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EVALUATION OF ECOTOURISM POTENTIALS THROUGH GIS AND REMOTE SENSING : A CASE STUDY IN HAWASSA TOWN AND ITS SURROUNDINGS, ETHIOPIA

A Thesis
Submitted to
The School of Graduate Studies of
Addis Ababa University

In Partial Fulfillment of the Requirement for the
Degree of Masters in Remote Sensing and
Geographical Information Systems (GIS)

Hailegebreal Tamirat

JUNE, 2013

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By

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LIST OF ABBREVIATIONS

AHP	Analytic Hierarchy Process
CR	Consistency Ratio
DEM	Digital Elevation Model
EMA	Ethiopian Mapping Agency
ERDAS	Earth Resources Data Analysis System
ESRI	Environmental System Research Institute
TM	Thematic Mapper
GIS	Geographic Information System
GPS	Global Position System
IFMP	Integrated Forest Management Project
LU/LC	Land-use /Land-cover
MCDM	Multi Criteria Decision Making
MCE	Multi Criteria Evaluation
NGOs	Non-Governmental Organizations
NMA	National Metrological Agency
RS	Remote sensing
SNNRP	Southern Nation Nationalities and People's Region
SRTM	Shuttle Radar Topographic Mission
TIES	The International Ecotourism Society
TISTR	Thailand Institute of Scientific and Technological Research
UNEP	United Nations Environment Program
USGS	United States Geological Survey
WTO	World Tourism Organization

ABSTRACT

Hawassa town and its surroundings, situated in the southern part of Ethiopia, have high ecotourism potential due to the abundant natural and cultural resource especially landscape, the lake and shore of the lake, moderate ecological conditions and wetlands that contribute to the development of the country by means of tourism. Therefore, the main objectives of this study were evaluating and identifying the ecotourism potential of the area using RS and GIS techniques for optimal exploitation of the area for tourism purpose. Ecotourism is considered as one of the most attractive subsets of tourism industry, which can contribute for natural resource conservation and local development, if properly managed. Integrated approaches of both RS and GIS techniques were used to generate visibility map, land-use/land-cover map (using 2011 TM satellite image), slope map, elevation map, proximity to the lake map, natural and cultural attraction sites point map, fauna and flora protection map, annual rainfall map, annual temperature map and proximity to the road map. These eleven factor maps were overlaid to evaluate the ecotourism suitability map of the study area. To make an accurate decision in relation to the most appropriate ecotourism suitability map, weighted overlay analysis and multi-criteria decision techniques were implemented. The results were classified in to four ecotourism potential areas (highly suitable, moderately suitable marginally suitable and no potential). These results are further verified by ecotourism potential sites point data collected in the field and pervious reports. The largest part of the area was identified as low suitable for ecotourism. Hence, this study concludes that Hawassa town and its surroundings can contribute for the national development through sustainable use of ecotourism potential of the area.

Keywords: Ecotourism, GIS, Multi-criteria evaluation, Remote sensing, Site suitability

1. INTRODUCTION

1.1. Background

Tourism is among the world fastest growing industries, and is one of the major sources of foreign exchange earnings of many developing countries (Megan, 2002). As one of the largest economic sectors in the world, tourism accounted for US\$919 billion worldwide in international tourism receipts in 2010 (WTO, 2011). Tourism is one of the driving forces of economic developments in industrialized, less-developed and developing countries. The tourism industry contributes substantially to strong economic growth, creation of skilled and semi-skilled jobs, greater export returns, foreign investments and currencies and economic well-being and social stability (Wilks, 2004). In this regard, ecotourism is one of the attempts that restructure the value of tourists and through a more holistic representation of tourism activities.

Ecotourism is defined as environmentally responsible travel and visitation to relatively undisturbed natural areas; in order to enjoy and appreciate nature (and any associated with cultural features) that promotes conservation. Ecotourism has low negative visitor impact, and helps to improve socio-economy of local populations (Ceballos-Lascurain, 1996). In recent years, ecotourism sector played a great role in improving the economy of developed countries. Moreover, it helps to conserve natural, environmental and cultural values of ecotourism areas (World Tourism, 2000).

Ecotourism encompasses all forms of tourism focused on nature, where the principal motivation is to observe and appreciate nature and traditional features in natural areas. It provides positive impacts on the natural and socio-cultural environment of the area, and negative impacts are limited and controlled. As the understanding of the close relationships between tourism and environmental conservation increases, researchers are calling on ecotourism industry to incorporate economic development as a fundamental element of conservation (Obadijah, 2012). Ecotourism contributes to nature conservation by providing economic benefits to communities and other stakeholders involved in this activity. Ecotourism not only creates jobs and provides local people with source of income, but it also

creates awareness among both inhabitants and tourists of the need to conserve natural and cultural sites that they maintain, visit and enjoy.

Evaluation of ecotourism potential sites could take place according what that the community has gained as a result of its involvement protection and ecotourism activity, either with the private sector, NGOs, with other communities, or via civil society associations or indigenous federations (Eplerwood, 2004).

Geographic Information System (GIS) and Remote Sensing (RS) techniques have accelerated research processes, and enhanced the accuracy with less expenses. To determine the potentials of tourism activities for a given area, a broad ecotourism evaluation through ground surveys, RS and GIS techniques are required. Thus, a meaningful relation can be established among various tourism activities (Jafar and Delavar, 2010). The capability of GIS in handling spatial aspects of conservation and its use in criteria-based evaluations for prioritization and selection of potential conservation areas have increased. According to these, criteria and factors are evaluated using GIS and RS techniques, together with field data and literature. All scores are to be standardized based on the importance. Preferences on the criteria and indicators are expressed as weights that are assigned by decision makers (Mui-How and Mitsuhiro, 2004).

Geographic information system is a valuable tool for investigating specific questions that relate to tourism development including location, condition of the area, trends and changes, routing to and through the site, and patterns associated with resource uses (Azizur, 2010). The benefits of using GIS can be summarized as, GIS helps to portray characteristics of the earth and monitor changes of the environment in space and time; GIS helps to deeply understand the meaning of spatial information and how that information can more reflect the true nature of spatially distributed processes, and GIS helps to model alternative actions and processes operating in the environment to anticipate possible results of planning decisions and to aid in making better decisions (Wong and Stauffer, 1996).

In general, the efficient tools that provide for storing, evaluating, manipulating and analyzing a great variety of spatial data are geospatial technologies. More specifically, through using high resolution satellite imageries like 'IKONOS 'and 'Quick bird', it can be used to map

land-use/land-covers and habitats, monitor landscape changes, species distribution, predict suitable habitats for different species and lead for mapping of potential ecotourism sites.

1.2. Research problem

Ecotourism potential evaluation and Decision-making in Ethiopia within the integration of various factors including landscape/naturalness, topography, accessibility, climate characteristics and wildlife conservation with natural environment is becoming complex. Cost-benefit analysis plays an important role for developing ecotourism in a sustainable manner. GIS and RS techniques are a set of powerful tools that provide solution through incorporating various factors to achieve sustainable ecotourism developments. Spatial data referenced can be used to identify conflict, analyze impacts over time and find a suitable solution for a specific problem (Azizur, 2010). Impact assessment is important in tourism development, and GIS can play a role in checking environmental conditions, examining the suitability of locations for proposed development sites, identifying conflicting interests and modeling relationships (Bahaire and White, 1999). Using RS and GIS in ecotourism evaluation is important for some specific reasons such as to organize all information about ecotourism, using different criteria and factors, facilitate evaluation, monitoring and controlling of ecotourism activities, identifies how stakeholders can become responsible for ecotourism marketing, analyzes different aspects of community involvement and participation in time space management and visual impacts, and analyze the characteristics of evaluated potential of ecotourism site.

Within this context, the current research is conducted in Hawassa town and its surroundings in Southern Ethiopia, which has great extent of landscape, natural lakes, flora and fauna. Moreover, it must recognize at the country level for its importance as a destination for ecotourism sites. However, it has been facing some problems due to unplanned development and other activities such as increasing deforestation of resources, biodiversity losses of the lake in relation to the management of ecotourism resources and un-delineated area that must be protected in relation to ecotourism resources. Consequently, it is very important to develop ecotourism potential sites of the study area in combination with different parameters

and factors. The present study hopefully will give a confidence in evaluation of ecotourism potential that meets the view of sustainable development.

1.3. Research objectives

1.3.1. General objectives

The main purpose of this study is to explore the potential of ecotourism using GIS and RS for planning resources relevant to ecotourism development in Hawassa town and its surroundings. The following are the specific objectives:

1.3.2. Specific objectives

- ❖ To evaluate ecotourism resources including land -use/land-cover, natural and cultural resources and tourists facilities in and around Hawassa town and its surroundings, using RS and GIS technology; and
- ❖ To identify the main ecotourism sites and to map the area, that is attractive by its nature in relation to ecotourism resources in the study area.

1.4. Research question

The following research questions need to be addressed in achieving the above mentioned objectives:

- What are the importance of GIS and RS in ecotourism potential site evaluation and planning?
- What are the major tourist facilities and services, and natural and cultural ecotourism resources in the study area?
- Which are the factors more responsible and how is it possible to stop biodiversity losses and to make the study area a productive ecotourism zone? How can we map ecotourism areas?

1.5. Benefit of the study

This study will help for ecotourism planners, policy makers and local communities to be aware of the significance of ecotourism in terms of the importance it provides for generating revenue by attracting tourists, conserving natural environment and promoting ecotourism potential sites. Moreover, it enables local people to be active participants to conserve their environment and to get benefits for their livelihood.

1.6. Expected output

The expected outputs of this research are the evaluated ecotourism site map with its area location using deferent criteria and factors. It is also expected to reveal the major tourist facilities, services, natural and cultural ecotourism resources of the study area and the importance of GIS and RS for ecotourism potential site evaluation.

2. REVIEW OF LITERATURE

2.1. Concepts and definition of ecotourism

Ecotourism is a form of travelling industry that occurs in destinations along with attractions of flora, fauna, cultural heritage and environment friendly activities (Suvdantsetseg *et al.*, 2012) Ecotourism is also known as ecological tourism, which is a form of tourism that appeals to ecologically and socially conscious individuals (Ryngnga, 2008). The concept or strategy of ecotourism is to meet the principles of sustainable development. Ecotourism is responsible for natural areas that conserves the environment and improves the welfare of the local people. As cited by Saroj and Parichart (2011), the importance of ecotourism as a strategy for sustainable development and this was recognized during the Earth Summit in 1992, when sustainable tourism was considered as an environment-friendly economic activity. The fundamental function of ecotourism is the conservation of the natural and cultural resources, income generation, education, local participation and capacity building (Ross and Wall, 1999). Being a nature based tourism; it takes into account the natural ecological attractions, their conservation and development. Its main aim is to safeguard the environment, provide benefits to the local people by generating revenue and education and pleasure for tourists (Wearing, 1995).

Though a recent phenomenon, ecotourism is one of the fastest growing sectors of industries worldwide. It was brought up as a development tool to protect natural environment and cultural diversity by attracting tourists and generating revenue for the government and local people without harming nature (Daniel, 2009). The development of tourism in and around protected areas is seen as one of the best ways of delivering economic benefits to remote areas by providing local employment, stimulating local markets and improving transportation and communication infrastructure (Rose and Wall, 1999).

Ecotourism can also convince local people that their resources are more valuable when intact than when extracted from ecosystem. When a visitor entrance fee structure is imposed, real economic incentives for protected areas can catalyses their formulation (Agardy, 1993).

Ecotourism hopes to change the unequal relationships of conventional tourism. Thus, it encourages the use of indigenous guides and local products. It claims to combine environmental education with minimal travel discomforts, help protect local flora and fauna and provide local people with economic incentives to safeguard their environment (Abdus *et al.*, 2000).

2.2. Tourism in Ethiopia

Unique cultural heritages and attractive natural resources that can attract tourists are endowments of Ethiopia. The obelisks, churches, castles, archeological sites and caves are some of the cultural resources of Ethiopia. High diversity of plants and animals are also a gift for Ethiopia. In addition to these, there are impressive features such as high mountains, rivers and lakes in Ethiopia. The favorable climatic condition is the other factor what makes Ethiopia to be attractive to tourists (Adem, 2008). As a result, Hawassa town and its surroundings are also set for the capital the Southern Nations, Nationalities and Peoples Regional state together with its attractive lakes, natural land-use/land-cover and unique cultural diversity.

There were 427,000 and 468,000 arrivals of tourists recorded for 2009 and 2010, respectively in Ethiopia. With this consideration 9.6% growth rate in 2009/10 at an estimated value of US 329\$ and \$522 million in Ethiopian tourism receipts was received (UNWTO, 2012). From a development perspective, the market share of tourism in developing countries is increasing significantly. In Ethiopia; tourism is one of the focal sectors of the five-year development plan (UNESCO, 2012) Long-term vision of the Government is to make Ethiopia one of the top ten tourist destinations in Africa by the year 2020, with an emphasis on maximizing the poverty-reducing impacts of tourism, and utilizing tourism to transform the image of the country (World Bank, 2006).

The fourth Century Persian Historian described the Ethiopian Kingdom of Axum as one of the four great empires of the world, ranking it alongside China, Persia and Rome. Axumite coins were found in India and China, and the obelisks of Axum (like the one looted by Mussolini and recently returned by the Italians) is the biggest single piece of a stone erected

(Adem, 2008). Ethiopia has a number of important national parks, the source of longest river in the world, and sites respected among followers of Christianity, Islam and Judaism and diverse African traditional societies. Ethiopia has very distinct cultural and historic products based on ancient Axumite civilizations and the Ethiopian Orthodox Church, the walled Old City of Harar with its seven gates considered as the fourth holiest city in Islam, as a cradle of civilization with fossilized evidence of the ancestors of Homo Sapiens as old as 4.4 million years, and the much more famous Dinknesh or *Lucy* (World Bank, 2006).

2.3. Ecotourism potential evaluation

The evaluation for ecotourism sites is conducted based on the nine chosen criteria namely: visibility, land-use/land-cover, conservation/protection, species diversity, elevation, slope, proximity to cultural sites, distance from roads and settlement size (Khwanruthai, 2012). Environmental evaluation necessity relied on qualitative and quantitative modeling for ecotourism development is unavoidable and on the point of economic aims, it is better to apply quantitatively relied on evaluation factors such as slope and topography (Mehrdad *et al.*, 2011). Evaluating ecotourism potentials of each area would lead to a wider participation of local people in natural resource conservation activities (Jafar and Delavar, 2010). Landscape ecology is the scientific base evaluation planning, land and landscape recovery and conservation management in many branches of geography and ecological sciences (Adem, 2008).

For example, Nouri *et al.* (2007) has established criteria and values for ecotourism evaluation. The aim of this sensitivity evaluation was to give objectivity to the Bushier Province coastline region in the Persian Gulf, so as to be able to identify areas needed ecological protection. With this objective, initially, the boundaries of the area under evaluation were established, based on the findings of the Integrated Coastal Zone Management Plan. Based on these parameters and by geo-referencing, photo mosaic Land Sat Satellite images and IRS was taken and basic maps of two influential areas were evaluated within the above mentioned limits, which included the coastal village boundaries. According to the study of Oladi and Taheri (2012), the ecotourism potentials of the region is evaluated to establish a meaningful relation among various ecotourism activities using RS

data, to identify the potential areas to establish and develop a lake and forest park, and to put the provided plan in a GIS data station to better introduce the attractions.

Eslami and Roshani (2009) presented an identification and evaluation method of the geographic potential for tourism. They suggested the following four steps:

- 1: Suitable variables to evaluate the tourism potential,
- 2: Chosen prerequisites in the form of processing layers,
- 3: Evaluation of geographic subject by Delphi and
- 4: General evaluation of potential use of algebraic function to present the output map for ecotourism potential.

2.4. Principle, element and criteria of ecotourism

As ecotourism was originally just an idea, not a discipline, many businesses and governments promoted it without an understanding of its most basic principles. Establishing internationally and nationally accepted principles, guidelines and certification approaches proceeded throughout the 1990s, but at a modest pace, as the process involved stakeholders from many regions, disciplines and backgrounds. Each region affected by ecotourism should develop its own principles, guidelines and certification procedures based on the materials already available internationally (UNEP, 2008). Another set of principles arose from attempting to evaluate ecotourism operations by Juliene (2011) who used TIES definition of ecotourism to create six principles (1) Minimizes negative impacts to the environment and local people, (2) Increases the awareness and understanding of the area's natural and cultural systems, (3) Contributes to the conservation and management of legally-protected lands and other natural areas; (4) Maximizes long-term participation of local people in the decision-making process; (5) Directs economic and other benefits to local people; and (6) Provides special opportunities for local people and tourism employees to utilize and visit natural areas.

As the concept of ecotourism popularized, the literature is filled with original, interpreted and adjusted ecotourism principles. The most influential ecotourism documents (Melissa and julienne 2011) produced after the World Ecotourism meeting during the International Year of Ecotourism, recognized that not only does ecotourism embrace the principles of sustainable tourism, but it also represent the following specific principles: (1) contributes

actively to the conservation of natural and cultural heritage; (2) includes local and indigenous communities in its planning, development and operation, and contributes to their well-being; (3) interprets the natural and cultural heritage to visitors; (4) encourages independent travelers, as well as organized tours for small size groups.

These principles have been used to develop the standard criteria – with specific indicators for each of these eight performance areas. All these principles allow recognition and encouragement of ecotourism products to evaluate the environmental improvements, which result in a more sustainable world.

2.5. GIS and RS application in evaluating ecotourism potential

2.5.1. GIS application in evaluating ecotourism potential

Geographic Information System has been widely discussed in environmental and resource management applications. In the context of ecotourism, however, it has limited but important applications. Geographic Information System provides a set of tools, which can be used for sustainable tourism planning and development (Daniel, 2009). According to Daniel (2009), GIS produced three types of information such as tourism resource maps, tourism use maps, and tourism capability maps. This enables to identify and answer the questions how much and where it is available and it helps for planners, stakeholders and managers to determine the capability of an area for the creation of new tourism products/services, to identify locations suitable for tourists/tourism, to evaluate land-use options, to identify zones of conflict/complementary, access points, water availability, wildlife habitats and to monitor tourist resources.

For example, Baharie and Elliot-white (1999) suggests that GIS can be applied in the following manner in tourism and ecotourism related issues like data access and practice work, data integration and management, tourism (ecotourism) resource recording, area description and map overlays, comparative land-use and impact analysis, analysis of visual disturbance, identifying most suitable locations for development, analyzing relationships

associated with resource use, assessing potential impacts of tourism development, visitor management flows, and community involvement and participation.

In the study of Azizur (2010), in order to introduce the ecotourism potential areas, first he carried out land-use /land-cover and its tourism attraction resources practices using GIS and RS techniques and then elevation and slope were produced using digital elevation model (DEM) of the study area. In general GIS can provide answers for a number of questions such as: what exists in a particular location, where specific features can be found, where the districts with rainfall are greater than 500 mm and less than 750 mm, what has changed over time etc. Both the integration of RS and GIS can be applied which areas suitable for developing destinations based on attractive aspects of culture, nature, traditional events, scientific interests, related facilities and availability of accesses in the region (Balt, 2012). Spatial analysis techniques with GIS provide the integrational framework. Once the criteria are selected, they are traditionally rated among each other using weights, which reflect the decision makers preference (James, 2012).

2.5.2. RS application in evaluating ecotourism potential

Remote sensing is the technique of deriving information about objects on the surface of the earth without physically coming into contact with them. This process involves making observation using sensor cameras, scanners, radiometer and radar. Mounted on platforms (aircraft and satellites), which are at a considerable height from the surface of earth and recording the observations on suitable medium images on photographic films and videotapes or digital data on magnetic tapes. Remote sensing enables to identify the land-use/land-cover, GIS and multi-criteria decision making (MCDM) were used to identify the potential ecotourism sites based on land-use/land-cover, environmental, economical and social indicators (Saroj and Parichart, 2009). The application of RS and GIS in the collection and analysis of wildlife abundance and distribution data suitable for conservation planning and management have examined by Leeuw *et al.* (2002).

2.6. RS and GIS application to Evaluating ecotourism potential in Ethiopia

According to the findings of Berhe (1992), studies in Arsi Province, Ethiopia applying GIS in land-use and design resulted in obtaining a higher compatibility between the proposed land-use type and dominant ecological conditions. Although some of the tourists might have a real environmental concern, this does seem more like a form of geo-tourism rather than ecotourism. In order to make tourism sustainable in Ethiopia, there was an attempt to introduce ecotourism in rural areas as components of natural resources management through creating diversified livelihoods for local people (Beek, 2001). Moreover, natural resources can provide economic potentials through ecotourism beside other uses (Couralet, 2004).

Even though, ecotourism was known since the 1980s when environmental issues of tourist destination areas increased (Sindiga, 1999), it was introduced in Ethiopia as a component of soil and water conservation under land-use planning of Oromia region to create alternative income generating options to reduce pressure on natural resources. For example, the Integrated Forest Management Project (IFMP) was introduced into Adaba-Dodola in the West of Bale Mountains National Parks with the aim of conservation of natural forest. Integrated Forest Management Project organized forest association dwellers by developing ecotourism through creation of non-wood income generating that reduces degradation of forest areas (Adam, 2008).

In the study of Daniel (2009), potentially suitable sites for ecotourism in the surroundings of Addis Ababa City mainly based on the natural components of ecotourism was involved in his study such as land use-land cover, soil, elevation, slope, vegetation density, temperature and rainfall. Ethiopia is a place for outdoor lovers, as the attractions throughout the country are open air. For energetic walking and trekking, pony trekking and mountain climbing it is practical in the Semen Mountains in the north and Bale Mountains in the south. However, the concept of ecotourism is still relatively new to Ethiopia and policy developers and makers still need some convincing findings about the significance of ecotourism. However, the Ethiopian Tourism Commission is aware of the benefits and has incorporated the development and promotion of ecotourism in its planning (Tewodros, 2010).

2.7. Background of RS and GIS

2.7.1. Concept of RS and GIS

In simple terms, RS is sensing the nature of earth surface objects from a distance. The Canadian Centre for Remote-Sensing defined it as the science (and to some extent, art) of acquiring information about the earth's surface without actually being in contact with it. This is done by sensing and recording reflected or emitted energy and processing, analyzing, and displaying that information. Remotely sensed images record the interaction of electromagnetic energy with the earth's surface. Targets in Remote-Sensing images may be any feature or object, which can be observed in an image, with targets or a point, line or area feature, which can be distinguishable with other features around in the image (Daniel, 2009).

Remote sensing images can be represented either in analog or digital format. Imagery displayed in a pictorial or photograph type is in analog format; whereas, if it is represented in a computer as arrays of pixels, with each pixel corresponding to a digital number, representing the brightness level of that pixel in the image, it is in digital format (Adam, 2008). Geographic information system is a computer based tool for mapping and analyzing feature events on earth. Geographic information system technology integrates common database operations such as query and statistical analysis with maps.

Geographic information system manages location-based information and provides tools for display and analysis of various statistics, including population characteristics, economic development opportunities and vegetation types. Geographic information system allows us to link databases and maps to create dynamic displays. Additionally, it provides tools to visualize, query, and overlay those databases in ways not possible with traditional spreadsheets. These abilities distinguish GIS from other information systems, and make it valuable to a wide range of enterprises for explaining events, predicting outcomes and planning strategies (Azizur, 2010).

2.7.2. Description of RS and GIS

Geographic information system is a computerized information system. However, there is an important difference between other databases; information in the GIS must be linked to a geographic (spatial) reference (latitude/longitude or other spatial coordinates). GIS as a computer hardware and software system designed to collect, manage, analyze and display geographically (spatially) referenced data. According to ESRI webpage, GIS as an organized collection of computer hardware, software, geographic data and personnel designed to efficiently capture, store, update, manipulate, analyze and display geographically referenced information. In terms of geographical information, geographically referenced information is a must (Tewodros, 2010).

A geographical information system operates on two data elements. These are geographical or spatial and attribute data. The spatial data refers to locational aspects either explicitly (using a standard geographical frame of reference such as latitude and longitude) or implicitly (using surrogate spatial references such as postcode/addresses). On the other hand, the attribute data includes statistical and non-locational data associated with a spatial entity (Baharie and Elliot, 1999; Estaes *et al.*, 1997).

There are five definitions of GIS based on its function (Baharie and Elliot, 1999, Burrough and McDonnel, 1998). These are a process based definition it is a system for capturing, storing, checking, manipulating, analyzing and displaying data which are spatially referenced to the earth, a tool box based definition it contains a powerful set of tools for collecting, storing, retrieving, transforming and displaying spatial data, a database based definition it is a database system in which most of the data are spatially indexed. And upon which a set of procedures operated in order to answer queries about spatial entities in the database, an application based definition its application, for example, includes cadastral information systems, planning information systems, site plan reviews, facility citing, and inventory and analysis and Organization based definition it is a decision support system involving the integration of spatially referenced data in a problem solving environment GIS is thus a collection of software packages for data input, storage, retrieval, analysis and output of information in the form of tables and/or maps. It deals with both locational and non-locational information of earth surface features.

3. THE STUDY AREA AND METHODS

3.1. Study area description

3.1.1. Location

The study area is situated in the Ethiopia Rift Valley basin in the region of Southern Nations, Nationalities and Peoples of Ethiopia. It is the capital town of Regional state, which is located 273 km to the south of Addis Ababa City. It was bounded by latitude $07^{\circ}9'54''\text{N}$ - $06^{\circ}49'54''\text{N}$ and longitude $38^{\circ}34'22''\text{E}$ - $38^{\circ}12'49''\text{E}$, covering a total area of 72497 hectares (Figure 1). The elevation in the district ranges from 1664 m to 2163m a.m.s.l., consisting of lower and middle hills. There are some important attributes that should be considered in order to develop successful ecotourism in the study area like, untouched landscape, have rich vegetation cover and considerable wildlife, traditional societies of indigenous people, the lake and recreational tourist attractions. Such characteristics suit the selection of the area for a case study to demonstrate the application of the methodology. Hawassa Zuriya Woreda and Shebedino Woreda are another study areas that surround the city in the West and south direction.

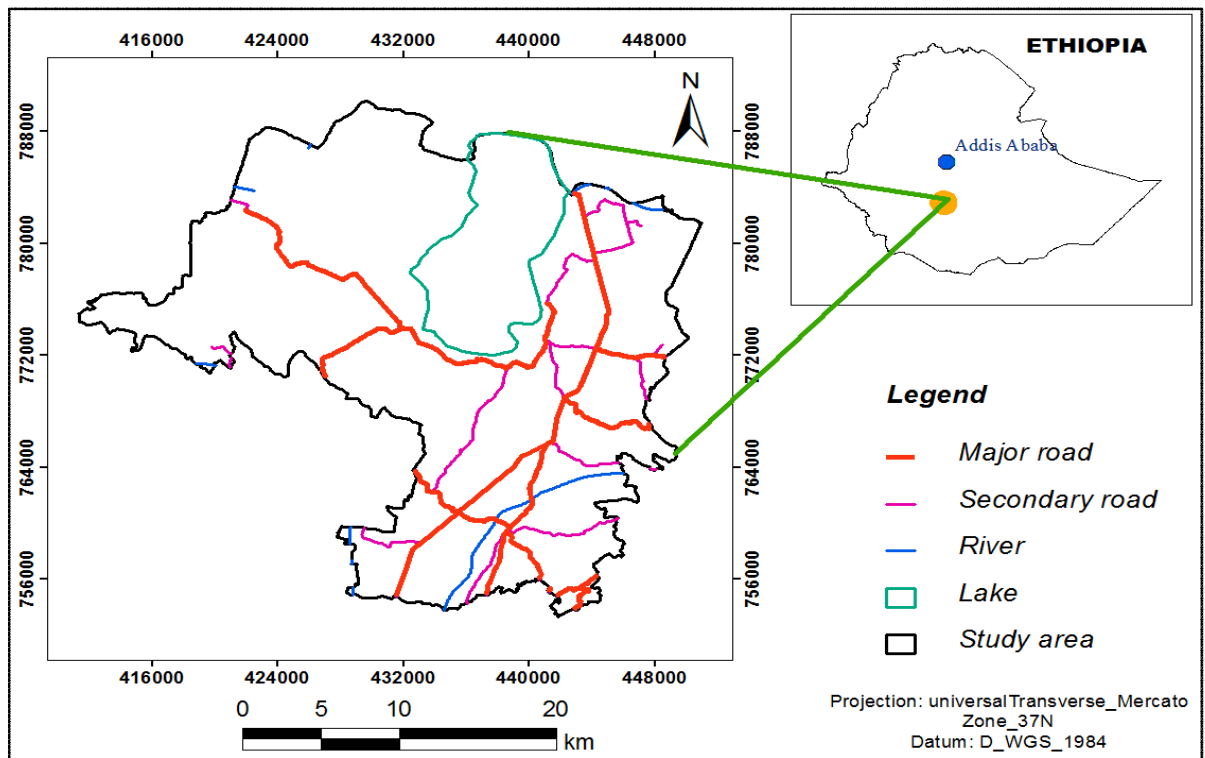


Figure1. Location map of study are.

3.1.2. Physical feature

Out the 75123 ha, the Hawassa town and its surroundings, 66337 of the area is land and 8786 ha of the area is covered by water. The dominant physical feature of the study area is the landscape, which is covered by open forests, vegetable land, farm land, water body and built-up area. Creation of the physical feature of Hawassa town and its surroundings is the rise of immediate danger of flooding (Tenalem, 2008). Because of this, the physical feature of Hawassa town and its surroundings have a mountainous terrain.

3.1.3. Climatic characteristics

The climate of Hawassa town and its surroundings can be classified as autumn, summer, spring and winter. The average humidity and rainfall for the past 20 years was 69 mb 79 mm, respectively. Maximum rainfalls happened during the summer season, which is almost 80% of annual rainfall and it starts from early June and continuing until September. Other seasons can be described as winter (October -January) and spring (February-May), (NMA, 2013). During summer the weather is characterized by a cool, wet and humid season. In spring, very little rainfall is available with lowest temperature and humidity. The winter season has the highest temperature and evaporation rates of the year. For most part of the year, the weather is moderately hot and humid.

Temperature

The temperature of Hawassa town and its surroundings fluctuate from January to December. The end of September and October is the coldest time and June to September is the hottest. Monthly minimum average temperature for the last 20 years showed around 7°C in the winter to over 15°C during the summer, and a maximum temperature increase from 23°C in summer season and 31°C in winter. The average annual maximum temperature recorded was 27°C and the average minimum temperature was 12.9°C. However, the data indicate that the temperature in Hawassa town and its surroundings is almost similar for the last 20 years. Figure 2 shows the Monthly average, minimum and maximum temperature in Hawassa town and its surroundings for the last 20 years

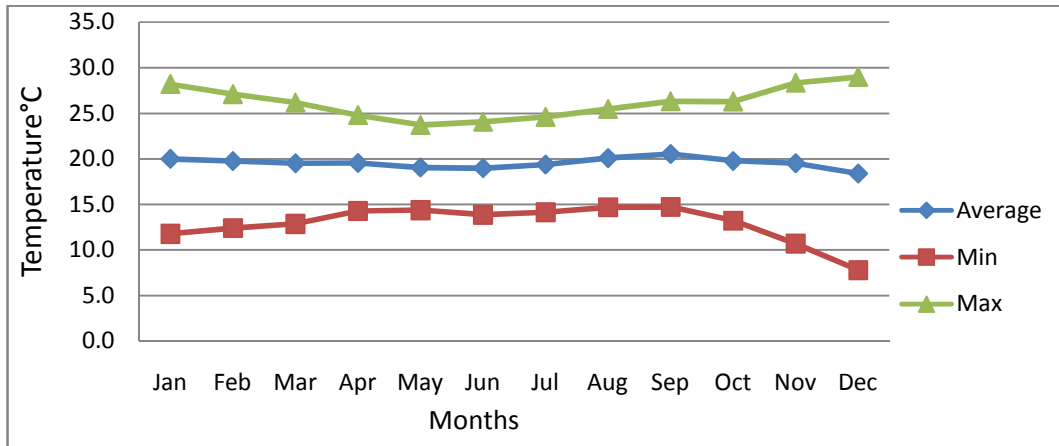


Figure2: Monthly temperatures variation

Rainfall

In Hawassa town and its surroundings, 48 % and 34% of the monthly rainfall occurs during the summer and spring seasons respectively. Monthly average rainfall over the last 20 years ranges from 29 mm in December to 117 mm in July. The highest precipitation was received in the summer season, which is 172 mm. According to the records, there was only little variation rainfall over the last 20 years (1990-2010). The highest and lowest average annual rainfalls were 1197mm (2006) and 703 mm (2009), respectively. Figure 3 shows average, minimum and maximum monthly rainfall for the last 20 years in Hawassa town and its surroundings.

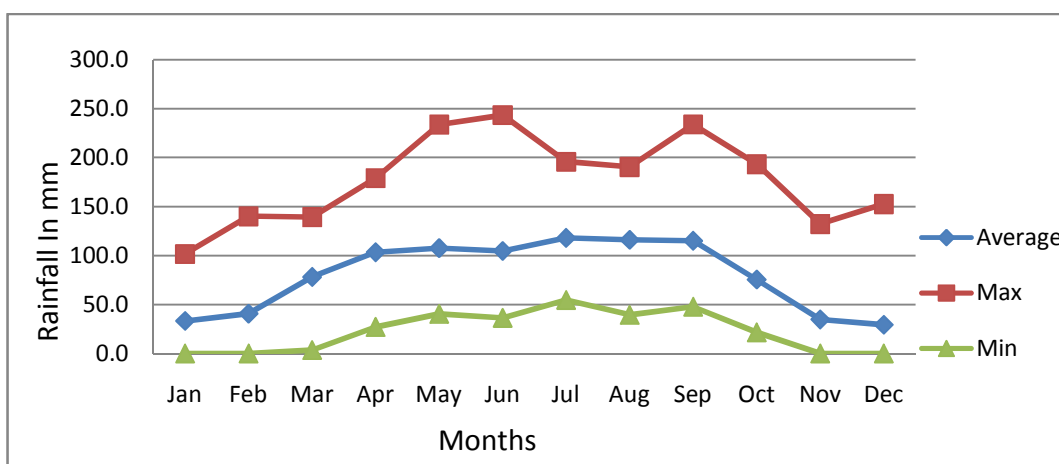


Figure 3: Monthly rainfalls variation (1990-2010)

Humidity

The humidity of Hawassa town and its soundings vary from time to time and also form month to month. The average humidity of Hawassa town and its surrounding was 69 mb for 20 years (1990-2010). The maximum humidity of Hawassa town and its surroundings for the last twenty years was occurred in May (95 mb) and the minimum humidity was in February (42 mb). Figure 4 shows monthly average humidity during (1990-2010) in Hawassa town and its surroundings.

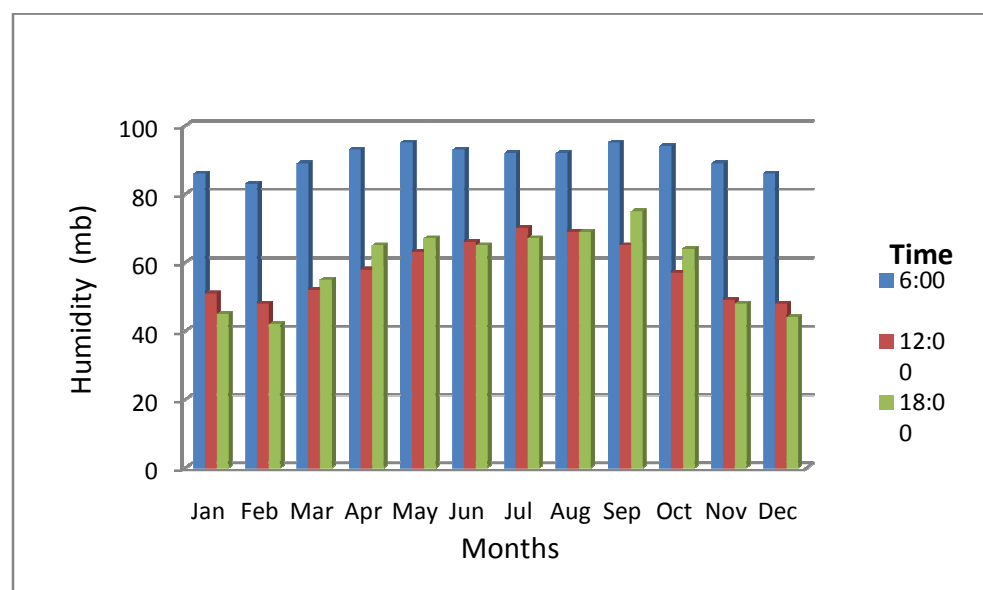


Figure 4: Humidity variation (1990-2010)

3.1.4. Flora and fauna

The areas of Hawassa town and its surroundings are covered with natural forests and woodlands. There is a complex mangrove ecosystem, which has great number of species diversity in the study area. The dominant species are *Fichus vasta* (Warika), *Balanitetes eygyptica* (Bedenna), *Chroton machrostachys* (Bsanna), *Chordia africana* (wanza) and *Dodonia viscosa* (Kitkita). Natural forest and woodland habitats trees dominate in the surroundings of the lake. The mangroves of the Hawassa town and its surroundings are unique compared with other forests, and they are the home of different species of birds and mammals. A number of endemic birds and mammals are seen in the area especially in the

lake and lakeside. The habitat provides high biodiversity such as marabous stock, great white pelican, hammer kop, shoveled, Egyptian goose, wattle ibis saddle and bill stork. Hippopotamus is the largest aquatic animals in this lake. In Hawassa town and its surroundings, baboons, hyenas, foxes, rabies, and korke are some of the animals found.

3.1.5. Lake Hawassa

The Hawassa catchment represents a large collapsed caldera bordered by highlands to the north and the east, the center of the caldera is occupied by the lake Hawassa (Tenalem, 2008). The altitude of the lake Hawassa is 1664 m.a.s.l. Representing the culmination of the Ethiopian rift base level occupied bay lakes; the floor of the caldera is faulted and dotted bay volcanic hills such as Tabor and Alamura (Tenalem, 2008).

Lake Hawassa is one of the major sources of fish for locale people. The fishing beach at Hawassa Lake especially, amora gedel, tikure wuha and yefiker hayqe, during the commercial fish grasp is being landed and sold, is an impressive to see. In addition to this the wetland zone is extensive and has abundant aquatic vegetation that will serve as one of the destination for tourism sites; that has high value for the development of ecotourism activity and uses as a source of food for many species of water birds. The lake Hawassa is highly endowed with view of animals such as hippopotamus and birds like storks, herons, Egyptian geese, and crakes. The lake provides an ideal spot for fishing and boating. The town of Hawassa is an attraction in itself, with a full of life and attractive outdoor market that gives something of the flavor of the life and commercial activities of the region with its green area.

3.1.6. Tourism facility in Hawassa and surroundings

The most visited site in Hawassa town and its surroundings is the lake, which is located in the west of the town. Approximately 81% of total visitors visit this lake. Mount tabor, millennium park, Amora Gedel, yefiker hayqe, Mount Alamura and Burikitu hot spring are also popular sites in Hawassa town and its surroundings for both local national and

international visitors. The town has several standard hotels close to the lake. Table 1 shows the number of domestic and foreign visitors the area visited during 2007-2012.

Table 1: Tourist arrival statistics for in Hawassa town and its surroundings (2007-2012)

Source: (Hawassa city administration culture and tourism office)

Year	Domestic tourists	Foreigners	Total
2007	19,136	2,532	21,668
2008	57,904	8,868	66,772
2009	45,212	8,674	53,886
2010	58,405	12,451	70,856
2011	83,842	23,916	107,758
2012	131,236	31,331	162,567

The numbers of domestic and foreign tourists is increasing from year to year. However, in the lake round, transportation problems are the main barriers for tourism development. The only way to enter this lake is through water transport. Visitors are not able to visit by encompassing the lake without boat. Due to the difficulty of hotel availability, lack of suitable accommodation, shortage of drinking water, lack of power and telecommunication facilities, very few foreign tourists visit the green area that is found far from the town in southern direction. Cultural and historical palace include cultural facilities, cultural way of living style in the Sidama Villages, Sidama Cultural House buildings activities, ceremonies of Chambalala, eneset planting procedures, coffee planting procedures, different species fish to eat, annual festivals and its diverse are also considered as tourist attraction.

3.2. Methods

3.2.1. Analytic hierarchy process (AHP) application

A) Concepts of AHP

MCDM combined with GIS data, is a powerful approach to systematically and comprehensively analyze a problem. A method that combines and transforms geographical data into a decision is Spatial Multi-Criteria Decision Making (Malczewski, 2004). The basic components of a multi-criteria problem are human value judgment, exchange evaluations, and assessments of the importance of criteria. However, criteria that have GIS capabilities can be used to achieve a desired objective (Moldovanyi, 2003). Investigation of a number of alternatives in the light of multiple criteria and conflicting objectives is the main purpose of multi-criteria evaluation techniques (Voogd, 1983).

A method which is widely used by AHP is Multi-Criteria Decision Making and was introduced by Saaty (Saaty, 1977; Saaty & Vargas, 2001). AHP can be used as a decision support tool and to solve complex decision problems. It uses a multilevel hierarchical structure of objectives, criteria, sub criteria and alternatives. Decomposition of the overall goal (suitability), comparative judgment of the criteria, and synthesis of the priorities are the three principles of AHP (Arabinda, 2003, and Baniya, 2008).

To express individual preferences or for judgment of absolute numbers, AHP uses a fundamental scale (Table 2). This scale consists of nine points. The reciprocal values ($1/3$, $1/5$, $1/7$, $1/9$) have been used where the row criterion is less important than the column criterion. Based on this, eleven factor objects were individually and simultaneously compared and consistently ranked. The score of that the row criterion is equal or greater importance than the column criterion. AHP also provides to measures and determine inconsistency of the credibility of the relative significance judgments mathematically. Based on the properties of reciprocal matrices, the consistency ratio (CR) can be calculated. Saaty (1980) suggests that if CR is smaller than 0.10, then the degree of consistency is fairly acceptable. But if it is larger than 0.10, then there are inconsistencies in the evaluation

process, and AHP method may not yielding meaningful results. More details of the CR calculation were given in Hossain *et al.*, (2007).

Table 2: The preference scale for pair wise comparison in AHP

Source: Adopted from Saaty, 1980; Saaty, 1990.

Scale	Degree of preference	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance of one factor over another	Experience and judgments slightly favor one activity over another
5	Strong or essential importance	Experience and judgments strongly favor one activity over another
7	Very strong importance	An activity is favored very strongly over another and dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2,4,6 and 8	Intermediate values between the two adjacent judgments	When compromise is needed
Reciprocals	Opposites	Used for inverse comparison

B) Decision Support System and Application of AHP

- **Decisions problem order**

Four fundamental steps involve for application of AHP and Decision-making problem (Piamviriyawong, 2006).

1) Model specification: determination of criteria for the evaluation of alternatives next to specified feasible investment alternatives. These criteria are further grouped into logical categories.

2) Pair wise comparison of categories and criteria: The relative importance of criteria within each category and each group of categories is established through pair wise comparisons using a square matrix order. The importance values are taken from (Table 2).

3) Weighting of potential alternatives: potential each alternative is ranked with respect to each potential criterion in the evaluation methodology. Pair wise comparison is applied to obtain weighting for qualitative data.

4) Potential rankings: lastly, weighting of the alternative is combined with the weighting of the criteria to form an overall rating for each factor. The factors with the highest weighting is ranked as the best choice, taking into account the importance of each criterion and the relative attractiveness of the factors with respect to each criterion.

- **Data standardization**

Geographic information system has very restricted capability for integrating geographical information and the decision maker's preferences. It is suggested that the integration of MCDM and GIS provides a platform for incorporating preference into GIS procedure (Piamviryawong, 2006). In deciding the data model for the integrated system is the compatibility of the data constructs between the GIS model and the MCDM modeling system is the fundamental issue.

In GIS-based ecotourism evaluation often arises as a consequence of the need to integrate into the evaluation process data measured not only in different units but also in different scales of measurement, such as nominal, ordinal, interval and ration scales. Data standardization is not designed to make the multi-criteria scores independent from the absolute values of the criteria. In fact, the value functions are clearly not independent of a positive linear transformation of individual values (Abinda Lakar, 2003). The purpose of standardization can be summarized as follows (Pereira and Duckstein, 1993):

1) To ensure that all natural scales, some of which may include nominal or ordinal data are converted to a common value scale with interval properties.

2) To account for the possibly non-linear or even non-monotonic character of relationship between nature and value scale.

3.2.2. Image analysis

Satellite image or remote-sensing data are available in digital format. Using ERDAS imagine software the Landsat TM 2011 image processing and analyses were performed. Digital image processing is used to enhance data as a preface for visual interpretation. Digital image processing and analysis also carried out automatically to identify targets and extract information completely by default. However, in digital image processing and analysis the manual intervention of human analyst is possible and this is good to carry out a complete image processing and interpretation. According to the Canadian Centre for Remote-Sensing and Lillisand and kiefer (2004) the most common image processing functions available in image analysis systems can be summarized into the following categories:

a) Image Enhancement

Atmospheric factor including atmospheric elements are the main influence of remotely sensed data that the facts will make it out of sight. The factors are due to atmospheric processes include absorptions, scattering, emissions, etc. Image Enhancement procedures were performed for the image to improve visual interpretability of the image by increasing clear contrast among various features view. These operations is completed in ERDAS imagine software specifically Fourier analysis tool, nose removal techniques. This is also important for signature editor process when finally the image should be classified. Contrast stretching and spatial filtering are some good examples of image enhancement where contrast stretching increases the tonal distinction among various features in a scene and spatial filtering enhances specific spatial patterns in an image.

b) Correction of Raw Satellite Images

In this study image Preprocessing is done to reduce any unwanted noises and geometric errors. These make possible to have the desired outputs from the image, before final analysis of satellite data and enhance the quality of the image data by reducing or eliminating various radiometric and geometric errors caused by internal and external factor. Radiometric and geometric corrections also considered necessarily to reducing errors that appear due to detector system, environmental attenuation error, geometric distortions due to sensor Earth

geometry variations and conversion of the data to real world coordinates (e.g. latitude and longitude) on the Earth's surface.

c) Image Classification and Analysis

Digital image classification methods can be divided into two major categories including supervised classification and unsupervised classification. In supervised classification techniques used to identify in the imagery homogeneous representative samples of the different surface cover types using signature editor. In case of supervising classification the researcher should have to set specific classes. It means, supervised classifiers require the user to decide which classes exist in the image, and then to demarcate samples of these classes which is called training area. Unsupervised classification does not involve training areas, but simply based on the number of classes that researcher wishes to have will classify simply. But in this the accuracy of the classified class will be in question. In this study supervised classification was performed in order to keep its accurateness. The supervised and maximum likelihood classifications are used for identifying land-use/land-cover of study area using landsat TM 2011 image. The image classifications steps were followed according to the flowchart.

3.2.3. Data collection, software and data sources

Data were collected to assess the indicators of tourist attraction sites availability using GIS and RS techniques. Data gathering including field surveys, collection of GPS data, laboratory analysis and secondary data collection from various organizations and individuals are listed in Table 3. Such materials include annual reports along with statistical data at the study area level, and other documents related to ecotourism. Primary data from the field survey were made through interviews and personal view. The experts were selected according to their knowledge and their experience in tourism, ecology and wildlife conservation. In addition, GPS receiver and digital camera were used in the field survey for the collection of natural attraction places, view point, cultural attractions sites, historical places and locations of Park in Hawassa town and its surroundings. Majority of the secondary data were gathered from different offices such as Ethiopia mapping agency (EMA), ministry of water resources, Hawassa city administration culture and tourism office, National Metrological Agency

(NMA), <http://dds.cr.usgs.gov/srtm/version1/Africa/> (SRTM data 30 meter resolution) and Toposheet map. The following data types and data sources, with their associated processing software, are used to evaluate potential ecotourism site map.

Table 3: List of data used and their sources

No	Data type	Source	Resolution (scale)	Soft ware used for processing and analyses of the data
1	Landsat TM image of the year 2011		Band 1,2,3,4,5 and 7,30 meter and band 6 120 meter	ERDAS Imagine and ArcGIS
2	SRTM data	http://dds.cr.usgs.gov/srtm/version1/Africa/	30 meter	3DEM, ERDAS Imagine and ArcGIS, and GLOBAL MAPPER
3	Toposheet	EMA	1:50000	ArcGIS
4	Meteorological Data	NMA		Microsoft Excel, ArcGIS
5	GPS data	Field survey		ArcGIS and Microsoft Excel
7	Digital Photo	Field survey		Adobe Photoshop and Microsoft
8	Cultural Attraction sites	GPS		ArcGIS and Microsoft Excel
9	Natural attraction places	GPS		ArcGIS and Microsoft Excel
10	Wild life areas	GPS		ArcGIS and Microsoft Excel
11	Protected areas	GPS		ArcGIS and Microsoft Excel
12	View point	GPS		ArcGIS and Microsoft Excel

3.2.4. Conceptual framework and flowchart of the analysis

The GIS and RS technology has been used in Hawassa town and its surroundings' to evaluate the ecotourism potential based on different objectives such, land-use/land-cover and its impacts on ecotourism, vegetation density, lake, animals and parks . Landsat TM satellite image data were used to identify present land-use/land-cover. SRTM Data were used as an input to develop elevation, slope and visibility map of the study area. GPS Data were also collected during field conduct and used to prepare natural attraction point map, cultural attraction point map and view shed point map. Interpolation of temperature and rainfall and extraction of distance from road and distance from the lake were carried out. This research included all the stages related to satellite image processing, including geometric correction, features extraction, geo- processing and image filtering of raw satellite images. Finally image classification was performed in ERDAS Imagine 9.2 to identify land-use/land-cover. Vector maps were prepared in ArcGIS.10.1 software. Digital images processing were produced in ERDAS Imagine 9.2 and data analyses were performed again in ArcGIS.10.1 and IDRISI Andes data processing software. A flow chart of this methodology processes stages are given in figure5.

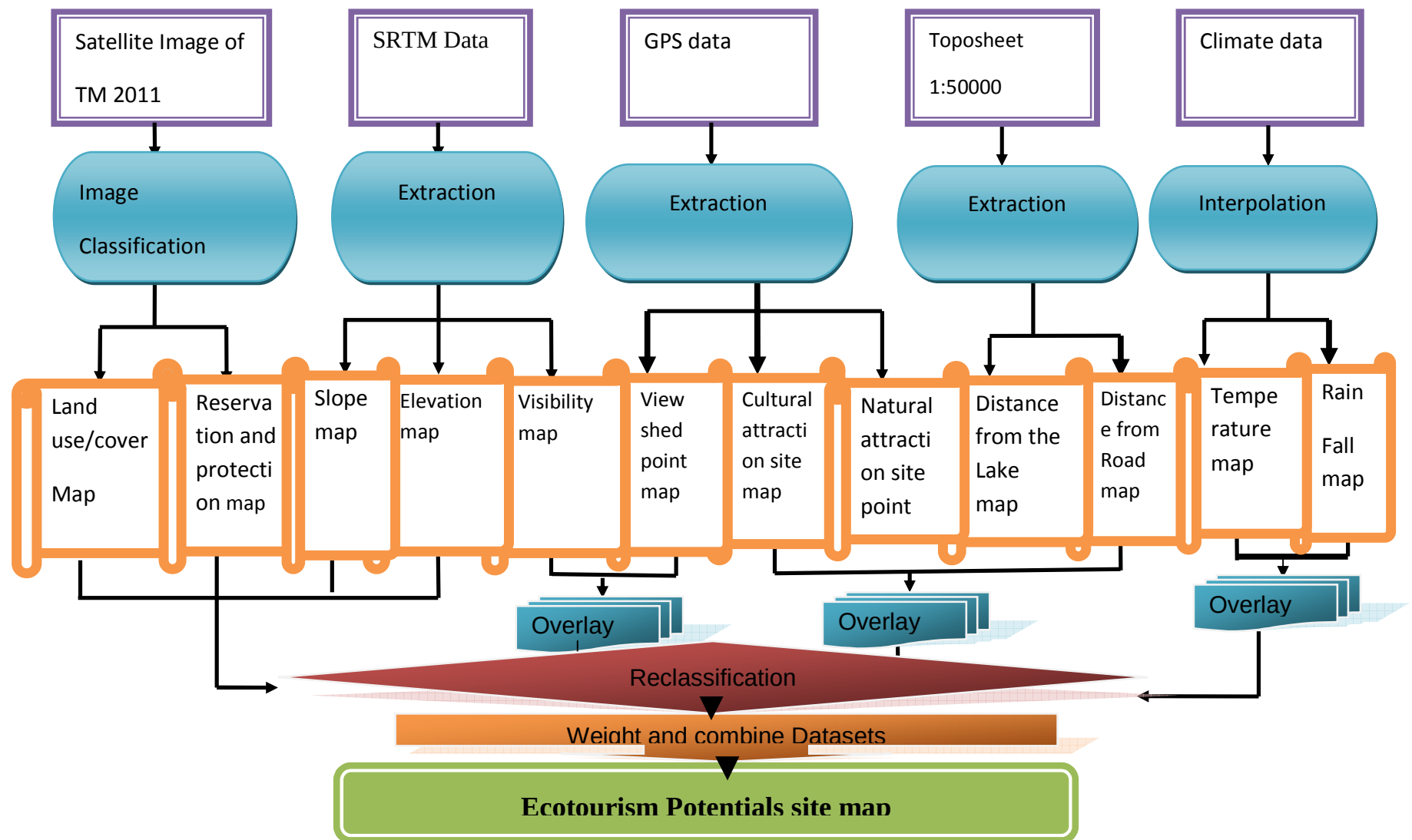


Figure 5: Flow chart of the methodology of the present study

3.2.5. Determination criteria and factor involved

The involvement of criteria and factors were determined based on natural factors and cultural characteristics in the study area for ecotourism potential suitability. Based on the acquired information, multi-criteria evaluation is done based on five criteria as indicators of suitability within the land ecosystem of Hawassa town and its surroundings: (1) landscape, (2) Flora and Fauna, (3) Topography, (4) accessibility and (5) climate characteristic. In addition, the evaluation process for ecotourism site was conducted based on 11 important factors, namely: (1) visibility, (2) land-use/land-cover, (3) conservation/*protection*, (4) elevation, (5) slope, (6) proximity to cultural sites, (7) proximity to natural resources, (8) distance from roads, (9) distance from the lake, (10) temperature and (11) rainfall. All these criteria and factors were chosen based on the opinion and reviewing of different literatures and information from various sources. Multi criteria decision making was applied to integrate decision maker's judgment and preferences to evaluations regarding to ArcGIS, and IDRISI Andes technique. Weight and score were given to each factor depending up on its relative importance in ecotourism suitability evaluation. Pair-wise comparison matrixes were implemented to record the overall results. The first step was the extraction of data to set the objective that is used to identify and evaluate potential ecotourism sites. The extraction was done based on ecotourism potential evaluation criteria and factor elements. At the second and third levels, five criteria and eleven factors were overlaid for the suitability evaluation of ecotourism sites. These were landscape (visibility, land-use/land-cover), Flora and Fauna (conservation/*protection*), topography (elevation, slope), accessibility (proximity to cultural and natural attraction sites, distance from roads, and distance from lakes) and climate characteristics (rainfall and temperature). At the fourth level was the scale of suitability of each factor reclassified as highly suitable, moderately suitable, marginally suitable and not suitable.

4. RESULTS AND DISCUSSION

4.1. Criteria and Classifications Factors Involved for the results

The factors that involved for classification of ecotourism potential sites in this study takes into account the cultural and natural resources that are directly related to the ecosystems and which have endemic characteristics in the area. Based on the acquired information from literature research, previous works and interviews with experts, five criteria and eleven factors were analyzed for identifying and evaluating of the potential ecotourism sites (see Table 4). These important criteria and factors were involved for the determination of what and which areas are best suitable for ecotourism development.

The factor that concerned in this study was done based on MCE that can be measured and evaluated. One of the difficulties in multi-criteria evaluation was Selecting/formulating criteria that need to be fulfilled in order to make the right decision. To solve this difficulty ArcGIS10.1 and IDRISI Andes software was used or represented by map layers, which contain attribute values for each pixel in raster data. The eleven related factors were grouped in to five criteria based on their ecotourism potential value. During this process, the data of all the selected factors were run individually.

Table4: Criteria and factors involved for evaluation of ecotourism potential site in this study area.

Ecotourism Requirement			Factor Suitability Rating				
Criteria/Factors		Unit	High Potential (1)	Moderate Potential (2)	Low Potential (3)	No Potential (N)	Reference
Landscape/ Naturalness	Visibility	Visibility Value/Lines Of Site	7-12High Visibility Value	3-6 Middle Visibility Value	1-3 Low Visibility Value	0 -1 (Invisible)	Kumari et al., 2010 and Chhetri
	Land Use Land Cover	Class	Highly Potential	Moderately Potential	Marginally Potential	No Potential	Banerjee et al., N.D. Analyse
Wildlife	conservation/ Protection	Protected Areas Class	Highly Potential	Moderately Potential	Marginally Potential	No Potential	Questionnaire
Topography	Elevation	Meter	1800-2000	1700-1800	> 2000	<1700	Jangpradit, 2007
	Slope Degree	Degree	0-5 %	5-25 %	25-35 %	> 35 %	Jangpradit, 2007
Accessibility	Proximity To Cultural Sites	Kilometer	0-5 km	5-10 km	10-15k m	>15 km	Khwanruthai , 2012
	Distance From The Lake	kilometer	0-5 km	5-8 km	8-12 km	>12 km	Daniel, 2009
	Proximity To Natural Sites	Kilometer	0-5 km	5-10 km	10-15 km	>15 km	Khwanruthai, 2012
	Distance From Roads	Kilometer	0-2 km. buffers	2-4 km. buffer	4-8 km. buffer	8-12 km. buffer	Boyd et al., 1995.
Climate Characteristics	Temperature	°C	17°C-18°C	18°C-18.5°C	18.5°C-19°C	19°C-20°C	Daniel, 2009
	Rainfall	mm	>1250 mm	1200 mm-1250 mm	1150 mm-1200 mm	921 mm-1150 mm	. Daniel, 2009

4.2. Results of criteria classification maps

In consideration of the acquired information, there were 11 important factors classification performed individually in the form raster format for suitability of ecotourism potential sites. These factor maps were overlaid together for final suitability classification of the study area for ecotourism. Data of all these selected factors were reclassified individually based on their value for ecotourism suitability analysis. For all each factors different scales of measurement value were assigned. In order to allow comparability, the factor maps were standardized. Standardization allows comparison of criterion scores within one alternative. In order to standardize, the raster features of all the factors were reclassified into a common scale range.

4.2.1. Landscape/naturalness

Landscape/Naturalness in this study represents the degree of variation of the natural landscape or the valued landscape character. These factors were present and analyzed to identify which areas are best suited to different types of eco-tourists and ecotourism experiences. Naturalness in this study area was explained in terms of its beautifulness of landscape and naturalness quality. Therefore, the degree of landscape and naturalness of the area were expressed in terms of the following;

Visibility

The visibility or view-shed analyses were done to determine the scenic attractiveness. Naturally unique places were collected using GPS in the form of point feature data. A visibility (scenic attractiveness) factor was produced from DEM data integrated with the location of natural uniqueness by view-shed analysis using ArcGIS spatial analyst tool on the basis of visible or not visible (lines of sight). Based on this concept the analyses of visibility of the classification map are shown in Figure 6.

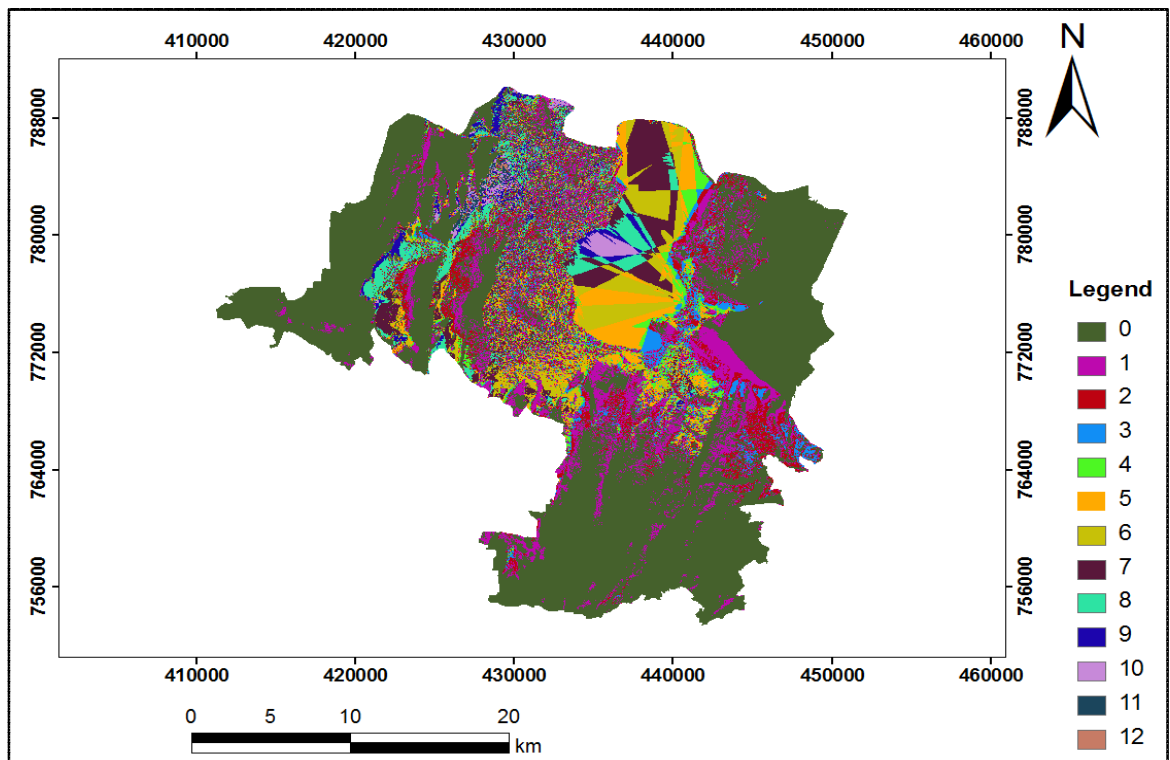


Figure 6. Visibility map

This was carried out by visibility values (lines of sight). In this study, high visibility values (7-12) were ranked as high, middle visibility values (3-6) were ranked as moderate, low visibility values (1-3) were ranked as marginal and invisible are ranked as not suited. The results of the reclassified visibility map are shown in Figure 7.

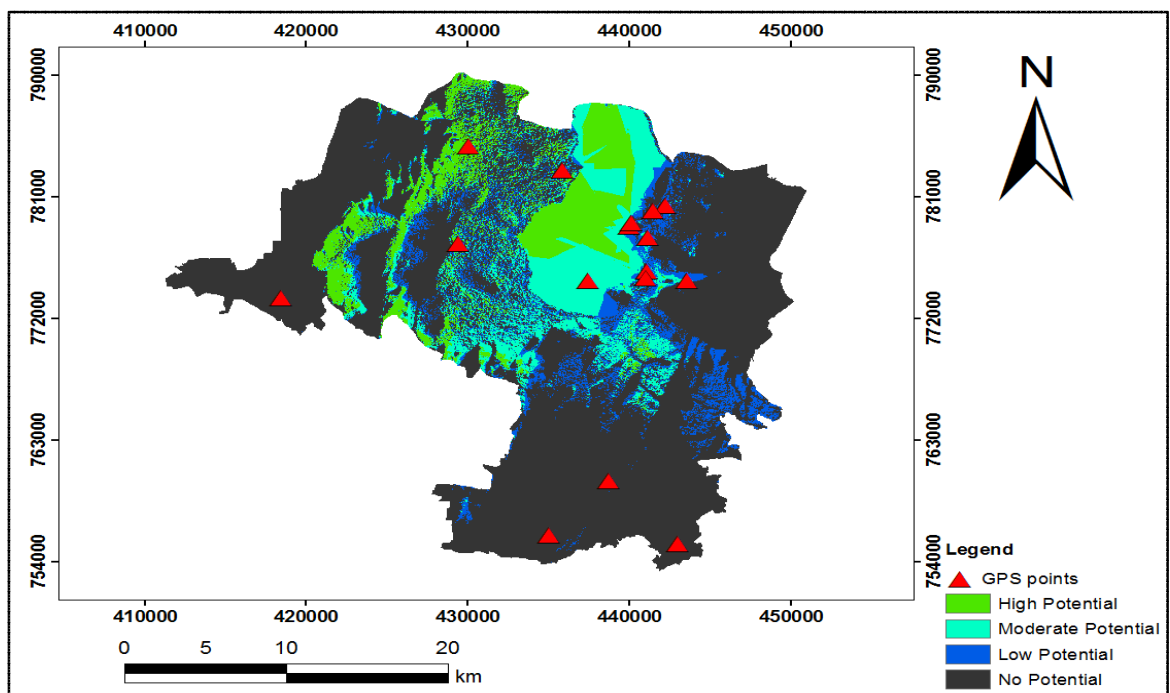


Figure 7. Reclassified Visibility map

Land-use/ Land-cover

Land sat TM image of the year 2011 was classified using ERDAS Imagine 9.2 software into 10 classes of land-use/ land-covers according to the current bio-physical vegetation characteristics of ecotourism potential resources as seen in (Table 5). These are dense forest, open forest, Enset farm, water body, plantation, crop land, cultivated land, urban and built-up land, degraded forest and Grass land. The results of the classified land-use/land-cover map are shown in Figure 8.

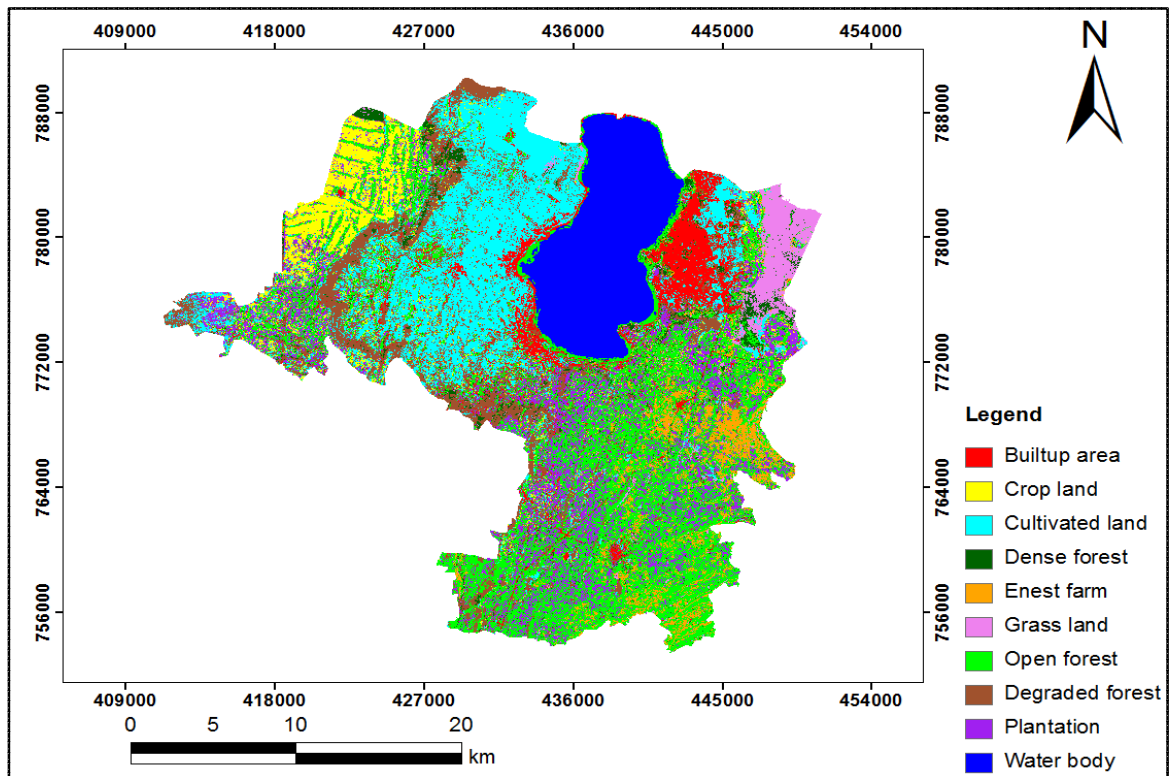


Figure 8. Land-use/ land-cover map of 2011

This study considered some important issues related to ecotourism potential resources. Therefore, the output maps were organized to have 10 classes of land-use/land-cover categories. Based on the present area land-cover/land-use characteristics the ecotourism potential resources were identified and mapped in the study area. The characteristics classified land-use/land-cover categories are described in table 5.

Table 5: Land-use/land-cover classification for ecotourism potential resources

LU/LC Type	LU/LC suitability
Dense forest	Consists of the main natural forest includes evergreen forest and swamp forest and it is highly importance for ecotourism as major ecotourism attraction, area need to be conserved.
Open forest	Includes mixed forest plantations, forest plantation and agro forestry that are caused by human activity and it is very important for ecotourism area needs to be managed and conserved properly to attract ecotourism.
Enest farm	Includes pasture and farm houses, poultry farm houses and aqua cultural land. It is highly important for ecotourism, can serve as ecotourism attraction.
Plantation and Grassland	Consists of mixed vegetables (avocado, potato, sugarcane, mango, banana, onion, coffee and grassy areas) it Should be properly monitored and protected from encroachments.
Crop land and cultivated land	Includes paddy fields, barely crops, maize, wheat crop and horticultural. This is the area under agriculture and infrastructure development is restricted.
Water body	Includes both natural water bodies (rivers and lakes). It is active for recreation as boating, parks and natural zoological parks
Built-up area	It is composed of cities, town and commercial, residential houses, villages, institution land, school, offices, health centers and transportation services. It Suitable for ecotourism infrastructure development
Degraded forest	It includes rangeland (bushes, shrubs and bamboo), marsh and swamp, mines and pits. It needs to be managed properly with possibilities of new plantation. Important from point of view of agro-forestry.

Therefore, the classified Land-use/land-cover of 2011 TM landsat satellite image were also reclassified in to four groups based their importance of ecotourism suitability. According to classification the area of dense forest and water body were ranked as highly potential; open forest, enset farm and plantation were ranked as moderately potential; grass land, crop and cultivated lands were ranked as marginally potential; built-up area and degraded forest were ranked as no potential. The results of the reclassified land-use/land-cover map are shown in Figure 9.

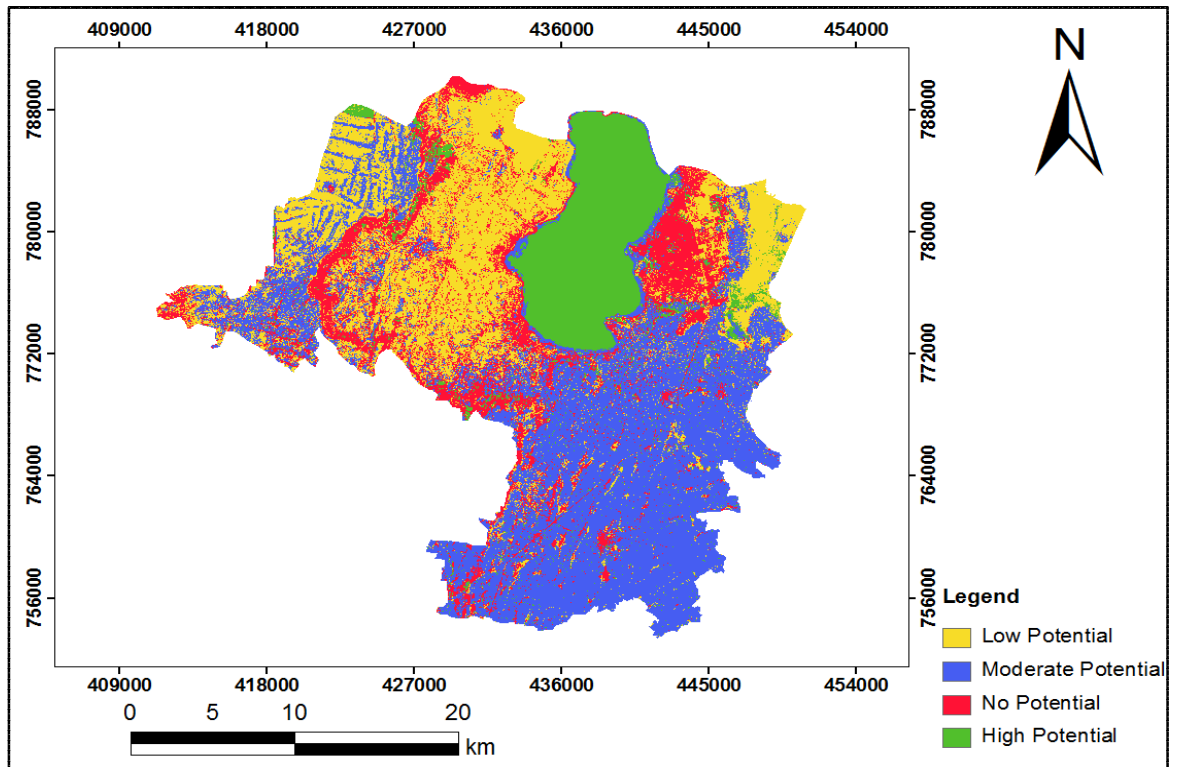


Figure 9. Reclassified Land-use/land-cover map

4.2.2. Flora and fauna

Flora and fauna condition concerns with conservation and protection of areas which are suitable for species diversity characterization as flora and fauna were big importance for attractions ecotourism potential.

Conservation/ Protection

The conservation/ protection factor was produced by reclassifying the land-use/ land-cover map with the type of areas, which are suitable for wildlife abundance with regard habitat to wildlife, rare species and endemic species. In this study, dense forest land-cover was ranked as highly potential for wildlife habitat; water bodies are ranked as moderately potential; and open forest areas are ranked as marginally potential. On the other hand, the classes of built-up area, farm land, grassland, degraded forest, cropland and plantations are ranked as no potential for wildlife (Figure 10).

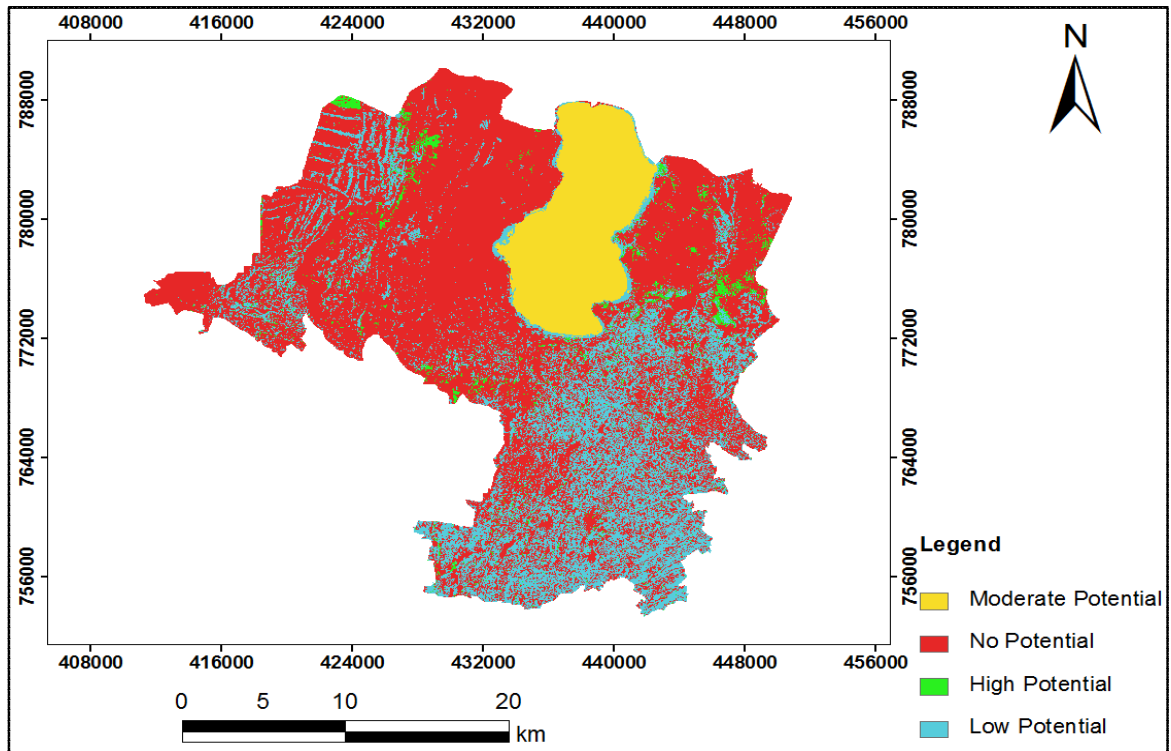


Figure 10. Reclassified conservations and protections map

4.2.3. Topography

In this study the necessity of topographical analyses were produced to describe surface shape and relief suitability of ecotourism potential in the study area. It refers to various shape of surface which represents the external shape of the earth. In this study topography considered as one of the most important factors of attractiveness for tourism, as it enables patterns and form for many other landform and land cover features were determined. Furthermore, elevation and slope factors was considered for the selection site for tourism construction project what areas are best suited to different types of eco-tourists and ecotourism experiences.

Elevation

To evaluate the height of place above or below a reference level such as mean sea level elevation were analyzed in the study area. To evaluate the nature and element of the area formation and the landscape, what areas is suitable for tourism were necessary to consider the position, angle and stage. This elevation factor was generated from Digital Elevation Model (DEM) using Global mapper, 3DEM and ArcGIS software (Figure 11).

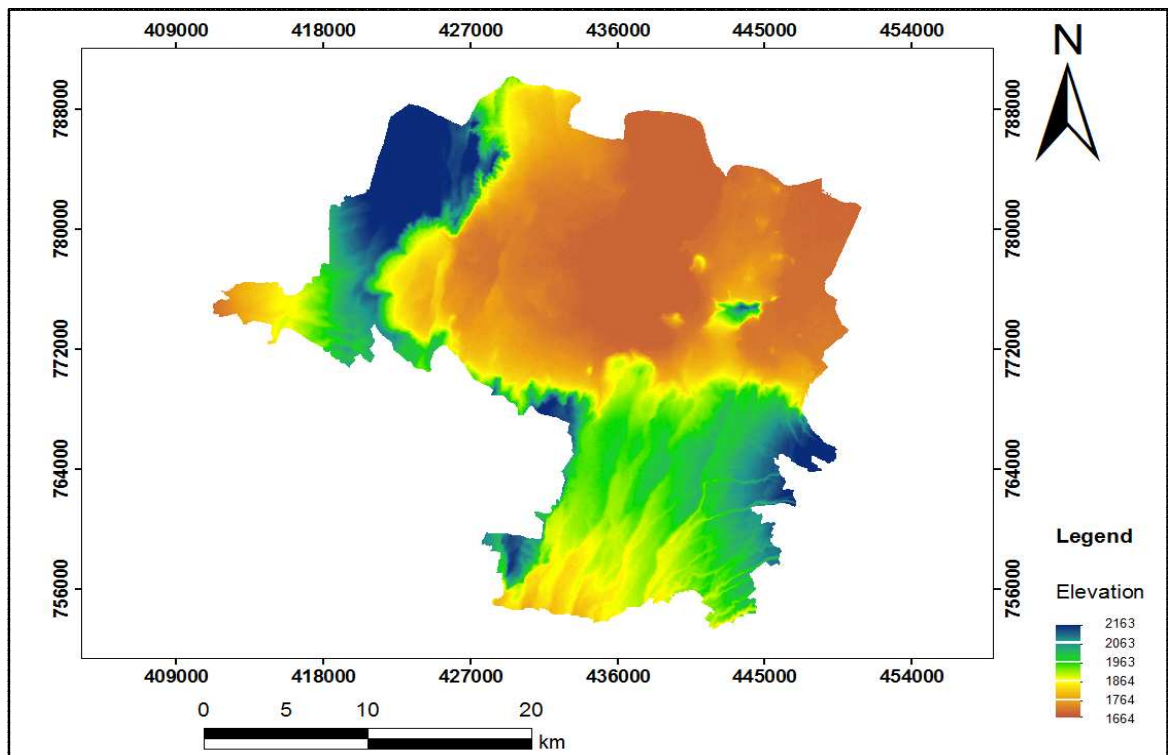


Figure 11. Elevation map

The elevation classes are evaluated based on the basis of attractiveness of the landscape for tourism and the significance for ecotourism potential was reclassified into four classes. This are elevation of 1800-2000 m are ranked as high relative relief; moderate relative relief (1700-1800 m); low relative relief (above 2000m); and no relative relief (<1700 m). The results of the reclassified elevation map are shown in Figure 12.

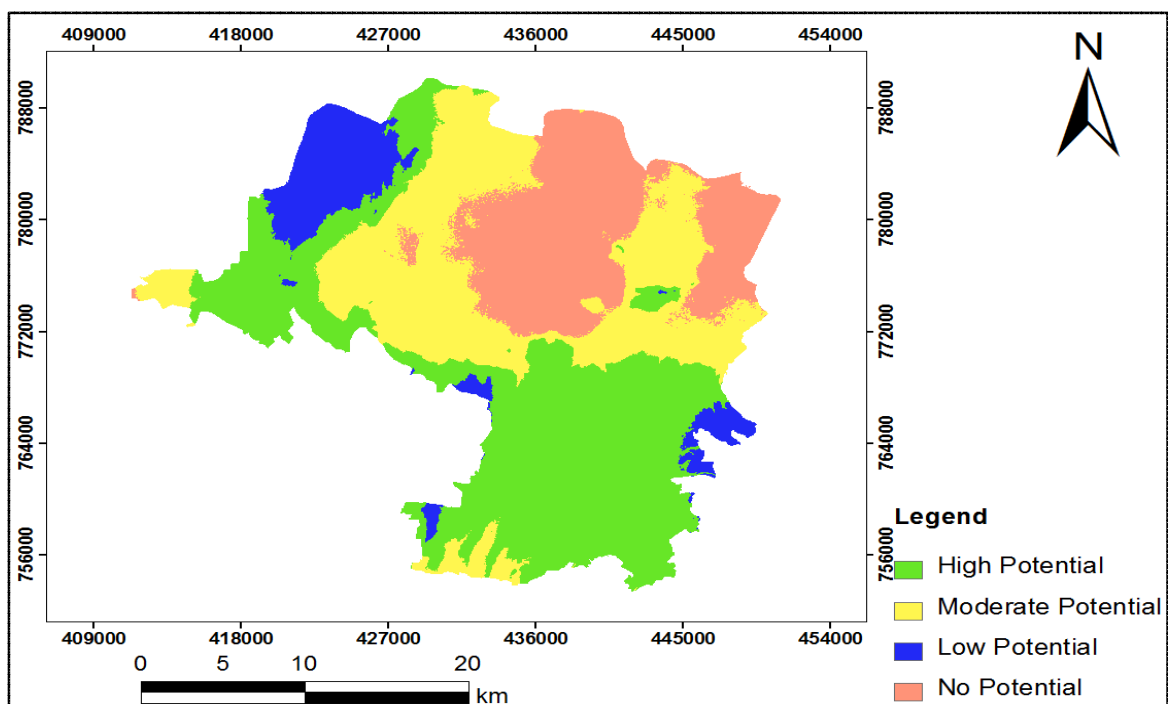


Figure 12. Reclassified Elevation map

Slope

Slope analyses in the study were takes place to determine visually attractive area during observation across with extensive geographical area. The complexity of the area were in terms of slope is a vital factor in the suitability analysis for ecotourism. This factor shows a varying degree, a complexity of area and slope of area which effect to selected area by defining percentage of slope that relates to sites suitable for ecotourism. In addition, slope is a safety indicator implying the gentler the slope, the higher the safety factor and vice versa. The result of the classified slope map is shown in Figure 13.

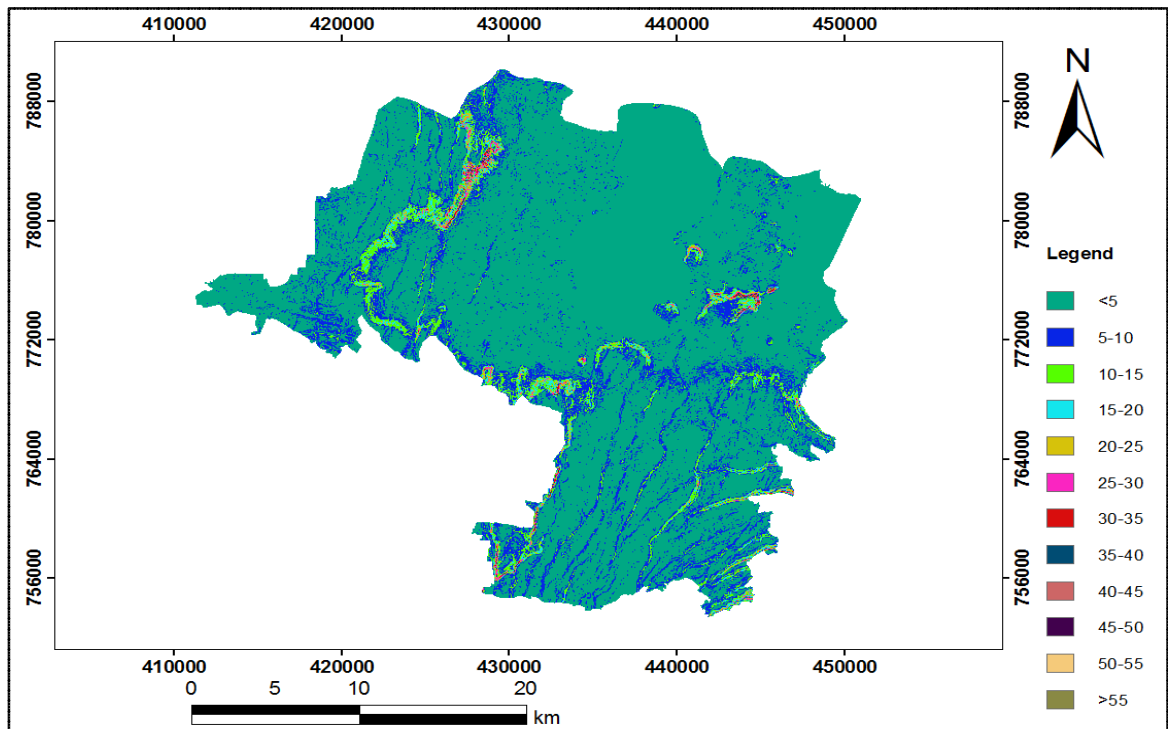


Figure 13. Slope map

Slope in this study represents the steepness of terrain features, calculated as the ratio of vertical distance to horizontal distance. Slopes were an important for ecotourism because all terrain features are derived from complex landmasses. Gentle slopes are more suitable for ecotourism than steep slopes. In this regard, the reclassified slope map was given from the degree measurement unit for ecotourism requirement. In this study the flat landform is the most suitable for ecotourism. Therefore, the 0° - 5° was ranked as highly potential; moderately potential 5° - 25° ; marginally potential 25° - 35° ; and no potential above 35° were in this method. The analyses of the reclassified result slope map are shown in Figure14.

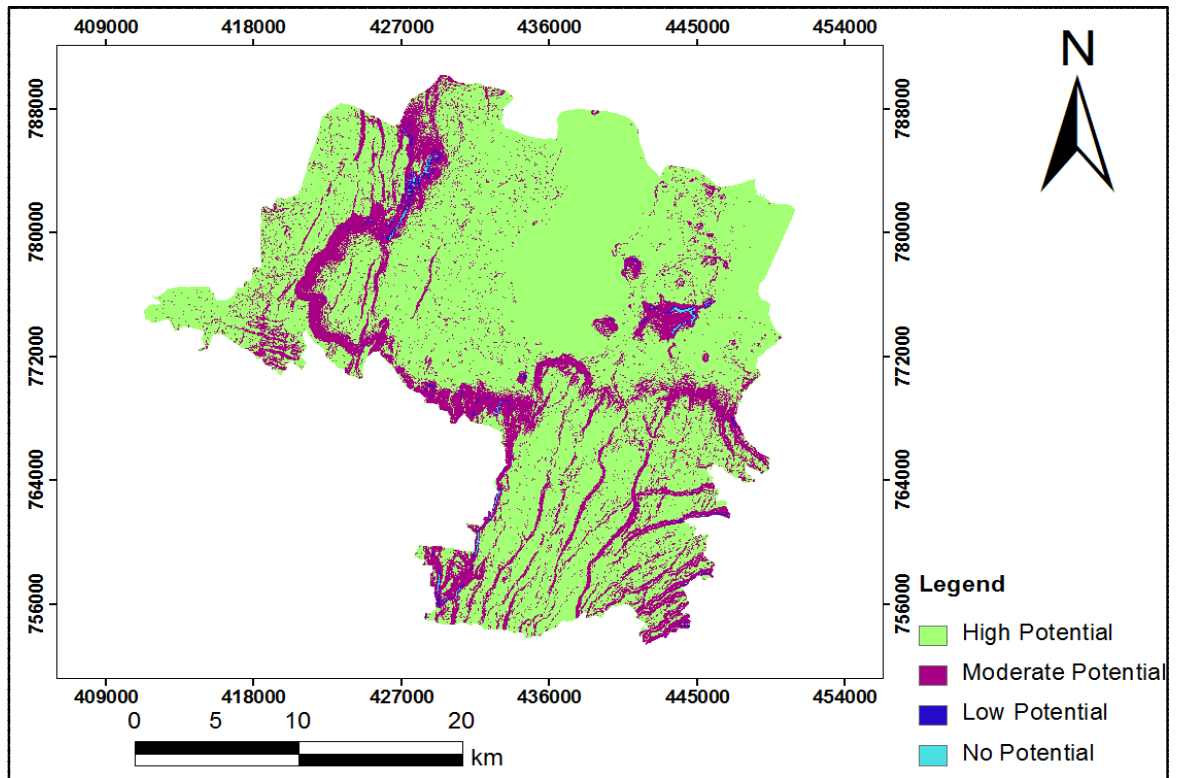


Figure 14. Reclassified slope map

4.2.4. Accessibility

Ecotourism often takes place in natural areas, lake bodies, cultural or historical resources and traditional places. Therefore, the accessibility to the natural attraction sites, cultural attraction sites, proximity to lakes, and distance from road (with regards to the attractiveness of the area) are important factors for ecotourism. The accessibility these factors were analyzed using proximity analyst tool in ArcGIS software based on their different distance.

Proximity to natural attraction sites

Proximity of natural attraction sites factor was classified through buffering analysis within different kilometer distance from natural attraction sites which are collected through GPS Garmin. Lake Beach, natural hot springs sites, mountains, aquatic animals place, animal parks, bird sites and forests are considered as natural attraction sites in this study. The result of the natural point map with specified distance in kilometer is shown in Figure 1.

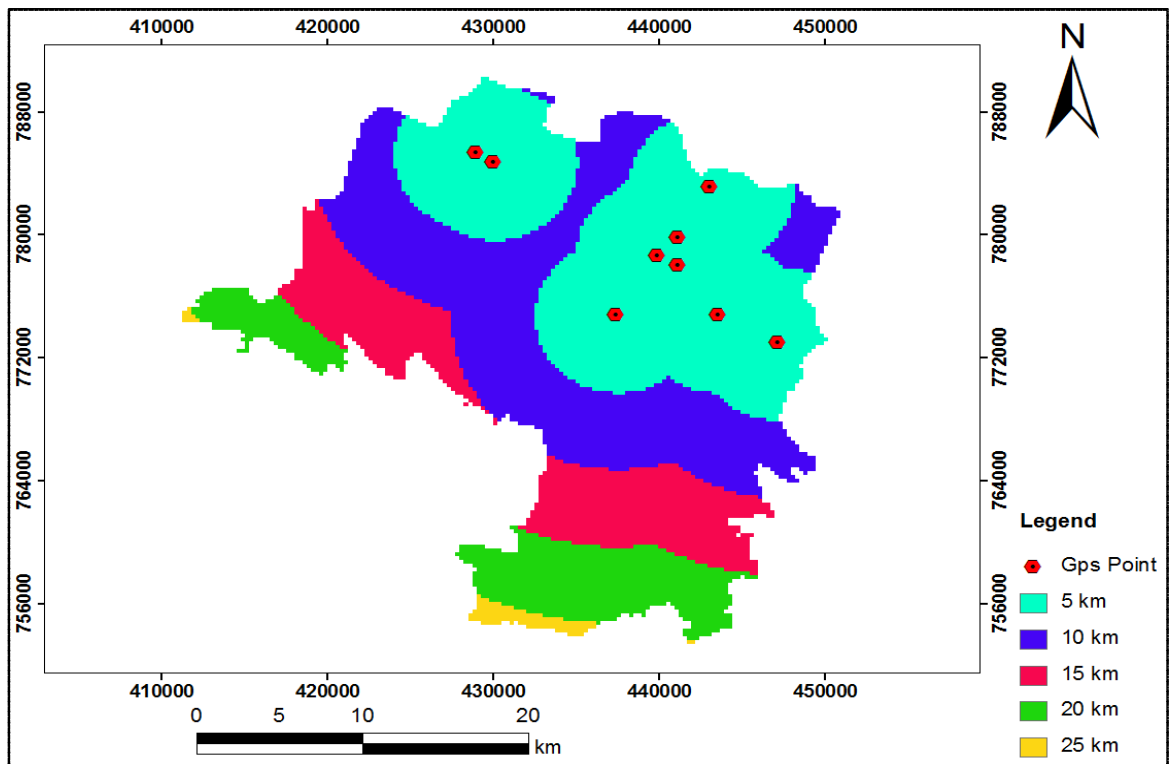


Figure 15. Natural tourism sites distance buffer point map

In this study, the reclassification was done in the areas nearby natural attraction sites (0-5 km) were ranked as highly potential; moderately potential (5-10 km); marginally potential (10-15 km); and no potential (above 15 km). The result of the reclassified proximity to cultural sites map is shown in Figure 16.

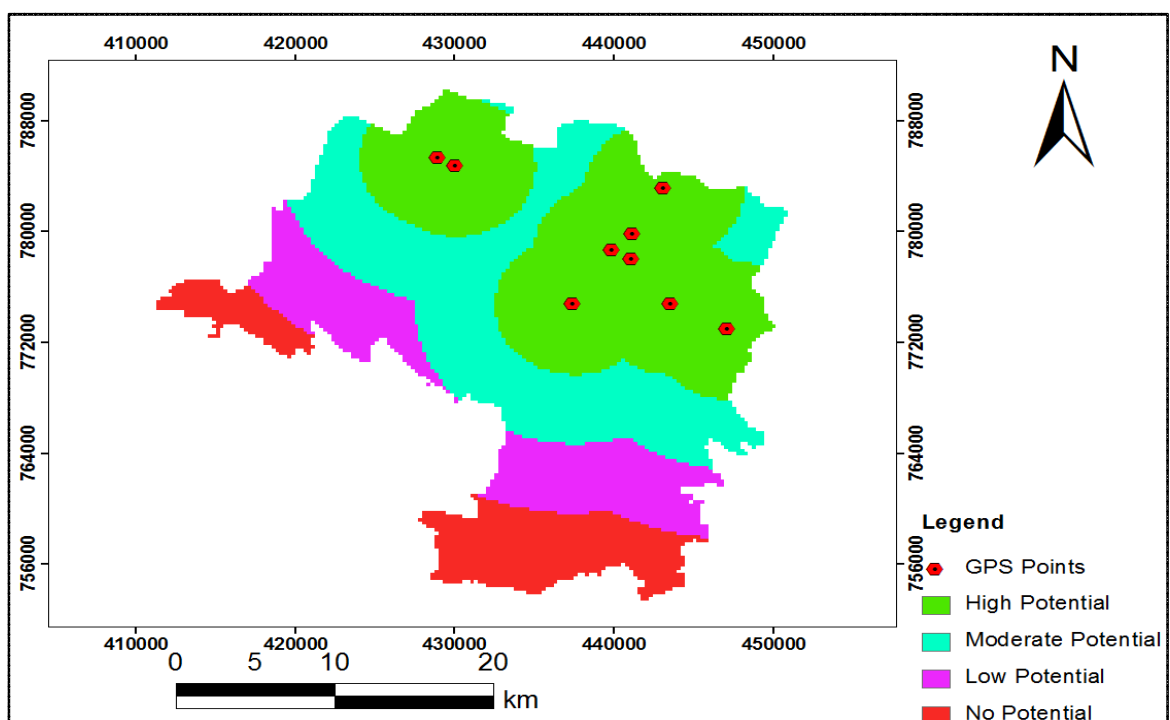


Figure 16. Reclassified Natural tourism sites distance buffer point map

Proximity to cultural attraction sites

Like proximity to natural attraction sites the proximity to cultural attraction sites factor was evaluated and classified through buffering analysis within different kilometer distance from cultural attraction site, which were collected by GPS Garmin. Historical places, cultural places, traditional festival places, and traditional way of farming activates were considered as cultural attraction sites in this study. Cultural and unique places were known from the Hawassa City Administration Culture and Tourism Office. The result of the cultural attraction point maps with specified distance in kilometer is shown in Figure17.

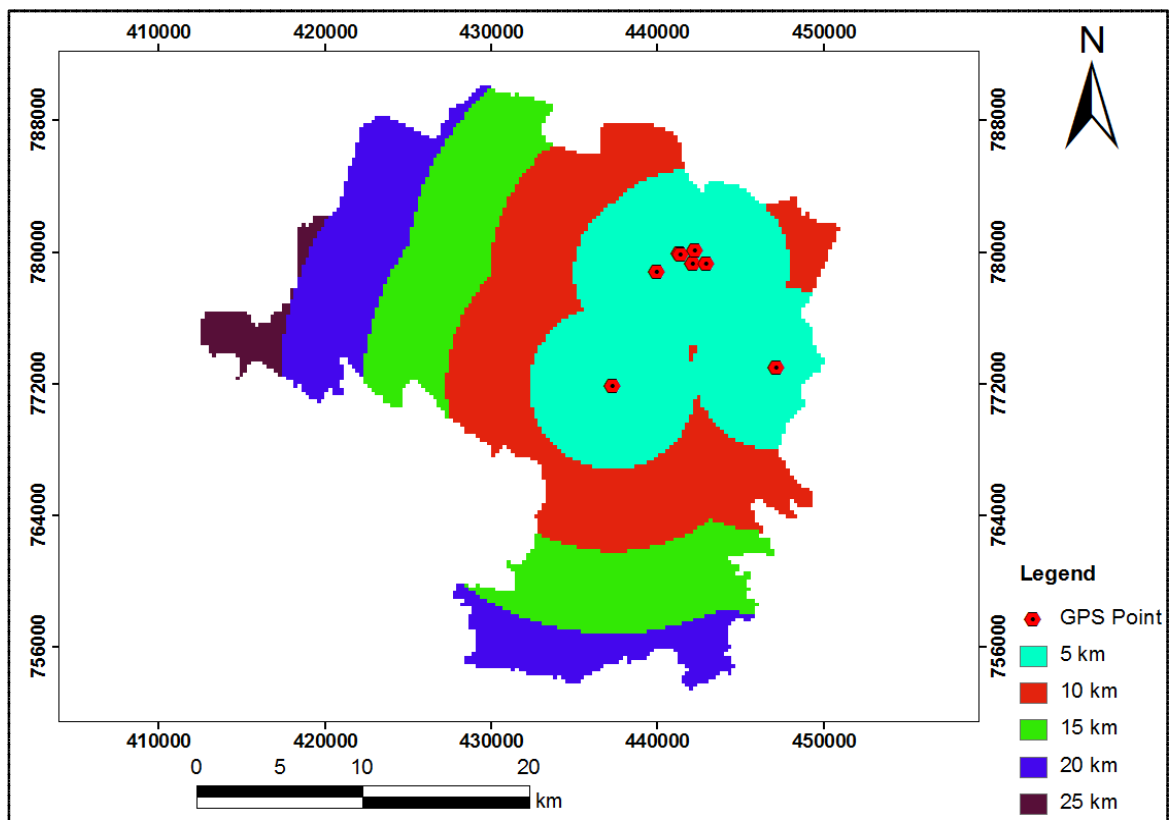


Figure 17. Cultural tourism sites distance buffer point map

Cultural attraction sites of the study area were reclassified in to four classes based on the distance to potential attraction sites. Result of reclassified cultural attraction sites were done by considering the areas nearby natural attraction sites. Cultural attraction sites within (0-5 km) distance were ranked as highly potential, moderately potential (5-10 km); marginally potential (10-15 km); and no potential (above 15 km). The result of the reclassified proximity to cultural sites map is shown in Figure 18.

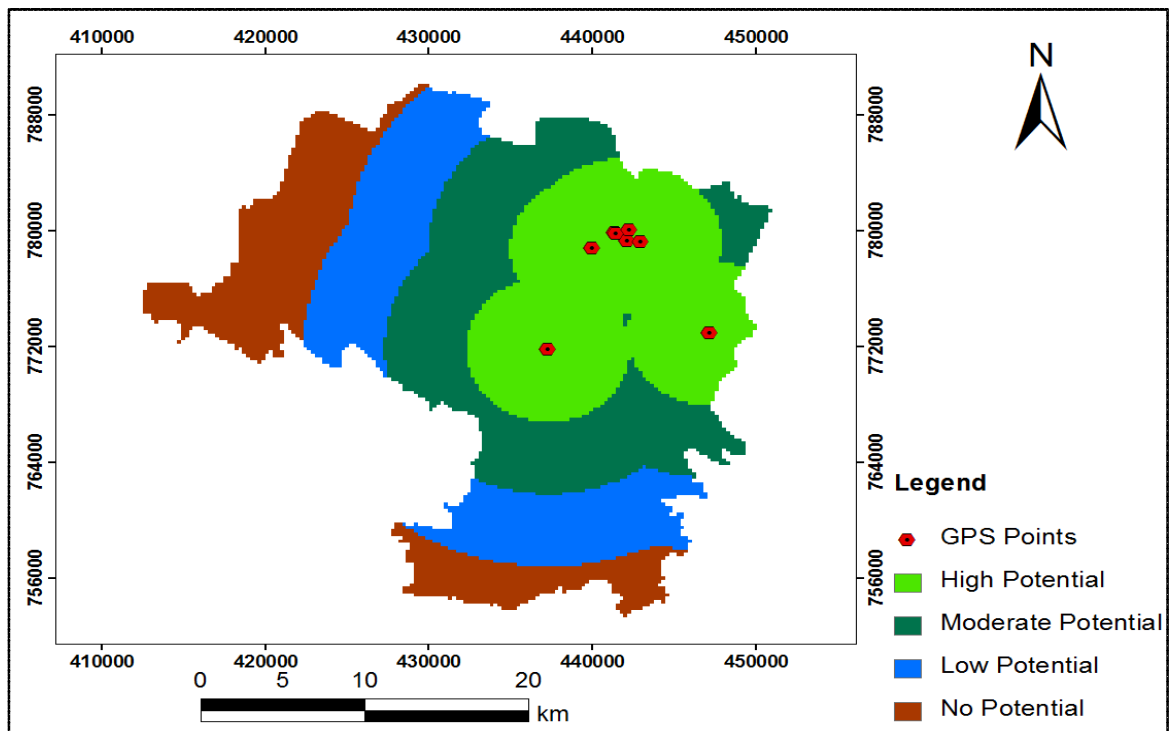


Figure 18. Reclassified cultural tourism sites distance buffer point map

Distance from roads

This criterion was classified based on the transport condition by access types and distance from the road types. Depending up on this the nearest areas is best suited for ecotourism attractions and experiences. The analyses of classified map distance from the roads are shown in Figure 19.

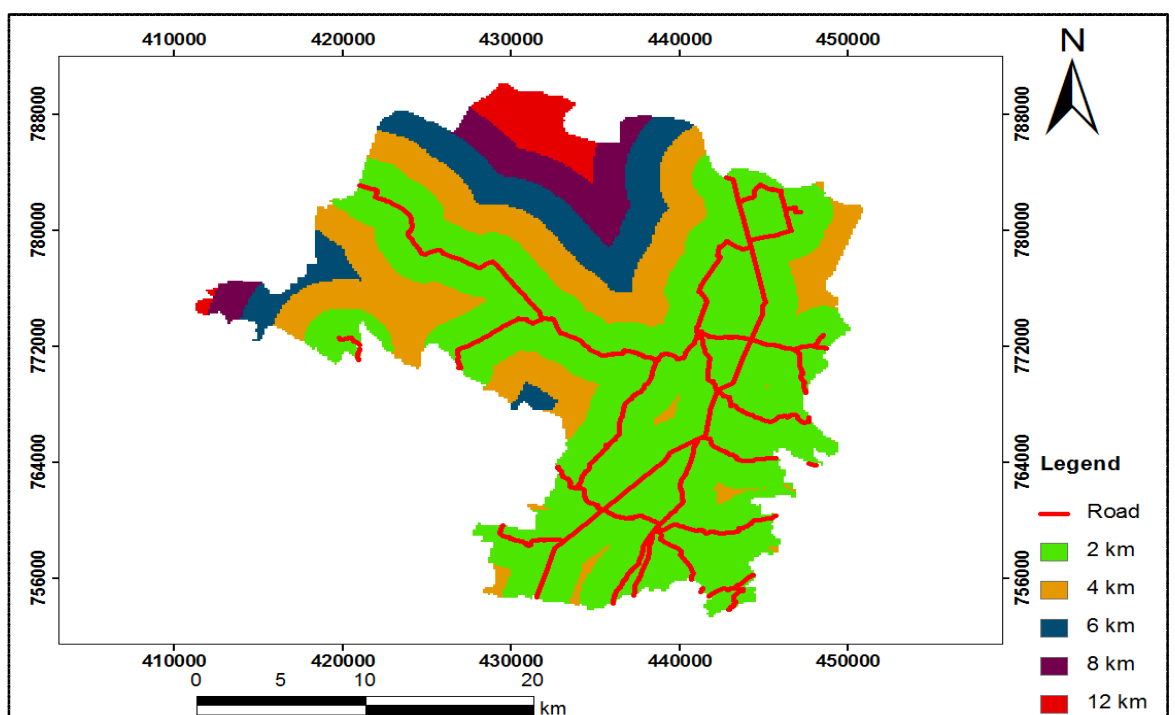


Figure 19. Road Distance buffer map

The areas within 2 km distance of any buffers around all roads were ranked as high potential for ecotourism development, the areas within 2-4 km distance buffer around main roads were ranked as moderate; the areas within 4-8 km distance buffer around main roads were ranked as marginal, and the areas within 8-12 km distance buffer around major roads were ranked as no potential. The result of the reclassified distance from the roads map is shown in Figure 20.

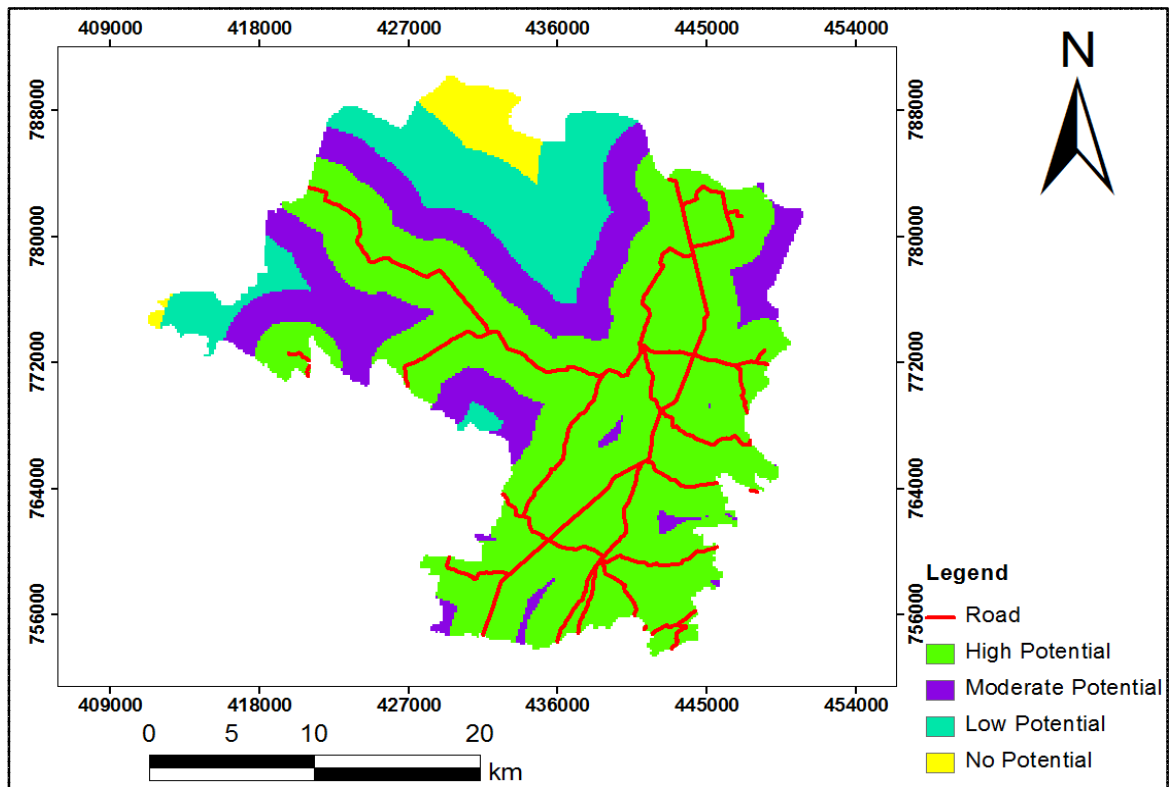


Figure 20. Reclassified road distance buffer map

Distance from lake

Availability of water in nearby distance is necessary for many purposes like active recreation as boating, parks, zoological parks, drinking, cooking and sanitation. Distance from Lake Hawassa was taken as one of the factor for sites suitability analysis. To produce the result of Lake Map, the shape file data was buffered in the spatial analysis tool proximity, multiple rang buffer to generate four order distances from the lake. The analyses result of the classified distance from the lake map is shown in Figure 21.

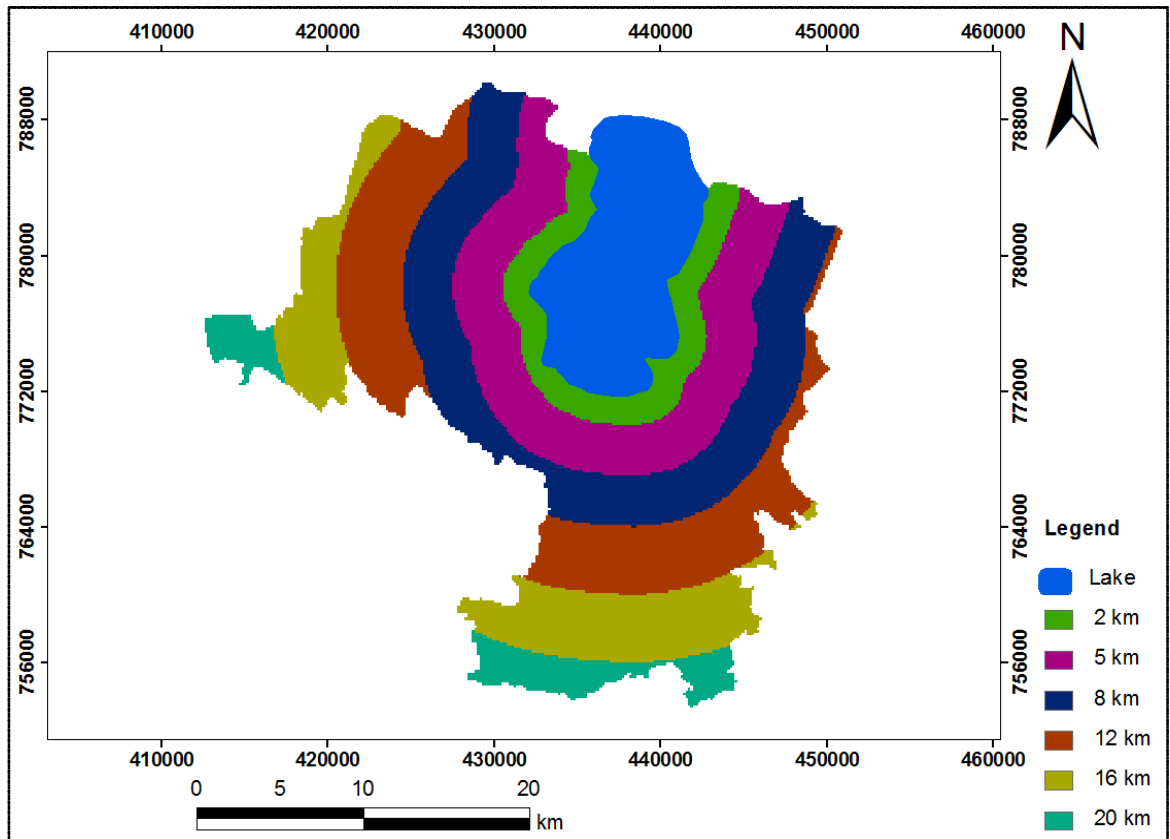


Figure 21. Lake Distance buffer map

The Lake map represented by polygon feature was not compatible for MCE. Hence, the polygon feature was converted into raster feature and reclassified into four classes based on the distance from the lake (Figure 22). The area near to water source (lake) less than five km was ranked as high potential as it was easily accessible for water needs; ranked moderate potential for distance 5-8 km; ranked as low potential for distance from 8-12 and rank no potential for distances far >12 km as unsuitable for ecotourism site location. The analyses of the reclassified distance from the lake map are shown in Figure 22.

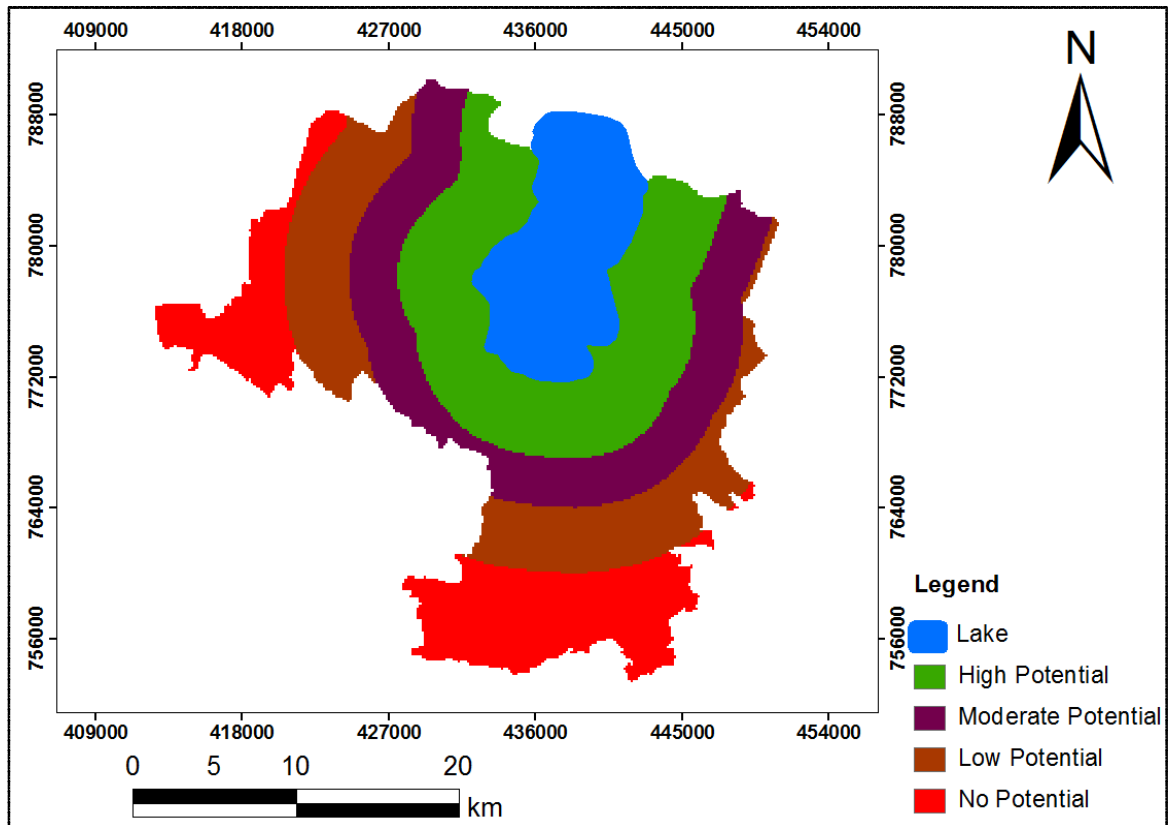


Figure 22. Reclassified Lake Buffer distance map

4.2.5. Climate characteristics

Annual rainfall characteristics

Growth of vegetation is determined by the availability of rainfall within specific area. As a result, to map the annual rainfall of the study area point features were interpolated using spatial analyst tool in ArcGIS software. The availability of surface and ground water is also directly or indirectly dependent up on the availability and amount of rainfall. Moreover, it highly modifies the state of weather condition of the area. Figure 23 shows mean annual rainfall map of the study area.

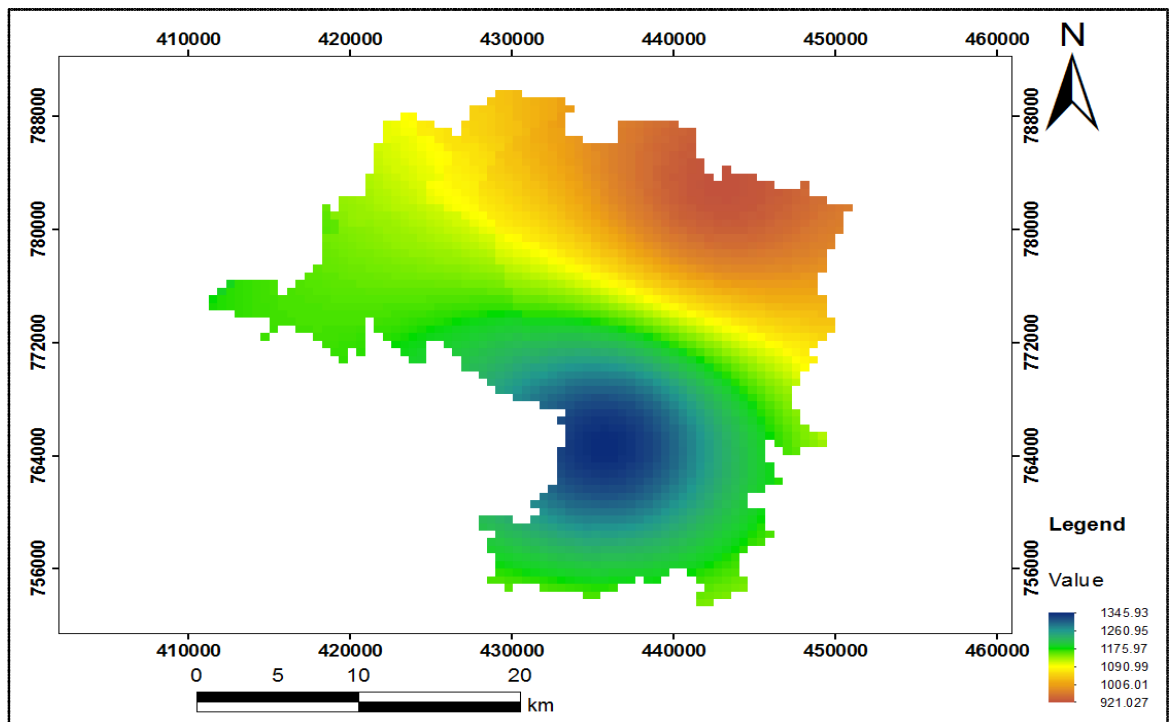


Figure 23. Mean annual rainfall map

Therefore, high amount of rainfall of a certain area is more suitable for ecotourism sites than less amount of rainfall. The mean annual rainfall of the study area range between 927 and 1345 mm. Mean annual rainfall value between 927 and 1150 was ranked as 4, between 1150 and 1200 as 3, between 1200 and 1250 as 2, and between 1250 and 1345 as 1. Figure 24 shows reclassified annual rainfall map of the study area.

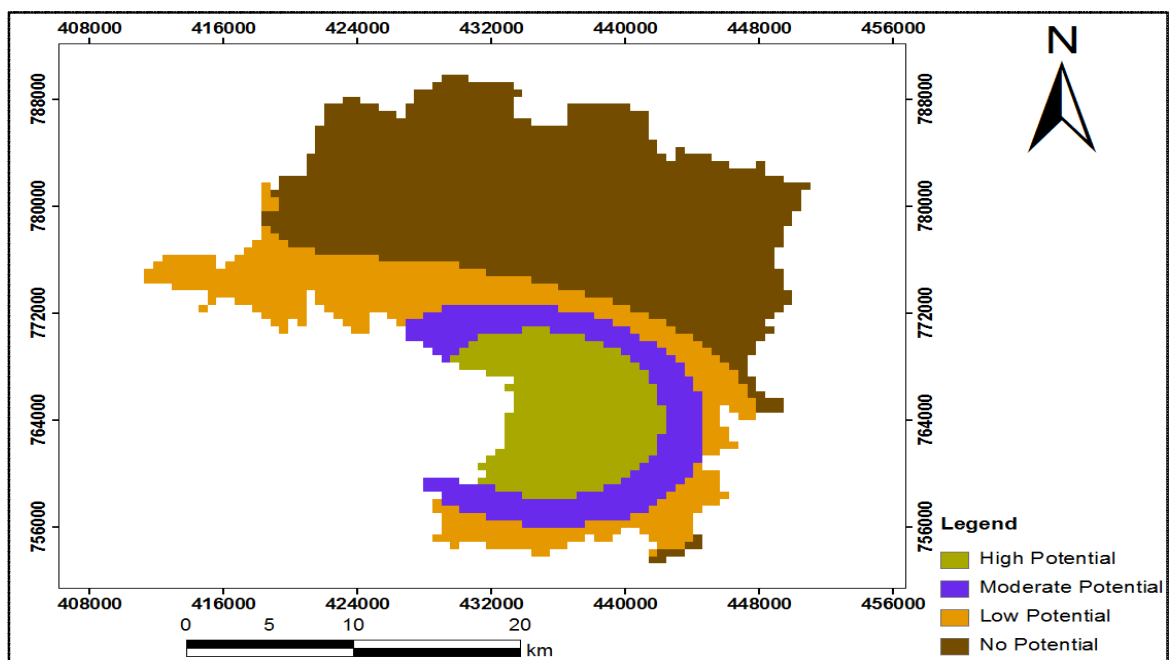


Figure 24. Reclassified mean annual rainfall map

Annual Temperature characteristics

Temperature of the area has a capacity that determined the weather condition of the ecotourism potential sites. To determine availability and distribution of vegetation, annual temperature characteristics were considered as a factor. With this regard the annual temperature of the study area were interpolated using spatial analyst tool in ArcGIS software. Based on the interpolation suitability of the temperature for human recreation and ecotourism sites in this study were classified. Generally, lowest temperature is considered as suitable for ecotourism, as most humans prefer low temperature area for existence and recreation. Figure 25 shows mean annual temperature map of the study area.

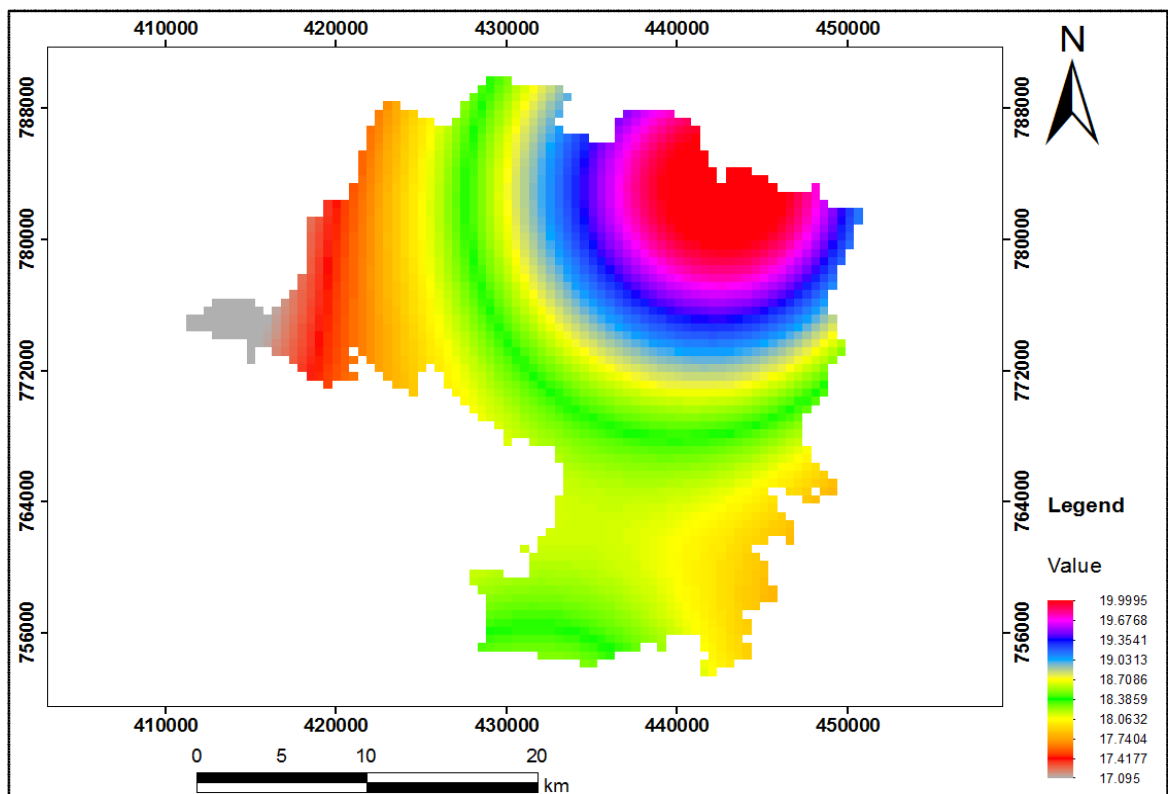


Figure 25. Mean annual temperature map

Mean annual temperature of the study area varied between 17°C and 20°C. Lowest temperature values were therefore, assigned the highest possible rank and highest temperature values were assigned the lowest possible rank. Temperature values between 17°C and 18°C were ranked as 1, between 18°C and 18.5°C is ranked as 2, between 18.5°C and 19°C were ranked as 3, between 19°C and 20°C were ranked as 4. Figure 26 shows reclassified mean annual temperature map of the study area.

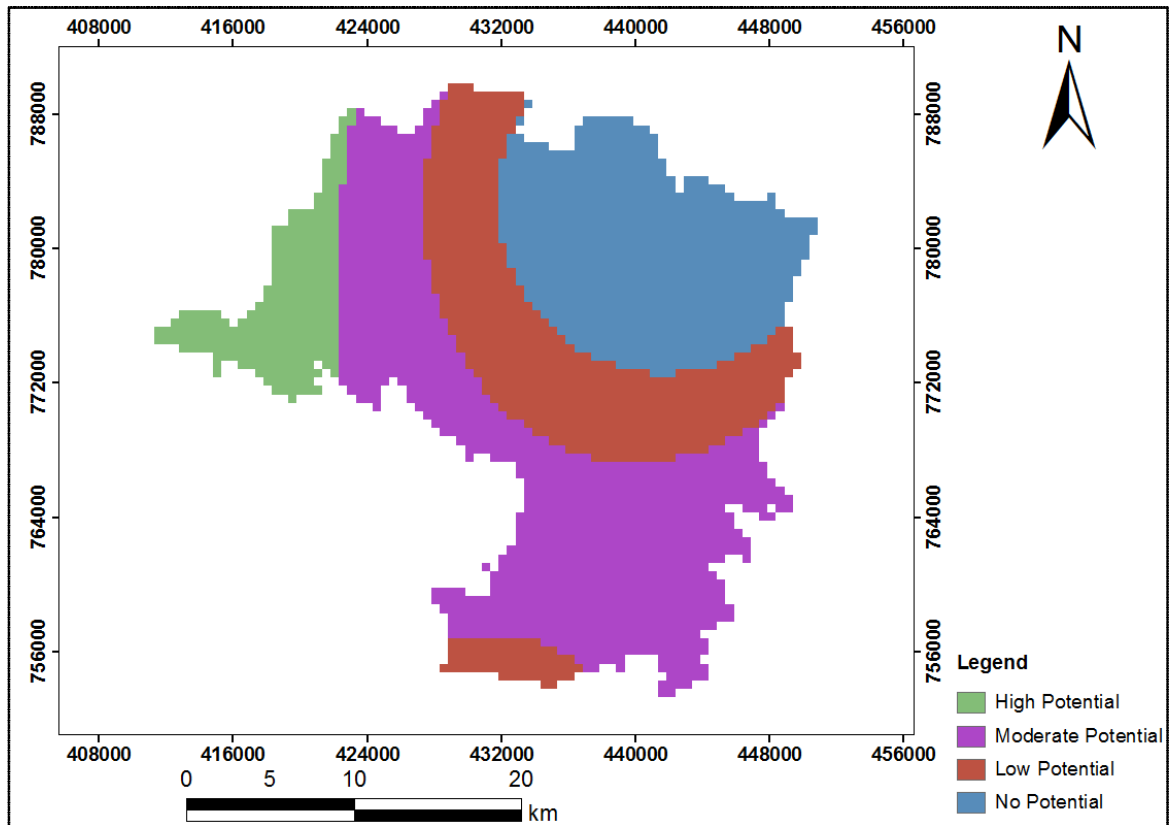


Figure 26. Reclassified mean annual temperature map

4.3. Factors Weighting, Evaluation and suitability Analysis

The actual factors and class weights of the parameters were involved in the study area in order to produce and evaluate the ecotourism suitability map. The result was determined the relative importance of one criterion over another. The task of assigning weights (deciding the importance of each factor) was performed outside GIS software on IDRISI Andes. To determine and achieve the relative importance of each factor in relation to the objective of this study, different literatures were reviewed. The method was evaluated within relative significance of all the parameters by assigning weight for each of them in the hierarchical order, and in the last level of the hierarchy, the suitability weight for each class of the factors was given. According to the review, the prioritizing of factor maps (or simply factors or criterion) from highest to lowest was as follows: visibility, Land-use/land-cover map, lake proximity map, protected area map, elevation map, slope map, natural attraction sites map, cultural attraction sites map, climate condition (temperature and rainfall map) and road proximity map. Table 6 shows the pair wise comparison of factor layers.

Table 6. Pair- wise comparison of factor layers

Layers	Visibility	Land-use/ land-cover	Lake	Protection	Elevation	Slope	Natural attraction	Cultural attraction	Rainfall	Temperature	Road
Visibility	1										
Land-use/ Land-cover	9/10	1									
Lake	8/10	9/10	1								
Protection	1/2	1/2	9/10	1							
Elevation	1/3	1/3	1/2	9/10	1						
Slope	1/4	1/4	1/3	1/2	9/10	1					
Natural attraction	1/5	1/5	1/4	1/3	8/10	1/2	1				
Cultural attraction	1/6	1/6	1/5	1/4	7/10	1/3	9/10	1			
Rainfall	1/7	1/7	1/7	1/6	1/5	1/4	8/10	1/3	1		
Temperature	1/8	1/8	1/8	1/7	1/3	1/7	1/5	1/5	1/2	1	
Road	1/9	1/9	1/9	1/9	1/5	1/9	1/7	1/7	1/5	1/2	1

Visibility, lake and land-use/land-cover with a slight difference have high importance for ecotourism than all others. Protected area, elevation map, slope map, and natural attraction sites map with a moderate difference were ranked as moderately less important for ecotourism suitability evaluation. Comparison of cultural attraction sites and rainfall factors were weighted strongly less important for suitability ecotourism potential map than visibility, lake and land-use/land-cover. Temperature and road proximity, on the other hand, was weighted very strongly less important than, Visibility, lake and land-use/land-cover and moderately less important than elevation map, slope map, and natural attraction sites map.

As it is indicated in Table 6 AHP weight Pair- wise comparison of factor layers was one of the most inclusive MCDM methods and extensively used MCE using IDRISI software method. It helps to make simpler the decision problem by creating a hierarchy of decision criteria with different number of factors taken into account in each step. For ecotourism suitability, eleven factor maps were produced and reclassified according to their degree of importance that they have for ecotourism and environmental sustainability. Separate tasks were performed using ArcGIS and IDRISI Andes software. In the GIS database, the attribute factors are represented by map layers and contain attribute GIS is used for

performing land suitability analysis, the selected and reclassified or standardize raster files with their scores were exported from GEOTIFF/TIFF format to IDRISI raster format and IDRISI software was implemented for the calculation columns of the matrix. To make sure the reliability of the output weights, the consistency ratio index (CR) were also calculated and it uses to measure the degree of consistency achieved in the matrix ratings which were randomly generated. Based on the properties of reciprocal matrices, the CR can be calculated in this study. Internationally if CR is smaller than 0.10, then degree of consistency is fairly acceptable. Thereby in this study, the consistency ratio result is 0.04, which is acceptable. Table 7 shows result the consistency ratio of the map weights.

Table 7: Principal Eigen vector of the pair wise comparison matrix

Factor	weight
Visibility	0.2056
Land-use/land-cover	0.2
Lake	0.1614
Protected	0.1243
Elevation	0.0747
Slope	0.068
Natural	0.0489
Cultural	0.0476
Rainfall	0.0273
Temperature	0.0171
Road	0.0121

Consistency ratio (CR) is 0.04.

The Eigen vector of weights were generated using IDRISI software 0.2056 for visibility, 0.20 for Land-use/land-cover map, 0.1614 for lake proximity map, 0.1243 for protected area map, 0.0704 for elevation map, 0.068 for slope map, 0.0489 for natural attraction sites map, 0.0476 for cultural attraction sites map, 0.0273 for rainfall map, 0.0171 for temperature and 0.0121 for road proximity. Output evaluation was then computed by multiplying by hundred for each factor map by these eigenvector weight values.

During weight overlay analysis the cell values of each input parameters were multiplied by the computed weight. The resulting cell values were added to produce the final out put raster. Then overall suitability result map was created into four class of suitability. These suitability classes were assigned to their respective suitability classes on the basis of reclassified suitability classes during reclassification and multi criterion evaluation. The level of suitability of the areas for ecotourism development was classified as: highly

suitable area; moderately suitable area; marginally suitable area; and not suitable area. The result of classified ecotourism suitability map area coverage shows in table 7.

The result of ecotourism suitability map takes place with the useful consideration of the factors for ecotourism such as view shed and landscape forms appropriate for an ecotourism destination, flora and fauna habitats, unique natural resources, proximity to cultural and historical intrinsic values, proximity to climate characteristics and proximity to road. The ecotourism evaluation class and the classified suitability map for ecotourism is shown in Figure 27.

$$\begin{aligned} \textbf{Ecotourism Suitability Map} = & 0.2056 (\text{visibility map}) + 0.20 (\text{land-use/ land-cover} \\ & \text{map}) + 0.1614 (\text{Lake Proximity map}) + 0.1243 (\text{protected area map}) + \\ & 0.0704 (\text{elevation map}) + 0.0811 (\text{slope map}) + 0.0489 (\text{natural attraction} \\ & \text{sites point map}) + 0.0476 (\text{cultural attraction sites point map}) + 0.0273 (\text{main} \\ & \text{annual rainfall map}) + 0.0171 (\text{mean annul temperature map}) + 0.0121 (\text{road proximity}) \end{aligned}$$

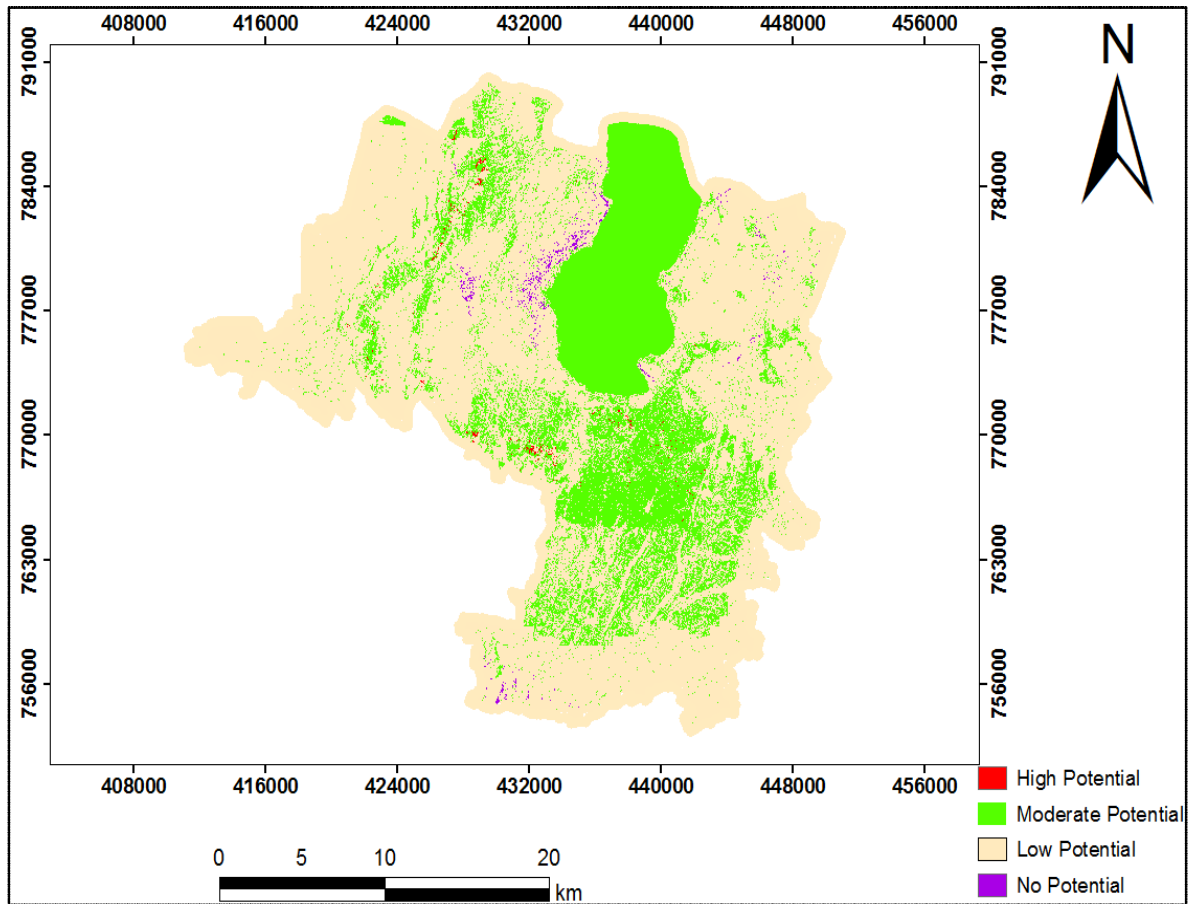


Figure 27. Ecotourism potential suitability map

Table 8. Extent of ecotourism potential suitability area

Suitability	Area (ha)	Area (%)
High Potential (s1)	4279.86	6
Moderate Potential (s2)	16715.13	23
Low Potential (s3)	50346.93	69
No Potential (N)	1156.76	2
Total	72496.68	100

The western part of the study area is highly suitable for ecotourism it accounts, 4280 ha and (6%) of the total area. These areas are characteristically endowed with green forests and visibility of the attractive sites (lake and parks). Therefore, the management of these areas is inclusive and addresses the issues of resource conservation, environmental management, and the control of ecotourism development. Moderately suitable areas are mostly located in the central and southern part of the study area, which accounts for 16715 ha, which is (23%) of the total area. Most of these areas are free from urban

settlements with a unique and wonderful natural beauty, diverse attractions and high tourism potential. Areas with the highest percentages of marginally suitable land are located in the southern, western and eastern part the Hawassa town, which is 50347 ha (69) % of the total area. These areas are appropriate for development facilities; also, these area are intensively used for grazing and agricultural purposes. These areas must rehabilitate in relation to the ecotourism resource development, by taking into account the condition of the natural environment, local society and culture. Infrastructures should be developed in harmony with local identity and with nature. Areas not suitable for ecotourism is also located in the western of the lake and southern tip of the study area it accounts for 1157 ha (2 %), which is relatively small extent.

4.4. DISCUSSION

According to FAO (1967), the land suitability map for ecotourism was classified based on four suitability classes as S1, S2, S3 and N (fig.27). In this study results were ranked based on the importance of different parameters for ecotourism sites. According to the set criteria, those with the best potential for ecotourism were identified. By considering the criteria and factors, the following typical ecotourism suitable sites were identified which are the results of all overlaid factors maps in particular, in order to present situation of ecotourism, future possibilities of ecotourism, ecotourism requirement and the expectations of ecotourism development in the area.

4.4.1. Highly suitable for ecotourism

These classes involves highly suitable sites for ecotourism but are most sensitive areas, and threaten of the natural characteristic within these areas will lead for sustainable ecotourism sites development activities. Similarly, sustainable ecotourism development in these areas will contribute for control and manage the resources in order to preserve their original conditions. To rehabilitate this area the local government at this time has planned to avoid all the activity which are negatively affect and are difficult. In environmentally sensitive areas, ecosystem protection is the first issue for effective, sustainable ecotourism suitable site development and will lead to minimize the negative environmental impacts (Khwanruthai, 2012). In study the areas which are well connected by roads, thus accessibility plays important role in determining high ecotourism potential

also. These areas are placed primarily between 1800 m to 2000 m elevations, 0°% to 5°% slope, 0 km to 5 km distance from the lake and are also characterized by very high level of environmental satisfaction value, moderate level of species diversity and ecosystem uniqueness. Flat, wet and cold areas, plays an important role for long life of ecosystem they have greater ecotourism capacity (Newsome *et al.*, 2002). These areas should be preserved or conserved and controlled in sustainable way, unless the existing of ecotourism resources in sensitive areas is still in harmful situation. More specifically, according to 2011 TM satellite image land-use/land-cover, these areas is characterized with abundant green forests, wildlife sanctuary, as well as rich unique natural and cultural heritage endowment. Its high value of natural resources is suitable for research and education as well as conservation of biodiversity and maintenance of the ecosystem. The destination has nature attractions and unique qualities for ecotourism.

4.4.2. Moderately suitable for ecotourism

The lake and central part of the study areas were identified as a moderate potential for ecotourism suitability sites. Moderately suitable for ecotourism classes, allows for moderate development but with high consideration on construction work and detail assessment of environmental impacts are required, especially in the lake side. These areas largely free from cultivation with large water body, high vegetation cover and have great tourism potential within its unique landscape and natural resources. The areas which they have natural ecotourism attraction sites and used as an incentive to preserve the rich biodiversity while on the other hand high biodiversity and ecosystem uniqueness attract more ecotourists (Newsome *et al.*, 2002). As a result, by facilitating proper ecotourism infrastructure and services under policy guidelines this area can be developed as ecotourism sites. Environmental awareness is raised among tourists and stakeholders. In this area the supervision should address and give a priority for the issues of resource conservation, environmental management, pollution control mechanism, liquid sewerage system, solid waste disposal sites and all tourism development control mechanism. The ecosystem processes are controlled by species diversity in a community and contribute on the way to the expansion of the destination (Peterson *et al.*, 1998). This area is dynamic for recreation such as boating, lake, mountains, unique trees and natural places parks. Therefore, these areas can be considered for ecotourism attractions, particularly for tourist activities such as walking, bird watching, sightseeing and any activities.

4.4.3. Marginally suitable for ecotourism

In this study the classification which is characterized by low sensitivity for the environment considered as marginally suitable area for ecotourism. These areas are occupied by crop farming practice, plantations, urban expansion; grazing and they are the areas that already need a special consideration. Therefore, to make these areas suitable for tourism development generally requires especial protection and promotes ecotourism resources and the use of natural resources. Azizur, (2010) also recommended preservation of these type land-use/land-covers and the unique cultural heritage; these areas could provide ecotourism services, which take into account the condition of the natural environment, local society and culture. Therefore, these areas must conserve the neutrality the area, must fulfill transport, green hotels, eco-lodge and public facilities to support ecotourism activities. These will increase opportunities for local people and communities to participate in ecotourism and will be one source of income to them.

4.4.4. Not suitable for ecotourism

The areas which was classified as not suitable for ecotourism potential in the region were 1157 ha (2 %) of total study area. In this study the area with several impacts of development and degraded environment was identified as not suitable for sustainable ecotourism expansion. According the result this class were situated within the scale factor of <1700 elevation, > 35 % slope, and 0-1 visibility weight value considered as not suitable for ecotourism. Areas characterized by such things are highly risky for tourism industry. It may have some environmental problems; however, those are controllable, because it is too small compare to others.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusion

Increased human interference in the ecologically fragile areas can cause irreversible change in the existing ecological processes. This necessitates a systematic management of ecotourism destinations, which can minimize the impacts from ecotourism activities while offering benefits to the local communities. The present study has tried to develop an integrated approach of ecotourism development by identification of ecotourism sites. Assessment of ecotourism sustainability at field-level has assisted in the identification of poor and very poor performance indicators.

The main contribution of this study was the identification of ecotourism indicators for identification of western and southern parts of the study area by applying the hierarchical structure of AHP in a geospatial environment. Secondly, a method for sustainability assessment of ecotourism destination was developed in four stages in the present study. Use of ecotourism indicators would help in identifying ecotourism potential sites based on the environmental parameters. MCE was done based on eleven criterion (factor) maps to produce ecotourism suitability site analysis. These were visibility, land-use/cover, protection, elevation, slope, proximity to natural attraction sites, proximity to cultural attraction sites, distance from roads, distance from the lake, mean annual rainfall and mean annual temperature. This can also have its implication at the site level environmental management of ecotourism activity based on ecotourism attractivity, ecological fragility and environmental resilience.

The present study was an attempt to develop ecotourism indicators for identification of potential ecotourism sites in geospatial environment and development of a method to assess the ecotourism sustainability in the study area. The present study provides scope for future studies using ecotourism indicators for identification of potential ecotourism sites in other ecosystems as well. It may also include other environmental parameters like environmental characteristics index and proximity accessibility index to make it applicable in other conditions also.

The identification of ecotourism sites were classified as moderately suitable for ecotourism, which is characterized by free from urban settlements with unique natural resources and a great tourism potential. While the area of marginally suitable for ecotourism involves the areas that are validating for practice. They are the most

appropriate areas for development. Finally, not suitable for ecotourism areas are highly risky for leading to problems; some are in a deteriorating already on the risk of destruction. Condition or have been destroyed. In general, the results of this study show practical means of evaluation of ecotourism service and ecotourism resource utilization. Ecotourism potential is a complex resource involving besides its spatial measurement, social and environmental implications. This study provides the stimulus for continuation of research and future investigations on sustainable development of ecotourism in all similar resourceful areas in Ethiopia and elsewhere.

5.2. Recommendation

Based on the present study, the following important recommendations are made:

- ❖ Additional research is essential with incorporating more factors to represent actual ecotourism development such as soil erosion, sedimentology of Hawassa Lake, species diversity, wetland importance and distance from different tribes of local community.
- ❖ Ecological conservation should get first priority in ecotourism sustainability in the highly and moderately classified ecotourism potential sites.
- ❖ Local level planning should be developed and adopted for ecotourism. In addition, villagers should be empowered to manage natural resources within the boundary of the village following participatory management practices.
- ❖ Dry and liquid waste disposal site and transport infra-structure in the beach of the lake should be facilitated in harmony with the nature of the lake.
- ❖ Map of the identified scenic potentials is needed to check with the reality on the ground before making decisions.

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APPENDICES

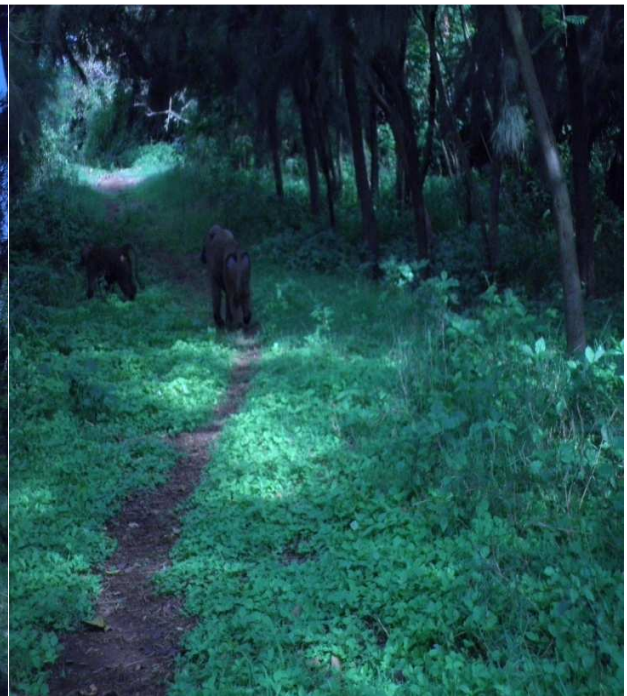
Annex 1: GPS Points

Cultural Attraction Sites			
Eastings	Northing	Suitability scale	Name of Attraction Sites
442140.3	779298.8	Low Potential (3)	Sidama Cultural Auditorium
441374	779883	Moderate Potential (2)	Timiket Bahir
441435.3	779852	Moderate Potential (2)	Shebele Hotel
442294.6	780097	Low Potential (3)	Arab Sefer
442938	779267	Low Potential (3)	Mesekel Square
437314.6	771843	Moderate Potential (2)	Ras Menegsha
447165	772968	Moderate Potential (2)	Burikitu
439992.2	778810	Moderate Potential (2)	Chambalala ceremony place
Natural Attraction Sites			
Eastings	Northing	Suitability scale	Name Of Attraction Sites
441126.4	777979.6	High Potential (1)	Tabor forest
443577.3	774783.5	High Potential (1)	View point of mount Alamura
430029	784748	High Potential (1)	Mekebesa
428956	785333	High Potential (1)	Anole
426661	789451	Moderate Potential (2)	Senkele
443095.6	783105.3	High Potential (1)	Millinium Parak
439900	778656.6	High Potential (1)	Amora Gedel
441159	779791	Moderate Potential (2)	Fikir Lake
447165	772968	Moderate Potential (2)	Hot spring
437446	774783	Moderate Potential (2)	Lake
View Point			
Eastings	Northing	Suitability scale	Name Of View Point Data
438712	760019	Low Potential (3)	Leku Town
441126.4	777979.6	High Potential (1)	Mount Tabor
443577.3	774783.5	High Potential (1)	Ensete farm area
429375	777564	Low Potential (3)	Dore Town
437446	774783	Moderate Potential (2)	wetlands
441092	775492	Moderate Potential (2)	Viwe Piont
442202.9	780342.8	Moderate Potential (2)	Tulu
441030	775001	Moderate Potential (2)	Werencha Kebele
430029	784748	High Potential (1)	Mekebesa
439992	778810	Moderate Potential (2)	Chambalala
440115	779086	Moderate Potential (2)	Lewi Resort
426661	789451	Moderate Potential (2)	Senkele Wilde Life Sanctuary
433397	869342	Moderate Potential (2)	Cheichei
434994	756001	Low Potential (3)	Yamere Hotel Park
442973	755347	No Potential (N)	Random View Point 1
413935	773350	Low Potential (3)	Random View Point 2
435855	782960	Low Potential (3)	Random View Point 3
418446	773527	No Potential (N)	Random View Point 4
441466	779975	Moderate Potential (2)	Haile resort hotel

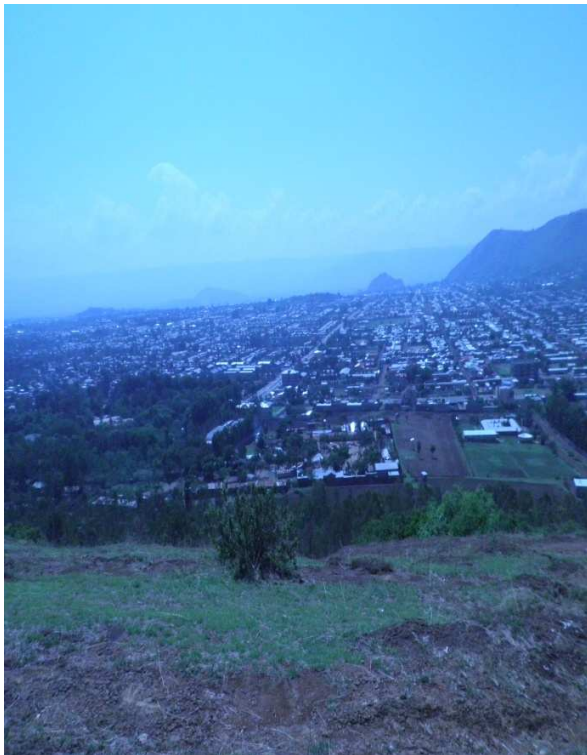
Annex 2: Plate 1. Hawassa lake wetland



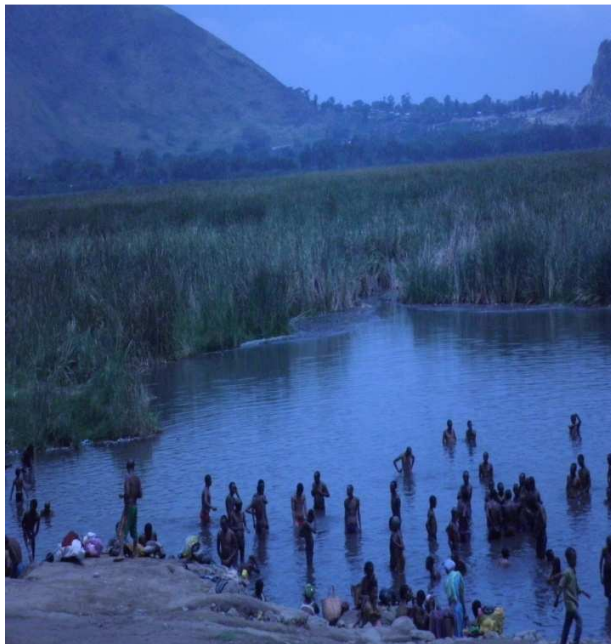
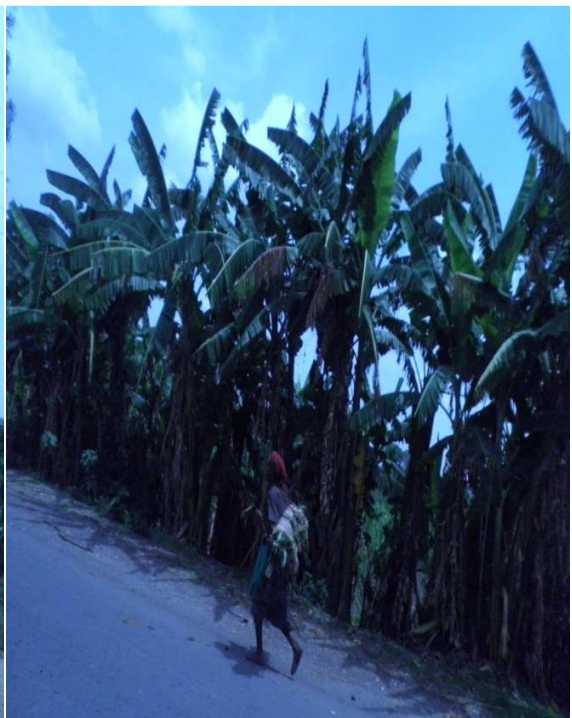
Annex 3: plate 2 Amora gedel and tikurwuha park



Annex 4: Plate 3 View point



Annex 5: plate 4 Burikitu natural hot spring



DECLARATION

I, Declare that this thesis is my inventive work and has not been presented for a degree in any other university and for all the data sources of the materials used as an input for this thesis has been acknowledged.

Name

Hailegebreal Tamirat

Signature

Place

Addis Ababa University

Date of Submission

July, 2013