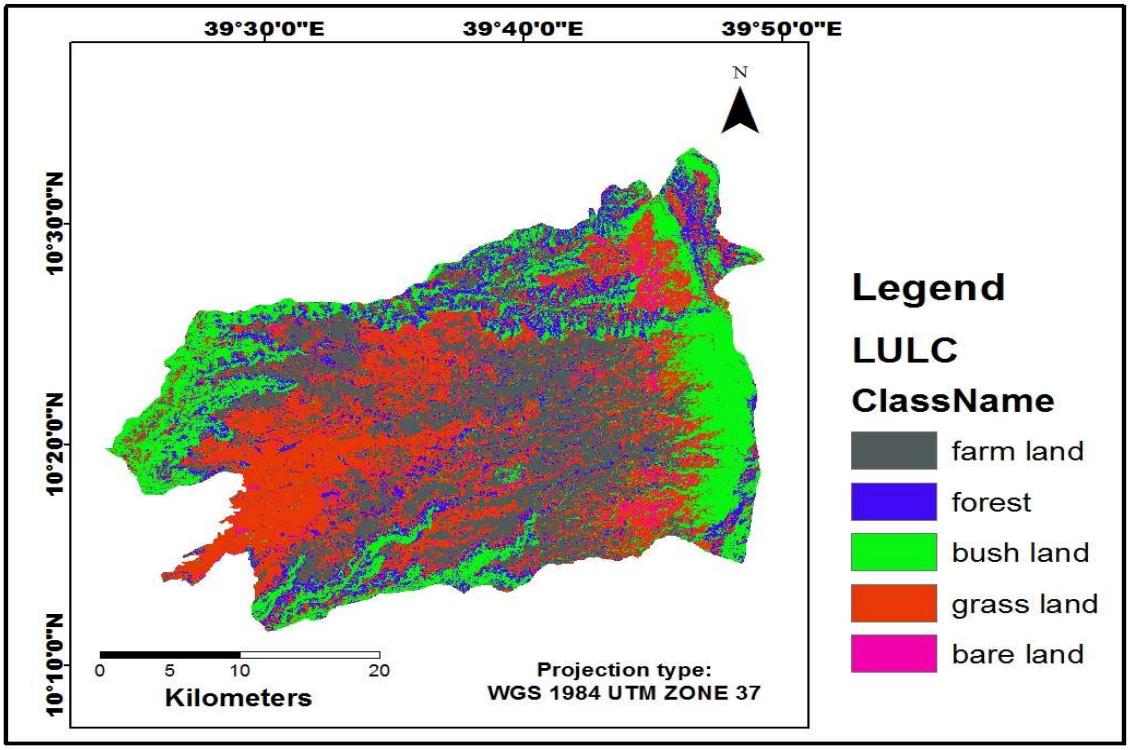


Figure 9: Land use land cover map of the study area

Land use land cover map represent spatial distribution of the land use manner in a study area. As it is indicated in the LU/LC map of the study area (Figure 10) 32.7 % (53900 ha) of the study area is covered by grassland, bush land and farmland 25, 24.2 %, 27289.8, and 26573.13 hectares respectively then follow it. Forest also take 15 % and cover 16861.6 hectares. The last share is belongs to bare land, which account 2.7 % and 3013.65 hectare from the total area of the study area. The data indicated that the proportion of land use land cover type that is highly important for ecotourism suitability covers large area. For example, forests and bush land even grasslands are highly important for ecotourism and environmental sustainability. Altogether, those features take the lion's share in the case of the study area. Other feature (bare land) is less or not important for ecotourism.

Accuracy assessment

One of the most commonly technique applied to assess classification accuracy is the use of an error matrix (sometimes called a confusion matrix).

Table 12: Error Matrix table

Class category	Reference (GCP) data						Producer accuracy %	user accuracy %
	1	2	3	4	5	Total		
Farm land (1)	**19**	0	1	0	1	21	86.36	90.47
Forest (2)	0	**15**	1	0	1	17	88.25	88.23
Bush land (3)	1	0	**19**	0	1	21	86.36	90.47
Grass and pasture land (4)	1	1	1	**12**	2	17	85.71	70.58
Bare land (5)	1	1	0	2	**17**	21	77.27	80.95
Total	22	17	22	14	22	**97**		

Source: Generated using Arc GIS 10.3 and excel

The overall accuracy under this classification is, 84 %; (82/97)*100. As clearly stated in error matrix table, lower producer's accuracy exists in the bare land class (77.27 %). The

remaining 22.73 % is omission error. This is probably due to the similar spectral properties of pixels in this LULC classes with some of others features. Like bare land similar with grassland and pastureland in dry season and form land under crop harvesting season and fallowing time may have a relative similar spectral property and make confuse the researcher to identify at pixels level. From the user's accuracy point of view, grassland and pastureland presented low accuracy (70.58). This implies that, to some extent, it is misclassified as bare land (ie.2) and other (1 for other three classes), respectively. This is probably caused by the presence of grassland and pastureland associated with other land use class in the study area and due to the GPS device low accuracy.

To this end, let see the relation between producer and user accuracy by taking grass and pasture land as an example. The probability that producer (researcher) as a grass site identified this grass site on the classified map is 88.71 %. However, when any user who will choose a grass land site on the generated map for possible decision making, the probability that this site which was identified on the map as a grass land, actually is a grass land only 70.58 %. The same is true for other categories or classes. The kappa coefficient also was 0.08. This implies that the classification was relatively good. Therefore, it become reasonable to employ the generated map for further analysis and studies; not only for potential tourism site selections but also for other studies.

The first stage in multi criteria evaluation is preparing a land use data to classify the land use and land cover according to their importance. As Tewodrose Kebede (2010) clearly stated in his study, landscape attractiveness is increase with vegetation cover. Diversity and density in vegetative communities in the landscape can produce spatial patterns that may carry higher scenic values for a visitor. Land use types would be in conflict or in line with ecotourism activities in case of a certain geographic area. Therefore, reclassifying it based on the situations is necessary.

Reclassification of land use land cover types was done based up on the relevance to the study area, expert's opinion and literature reviews. Accordingly, bush land and forestland get the first rank (i.e. highly suitable); grassland, 2; farmland, 3; and bare land four. This

is because of; in case of the study area, most ecotourism potential resources are included in the first two classes (i.e. forest and bush lands). Whatever being the case forest land is one of appealing land use for ecotourism development. In grassland also, since it is found associated with forest and bush land there are a number of endemic species. Farmland is not commensurable with ecotourism. In this case, for example, soil features can greatly affect tourist activities in tourist destinations so that marsh soils severely limit recreational activities or walking on loosely structured soils can cause severe erosion. However, since ecotourism activities in the study area is underutilized, as the researcher opinion tourist's impact on farmland may not be significant. Hence, the intention of this study is to generate ecotourism suitability map, the rank of farmland is appropriate.

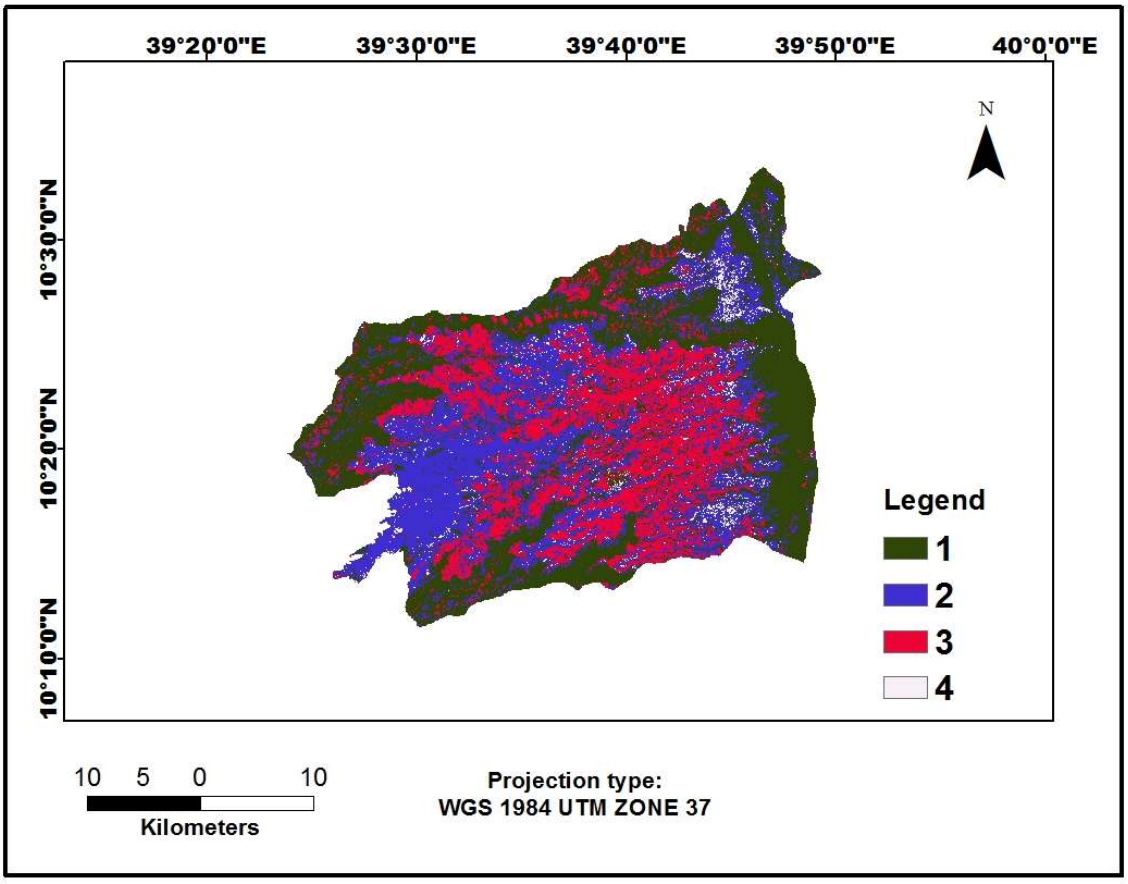


Figure 10: Reclassified LULC map

4.2. Elevation map

Elevation value of the study area ranges from 1663 to 3564m. The area found under 1663-2146 altitudinal range cover 499.41 hectare (4.25 %). It also shares the minimum coverage. The other altitudinal categories, 2145-2492 (9.6 %) and 2492_2760 (9.9) are covered 1127.52 and 1105 hectares respectively. On the other hand, when elevation increases its proportionate area shows a relative percentage increase. Elevation range between 2760 and 3002 and between 3002 and 3234 and, 3234 and 3564 for example, accounts for 32.62, 24 and 20 %, respectively.

For ecotourism suitability, highest elevation is preferable. Accordingly, highest rank was assigned to highest elevation, and vice versa. Elevation range between 3098 and 3564 is sfg\plkjhgflassified as 1 (i.e. suitable); between 2698 and 3098, 2; between 2240and 2698, 3; and, between 1663 and 2240, 4. Figure 17 depicts reclassified elevation map of the study area.

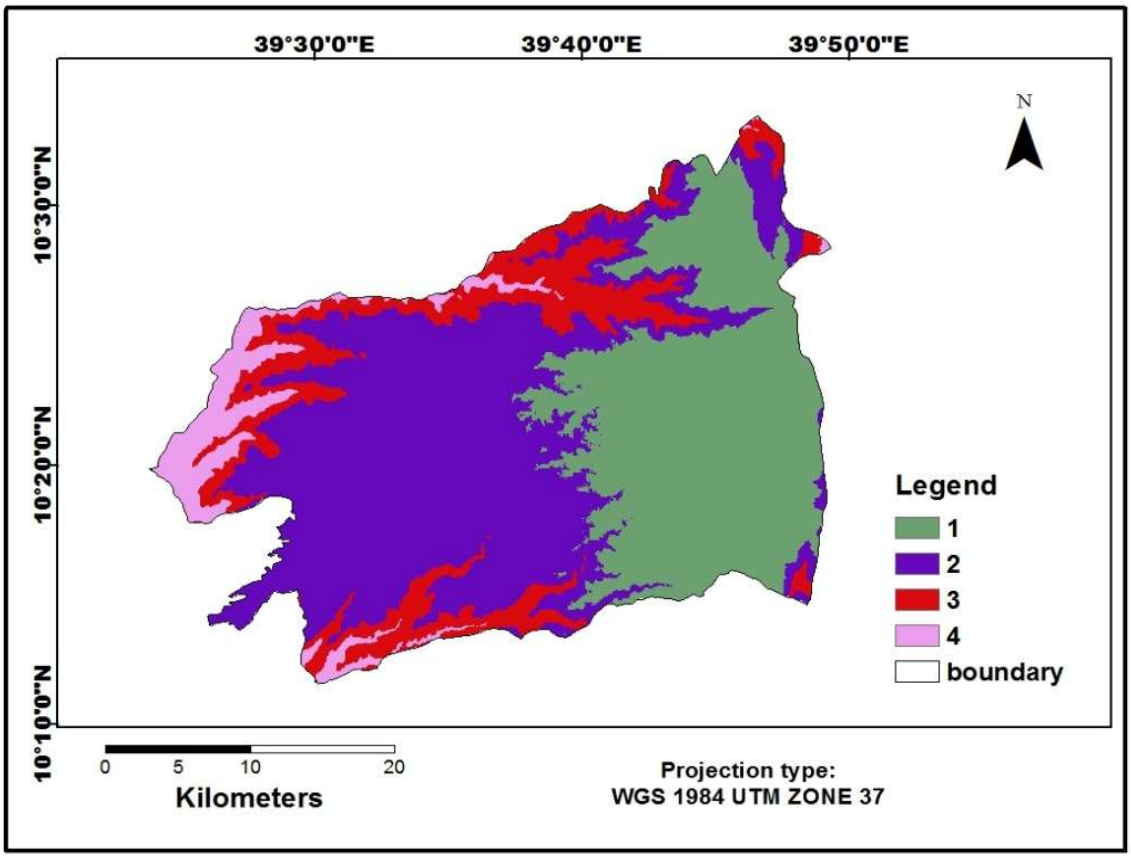


Figure 11: Reclassified elevation map

4.3. Slope Map

Slope represents the steepness of terrain features and it is calculated as the ratio of vertical distance to horizontal distance. Slope of the terrain surface can be explained by degree or percent for change of slope. Percent measurement unit explains the slope of the study area. Slope is important for ecotourism because all terrain features are derived from complex landmasses.

In case of this study, with increase in slope value there is decrease in area percentage share. The highest slope range has the lowest percentage of area share where as the lowest slope has the highest percentage of area share. For example, slope range between 53 and 100 accounts for 0.3 % 425.7(hectare) only. The other range starting from 14 and 20 up to 41 and 53 also have minimum shares. Whereas slope range between 0-4 and 4-9 account for 30.28 % (33178.5 ha) and 33.4% (36605 ha) respectively.

Since cliff and hanging wall landscape is result of steep slopes that create good scenic beauty, it is more suitable for ecotourism than gentle slope. As a result, highest rank is assigned to highest slope values and lowest rank is given to lowest slope value. A slope value between 0 and 7 is ranked as 4; between 7 and 18 as 3; between 18 and 32 as 2; and above 32 as 1.

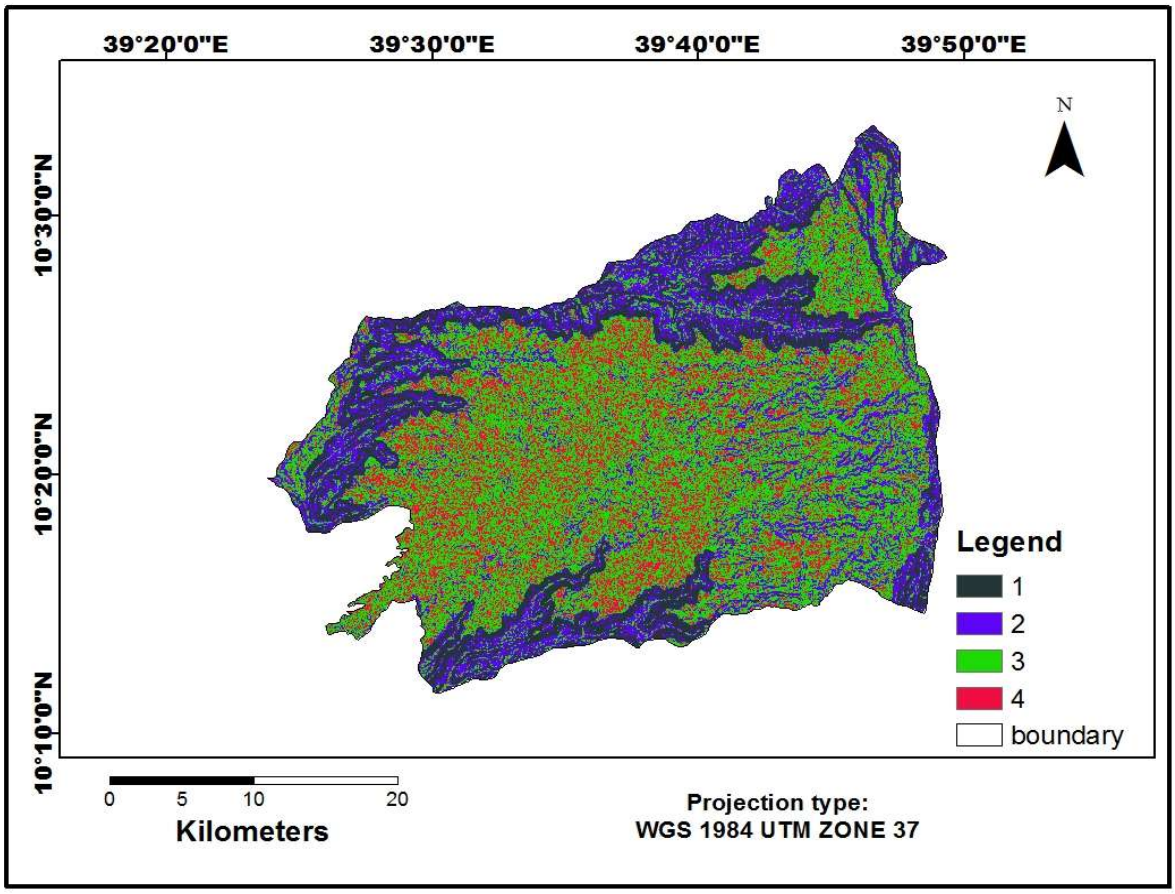


Figure 12: Reclassified slope map

4.4. River Map

Water resources play a determining role in tourist destinations. Ecotourists and peoples prefer to spend their leisure time and vacation somewhere that possibly has the closest distance from water sources such as springs, rivers, wetlands, lakes, etc. Whatever a tourist destination is closer to water resources; it would have a greater potential for ecotourism development. The areas nearest to river are account more share than the outlying. For example, 16 %, 15% and 40 % is far 0.5, 1 and 3 km from river. They

together account 61 % of the area. This show that most part of the study area is found associate with river. This also makes the area to have high ecotourism potential. On the other hand, the proportional share of remote areas is relatively low. For example the area distant up to 12 and 24 km from river is account 9.3 (10256.4 ha) and 0.4 (528.4 ha) %. River map is represented by line feature is not compatible for MCE. Firstly, the line feature should group in to buffer zone and convert in to raster feature. Then reclassified based on their suitability (Tewodros, 2010). As a result, highest rank is assigned to lowest buffer distance and lowest rank is given to highest buffer distance. Thus, the areas that are found below 1 km buffer zone reclassified as 1; between 1 and 3 km as 2; between 3 and 6 km as 3 and above 6 km as 4.

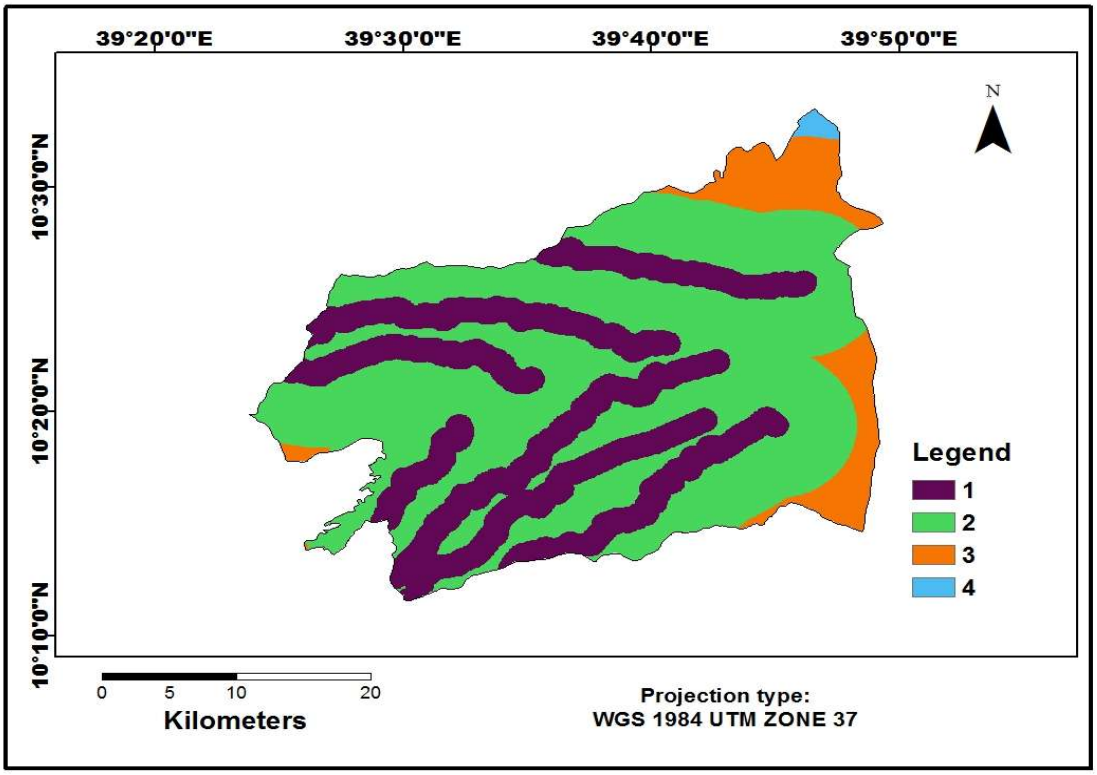


Figure 13: Reclassified river map

4.5. Road Map

Road accessibility is essential for ecotourism development. Whatever the given area has unique natural resources and features, if it is out of access extremely; its value to ecotourism development is meaningless (Geremew and Leul, 2015). Most part of the

area is found out of the road accessibility. For example, 28.9 and 4.7 % of the study area is far 12 km and 16 km from the available road. Whereas 7.98, 7.3 and 24 % of the area is located near to the road access, they far 0.5, 1 and 3 km respectively.

Ecotourism activities are not recommended in those extremely remote areas. As a result, highest rank (first rank) is assigned to nearest areas that have low buffer zone distance and lowest rank is given to remote area from road access. Thus, the areas, which are found below 1 km buffer zone, reclassified as 1; between 1 and 3 km as 2; between 3 and 6 km as 3 and above 6 km as 4.

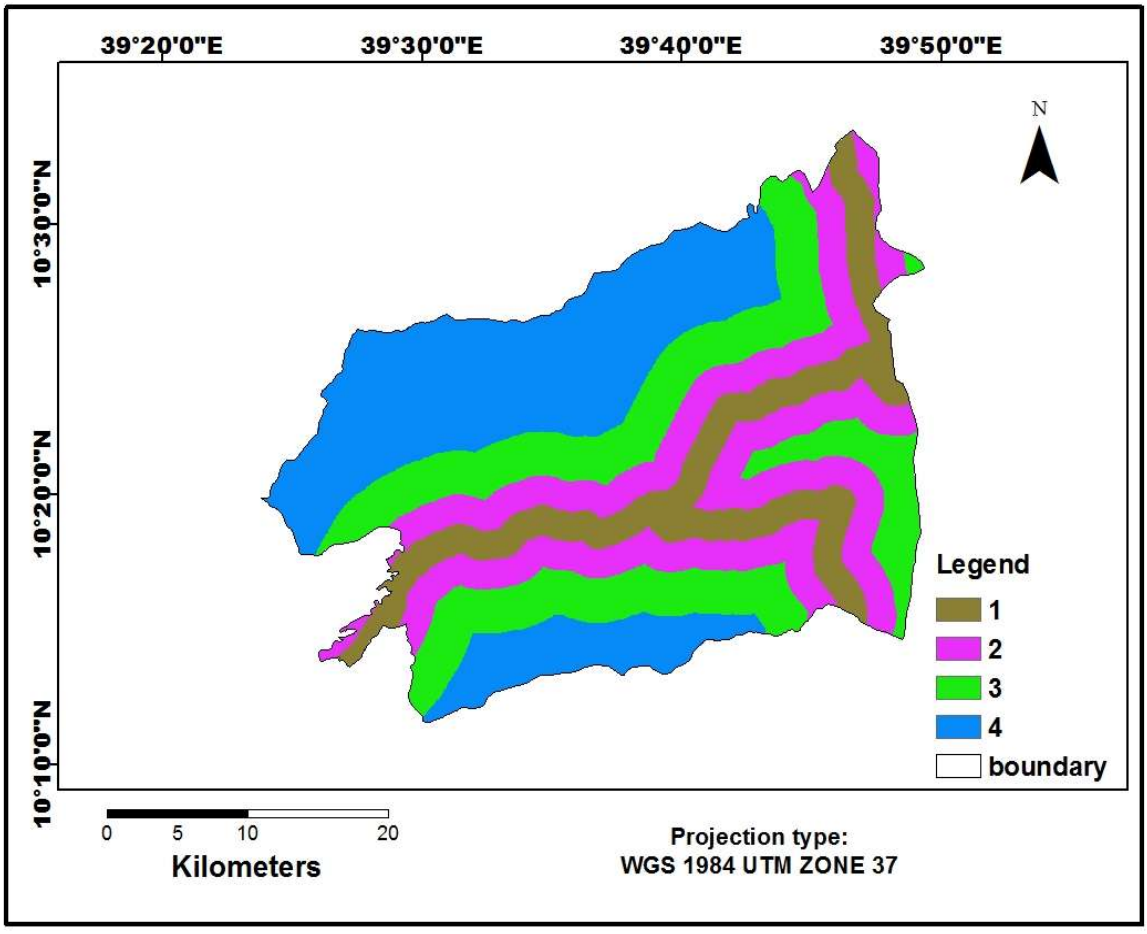


Figure 14: Reclassified Road map

4.5. Multi criteria evaluation and ranking

Twelve (six to agricultural experts and six to tourism office members) questionnaires were distributed and then, the experts rank those LULC classes and factors base on their significance for ecotourism suitability found in the study area. Most suitable classes and factor maps were given least value (1st rank) whereas least attractive sites were given highest value (5th rank). To evaluate the questionnaire a matrix was developed in which the column matrix indicates the value of rank and the raw matrix indicates list of LULC classes and factor maps. The total number of respondents to that class then multiplied values given to each category or factor map and these were aggregated for all lists of ranks. To determine the final value of rank, the number of respondents to that attraction category divided the aggregate value (total weight) of each attraction. Finally, those got minimum average weight, take the first rank and vice versa.

Table 13: Questionnaires Matrix

Possible Attractions categories	Rank					Total weight	Average weight	Class rank	Factor rank
	1st	2nd	3th	4th	5th				
LULC Map	6	4	2			20	1		1
Forest	5	5	2			21	1.05	1	
Bush Land	4	5	3			23	1.15	2	
Farm Land	1	2	3	3	3	41	2.05	4	
Grass Land	4	3	4	1		26	1.3	3	
Bare Land				1	11	59	2.95	5	
River Map	2	3	4	4		36	1.8		4
Road Map	4	4	2	3		29	1.45		3
Slope Map		1	3	4	4	47	2.35		5
Elevation Map	4	4	3	1		25	1.25		2

As the questionnaires matrix (table 13) shown, the average weight of forest, bush Land, Farm Land, Grass Land and Bare Land is 1.05, 1.15, 2.05, 1.3 and rank; 1, 2, 4, 3 and 5 respectively. Similarly, the weight and ran of those the identified factor maps is 1, 1.8,

1.45, 2.35 and 1.25 and 1, 4, 3, 5 and 2 for land use land cover map, river map, road map, slope map and elevation map respectively.

4.6. Weighted overlay, Evaluation and suitability Analysis

Assigning a weight to each reclassified raster factor map in the overlay process allows controlling the influence of different criteria in the suitability . Weighted overlay is one method of ing suitability. Arc GIS uses the following process for this analysis.

- Values in the raster's are reclassified to a common suitability scale.
- Each reclassified facto maps were assigned a weight in the suitability analysis.
- Factors were over lied: by multiplying with their respective weight and totaling the values to derive a suitability value.

Weight for each factor maps was assigned based on the relevancy to the study by considering the situation in study area and by using pair wise comparison method. As (Athanasioa kolios et. Al, 2016) idea, other quick binary approach (like Boolean analysis) all influencing factors have equal importance. However, most often criteria or factors are not equally influence the decision on a given suitability analysis. To compensate this limitation weighted overlay operation is recommended.

Table 14: Pairwise comparison matrix

	LULC	Elevation	Slope	Road	River
LULC	1	2	7	3	3
Elevation	½	1	5	3	3
Slope	1/7	1/5	1	1/3	1/3
Road	1/3	1/3	3	1	1
River	1/3	1/3	3	1	1
Sum	2.309524	3.866667	19	8.333333	8.333333

As it is indicated in the pair wise comparison matrix table 14, LULC is equal to moderate important than elevation, also very strongly important than slope and moderately important than road and river for ecotourism. Elevation is strongly important than slope, and moderately important than road and river. On the other hand, slope is moderately less important than road and river, very strongly less important than land use land cover, and

strongly less important elevation map. Road and river moderately less important than land use land cover and elevation respectively. Finally, Road and river have equal important to each other and vice versa.

To determine the weight of each factor map normalization process is needed. To normalize the pair wise matrix value (table 18), each cell value is divided by its column total (sum). Then, to get the weight of each class, the mean value of the row calculated.

Table 15: Normalization result

	LULC	Elevation	Slope	Road	River	weight
LULC	0.43	0.51	0.36	0.36	0.36	41
Elevation	0.2	0.23	0.36	0.36	0.36	30
Slope	0.06	0.05	0.04	0.04	0.04	5
Road	0.14	0.08	0.12	0.12	0.12	12
River	0.14	0.08	0.12	0.12	0.12	12

Consistency ratio=0.021 < 0.1 (acceptable)

Therefore, the weights of land use-land cover map, elevation map, slope map, road and river map is 41, 30, 5and 12 respectively. Accordingly, the prioritizing of factor maps from highest to lowest is as follows: Land use land cover map, elevation map, road and river map, and slope map. The final ecotourism suitability map was then computed by multiplying each factor map layer by their respective weight in arc GIS 10.3 software extension, weighted overlay.

Finally, the ecotourism Suitability map = 41 (land use-land cover map) +30 (elevation map) +5 (slope map) + 12(road map) +12 (river map)

Weighted Overlay is a technique for applying a common measurement scale of values to create an integrated analysis. It is common in such Geographic problems that often require the analysis of many different factors.

While running the suitability using a weighted overlay, the cell values of each input factor maps are multiplied by the estimated weight (% of influence). The resulting cell values are added in order to generate the final output raster. The value

"1" indicates the highly suitable site whereas the value "4" indicates not suitable site. Finally, raster of overall suitability is created with four suitability classes; highly suitable, moderately suitable, marginally suitable and not suitable.

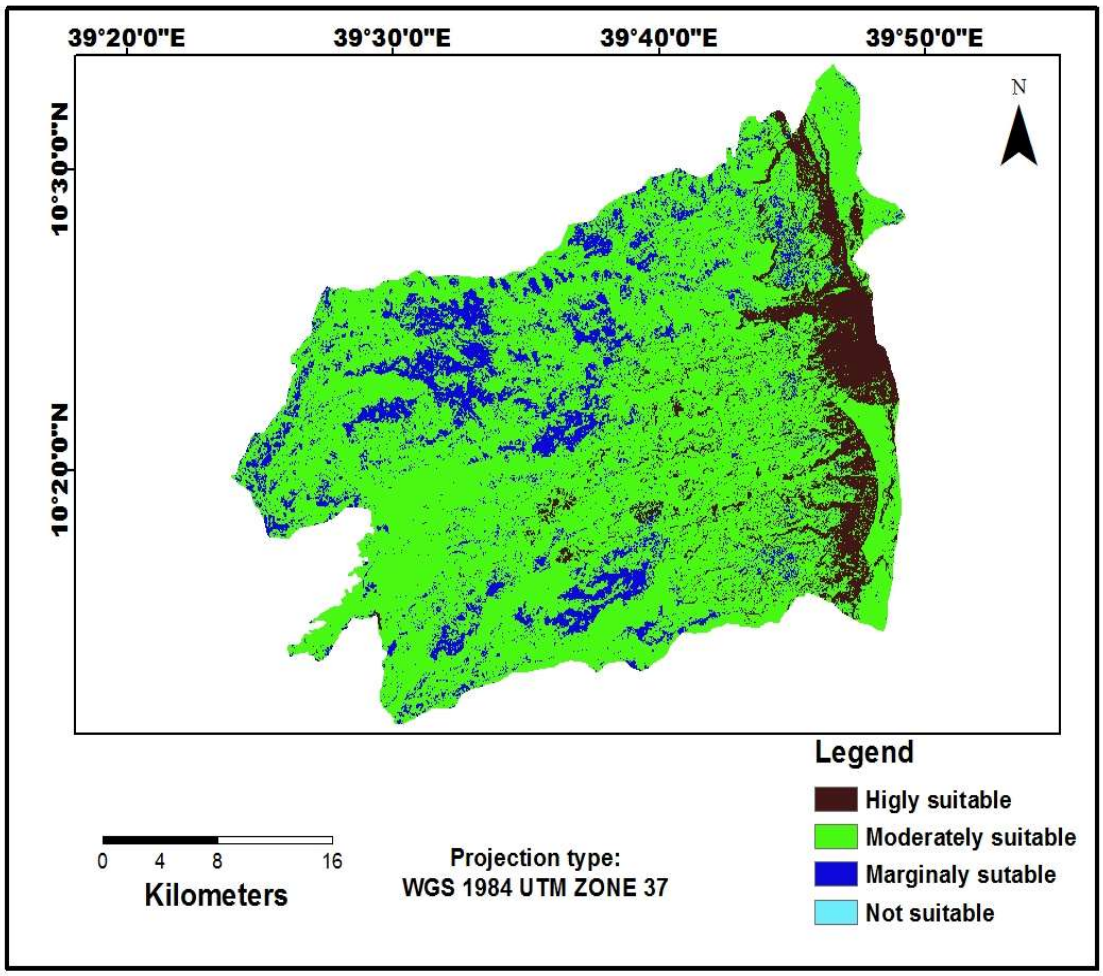
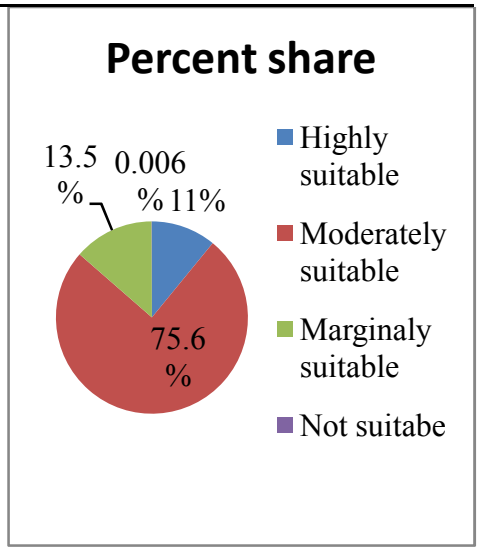


Figure 15: Ecotourism suitability potential site map

Table 16: Ecotourism sites percentage share

Suitability class	Area (ha)
Highly suitable	11908.44
Moderately suitable	82613.79
Marginally suitable	14742.54
Not suitable	6.84



As it is shown in the table 16, out of the total study area 11 % (11908.44 hectare) is highly suitable area for ecotourism and environmental sustainability under the current situation. As Suryabhagavan (2015) idea, the ecotourism processes is highly maintained by natural species and features diversification. Therefore, based on the identified factors and criteria this site contained most ecotourism potentials and considered as the first ecotourism related recreational and development site. The moderately suitable sites also account around 75.6 % (82613.79 hectare). This implies that if there is a comprehensive and participatory ecotourism planning with in short period of time most part of the study area can be suitable. The rest marginally suitable areas also account 13.5 % (14742.54) of the district, which is mainly lied on most part of farmland; this is the area where almost all local community found. Such areas have a great potential, if they get a due attention from any concerned bodies, to maintain sustainable ecotourism development and to make the local community more beneficiary.

Nahid Almasi (2011) also acknowledges that, relating ecotourism activities with the local community day-to-day activities have a power to maintain sustainable development. As identified by different writers (Amogne, 2012); Dasenbrok, 2002; Ngece, 2002; Lowmen, 2004 and Weggoro, 2008) due to low living standard in villages the presence of ecotourists and ecotourism activities can contribute to economic and livelihood

diversification for local communities by creating new jobs, employment opportunities, development of infrastructure etc. The other 0.006 % or 6.84 hectare of the study area also considered as not suitable site. It is insignificance in its share but this indicates the area is less important for environmental sustainability and ecotourism activities. Thus, it requires impact assessment and environmental management. Moreover, the area can serve as a source of raw material for infrastructure development.

4.7. Discussions

According to Daniel (2011), for ecotourism suitability mapping considering natural factor and criteria should come first. Other socio-economic variables become better for further study about the impact of ecotourism and related activities in a certain area. Therefore, in case of this study, by considering the nature of the study area and the available information, time and resource, the researcher tried to include three criteria and five factor maps. Namely landscape (land use land cover map); topography, (elevation and slope map); and accessibility, (road and river map. MCE is done based those factor maps to produce the potential site suitability for ecotourism.

The result depict that, highly suitable areas in the study district that where covered by forest and bushes, found near to river and road, and characterized by highest elevation and slope ranges. For example, Some of earlier studies (Daniel, 2009; Sridam Samanta, 2015 and Tewodros ,2010) suggest that, The higher elevation range, vegetation cover, convexity and concavity generate undulation in slope profile that appears visually attractive to observers across a wider geographical area. Areas with short distance from river and road network also have higher suitability value for scenic attraction than other because such type of land feature is not existed everyplace.

As it is indicated in figure 21 most part of the highly suitable area lies in eastern part of the study area. On the other hand, the map shows that, even though their proportion is relatively insignificant, the suitable sites are lies in the central part of the study area. As identified by different researcher so far, (Sridam Samanta, 2015; Daniel, 2009 ; Geremew and Leul, 2015) areas where satisfies almost all criteria are grouped under the highly suitable class. Specifically, Anazsted, Guassa community based conservation area, wojed

forest and ridge topography, Siregedel plateau and attractive land features and upper gorges of Shay and Wizar River, and around Mehal meda are among the highly suitable sites in the study area.

In the case of second class, moderately suitable is the suitable capacity of sites with medium and satisfies most of the criteria set up, but some criteria are not satisfied. For a surprise most part of the study areas are incorporated under the moderately suitable category. Almost all southwestern and central part of the district has moderate potential for ecotourism and related activities. Those grass and open communal land area like Amed guya, some part of Guassa areas and Quangue area grouped under the moderately suitable areas.

The marginally suitable site is area with low suitability and satisfies some of the criteria set up, but most of the criteria are not satisfied (Sridam Samanta, 2015). Thus, in this study the marginal suitable sites are found dispersedly in northern and southern part of the study area. However, the proportion of not suitable site is almost insignificant in all part of the study area. In this case, we can understand that not all of criteria are satisfied. According to Geremewu and luel (2015), areas with some deterioration condition have not suitable for ecotourism development. Likewise, in case of this study these sites are areas with degraded environment like that of bare land.

Moreover, the result indicated that 11 % of the study area was highly suitable for ecotourism and environmental sustainability under the current situation. As compared to other researcher findings; Denial (2009) (11 % highly suitable), Ermias (2015) Geremew and Leul (2015) (14 %), the potential site in the case of the study area is relatively good. The geospatial techniques are a great tool for analyze and for generate planning support in space as proved by this study finding.

CHAPTER FIVE

5. Conclusion and Recommendations

5.1. Conclusion

This study attempted to develop ecotourism suitability map that further support decision making process in Menz Gera Midir District; one of the district of North Shewa zones of Amhara National Regional State. Beside this, the study also intended to identify the controlling factor and to formulate criteria in order to produce potential ecotourism map. Namely: landscape (LULC map), topography (elevation map and slope map), and accessibility (road map and river map). In order to arrive at the final stage geospatial (GIS and RS) techniques were applied dominantly with multi criteria evaluation.

The study also shows that, LULC map (41%) and elevation map (30%) have more influence on the generated ecotourism suitability map, followed by river and road map (12% to each), and slope map (5%). The land use land cover map of the study area that is one of the factor maps was derived from Land sat 8 satellite imagery is classified in to five classes by using supervised maximum likelihood image classification method. Namely: Farmland, forestland, grassland, bush land and bare land, they account 24.23, 15.37, 32.7, 24.89 and 2.7 % of the study area. Then it could be reclassified based on the relevant to the ecotourism suitability map. This process is the same to other factor maps.

The study has demonstrated the application of geospatial techniques and multi-criteria decision-making role in solving a spatial problem of selecting suitable sites for ecotourism development and for minimize mismanagement of resources in Menz Gera Midir district; based on the stated objectives and criteria/factors for the identification of potential ecotourism sites. The advantage of applying MCE with geospatial techniques as a methodology is that suitability analysis can easily performed on the results by employing graphical user interface, which allows the decision maker to decide and further it help to produce visible decision support material for ecotourism and environmental planner in particular and for any concerned bodies in general.

Based on the output of this study, it was found that the Woreda has a potential for implementing wind farms to generate power. This will bring environmental sustainability and improve the socio-economic benefit of the local community by helping the decision maker to have integrated, comprehensive and scientific information about the environ.

Generally, this study finding proved that since ecotourism is an activity that strongly implies the geographical dimension and geographic information system is a technology specifically developed for the management and study of spatial phenomena. The criteria and factors for potential ecotourism site selection and for sustainable development of ecotourism's activities, resources and facilities managements are further identified and enhanced by GIS based MCDM approach. Therefore, this methodology is applicable and

5.2. Recommendations

This study tried to generate potential ecotourism sites map by considering physical criteria and factors. Therefore, In order to make those identified site suitable destination for tourists and to contribute something for the local community, it should linked with the construction of infrastructure such as roads , and of tourism facilities, including resorts, hotels, restaurants, shops and by inviting and motivating different investors and individuals.

Multi-criteria evaluation has a nature of subjectivity at the time of choosing criteria/ factor and defining weight for each factor maps. To minimize this, the process should be more participatory as much as possible as the time and available resource allows. Here again the researcher recommended that further studies should include the opinion of tourists themselves in addition to the expert and researcher opinion.

The district and any concerned bodies tourism and environmental planner should consider such like spatial decision support system to improve the quality of ecotourism potential sites and to maintain sustainable development.

Further studies should observe the distribution of potential ecotourism resources in every aspect to assess to potential of the district by using such like study as empirical evidence and by adding some criteria and factors, especially from socio- cultural aspect. Moreover, here the researcher recommends that to promote and generate tourist guide map and manage tourism resource applying geospatial techniques are effective.

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APPENDIX

a. QUESTIONNAIRE

The aim of this questionnaire is to gather information about Menz Gera Gidir district, regarding ecotourism attractions and it also aims to determine the rank of those illustrated alternative based on their degree of attractiveness. Since your response is valuable for the mentioned objective, the writer kindly requests you to give your answers to the stated questions as much as possible as you can honestly. It will be processed in computer in such a way that no personal identification will be possible.

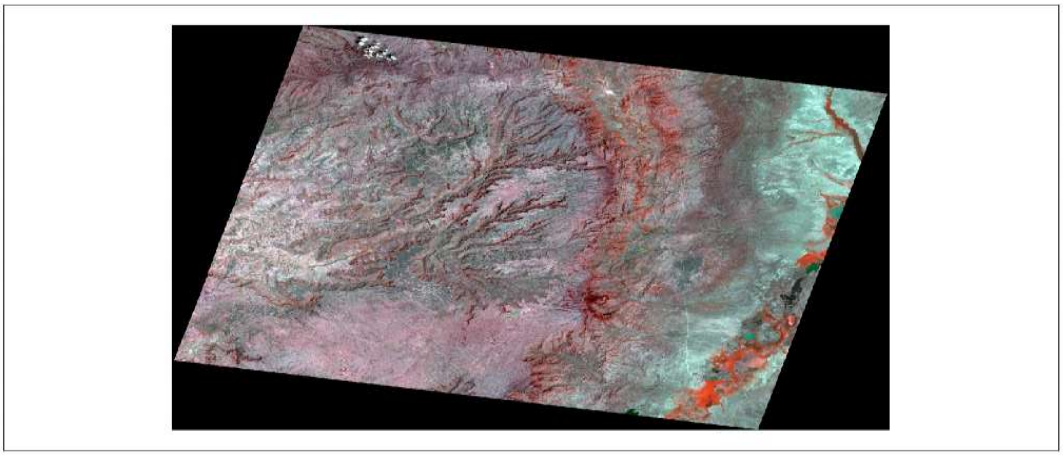
I greatly appreciate your cooperation in advance!

Please rank these attractions according to their degree of attractiveness (give least number for example 1- to the most attractive site, and highest number to the least attractive site). Put a 'thick mark' on the class or factor base on their relevance to ecotourism and site selection.

Possible Attractions categories	Rank				
	1st	2nd	3th	4th	5th
LULC Map					
Forest					
Bush Land					
Farm Land					
Grass Land					
Bare Land					
River Map					
Road Map					
Slope Map					
Elevation Map					

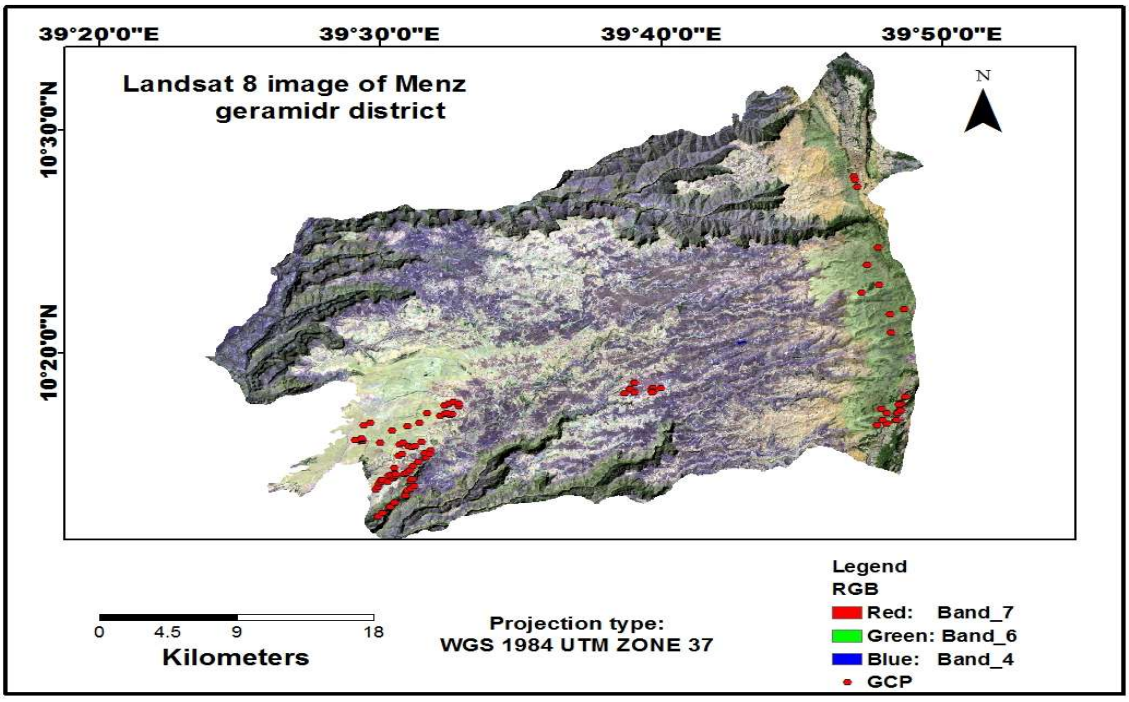
b. Raw Satellite Image

Space craft Id	Landsat_8	Cloud Cover	0.03
Sensor id	Oli and Tirs	Cloud Cover Land	0.03
Path	168	Image Quality Oli	9
Row	53	Image Quality Tirs	9
Date Acquired	2017-02-11	Tirs Ssm	Final



Source: downloaded from earth explorer freely (2017)

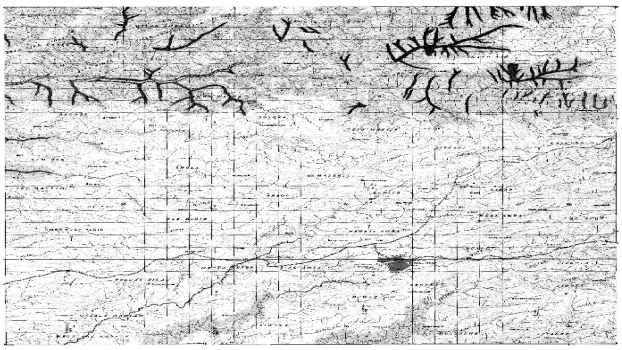
c. Landsat 8 Image of The Study Area With GCP In FCC



D. DEM raw data

Data Set Attribute	Attribute Value
Entity ID	ASTGDEMV2_0N10E039
Agency	NASA/METI
Acquisition Date	2011/10/17
Vendor	NASA/METI
Map Projection	GEOGRAPHIC
Sensor	ASTER
Resolution	1 ARC-SECOND
File Size	21106330
Sensor Type	GDEM
Ellipsoid	WGS84
Units	DEGREES
Version	2.0
Product Format	GEOTIFF

E. Toposheet of the study area



F. Ground control points

FID	code	POINT_X	POINT_Y	class name	class id	FID	code	POINT_X	POINT_Y	class name	class id
0	1	554470.4	1131104	farm	1	49	3	587859	1145656	Bush	11
1	1	554623.6	1131328	farm	2	50	3	587927.9	1144088	Bush	12
2	1	554735.5	1131570	farm	3	51	3	554659.6	1128905	Bush	13
3	1	554818	1131734	farm	4	52	3	554941.5	1129137	Bush	14
4	1	554847.4	1131864	farm	5	53	3	555386.3	1129650	Bush	15
5	1	554953.4	1131876	farm	6	54	3	555737.1	1130064	Bush	16
6	1	555330.4	1132241	farm	7	55	3	556444.9	1130621	Bush	17
7	1	555489.5	1132324	farm	8	56	3	556526.4	1131060	Bush	18
8	1	555666.2	1132371	farm	9	57	3	556795.7	1131166	Bush	19
9	1	556302.3	1132382	farm	10	58	3	556946.1	1131379	Bush	20
10	1	556508.5	1132488	farm	11	59	3	556758.1	1131793	Bush	21
11	1	556691.1	1132689	farm	12	60	3	556845.8	1131943	Bush	22
12	1	556897.3	1133072	farm	13	61	4	555292.3	1131774	Grass	1
13	1	557262.5	1133431	farm	14	62	4	555611.8	1132006	Grass	2
14	1	557745.5	1133784	farm	15	63	4	555712	1132193	Grass	3
15	1	557686.6	1134102	farm	16	64	4	555774.7	1132244	Grass	4
16	1	558016.4	1134350	farm	17	65	4	555793.5	1132356	Grass	5
17	1	557981.1	1134067	farm	18	66	4	555718.3	1132926	Grass	6

18	1	570669.2	1139068	farm	19	67	4	554766.1	1134994	Grass	7
19	1	571013.6	1139403	farm	20	68	4	555530.4	1135983	Grass	8
20	1	571281.5	1139154	farm	21	69	4	557334.5	1136610	Grass	9
21	1	571252.8	1139948	farm	22	70	4	556570.2	1136359	Grass	10
22	2	556064.5	1134847	Forest	1	71	4	557829.3	1137374	Grass	11
23	2	556234.9	1134955	Forest	2	72	4	554164.8	1136629	Grass	12
24	2	556637.6	1134692	Forest	3	73	4	553644.8	1135075	Grass	13
25	2	558976.5	1138022	Forest	4	74	4	553569.6	1135275	Grass	14
26	2	559255.3	1138208	Forest	5	75	5	553732.5	1136409	bare	1
27	2	559534.1	1138316	Forest	6	76	5	553294	1135207	bare	2
28	2	559890.3	1137945	Forest	7	77	5	553469.4	1135275	bare	3
29	2	559874.9	1138162	Forest	8	78	5	553156.2	1135200	bare	4
30	2	585468.9	1157001	Forest	9	79	5	553582.2	1135344	bare	5
31	2	585536.8	1156696	Forest	10	80	5	555987.6	1133904	bare	6
32	2	585689.6	1156158	Forest	11	81	5	556169.3	1134029	bare	7
33	2	587681.1	1136588	Forest	12	82	5	556864.6	1134586	bare	8
34	2	588263.9	1136910	Forest	13	83	5	557021.2	1134705	bare	9
35	2	588360	1137470	Forest	14	84	5	557459.7	1135037	bare	10
36	2	588558.1	1137702	Forest	15	85	5	558650	1137199	bare	11
37	2	588586.4	1138246	Forest	16	86	5	558969.4	1137311	bare	12
38	2	588422.3	1138200	Forest	17	87	5	559176.1	1137324	bare	13
39	3	587047.4	1136480	Bush	1	88	5	559339	1137255	bare	14
40	3	587347.3	1136893	Bush	2	89	5	559426.7	1137324	bare	15
41	3	587681.1	1137465	Bush	3	90	5	559113.5	1137393	bare	16
42	3	587307.7	1137827	Bush	4	91	5	572394	1139422	bare	17
43	3	588824	1138806	Bush	5	92	5	572470.9	1139493	bare	18
44	3	587100.9	1148085	Bush	6	93	5	572966.6	1139517	bare	19
45	3	586377.3	1149705	Bush	7	94	5	572495.1	1139218	bare	20
46	3	587083.7	1151100	Bush	8	95	5	572404.1	1139240	bare	21
47	3	586032.7	1147430	Bush	9	96	5	572418.2	1139175	bare	22
48	3	588789.4	1146069	Bush	10						

Source: Field survey (2017)

G: factor maps ranges and area coverage

Elevation range (m) a.s.ls	Area (he)	%
1663-2146	499.41	4
2146-2492	1127.52	10
2492-2760	1105.02	9
2760-3002	38255.99	33
3002-3234	2815.47	24
3234-3564	2352.06	20
Slope range (%)	Area (ha)	%
0-4	33178.5	30.3
4-9	36605.07	33.4
9-14	14310.54	13
14-20	9991.44	9
20-26	6662.61	6
26-33	4486	4
33-41	2495.79	2.3
41-53	1882.22	1.3
>53	425.7	0.4
Road Distance (m)	Area (he)	%
500	8750.43	7.988
1000	8078.76	7.37
3000	26652.78	24.3
6000	29190	26.6
12000	31704	28.9
16000	5167	4.7
River Distance (m)	Area(he)	%
500	17649	16.11
1000	17070.7	15.58

3000	44250	40
6000	19783	18
12000	10259	9.36
24000	528.48	0.48

G: photos (in potential ecotourism sites) Source: Field survey (2017)

Topography around Anazstedkebele, source field survey (2017)

Topography and bush land at upper river mouth around Anazsted kebele, source field survey (2017)