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GIS and Remote Sensing application for Ecotourism facility development site suitability analysis: The case of Bale Mountains National Park, Ethiopia.

By

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Thesis Submitted to the Department of Tourism Development and Management in Partial Fulfillment of the Requirements for the Degree of Masters of Art

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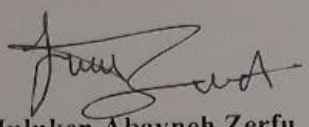
Candidate Declaration

I declare that this thesis is done by my own efforts and means and has not been presented for a degree in any other university. All sources of material used have been acknowledged and Information taken from external sources are cited accordingly.



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This is to certify that the thesis prepared by Muluken Abayneh, entitled: GIS and Remote Sensing application for Ecotourism facility development sit suitability analysis: The case of Bale Mountains National Park, Ethiopia. Submitted in partial fulfillment for the requirements of the degree of Master of Art (Tourism Development and Management) comply with the regulations of the university and meet the accepted standards with respect to originality and quality.

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Abstract

There is georeferenced data and information gap in protected areas tourism facility developments site identification so these studies aimed at identify and prioritize suitable sit for ecotourism facility development in Bale Mountains National Park (BMNP), using multi criteria decision making (MCDM) analytical hierarchical process (AHP) and by applying Geographic Information System (GIS) technique. Therefore, Ecotourism facility development suitable sites were identified by seating criteria. For this study, five criteria were identified to evaluate suitability of sites, based on literature review, tourism master plans and regulations and experts' opinions. The identified criteria were slope, land use/land cover, elevation, distance to river and road, where weights of the criteria were determined using the pair-wise comparison technique of AHP. The site suitability model and suitability maps were generated in ArcMap 10.7.1 using Geo processing model builder and subsequently, the land suitability map of ecotourism was created using GIS spatial analyst weighted overlay tool.

The degree of suitability was classified as highly suitable, moderately suitable, marginally suitable and not suitable for ecotourism facility development. In general, the result of the land suitability analysis for ecotourism facility development in this study yielded four suitability classes, ranging from class 1 to 4. Class 1 represent the highly suitable areas which covers 1.6% (35.6 km^2), Class 2 the moderately suitable areas make up about 26.2% (571.6 km^2), 3^{rd} class is marginally suitable areas which covers 52.5% (1143.8 km^2), and not suitable area grouped under class 4 and account for 19.7 % (427.9 km^2) of the study area. From the analysis, one can learn that geographical information system and multi-criteria decision making framework can be used as a solution for a complicated decisions making in ecotourism development and for proper site selection of land use planning in protected areas including BMNP.

Key Words: Ecotourism, Multi-criteria decision making, analytical hierarchical process, suitability and GIS, RS.

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Acronyms

AHP	Analytical Hierarchical process
BMNP	Bale Mountains National Park
CR	Consistency Ratio
DEM	Digital Elevation Model
EBI	Ethiopian Biodiversity Institute
ETA	Ecotourism Associations
EWCO	Ethiopian Wildlife Conservation Organization
EWCA	Ethiopian Wildlife Conservation Authority
EWCP	Ethiopian Wolf Conservation Programme
EWNHS	Ethiopian Wildlife Natural History Society
FZS-BMCP	Frankfurt Zoological Society Bale Mountains Conservation Project
GMP	General Management Plan
GIS	Geographical Information System
GPS	Geographical Positioning System
IUNC	International Union for Conservation of Nature
MCDM	Multi-Criteria Decision Making
MoCT	Ministry of Culture and Tourism
NGOs	Non-governmental Organizations
UNESCO	United Nations Educational, Scientific and Cultural Organization
WTO	World Tourism Organization
WTTC	World Travel and Tourism Council
WWF	World Wildlife Fund

1. Introduction

1.1. Background

By the early 21st_century, the Tourism sector becomes one of the world's most important economic sectors. It has shown rapid growth and its impact is becoming apparent from the Arctic to Antarctica. The sector also becomes one of the three global economy driving sectors next to technology and telecommunication (Adeleke, 2005). The tourism sector has a great role in supporting the economic growth, development, and employment generation (World Bank, 2018). Tourism in wildlife areas is seen as an engine for the conservation of resources, means for economic development in developing countries, and plays an important role to reduce the deep-rooted poverty by engaging the local community in the sector and through distributing its benefits. A well-managed protected area provides a variety of benefits such as, maintaining biodiversity, helping the recovery of rare and endangered species, maintaining ecological and ecosystem balances. If protected areas are developed sustainably and well-promoted, they are one of the main tourism resources that attract visitors and provide benefits for the local community as well as contribute to the economy of a country besides providing other goods and services (UN WCMC, 2019).

In the recent century, people are widely traveling to protected areas where wildlife is originally enjoyed. This benefits the local community and supports conservation. Freedman and Tyrvainen (2010) stated that the Nature-based Tourism is one of the fastest-growing sectors of the tourism industry, if these travel towards the protected areas and its requirement the development of infrastructures and facilities are not sated in a well-planned and managed in a pre-planned manner it would have a potential negative impact on the natural ecosystems.

Currently, Tourism becomes more competitive business hence, to make this business sustainable, attract more visitors, and to raise visitor satisfaction, besides having unique potential tourist attraction sits; the development of infrastructures and facilities is most important to accommodate and boost the satisfaction of customers. In this regard, protected areas should have proper destination development programs as ecotourism areas are characterized by a fragile environment for any development activities.

Hence, the management and development of protected areas require attention, which might challenges decision-makers on how to minimize the negative impacts and maximizing the benefit of tourism. In general, tourism development and planning in protected areas should base on suitability analysis using reliable information and the application of contemporary information technologies.

In this regard, the Geographical Information System (GIS) is among the technological facilities that have wider applications including planning and management tools. Therefore, GIS can assist the planning and management of protected areas particularly for tourism destination development organizations achieving. The tool helps sustainable development by providing geographically referenced information that can make essays and effective decision making for complex tourism development activities and planning.

1.2. Statement of the problem

Due to the rapid growth of ecotourism and the increasing number of tourists moving to the natural areas it's challenging for a decision-maker on how to manage ecotourism to minimize the negative impacts for sustainable development and accommodating the tourists. In most cases protected areas represent the highest level of biodiversity so, ecotourism facility development in such areas must be ecologically sustainable to protect the natural values and be located in appropriate areas to reduce the negative impact. To help decision-makers make the best choices, careful analyses are needed on the decision-making situation, alternative actions, con-sequences of alternative decisions, and preferences (Ranya et al. 2013; Feizizadeh et al. 2014). Hence in this regard, little research has been done to assist development actors, decisions makers and policymakers in regard to protected areas development. Therefore, this research tried to fill the gap by doing a research applying GIS technique and remote sensing data through a multi-criteria decision-making process as one way to provide more spatial referenced information.

Bale Mountains National Park (BMNP) is one of the protected areas in Ethiopia. The park has unique biodiversity, which is tentatively listed by UNESCO as one of the world heritage site having the largest Afro-alpine ecosystem, grassland, woodlands, and most extensive natural forest (BMNP, 2017). The park is home to a variety of unique, rear, and endemic species which

is explained by the motto of "*one park many world*s". This means the park with huge potential of providing diversified visitor experience.

Regardless of the high tourism potentials of the park, tourism development of BMNP is not at the expected level due to multiple problems. The challenges of the park include limited tourism infrastructures, inadequate and poor quality services, and promotion gap. These limitations have a direct negative impact on park tourism development and undermine the tourist's experience. This underdevelopment of tourism facilities and less number of visitors thereby makes the park to have a lesser economic contribution. The major problems are related to administration problems, park management, and expert skill gaps, inadequate budget allocation and, lack of scientific research to convince a decision-maker (Mebratu, 2016).

The tourism infrastructures in the area are underdeveloped this is mainly related to the inadequate financial resource and gap in appropriate plans supported with reliable geospatial information's which is basic for decision-making. The park identified the ecotourism facilities needed in the area but there is a gap in the planning document to associate with geographically referenced data. The 10-year General management plan (GMP), the three-year action plans of the park indicated the importance of tourist facility development (BMNP, 2017), while the documents have a gap on geo referenced data. The U.S National Park Service management polices (2006), suggests a general management plan has to include a map that delineates management zones or districts that correspond to a description of the desired resource and visitor experience conditions for each area of the park so one of the need of doing this research is filling the gap with a research done using reliable spatiotemporal information by allaying GIS.

It is imperative that only some areas of a park suitable for ecotourism facility development that matches ecotourism criteria with the basic resource characteristics and there is only limited acceptable level of land use other than conservation in the study area. If sustainability and the importance of multiple functions are not recognized in wildlife area management and land-use planning, there is a risk that the ecosystem will gradually lose many of their characteristics such as a natural ecosystem process and suitability for recreation (Hjorts and Strade 2001). Therefore, to minimize environmental impacts, to ensure sustainable tourism development, to provide the required facilities information in connection to tourists preference, and to identify viable strategies for sustainable use and conservation of the natural resources it is important having a

reliable information's based in research supported by GIS application and there is an information gap on the topic.

Thus, the major objective of this study is to demonstrate the use of GIS applications and Remote Sensing data in tourism development of a tourist destination from the planning to decision making which will help the sustainable ecotourism development by minimizing the negative impact may occur.

1.3. Objectives

The general objective of this study is to examine and demonstrate the role of GIS application in the Ecotourism facility development land suitability analysis in Bale Mountains National Park. This will be achieved by supporting a list of specific objectives

1. Identifying the land use land cover of the park and its implication towards the ecotourism development.
2. Evaluating the land suitability for ecotourism facility development in the study area.

2. Literature review

2.1. Ecotourism

The unwise and misguided use of natural resources and unmanaged mass tourism and its supporting development in the protected areas has degraded the natural environment. Ecological components and activities that can disturb the ecological balance have affected all living creatures including the man-kind who is responsible for all the cases (Cengiz and Tulay, 2014). People in the 1960s and 1970s have started to risen the issue of the environment and the negative consequence of mass tourism which contributed to the environmental movement and searching of alternatives for such distractive types of tourism which have led to the development of ecotourism.

Since the start of the concept of ecotourism to the development in the 1980s, the concept has passed with many definitions and continues the evolution and still, there is no a universal agreed definition, ecotourism has also been called in many ways nature tourism, green tourism, adventure tourism, natural history tourism, and rural tourism (Whelan, 1991; Western, 1993; Honey, 1999).

There are many definitions developed by deferent scholars and organizations and for this study, we put the definition developed by the International Ecotourism Society, as:

"Responsible travel to natural areas that conserves the environment sustains the well-being of the local people and involves interpretation and education". And as EBSCO (2009) stated, all definitions of ecotourism are pointing out three important objectives: Travelling to natural areas, protecting the environment, and benefit the local communities.

Now a days the Ecotourism society looks like they are agreeing on some common concept of ecotourism, which is ecotourism is believed to be one of the sustainable development branches of the tourism sector that shows rapid growth and contributes to the environmental conservation, creates a job opportunity for the local community, generating economic and social benefits and promotes cultural preservation (Boo, 1990; Brandon, 1996; Wells, 1997; Weaver, 1998; Notzke, 1999; Ross and Wall, 1999; Slinger, 2000; Cheung & Jim 2013; Cobbinah, 2015; Das and Chatterjee, 2015).

Ross & Wall (1999) indicated that in successful ecotourism, the dynamics between people, resources, and tourism are such that each makes positive contributions to the others." To make the Ecotourism development sustainable and contribute to the expected level, ecotourism should be integrated with the conservation and development concept holistically all components linked, compromised, and balanced to each other."

Now a day both developed and developing countries are giving very much attention to ecotourism for many reasons and mostly because of earning foreign exchange from the sector boost their economies. According to WTTC (2018) report, the sector directly contributed $120.1 billion, which account for about 4.4% contribution to the global GDP in 2018. Contribution of direct global Travel & Tourism for the GDP in year 2018 was estimated at $2,751 billion and able to sustain 9.1 million jobs which are equal to 7.4% of direct jobs sustained by global Travel & Tourism.

2.1.1. Ecotourism development in Ethiopia

Ethiopia is a land with plentiful, remarkable, and magnificent tourist attractions. The exceptional combination of historical, cultural, and natural attractions marks the country as a unique tourist destination in the region (MoCT, 2009).

Since 2012, Ethiopia boasts 13 World Heritage Sites (including the Rock hewn churches of King Lalibela, Simien Mountains national park, Castel of Gondar, Stele of Aksum, Lower Valley of the Awash, Lower Valley of the Omo, Tiya, Harar Jugol, Konso Cultural landscape, Mesqel festival, Geda system, Fichhee Chambalaalla and Ethiopian Epiphany, which is more than any other country in Africa. There are also five tentatively inscribed UNESCO heritages including Bale Mountains National Park,

The country is endowed with unique wildlife resources including World biosphere reserves, more than 20 national parks, 3 wildlife sanctuary, 7 wildlife reserve, 3 community conservation areas, and 18 controlled hunting areas, welcoming 926 bird species, of which 16 are endemic, 284 mammalian faunas (32 endemics), 200 fish species (40 endemics) and unquantified level of diversity and endemism in floras (EWCA, 2011; EBI, 2015). This all makes the country to be considered one of the most remarkable ecotourism potential destinations.

The protected areas offer ecotourism and leisure activities such as wildlife viewing, trekking, mountaineering, and bird watching (Henze, 2007; Martin, 2008).

Even though the country has huge eco-tourism potential and there are some improvements in roads, trails, and accommodations, most tourism resources are under threat and Ecotourism is still in its infancy stage even the basic infrastructures, accommodations and Facilities for visiting most of the ecotourism sites are extremely limited. (Henze, 2007)

Ecotourism facility

Ecotourism facilities are infrastructures which are developed in and around an ecotourism sites to accommodate the visitors those who comes to visit the site and enables them to stay in a beater condition such as lodges, camping's, visitor centers, reception and ticket offices, restrooms, trails and other (U.S National Park Service, 2006; Panasiuk, 2007). These tourism infrastructures are one of the basic components that can determine the amount and structure of the tourist movement and the development of such tourism facilities seek to reduce the negative impacts on the environment by selecting the appropriate site, reducing the consumption of non renewable resources and by minimizing the wastes (U.S National Park Service, 2006; Panasiuk, 2007). And the development of ecotourism facilities in protected areas depends on the type of the ecology that the area has and the types of tourists that the destination management need to attract (Drumm, A. et al., 2004)

2.2. GIS Application in Tourism

There are several definitions developed by different authors from different disciplines for GIS and GIS in this study mean a Geographical Information System (GIS) which is a computer-based tool for the chain of operations from a survey, collection, storage, analysis and provision of a spatially referenced information's that can be used for planning to decision making in sustainable tourism destination development and management in a protected area (Sobeih 2005; Goodchild 2010; Yianna and Poulicos 2011).

GIS technology has been effectively used in the wildlife sector in various ways as an effective tool for assessing, managing, analyzing, and visualizing wildlife data to target areas where interventional management practices are needed and to monitor their effectiveness.

A GIS helps wildlife management professionals examine and envision; habitat requirements and ranges, population patches and linkages, disease levels within populations, the progress of management activities, historical and present wildlife densities among others (Bruzzone and Smits, 2002). Bale Mountain National park is also one of a national park that uses a GIS database in wildlife management; the park office uses an Ecological Threat Monitoring Database which has different sub-categories within it such as Mountain Nyala census, livestock grazing monitoring, illegal settlement monitoring, forest resource use, and Ethiopian Wolf monitoring.

The GIS application has been used in tourism for a various purpose which includes tourism planning, resource assessment and management especially for protected area management, wildlife monitoring, suitable ecotourism site identification and recently, Due to its characteristics, GIS technology enables implementation on various web pages, combining with other applications, development of spatial and non-spatial data databases and adapting to specific needs (Jovanovic, and Njegus, 2013) destination managers started to use the application in tourism marketing. Culbertson et al. (1994) explained the great impacts of using GIS technology in planning for sustainable development and environmental analysis.

Now a day, decision making in the tourism sector is become more complex due to different land use interest and high competition in the world tourism market which makes the destination developers conscious about site selection for eco-tourism developments and the Multi-Criteria Decision Analysis (MCDA) techniques deal to simplify such complexities those arise for handling a large amount of complex information consistently.

When the MCDM technique embedded with GIS it can be used successfully for land suitability analysis that is, for identifying suitable locations against given purposes Ullah and Hafiz, (2013).

Land suitability analysis is a process to determine whether the land resource is suitable for some specific uses or not and to determine, evaluate, and to assign suitable areas for the specified land uses and set of wide variety criteria must be developed depending on the objectives. GIS-based MCDM can be thought of as a process that merges and transforms spatial and non-spatial data (input) into a resultant decision.

Ahmad et al. (2015) used GIS to identify and study the vulnerable zones and ecotourism status in Ilam Province. Their research procedure indicates that the GIS-based multi-criteria decision making could be quite a capable approach to handle a variety of criteria affecting site attraction for ecotourism development that can greatly enhance ecotourism planning to determine site-attraction characteristics.

Samanta and Baitalik (2015) studied to identify potentially suitable sites for ecotourism in the surroundings of Bankura mainly based on the natural components of ecotourism. Even factors, namely, land use-land cover, soil, elevation, slope, vegetation map, road network map, drainage map and also temperature and rainfall were considered to determine the suitability of an area for ecotourism. In another comprehensive study, Bhaya and Chakrabarty (2016) attempted to identify potential eco-tourism site in Jungle Mahal using remote sensing and GIS techniques in forest dominated areas of West Bengal. After identifying the potential sites, a demonstrative plan has been made for ecotourism development based on locally available natural resources Likewise, Suryabhagavan et al. (2015) investigated the identification of potential eco-tourism sites in Hawassa town by using an integrated approach of multi-criteria evaluation and concluded that Hawassa town and its surrounding can contribute to the national development through sustainable use of ecotourism potential of the area.

2.3. Multi-Criteria Decision Making (MCDM),

MCDM is a framework that can help decision-makers and scholars to choose among alternatives by showing the tradeoffs between the criteria, which enables them to make choices in a rational, consistent, and documentable manner (Zeleny, 1982) and the primary issue in Multi-criteria Evaluation is concerned with how to combine the information from several criteria and to form a single index of evaluation. As stated by Bukenya in 2012 the framework includes a procedure

- Defining the desired objectives,
- Selecting evaluation criteria
- Identifying the alternatives
- Selecting performance indices/ measurement scales
- Constructing an evaluation matrix of the alternatives vs. the criteria array
- Performing the selection process

A decision is a choice between alternatives and in tourism, a decision may need to be made about what areas are the most suitable for proposed development activity and this requires to set up and test with different criteria very carefully through, the Multi-Criteria Evaluation and GIS analysis these criteria Images representing suitability combined to form a single suitability map from which the final choice will be made. GIS-based decision-support systems sustain decision-makers, in evaluating alternatives to enhance decisions and to achieve specific objectives Looney, (2001) and Tewodros, (2010) explained this as the spatial multi-criteria analysis results depend not only on the geographical distribution of attributes but also on the value judgments involved in the decision making process and multiple factors must be cross-checked such as natural environment condition, landscape condition, safety condition, and infrastructure condition.

Therefore, two considerations are important for spatial multi-criteria decision analysis: the GIS component (data acquisition, storage, retrieval, manipulation, and analysis capability); and the MCDM analysis component (aggregation of spatial data and decision-makers' preferences into discrete decision alternatives). Masoum, et al., (2015) in his study to identify the appropriate areas for ecotourism development in Marvdasht, Iran he used the analysis components of MCDM and concluded the use of integrated MCDM-GIS approach effectively assists ecotourism planning and, can help policy and decision-makers to approach tourism development' issues with a deeper understanding of environmental factors.

2.4. Analytic Hierarchy Process (AHP)

The AHP is one of the most extended Multi-Criteria Decision Making (MCDM) techniques that have been seen as a method that provides a structural basis for qualifying the comparison of decision elements and criteria in a pair-wise technique produces the relative preference weight for each criterion. AHP was first developed by Saaty in the late 1970s, which is a simple and flexible decision-making tool to conduct a multi-criteria evaluation that can be used with integrated GIS spatial analysis for the site selection in ecotourism development and has been used to estimate weights of various sets of criteria, which are then integrated with GIS to display the location and size of those ranked ecotourism destinations (Kumari, et al. 2010; Bunruamkaew, 2012; Ullah and Hafiz, 2013; Dhami et al. 2014).

The AHP with GIS combines decision support methodology with powerful visualization and mapping capabilities which in turn facilitates the creation of land use suitability map and the Combination of GIS capabilities with MCDM techniques involves the phases of intelligence, design, and choice to assess the ecotourism sustainability by matching the characteristics of an area with those attributes most appropriate for ecotourism. This is supporting decision-making for planning tourism facilities and ecotourism resource utilization for sustainable development (Bunruamkaew, 2012).

There are five steps to be sequentially performed to output a structured decision using expert judgment through AHP. (Cuirong et al. 2016)

1. Model the problem as a hierarchy.
2. Establish a pair-wise comparison matrix to evaluate the priorities among the elements of the hierarchy.
3. Synthesize those judgments to yield a set of overall priorities for the hierarchy;
4. Check the consistency of the judgments.
5. Final decision based on the results of the process.

3. Method and methodology

3.1. Study area description

Bale Mountains National Park (BMNP) is located at about 400 km south-east of Addis Ababa with a geographical location between 6 º 29'–7 º 10' N and 39 º 28'–39 º 57' E. The park found in two zones of Oromia region, i.e., Bale and West Arsi zones. The park area is surrounded by five woredas (sub district), namely: Adaba in the west, Dinsho in the North, Goba to the Northeast, Delo Mena and Harena Buluk to the south and covers 26 rural kebeles.

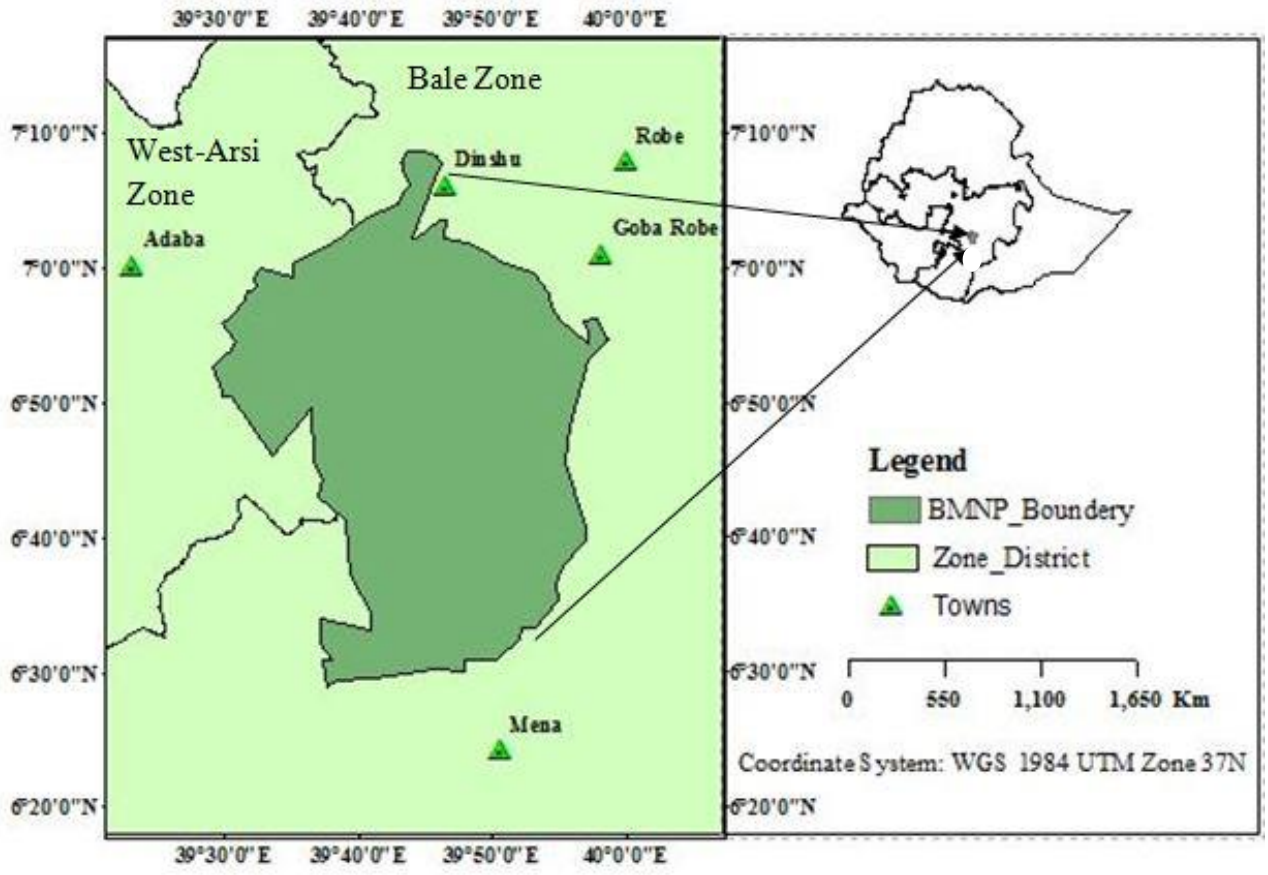


Figure 1: Location map of the Bale Mountains National Park

The Park was first proposed in the 1960s, by the late Dr. Leslie Brown and Mr. John Blower, and established as a park in 1970 to conserve the endemic and endangered species Ethiopian Wolf (*Canis simensis*) and Mountain Nyala (*Tragelaphus buxtoni*). And finally the park gazette and formally announced through proclamation number 338/2014 under Council of Ministers Regulation with an area of 2,150 km^2.

3.1.1. Ecological classification and major habitats

Bale Mountains National Park is characterized by the center of endemics and evolution for several biological taxa and is part of the Eastern Afromontane Hotspot of Biodiversity area (Williams et al., 2004). The park consists of three main zones and five major habitats division based on the altitude and vegetation type. The three park zones are i) southern Harena forest with an elevation of 1600m to 3500m.a.s.l. ii) the central Afro-alpine areas and Sanetti plateau peaks falling in the elevation between 3500 and 4389m.a.s.l. and iii) the northern Gaysay/Adelay forest and grassland area having elevation from 3000 to 3500m.a.s.l. (BMNP, 2017).

3.1.2. Biological Diversity

BMNP has a great deal of continuous Afro-alpine and Afromontane forest habitats and a globally important center of endemism designated as a biodiversity hotspot by Conservation International (Williams et al. 2004).

3.1.2.1. Flora

The Bale Mountains National Park and surrounding areas provide a complete altitudinal zone of vegetation starting from the broadly deciduous woodland in the lower parts, extending through various types of moist forests to ericaceous woodland, and culminating at *Helichrysum* dominated moorland which makes the area to hold a diversified number of floras. The total number of taxa for the Bale floristic region is estimated at more than 1600 species. Of these, 163 are endemic to Ethiopia and 23 to Bale alone, which account for 14% endemic plants in Ethiopia. According to the Ethiopian Biodiversity Institute, more than 340 medicinal plants are recognized in the area. The different habitats of BMNP where the northern grassland is predominated by swamp grasses and sedges; the northern woodland (open woodland) dominated by *Hagenia Abyssinia* and *Junipurs procera*; the Central part is characterized by afro-alpine and the Erica belt mainly dominated by *Giant lobelia*, Helichrysum, *Erica arborea, Erica trimer*, Alchemilla species, while Harena cloud forest is covered with species of vascular plants that include trees, shrubs, herbs, lianas and epiphytes like Coffee arabica, and bamboo (Figure 3).

Figure 2: Range of the park flora

The forest is known to support high levels of biodiversity and endemism, including many threatened plant species. It also harbors the most important stocks of wild genetic material in Ethiopia, including wild coffee and a large number of medicinal plants (Wakjira et al., 2011)

3.1.2.2. Fauna

The great altitudinal variation and habitat diversity in the different parts of BMNP creates conducive environment to harbor varieties of wild animals. The Bale Mountains National park supports the world's highest density of endemic mammals together with a rich bird and lower vertebrate fauna. If these resources are well conserved, developed, and promoted for game viewing as an ecotourism potential resource it plays a crucial role for the sustainable local as well as country development (EWNHS, 1996; EBI, 2014).

3.1.2.3. Mammals

The park encompasses more than 78 mammal species and 20 are endemic from those endemics 2 are from the antelopes (Mountain Nyala and Minilk Bushbuck), the canine's carnivore Ethiopian Wolf, from the primates Bale Monkey and the rest belongs to small mammal rodents that include the Giant molerat (Figure 4).

Figure 3: Some wild animal of the park

On the northern grassland and open woodlands, there are several antelopes which are grassers and browsers. The Afro-alpine and the plateau are more dominated with rodents such as Molerats, rats, shrews, and mousse which play an important role in soil fertility and the hydrological system.

The high altitude Afro-alpine area is home for the elegant canid species of Ethiopian Wolf. The Wolfs are feeding rodent community with the preference of the Giant Molerat. The moisture Harena forest is used to harbor big carnivores like Black-manned Lion, Leopard, and wild-hunting Dog which is not seen for a longer period. The elusive, endemic, and bamboo specialized primate Bale Monkey are some from the many wild faunas found inside the park. The park preserves the last and viable populations of two endangered spectacular species, the Mountain Nyala (*Tragelaphus buxtoni*) and the Ethiopian Wolf (*Canis simensis*) (Gottelli and Sillero-Zubiri, 1992; EWNHS, 1996; EBI, 2014)

3.1.2.4. Avifauna

Bale Mountains National Park is the richest in bird fauna and, hence, is considered as a critical important bird area in the country (EWNHS, 1996).

The park is home to more than 310 bird species, 6 of them are endemic to Ethiopian, 11 are near-endemic exist in Ethiopia and 170 migratory birds recorded within the park which makes it as one of the most important bird areas of Ethiopia that ranking 4th important birding area on the African bird club (BMNP, 2013). The birds are distributed within the park differently based on their feeding habits and habitat preference.

Most of the small and forest loving seed eaters and nectarines are distributed to the northern grassland, open woodlands, and Harena forest.

The afro-alpine, upper plateau, and cliffs have large raptors distributed and the area offers a suitable habitat for resident, migrant, and overwintering raptors. In this area, it is common to see the big raptor/birds of prays soaring. This high affinity is associated with the existence of high diversity and density of rodent species (Gottelli and Sillero-Zubiri, 1992).

The highland streams, marshes, wetlands, and the alpine lakes are favorable for watering birds and important breeding sites, the alpine lakes and other water bodies in the park also attract many wetland bird species such as the endemic blue-winged goose and spot breasted plover. The presence of wetlands and moorlands in the Sanetiy plateau has attracted a small number of the wattled crane (Asefa, 2006).

This area is considered as bird paradise for oriontologists and bird watchers but, the human population growth and expansion of settlements to the park and high dependency on the park resource and other related are damaging the diverse ecosystem at an alarmingly and this has a major impact on the population and the distribution of the bird. Therefore, appropriate conservation is needed for the crucial role it plays in the sustainable development of the livelihood of the local community by promoting bird watching tourism (Asefa, 2006; Birdlife International, 2020).

3.1.2.5. Herpetofauna

Bale mountains' national park diversified habitats provide a good refugee for the herpetofauna, which has highly restricted distributions. Erica forest and the moorland belts are the most preferable area for herpetofauna, especially for amphibians.

In connection to this, the park is home for 17 species of amphibians and few species of reptiles, which have been recorded in the area of which 48% are endemic to Ethiopia (Malcolm and Stephen, 2011). There are 11 amphibians and 4 reptiles recorded within the park. The existence of herpetofauna is an indicator that the park has a well-diversified ecosystem. All becoming history due to a highly growing population resulted in encroachment of preferable areas of Harena forest and degradation of Erica forest belt (BMNP, 2013; Conservation Leadership Programme, 2014; Saber et al. 2019).

3.1.3. Geology and Climate

The present topography of the Bale Mountains is a reflection of the long term, probably over 20 million years of weathering processes that underwent due to heat and pressure that had been originated from the Oligocene lava outflows. There have been at least two glacial periods in the history of the mountains. These specific mountains were glaciated as little as 2,000 years ago. During the last ice age, the Bale Mountains were among the most extensively glaciated areas in Ethiopia and, the large volcanic edifices in the area had formed some of the highest peaks on the plateau. The Fluctuations in climate over the last historical period have affected the vegetation and another biodiversity in the area (Tefera et al., 1996; BMNP and FZS, 2013; BMNP, 2017).

As a result of the great altitudinal variation in Bale Mountain massifs, considerable variations of climatic conditions are recorded. In previous times, the Bale Mountains were characterized by nearly 8 months of rain in a year that falls in two rainy seasons. These days, the rainy seasons are not predictable and shrinking over time. Temperature records from the Bale Mountains indicate that the wet seasons are comparatively warm and the dry seasons are extremely nocturnal cold and diurnal warm. The average temperature range is $9 – 16^0$ C (World Weather Online 2020), the lowest historical recorded temperature at the highest plateau of Bale (Sanetiy) was -15ºC and the maximum record was 26ºC (Hillman, 1986).

The northern part of the park is supportive of plant growth with an ample amount of rainfall, moderate temperature, and relatively humid. The central plateau consists of extremely cold climatic conditions, erratic rainfall, usually wet and waterish air, icy and frostiness, frequent mist, and hail. Additionally, due to macroclimate variations highlands and valleys create microclimatic conditions usually favored by plants and animals, particularly at the central plateau (BMNP, 2017).

3.1.4. Hydrology

Ethiopia's high plateau is home to several rivers, earning it the nickname "the water tower of Eastern Africa." These rivers flow from the highlands and out through deep valleys and gorges throughout the country. The Bale Mountains are an important water catchment and source of more than 40 rivers and streams, including five major rivers: Wabe Shebelle, Genalle, Web, Dumal, and, Welmel (Figure 5).

The mountains and forests of this ecosystem are a critically important water catchments area supplying perennial water to more than 20 million people in the lowland areas of Ethiopia, Somalia and Northern Kenya especially in the dry season (BMNP, 2017).

Figure 4: Water resource potential of the park

The rivers also serve to generate hydroelectric power such as Melkawakena hydroelectric power station plant of Wabe Shebelle River, which generates power for the entire Bale demand operates because of the streams flowing from the Bale Mountains. The mini hydroelectric power at Delo-Mena also generates power from the Yadot River which is tributary of the Genalle River.

This Water body's deferent crater lacks, wetlands, streams and big rivers found throughout the park are home to deferent watering birds, amphibians and used as a water point for the wildlife exist. The water sources are important ecotourism attraction and there are numerous natural mineral water springs, called *Hora*, which are locally believed to provide an essential source of minerals for livestock.

3.1.5. People living in and around the park

The park and the surrounding region are predominantly occupied by Oromo people and speak Oromifaa. Agriculture is the major sector that supports the livelihood of households and communities in and around the Bale Mountains National Park which includes Farming and Livestock husbandry (Kebede et al, 2014). Barley and Potato are the major products of the area and the population dependent on the forest products is significant to support livestock husbandry as the main source of their livelihood (Barbre, 2013).

Also, legal and illegal timber and non-timber forest products harvested from the park such as hatching grass, wood for Construction, lianas, bamboo, and softwoods for traditional beehives fuel-wood, medicinal plants are some of the forest products that are usually collected from the wild and wild coffee also used both for household and commercial purpose. Alternative job opportunities are not widely available for communities living around and this makes the local more dependent on the natural resource and subsidiary farming increased.

3.1.6. Eco-tourism activities

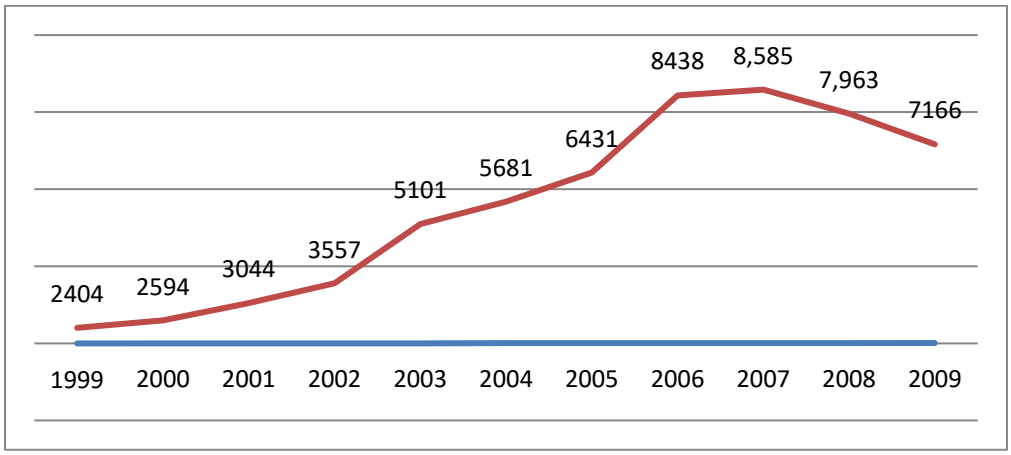
Tourism has begun in the area but not yet well developed if the potential resources of the park are managed, developed, and well-promoted it creates opportunities for viewing rare and endangered mammal and bird species for the tourists and economic benefits to the local community. The park is an important area for research and studies serves as a field laboratory for higher institutions of the country dealing with natural resource related field of studies to support theoretical principles taught in class through practical observation.

The Park has contributed for the establishment of ecotourism associates which provides goods and services for the park visitor and are being benefited from the tourism but these benefits do not show a uniform distribution among the villages found in and around the park and also the park existence creates temporary employment opportunity for the locals.

There are 8 associates who provide services and goods in Bale Mountain National Park ecotourism sectors:

Association	**Product type**
➢ Barre women	✓ Handicraft
➢ Borofa porters	✓ Porting
➢ Kerensa horse renters	✓ Horse renting
➢ Key kebero cooks	✓ Cooking
➢ Wood sellers	✓ Providing non-indigenous firewood
➢ Nyala guides	✓ Guiding
➢ Sankete honey and coffee providers	✓ Selling wild coffee and forest honey

When we see the recipient of tourism in the park is far below its potential. The park received 3,242 international and 4,766 domestic visitors in total 8,585 visitors come to the park and generated 804,945Birr in the fiscal year of 2007 E.C (2014 GC) which is the highest record (Figure 6).



Source: BMNP (2017)
Figure 5: Visitor trend in Bale Mountains National Park

As we have seen from the above chart and table the annual figure even if the result is showing positive progress it is still lower than that of the monthly tourist volume of other east African National Parks in Kenya and Tanzania.

Even if the park is endowed with high potential tourism resources these resources are not well developed based on standards. The park doesn't have clear marketing strategies and is not well promoted. There are some starts as the park developed its guiding books, bird booklet, brochure, and website but need a follow-up and updating.

There are only a few hotels in nearby towns like Robe and Goba which serve tourists and only two lodges (Dinsho and Bale Mountains Lodge) inside the park. Dinsho lodge found at the headquarter, while the high-class Bale Mountains lodge is located at the Kach clearing of Harena Forest, which is luxuries and the beast accommodation exist for the area with a welcoming staff. Its strategic location makes it easy to enjoy the unique future of Gusa Mountains and the bamboo forest located behind the lodge and both the surrounding plateaus and the Harena forest. The park has more than 20 satellite campsites; however, only three have basic facilities.

The rest campsites are open with no facility that makes the trekking difficult, which reduced stay length and satisfaction of tourists in the park. All the mentioned facilities and accommodation problems reduce the tourist flow and tourists who come to Bale to face the problem of accommodations that undermine the potential economic contribution of the park.

3.1.7. Challenges/Threats of the BMNP and its conservation

The tendency of establishing human settlements in wildlife areas is becoming common and endangering the future life of wildlife species (Ogutu et al., 2012), like many of other protected area the Bale Mountains National Park is under increasing human population pressure from the surrounding area and migrant settlers. In this section, we describe the main issues that prevent the park from carrying out conservation role effectively and to use Ecotourism potential.

There are considerable threats from the many the main pressures on the park are related with human population growth and related problems:

The human encroachment (settlements) toward the park has increased from time to time and this settlers use the park natural resources for deferent purposes like housing materials and firewood if it is managed in a wise way will have a major negative impact on the forest resources and the wild animals which are dependent on it. The people who are living inside the park and the surrounding areas practice agriculture inside the park by clearing the forest and fires on forest and afro alpine Erica areas for livestock grazing this affects the park ecology and sometimes result the human-wildlife conflict in the resource use, there have been an occurrence of predation of livestock, crop ride, wild animal killing and disease transmission specially from the domestic dogs to the Ethiopian wolf

3.2. Research Methodology

This research followed a case study approach for the acquisition of in-depth data and information in a short time. Omale (2012) suggested that a case study is an intensive approach to gear studies towards a thorough understanding of a given phenomenon and provide thorough, in-depth, comprehensive, and well-ordered information. The study applied a combined geographical information system (GIS) techniques with multi-criterion decision-making (MCDM) framework to identify and evaluate land suitability for ecotourism facility development. This method helps to locate appropriate sites for ecotourism facility development activity by the intent of minimizing the possible negative impact of ecotourism development on the natural resource and ecosystem services of the area. The research task is achieved by identifying and examining the suitability of different parts of the park. In this process, different criteria identified and assigned numbers to facilitate the decision-making process for the suitability analysis to yield a suitability map this was summarized as shown in the following diagram (Figure 7).

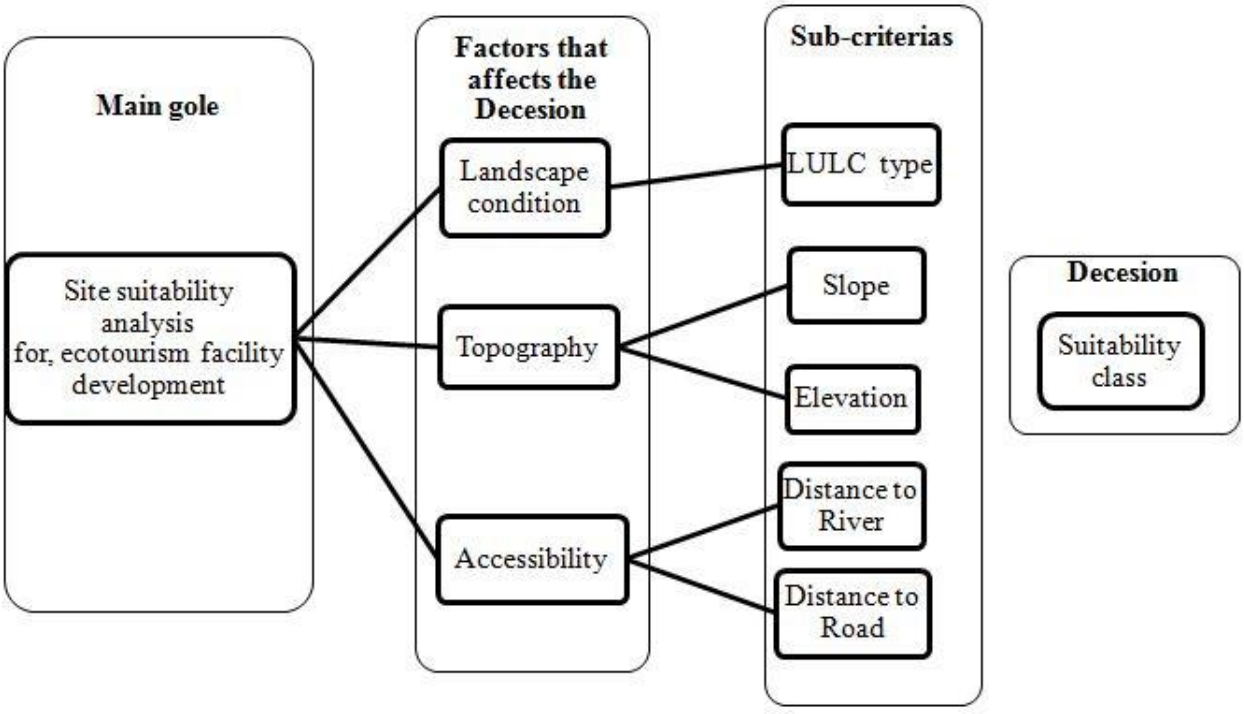
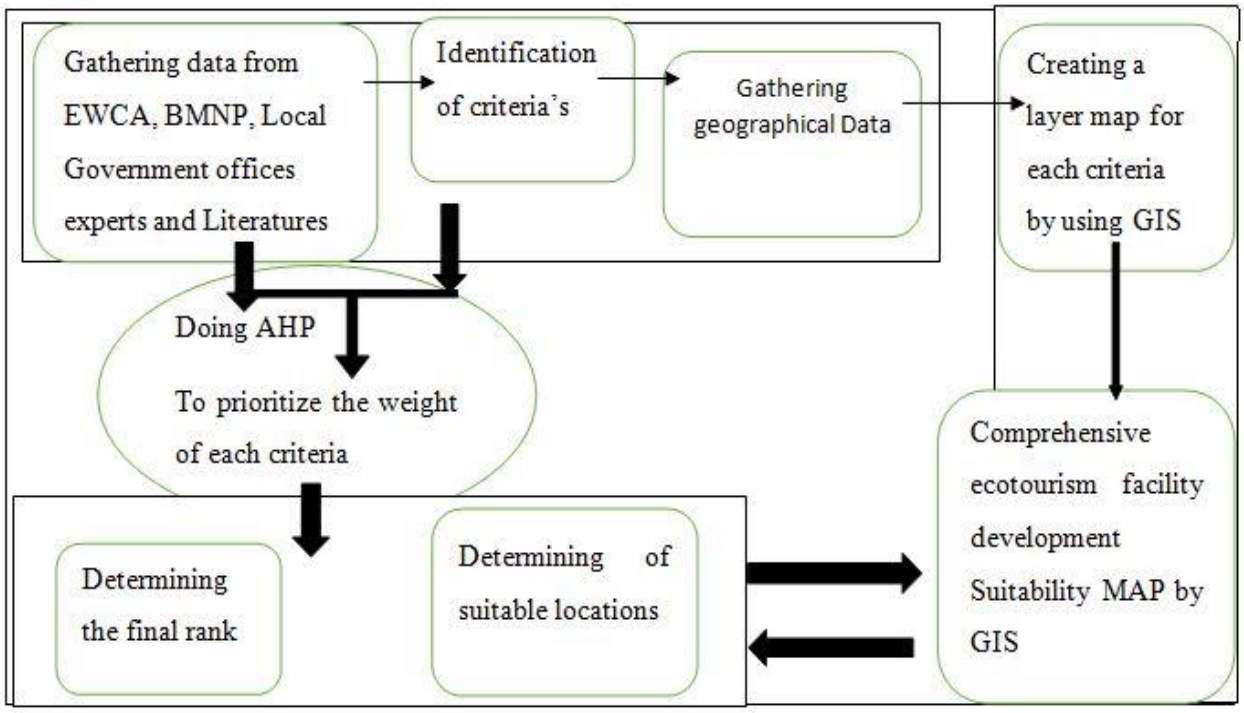


Figure 6: Suitable ecotourism development sits evaluation framework

As shown in Figure 8, there were four important steps followed to produce site suitability map for ecotourism facility development and these are:

1. Identifying criteria to be used in the suitable analysis,
2. Assigning weight for the criteria and prioritizing
3. Generating a suitability map
4. Determining suitable areas.

The site suitability analysis methodology was summarized in this analytical frame work



Source: Modified from (Cetinkaya et al. 2018)
Figure 7: Analytical Framework which shows the MCDM process for site suitability analysis.

3.2.1. Study area selection and sampling

Bale mountains national park was purposefully chosen for different reasons mainly the park has diversified ecotourism resources that are very sensitive for disturbance, endowed with the different representative ecosystems, and harbors several endemic and endangered species.

Quantitative and qualitative data were collected through key informants interviews (KIIs) selected purposively from stakeholders of the park.

Therefore a total of 15 key informant interviews (KIIs) conducted drown from different actors, mainly 5 experts from BMNP, 3 experts from Ethiopian Wildlife Conservation Authority (EWCA), 2 administrates from Ethiopian Wolf Conservation Program (EWCP) and Frankfurt Zoological Society _ Bale Mountains Conservation Program (FZS-BMCP) and 5 guides from Nyala guides associates.

3.2.2. Data sources and data collection method

Both primary and secondary data pertinent for suitability modeling of ecotourism facility development were collected from different sources.

The primary data were collected through key informant interviews (KII). KII checklists (questionnaire) were designed and administered with 15 experts and guides. The experts were mainly park management and expertise, ecotourism association members, and expertise from two actively working NGO. The KII checklist focuses on their preferences of criteria, and alternatives to the criteria to determine the appropriate weights for the analytic hierarchy process (AHP). Duos to COVID-19 questionnaires (KII checklists) were distributed through email to expertise and interview was conducted through electronic way with selected key informants.

The KII respondents were asked to suggest their preferences about each criterion. Also, published and unpublished literature and expert opinions were used to set weight and rank the suitability analysis criteria. Besides the KII, ground truth point (GCP) was collected through field observation and survey assisted by Global Positioning System (GPS) and datasheet. The data collected involves characterization and biophysical data information, and a photographs were taken using a digital camera.

As input for GIS-based analysis, satellite images were collected from different sources. Hence the remote sensing data used in this analysis mainly 30-meter spatial resolution Landsat images and 20-meter spatial resolution SRTM- Digital Elevation Model (DEM) downloaded from the United States Geological Survey (USGS) archives (https:/earthexplorer.usgs.gov). The park boundary maps and other shapefiles required for the study where collected from various governmental and non-governmental organizations, such as BMNP, EWCA, EMA, and FZS. Moreover, Google earth was used during the image classification.

3.2.3. Selection of Criteria

The GIS-based multi-criteria site suitability analysis is performed to identify suitable spatial locations based on some criteria. To start the suitable site identification process, a list of relevant criteria were selected based on literature review from different studies, expert opinion, the park management plan tourism data, and field observations.

Five criteria were identified and used to prioritize sites for ecotourism facility development. These criteria are slope (SL), elevation (El), land use/land cover (LULC), proximity to river (DRi), and proximity to a road (DRo). Those factors were identified as most important to determine the potential sites that best suited for ecotourism facility development. Details of the factors, corresponding criteria's and data sources to do the analysis is given below in table 1.

Table 1: Factors and data sources used for the suitability analysis

Factors	**Criteria data**	**Data typed and source**
Topography	Slop, Elevation/altitude,	SRTM-DEM data obtained from USGS archives (https:/earthexplorer.usgs.gov
Landscape condition/ Environment Condition	Land use land cover type	➢ 30-meter spatial resolution Landsat 7 images obtained from (https:/earthexplorer.usgs.gov ➢ Field survey with the help of portable GPS and photo camera
Accessibility (economic and safety)	Distance from Road/ accessibility, distance from the water	Map (shapefiles) obtained from EWCA(BMNP), FZS_BMCP, EMA and CSA

Source; own computation

In the study, five criteria were designed to construct a tourist infrastructure' suitability model. According to FAO (1996) land suitability classification standards the land classes are grouped as highly suitable (S1), moderately suitable (S2), marginally suitable (S3), currently not suitable (N1), and permanently not suitable (N2) accordingly.

Therefore, According to Food and Agriculture Organization guidelines for land evaluation outlined by Bunruamkaew (2012), potential ecotourism site identification study, four degrees of suitability classes have been applied in this study for analyzing land evaluation for the ecotourism facility development in the study area, by ceasing the (N1) because area within ecotourism site identified as currently not suitable for facility development means it requires changing the landscape and intervening with natural processes but in protected areas specifically in national parks the priority is protecting and conserving the wildlife and natural landscape so we class those two class (N1) and (N2) as a not suitable class.

Based on Ethiopian national tourism development master plan and guidelines, various publications and literature reviews and, experts opinion the ecotourism facility development factors, criteria, and their ratings were defined (Table 2).

Table 2**:** Suitability evaluation factors, criteria, and ratings

Factor layer	**Criteria layer**	**High Suitable**	**Moderate Suitable**	**Marginally Suitable**	**Not Suitable**
Environmental condition	Land use land cover	Bare land & Shrub land	Grassland & Woodland	Forest	Afro-alpine, bushes(Erica), Erica forest, Settlement/ Agriculture & Water body
Topography	Slop	0-5°	5-10°	10-20°	>20°
	Altitude/elevation	1432 – 2500 m	2500 – 3200 m	3200 – 3700 m	>3700 m
Accesses	Distance from river	0 - 1000 meter	1000 - 3000 m	3000 - 4000 m	>4000m
	Distance from road	Within 1 km	1 - 3 km	3 - 5 km	>5 km

Source: Developed by the researcher based on observation, KII, Bunruamkaew, 2012 and Cuirong et al., 2016

3.2.4. Data input analysis method, tools and materials

Land use land cover

30m resolution Landsat7 image Landsat ETM+ imagery captured in 2020 was acceded from https://www.usgs.gov/.. Then Image geometric correction and stacking layer of each scene band was conducted subsequently in ERDAS IMAGINE 15.1. After stacking layers were conducted, then the three scenes were mosaiced together and subsetted to the study area then the Image was processed and classified using ERDAS IMAGINE 15.1 supervised classification and crosschecked with the data collected from field survey and Google earth image.

And finally the accuracy assessment was done using point from field and Google earth image.

Table 3: Error matrix: Accuracy assessment for land use/land covers classification

Pridict	**class 1**	**class 2**	**class 3**	**class 4**	**class 5**	**class 6**	**class 7**	**class 8**	**class 9**	**class 10**	**Row total**
1	**48**	0	2	0	0	0	0	0	0	0	50
2	0	**64**	0	2	0	0	4	0	0	0	70
3	14	0	**99**	0	0	0	7	50	0	0	170
4	0	0	0	**120**	13	68	0	10	0	35	246
5	0	1	0	0	**131**	0	6	2	0	0	140
6	0	0	0	3	2	**162**	1	0	50	93	311
7	0	28	0	0	1	0	**159**	2	0	0	190
8	0	0	0	0	0	0	0	**170**	0	0	170
9	0	0	0	0	0	0	0	1	**87**	0	88
10	0	0	0	0	0	0	0	0	0	**71**	71
total column	62	93	101	125	147	230	177	235	137	199	**1506**

Based on our error matrix we can check the accuracy by the following formula

$$accuracy\ \% = (total\ true\ value \div totale\ sample\ value) \times 100\%$$

Total true value = (48+64+99+120+131+162+159+170+87+71)

= 1111

Total sample value = (50+70+170+246+140+311+190+170+88+71)

= 1506

Accuracy % = (1111/1506) * 100% = **73.8**

According to Landis and Koch, 1977 the Kappa statistics value greater than 0.80 (i.e., 80%) represents a strong agreement and a value between 0.60 and 0.80 represents a substantial agreement.

Slope analysis

Topography contains two criteria namely slope, and aspect. The slope is one of the most factors important to reduce the cost of construction and minimize risk from natural danger like flooding. Thus, these factors were generated from the 20x20m resolution Digital Elevation Model (DEM) of the country. Hence, DEM data clipped (masked) using the study area shapefile in the analysis tool of ArcMap 7.1 (Figure 9B). Then, the clipped DEM data was analyzed (reclassified) in the surface analysis tool of ArcMap 7.1 using slope criteria developed for this purpose.

Elevation analysis

Elevation determines the distribution and abundance of wildlife and also influences plant growth (Chawla et al., 2008). The Elevation map of the study area was generated from the DEM of the study area (Figure 9B) which ranges from 1432 – 4389 m.a.s.l and reclassified in the surface analysis tool of ArcMap 10.7.1. From the safety and coast of construction perspective, the higher altitude ranked as not suitable and area at lower altitude considered as suitable.

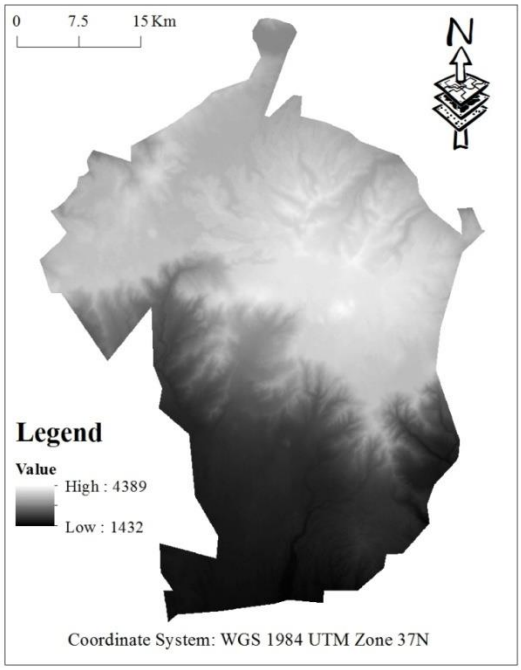


Figure 8: DEM of the study area from Landsat ETM+ imagery 2020

Distance to water sources

The availability of water in nearby is necessary beside of attracting the visitors for refreshment it is important for doing construction work and in camping areas important for sanitation, drinking and cooking purpose. The river shapefiles of Ethiopia were obtained from EMA and clipped by the study area boundary then cross-checked with the data obtained from BMNP and FZS_BMCP. Then the proximity factors were processed in ArcMap 10.7.1 using analysis tools i.e.; Proximity (buffer) and the river line feature was converted into raster feature and reclassified into four classes based on the distance from the river.

Proximity/distance to road

To select a suitable site for ecotourism facility development, accessibility, or proximity to the road is important. In addition to a reduction in construction costs for facilities, road network connects from major tourist transit to the interior parts of the park.

It provides easy and faster movement for facility development and accessibility is one of the prerequisites Thus, an area with less distance from the road are taken as highly suitable and the more distance from the road as not suitable. The existing road network map of the study area was taken from BMNP, FZS_BMCP and Google earth. The analysis was made in the analysis tool (proximity/buffer) in ArcMap 10.7.1.

Site suitability analysis for ecotourism facility development

ArcMap 10.7.1 was used to perform mapping and data analysis (overlay operations) for identifying suitable locations for ecotourism facility development and reclassification process. The data collected using KII questionnaires were processed and analyzed by using Microsoft Excel and AHP done as necessary to identify and weigh the criteria for the analysis of land suitability and doing the overlay process. Details of software and instruments used in this study are presented in table 4.

Table 4: the software's and instrument used to execute the research

No	Types of Software's and instruments	Description
1	ArcMap 10.7.1	Used For data editing, digitizing, creating, analyzing and mapping
2	ERDAS Imagine 2015	Used For satellite image preprocessing and classification
3	DNRGPS	Used to transfer data from Garmin handheld GPS receiver to the computer.
4	GPS	Coordinate data collection on the site
5	Micro-soft Office Excel	Used For GPS data importing and converting to Spatial Data in ArcMap

Source; own computation

3.3. Determining and Preparing Criterion Weight using AHP

For the sack of this study, producing the suitability map of ecotourism facility development in support of GIS and a multi-criteria evaluation is the final output which makes the complex decision-making process in tourism smooth by creating a hierarchy of decision criteria. AHP pairwise comparison method was used for weighting the criterion systematically which helps in determining the relative importance of one criterion over another. The method was introduced in 1977 and was developed and used by Saaty (1980).

The study applied the expert's opinion to calculate the relative importance of the five criteria involved. In this regard, 15 experts from the park and EWCA were questioned. The questionnaire (Appendix B) used contains the comparison matrices constructed, where each criterion is compared with the other criteria relative to its importance and scored with a Fundamental scale preference from 1 to 9 (table 5) as explained by Saaty (1980).

Table 5: Fundamental scale preference comparing two parameters in AHP

The intensity of importance (Scales for the relative importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgment strongly favor one activity over another
5	strong importance	Experience and judgment strongly favor one activity over another
7	Very strong importance	Activity is strongly favored and its dominance demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values	When compromise is needed
1/3, 1/5, 1/7, 1/9,	value for inversely comparison	

Note: Adopted from Saaty, (1980)

Based on the questioner and expertise opinion a weight for each criterion is calculated and used to derive a consistency ratio (CR).

The first step in the AHP procedure is to make pairwise comparisons between each criterion as given in table 6.

Table 6: pairwise comparison matrix for each criterion

criteria (C)	Slope	Elevation	LULC	D. River	D. Road
Slope (c1)	1	3	5	3	7
Elevation (c2)	(1/3)	1	3	2	2
LULC (c3)	(1/5)	(1/3)	1	(1/2)	2
D. River (c4)	(1/3)	(1/2)	2	1	3
D. Road (c5)	(1/7)	(1/2)	(1/2)	(1/3)	1

Then the fraction values were changed to decimal (Table 7) for doing the follow-up calculations.

Table 7: A completed comparison matrix

	Matrix value for the criteria's				
C	**c1**	**c2**	**c3**	**c4**	**c5**
c1	1	3	5	3	7
c2	0.333	1	3	2	2
c3	0.2	0.333	1	0.5	2
c4	0.333	0.5	2	1	3
c5	0.143	0.5	0.5	0.333	1
Sum	2	5.333	11.5	6.833	15

The next step is to normalize the matrix and calculating the criteria weight

For doing the normalization each entry in the column value of the comparison matrix is divided by the column sum to get its normalized score. After having the normalized score it is possible to do the criteria weight to do so divide the sum of each normalized value row by the number of the criteria which is five that give output shown in table 8.

Table 8: normalized pair-wise comparison matrix and criteria weight

C	**c1**	**c2**	**c3**	**c4**	**c5**	**Normalized value sum**	**Criteria weight**
c1	0.5	0.56	0.43	0.44	0.47	2.4	0.48
c2	0.16	0.19	0.26	0.3	0.13	1.04	0.208
c3	0.1	0.06	0.09	0.07	0.13	0.45	0.09
c4	0.17	0.1	0.17	0.14	0.2	0.78	0.156
c5	0.07	0.1	0.04	0.05	0.06	0.324	0.065

After having all the above the next step is calculating the Consistency by multiplying each matrix value of the criteria (Table 7) by the criteria weight (Table 8) and getting Weighted sum value by summing the value of each row of consistency value. Having this we can do the weighted average by dividing the weighted sum to the Criteria Wight (table 9).

Table 9: weighted Average of the criteria

C	**c1**	**c2**	**c3**	**c4**	**c5**	Weighted sum	Criteria weight	weight Average
c1	0.48	0.62	0.46	0.47	0.45	2.48	0.48	5.17
c2	0.16	0.21	0.27	0.31	0.13	1.08	0.208	5.2
c3	0.09	0.07	0.09	0.08	0.13	0.46	0.09	5.1
c4	0.16	0.1	0.18	0.15	0.2	0.8	0.156	5.1
c5	0.07	0.1	0.05	0.05	0.06	0.335	0.065	5.15
							∑ weight average	**25.72**

Now we can proceeds to the consistency of the judgments

CR = C.I. / RI If the Consistency Ratio is below one (< 1) it is acceptable

CR (consistency ratio) C.I (consistency Index) RI (Random Index)

CI = $(\lambda_{max} - n)/n - 1$ (n represents number of criteria)

λ_{max} = ∑weight Average / n

The random index value of the criteria RI is taken from saaty table

Table 10: Random consistency index (RI) (saaty, 1980)

Matrix size	1	2	3	4	**5**	6	7	8	9
Random consistency Index (RI)	0.00	0.00	0.58	0.90	**1.12**	1.24	1.32	1.41	1.45

The final outputs will be

λ_{max}=5.145, CI = 0.036, RI = 1.12, CR = 0.032

C.R = 0.032 < 0.1 as Saaty suggested if the CR is less than or equal to 0.1, then, the inconsistency is acceptable.

Table 11: Calculated weights for the criteria's

Criteria's	**Weight**
C1, slope	W1= 48
C2, Elevation	W2= 21
C3, land use land cover	W3= 9
C4, Distance to River	W4= 16
C5, Distance to Road	W5= 6
	100

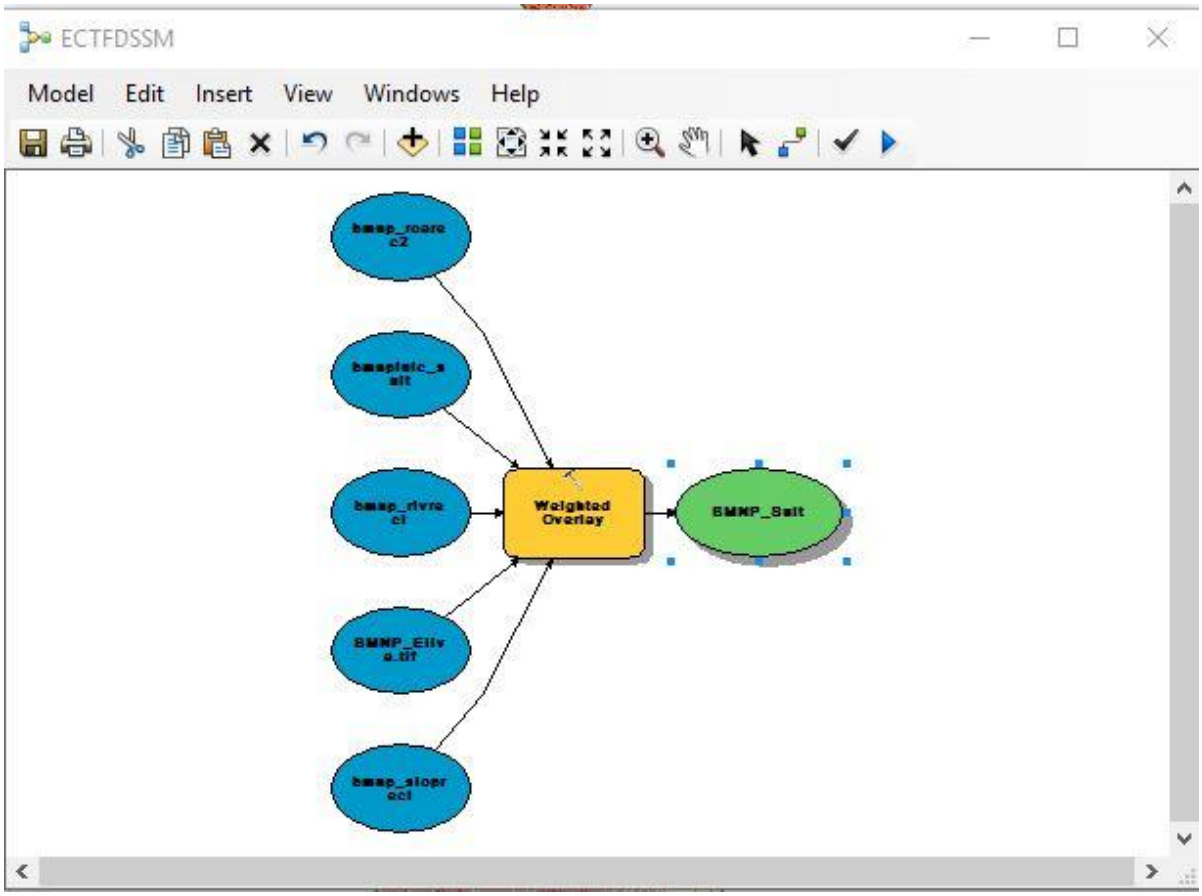
Finally, Based on the weighted criterion the ecotourism facility development site suitability map (ECTFDSSM) was produced by using this logical formula given by Ronald (2001) in ArcMap 10.7.1 spatial analyst weighted overlay extension tool by developing a model in Geoprocessing model builder.

$$Sm = \sum_{i=1}^{n} Wi * Ci$$

Where Sm is the suitability map, Wi is the criteria weights and Ci are the factor criteria map used to determine the suitable site.

(ECTFDSSM) = 48*slope map + 21*Elevation map + 9*Land use land cover map +16*Distance to River map + 6*Distance to Road map

Figure 9: Ecotourism facility development site suitability analysis model



Finally, the site suitability was classified into four classes; highly suitable, moderately suitable, marginally suitable and, not suitable.

4. Result and discussion

4.1. Site suitability evaluation inputs data analysis for Ecotourism facility development and input Maps.

4.1.1. Implication of the LULC types for ecotourism practice

A land-use land cover (LULC) map is the foundation of sustainable ecotourism development planning and which helps to site a suitable location for ecotourism facility development. The analysis identified 10 LULC types using image analyses (Figure 11),. The identified LULC from the image analysis include: Afro-alpine, Erica forest, High forest (Harena), Woodlands, Bushlands (Erica), Shrublands, Grasslands, Water bodies, Settlement & cultivated lands and Bear lands.

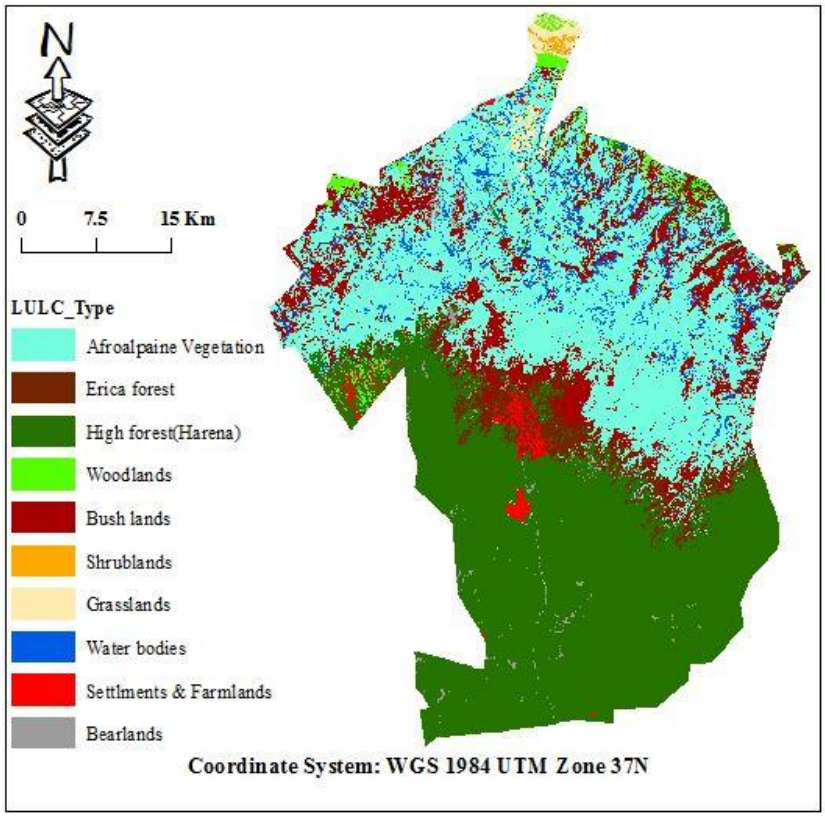


Figure 10: BMNP land use land cover map of the year 2020

As shown in table 12, the analysis revealed that high forests are the major LULC types, which cover 38.6% (847km^2) followed by Afro-alpine vegetation and Erica dominated bushlands that

accounting for 35.2% (772.2 Km^2) and 12% (264.1km^2), respectively and the rest other LULC accounts below 5%.

Table 12: LULC in BMNP and the area coverage

Code	**LULC Types**	**Area _ Km^2**	**Area_%**
1	Afro-alpine	772.3	35.2
2	Erica forest	107.2	4.888631
3	High forest (Harena)	847	38.61204
4	Woodlands	32.8	1.49797
5	Bush lands (Erica)	264.2	12.04281
6	Shrub lands	4.2	0.193084
7	Grasslands	25.4	1.156625
8	Water bodies	96.8	4.411634
9	Settlement & cultivated lands	23.4	1.066623
10	Bare lands	20.3	0.9

The LULC analysis map was used to generate a suitability map of the different LULC types using ArcMap and yielded 4 classes (Figure 12).

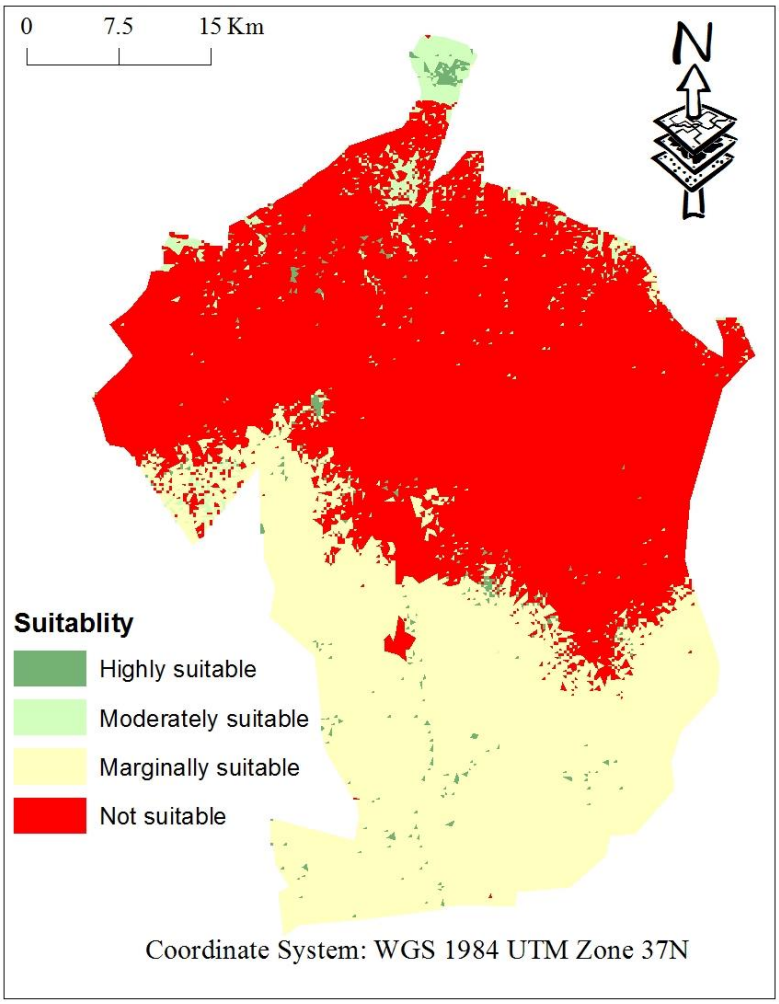


Figure 11; the reclassified Suitability map of the study area

Ecotourism facility development criteria were used to generate suitability classes for the different LULC types which will be used to generate overall suitability analysis. The decision making process in land use requires to identify the most appropriate spatial pattern Therefore; the LULC provides significant information for effective natural resources conservation and ecotourism development (Bunruamkaew, 2012). As infrastructure development in protected area requires an open space so; bare lands, shrub lands, grasslands, and woodlands were given higher value and, identified as suitable areas (Table 13). The assumption, here is that, unless such ecotourism facility development utilize open area, it might request us to clear forested areas which are important habitats for the wildlife as such intervention on forested area disturbs or damages the park ecosystem. Therefore, forestlands and Afro-alpine areas were considered as not suitable or less suitable areas due to their ecological diversity and sensitivity for a disturbance.

Table 13; suitability class in LULC and area coverage

Code	Suitability	Habitat type	Area_km^2	% cover
1	Highly Suitable	Bare land & Shrub land	24.3	1.1
2	Moderately Suitable	Grassland & Woodland	57.5	2.6
3	Marginally Suitable	High forest (Harena)	846.2	38.6
4	Not Suitable	Afro-alpine/, bushes(Erica), Erica forest, Settlement, farmland & Water body	1265.7	57.7

The fieldwork and satellite images analysis revealed that the park has faced LULC fragmentation and transformations of the main wildlife habitats. Field survey and observation confirmed that the local communities depending on the natural resources of the park for their livelihood. It was observed that peoples are expanding far away from settlements villages searching for new farm and grazing-lands. In connection to this, KII respondents indicated that mobility and encroachment have been negatively impacting the size of land available for habitat protection, species conservation, whole biodiversity, and the ecosystem. Many protected areas in Ethiopia are becoming isolated and the reasons for the isolation include growing human population in areas adjacent to protected areas and land-use change towards agriculture, infrastructure, and settlement in previously unpopulated areas (Hansilo and Tiki, 2015)

Particularly the Sanetti plateau is degraded, which is the most important place for the conservation of rear and endemic Ethiopian wolf and the abundant rodents. Also, this area is most important for the hydrological system and birdlife. The other most importantly impacted area is Harena forest, which has three villages inside and the population is increasing over time. KII respondents underlined that encroachment in Harena forest has been creating an adverse impact on the most elusive and large home ranging wild animals such as the endemic animals (Bale Monkey, Black-manned Lion, leopard, and Wild Hunting Dog) which counted almost a decade since it is observed in the park.

Figure 12: Rira village

As per the KIIs and field observation water availability has become increasingly a concern particularly in recent decades as rivers and water sources have been reducing and being dry most of the year. Mainly the alpine creature lakes found on the plateau and in the afro-alpine areas and the rivers which have sourced their origin from the afro-alpine areas of the park are degrading over time.

The field survey and KIIs verified that human encroachment, the increasing livestock grazing pressures, and the lake of the buffer zone for the park resulted habitat fragmentation on the connectivity process of important biodiversity areas. This is attributed to a lack of corridors to safeguard the wild animals; moreover, the encroachment provides a suitable condition for invasive plant species like *Solanum incanum* to expand in the open woodland and grassland parts of the park and transforming the habitat into other LULC types.

Most of the park area remains restless with the human movement and domestic animals interfering species mobility, specifically for animals that need bigger land for survival and the elusive animals. During the field research, humans and wildlife conflicts were also observed particularly in many parts of the park with high intensity and prevalence along major LULC borders.

According to KII, the human encroachment inside of the park is mainly associated with the discovery of new lands for settlements, livestock grazing, and farming (crop production), forest, and forest product extraction. Expansion of agricultural activities in Harena forest accelerated deforestation and resulted significant reduction (in number) and disappearance of many wild animals such as lions, leopards, and Wild Hunting Dogs.

Figure 13: Farm inside Harena forest

In line with this finding, different studies done in nature conservation areas confirm that the human encroachment owing to population growth, natural resources exploitation, crop production, livestock grazing, settlement, and natural and anthropogenic fire onset are among main causes for degradation of wildlife areas (Mucova et al., 2018; Padonou et al., 2017; Akinyemi, 2017; Wingate et al., 2016). According to Ethiopian Biodiversity institute if the heavy utilization of resources continues at the same pace for the coming decades, the more easily accessible highland, Erica-Hypericum woodland might disappear. The studies have associated the wildlife areas degradation with a socioeconomic factor with less attention on biodiversity conservation, inadequate collaboration among development sectors, and poor human settlements programs that adversely degraded ecotourism sits and undermined the economic contribution of the resources.

4.1.2. Topographic mapping

Slope

Slope is a safety indicator the gentler the slope, the higher the safety factor and vice versa and related with the coast of facility development due to accessibility. In the study area slope and elevation were generated from DEM data and classified using evaluation criteria. The slope analysis yielded the slope of the study area which ranges from 0° to 78°.

The reclassified slope map was given from the degree measurement unit and the flat landform is seated as the most suitable for ecotourism facility development site, while steeper slopes areas are stated as less suitable. Therefore, land with 0-5° identified as highly suitable; 5-10° as moderately suitable; 10-20° as marginally suitable and, areas which have a slope above 20° as not suitable. Therefore, based on slope analysis the study area is varying from highly suitable to not suitable (Figure 14). Similar results were reported by Bunruamkaew (2012) in Thailand and Cuirong et al. (2016) in China. They concluded that “slope” would be an appropriate criterion for ecotourism development and Slopes greater than 20◦ were considered to be steep and extremely unsuited for construction. As showmen in table 13, the land having 10-20° cover relatively larger proportion which accounts about 36.4% (797.5km^2) which is classed as marginally suitable (S3) followed by land with 5-10° slope, covering about 26.7% (583.6km^2) which classed as moderately suitable (S2).

Depending on the slope, the two extreme classes, i.e., Not-suitable (N2) and highly suitable (S1) classes respectively accounts 23.8 and 13.1%, which cover 520.5 and 287.6 km^2.

Table 14: suitability class based on slop and the area coverage

Code	Slope Range in degree	Suitability class	Area in Km^2	%
1	0 – 5°	Highly Suitable	279.5	12.8
2	5 – 10°	Moderately Suitable	576.3	26.3
3	10 – 20°	Marginally suitable	802.7	36.7
4	>20°	Not Suitable	530.4	24.2

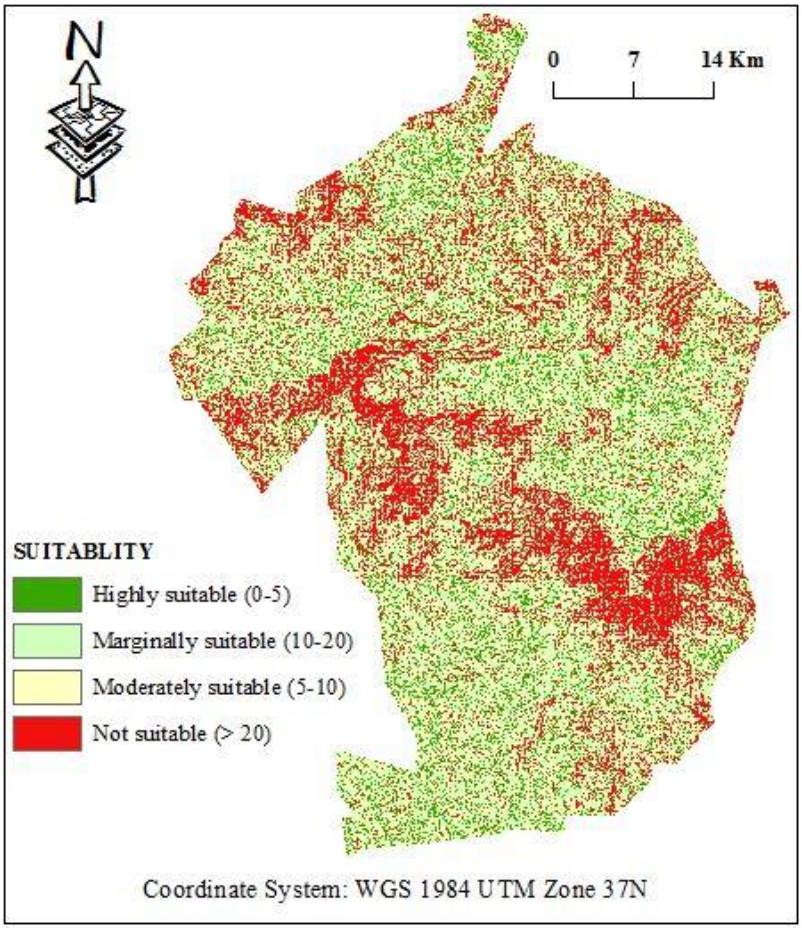


Figure 14: Reclassified slope map of the study area

Elevation

Based on the observation and key informant, the altitudinal variation in the area has a major influence upon the climatic conditions of the study area, in the upper parts (Sanity plateau) which has a very cold and rainy climate, where the temperature sometimes drops below zero degrees Celsius. In the study area, vegetation zones have a direct relation with Altitudinal variation on the lower altitudes plants grow high and dens in forest level, and on the upper altitude the plant diversity reduces and the growth becomes less at shrub and bush level. Based on safety reasons and the coast of construction the higher altitude areas are classified as not suitable, while areas having lower altitude classed as suitable (figure 15).

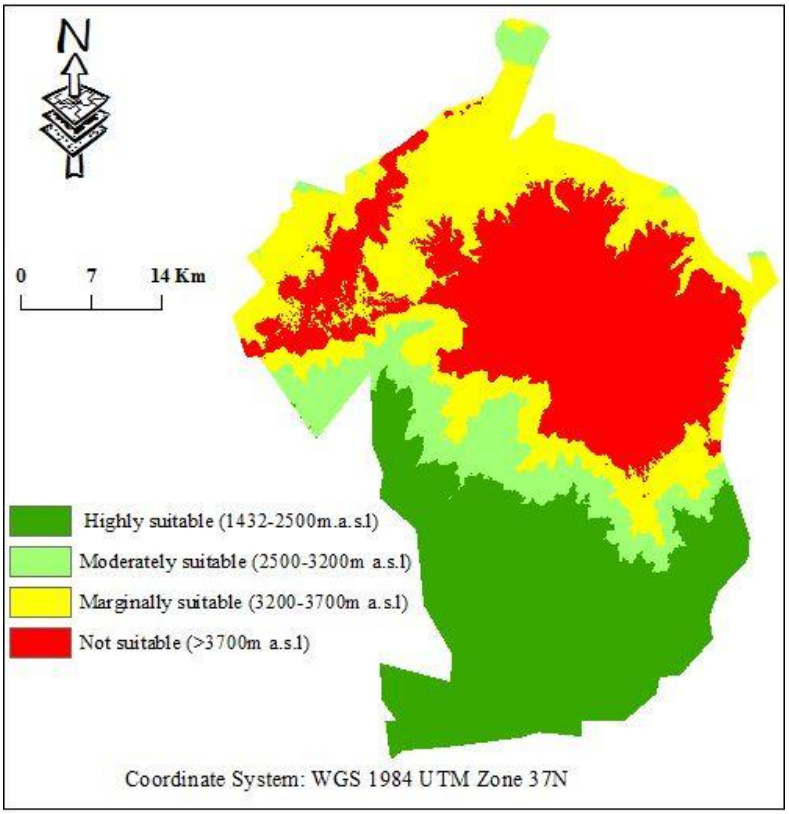


Figure 15: reclassified elevation map of the study area BMNP.

Therefore, as indicated in table 15, areas with the highest altitude (>3700 m.a.s.l.) are ranked as not suitable covers an area of 677.5 km^2, 3200 – 3700m a.s.l as Marginally Suitable covers an area of 574.9 km^2, 3200 – 3700m a.s.l as moderately suitable covers an area of 237.7 km^2 and the lowest altitude in the study area 1432 – 2500m a.s.l are ranked as highly suitable covers an area of 703.6 km^2.

Table 15: suitability class based on elevation

Code	Altitudinal Range	Suitability Level	Area in Km^2	% cover
1	1432 – 2500 m	Highly Suitable	703.6	32
2	2500 – 3200 m	Moderately Suitable	237.7	10.8
3	3200 – 3700	Marginally Suitable	574.9	26.2
4	>3700 m	Not Suitable	677.5	31

4.1.3. Distance to Rivers

In these study Areas closer to water resource are considered as suitable and far from water points are considered as not suitable. Several studies Kumari et al., 2010 in West District of Sikkim state, Bali, et al. (2015) in Anzali Northern Iran and, Cuirong, et al. (2016) in China emphasized the importance of "distance from water resources". Based on the analysis of the criteria distance to the river, the study area was classified into 4 classes ranging from highly suitable to not-suitable (figure 9).

Area classed as highly suitable covers an area of 23.4% (514.4 km^2), areas classed moderately suitable covers an area of 18.5% (404.8 km^2), areas in marginally suitable class covers an area of 24.1% (529.2 km^2), and areas classed as not suitable covers an area of 34% (746.9 km^2) (Table 16).

Table 16: suitability based on Distance to River

code	Suitability	Distance to river	Area _ km^2	Area _ %
1	Highly suitable	0 - 1000 m	514.4	23.4
2	Moderately suitable	1000 – 3000 m	404.8	18.5
3	Marginally suitable	3000 - 4000m	529.2	24.1
4	not suitable	> 4000 m	746.9	34

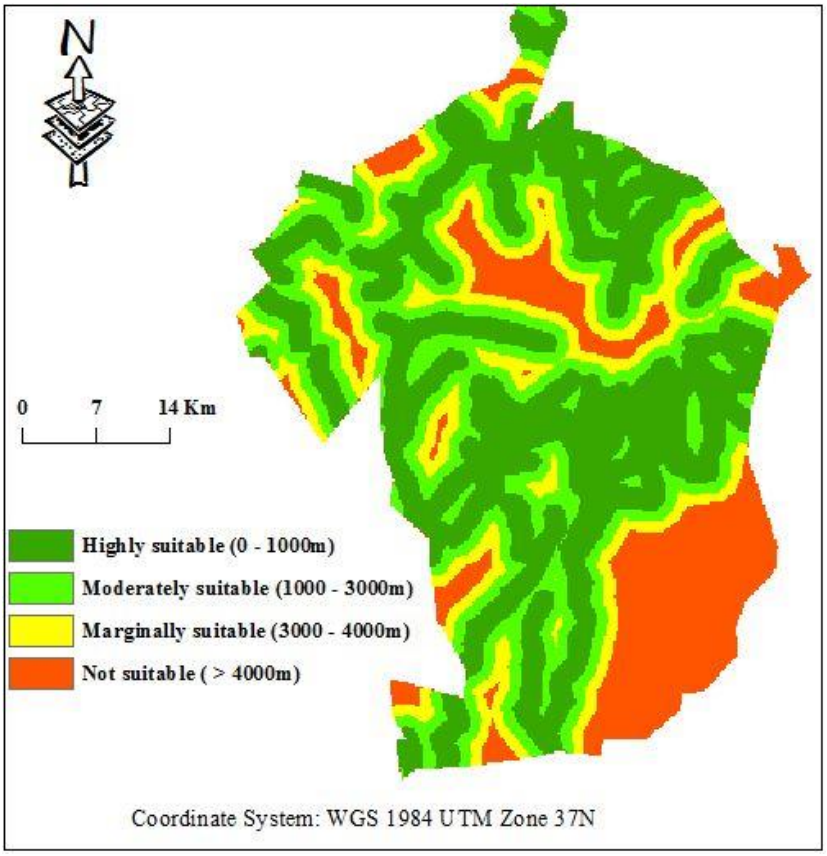


Figure 16: reclassified River map of the study area BMNP

4.1.4. Distance to Road

One of the challenges for facility development in the study area is lack of accessibility and road connection that connects the routs inside the park this makes the facility development coast high and challenging to move materials to the areas. The importance of accessibility was highlighted by other researchers e.g. Kumari, et al., (2010); Bali, et al. (2015) and, Cuirong, et al,. (2016). Road map represented by line feature is not compatible for MCE so Firstly the line feature was converted in to raster feature and reclassified in to four classes based on the distance from the road. Areas within 1 km buffer around the roads are ranked as highly suitable, areas within 1 - 3 km buffer around the roads are ranked as moderately suitable, areas within 3 - 5 km buffer around the roads are ranked as marginally suitable and areas within 5 km and outside of any buffers around all roads are ranked as not suitable for ecotourism facility development. The proxy to the road analysis result shows that more than half of the study area is not suitable for eco tourism facility in this regard (figure 16).

Accessibility to roads in the study area is poor. Only 10.5 % (230.6 km^2**)** of the area has a score of 1 which is highly suitable, 16.6 % (364.8 km^2), and 56.4 % (1236.3 km^2**)** has a score of 3 & 4 which are marginally suitable and not suitable respectively (Table 17).

Table 17: the road suitability classes and area coverage in the study area

code	**Distance to a road (Km)**	**Suitability**	**Area_km^2**	**Accessible % area**
1	0 - 1	Highly suitable	230.6	10.5
2	1 - 3	Moderately suitable	361.3	16.5
3	3 - 5	Marginally suitable	364.8	16.6
4	>5	Not suitable	1236.3	56.4

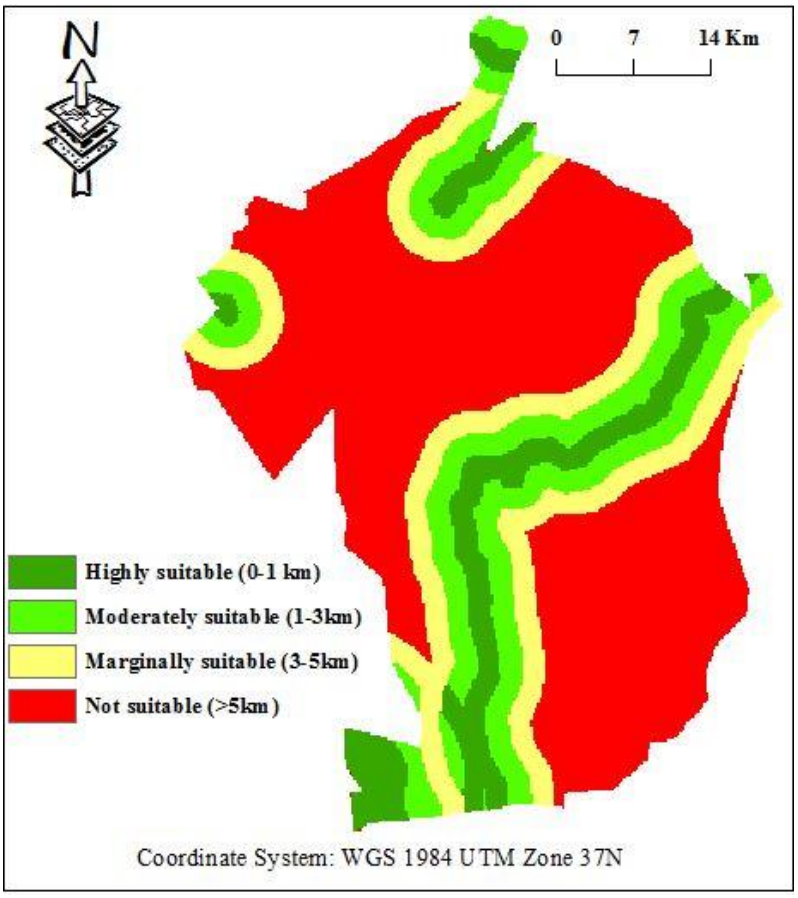


Figure 17: Reclassified road Map of the study area BMNP

4.2. Ecotourism facility development site suitability analysis result

The MCDM/AHP method was used to evaluate the priority weight of each criterion and the Geographic Information System (GIS) is an integrated technique used to assess suitable land for ecotourism facility development within the study area. According to the model generated by the weighted overlay analysis method in ArcMap the suitability map for ecotourism facility development was produced as shown in figure 19.

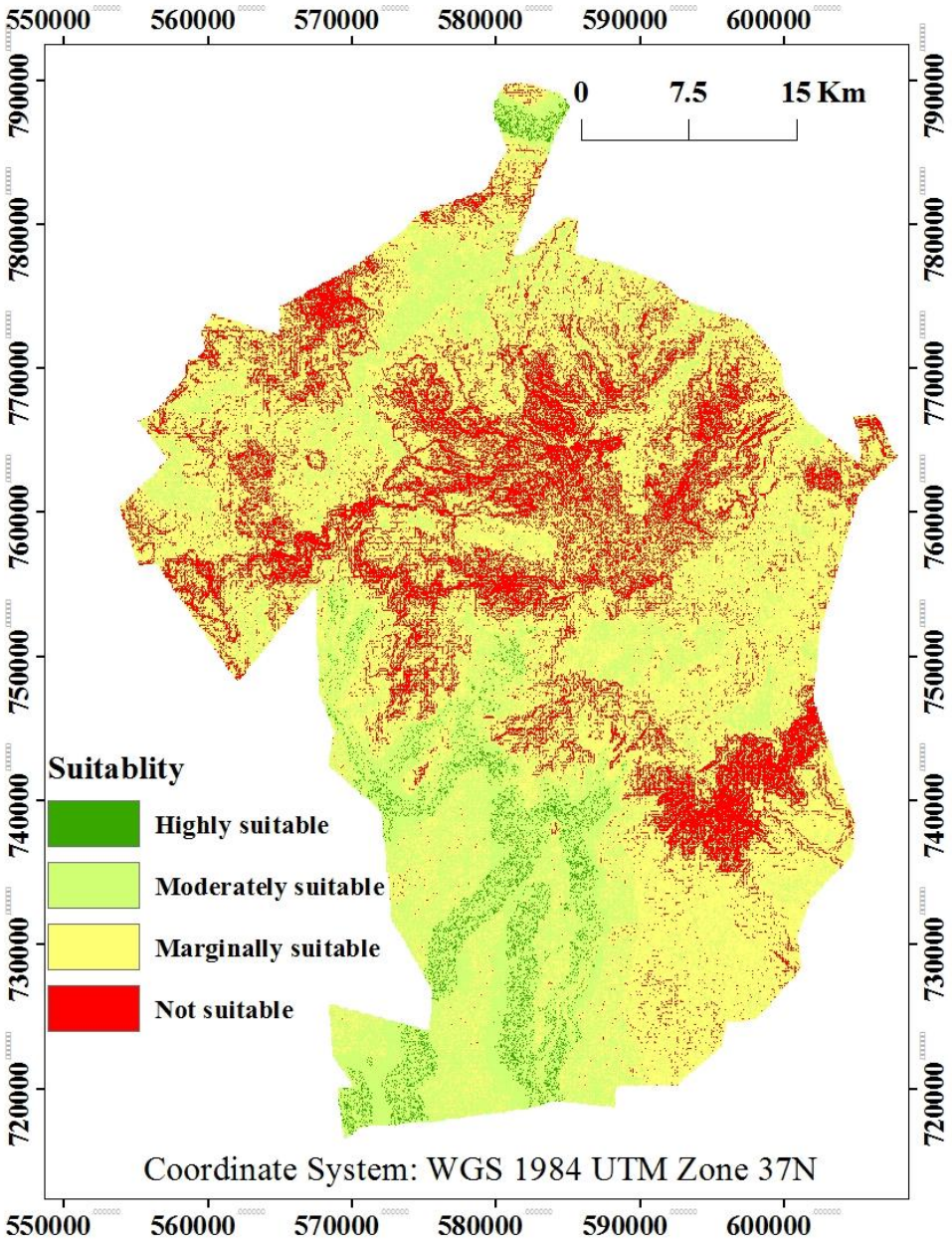


Figure 18: suitability map for ecotourism facility development sit

As indicated in Figure 18, the ecotourism facility development site suitability model map was generated using different researchers publications (Bunruamkaew, 2012; Ullah & Hafiz, 2013; Mihret & Yohannes, 2015; Cuirong, et al., 2016; Taye, et al., 2019) and FAO's four suitability classes; highly suitable, moderately suitable, marginally suitable and not suitable.

In this study it was found that areas of 1.6 % (35.6 km^2) as a highly suitable site for ecotourism facility development located in the northern grassland, open wood lands and part of the Harena forest. The 2nd class moderately suitable areas make up 26.2 % which covers an area of 571.6 km^2 located in the part of the Afro-alpine area and part of the Harena forest. The largest class of the study area is found in the marginally suitable class which covers 52.5 % (1143.8 km^2) and an area of 19.7 % (427.9 km^2) is identified as not suitable for Eco-tourism facility development site, located at the central part of the plateau, Afro-alpine areas, Erica shrubs, and Erica forest.

Table 18: suitability classes and area coverage in the study area

Code	**Suitability class**	**Area_km^2**	**% 0f area suitable**
1	Highly suitable	35.6	1.6
2	Moderately suitable	571.6	26.2
3	Marginally suitable	1143.8	52.5
4	Not suitable	427.9	19.7

According to previous studies (Pareta, 2013; Cuirong et al., 2016), areas which satisfy almost all criteria are grouped under the highly suitable class. Based from the field observation, LULC and the final suitability map in the study area the large part of the highly suitable area lies in the northern Grassland, woodland and the southern Harena forest area which are main habitats for many endemic and endangered wild animals' like mountain Nyala, Menilik Bushbuck, Bale Monkey, Black-manned Lion, leopard and number of bird species which are main ecotourism attractions and create a good opportunity to observe a plenty of wildlife and important conservation area. The conservation of natural assets is important for tourism. At the same time, the tourism sector itself must make sure that its activities do not damage them rather help to sustain the nature (UNWTO, 2013).

Therefore, ecotourism facility development in these areas should be with certain limitations and further investigations are needed to avoid potential impacts on the ecology for the sustainability. The Moderately suitable class areas are those satisfies most of the criteria, but some of the criteria are not satisfied. The moderately suitable class areas are located in the most part of the moist and dense part of the Harena forest areas, where ecotourism activity is much lower and it can be developed as an ecotourism destination by developing proper ecotourism facilities in considering environmental sustainability and a detailed assessment of environmental impact due to its forest coverage and in part of the Afro-alpine area.

Based on the study result the largest parts of the study areas are incorporated under the third class the marginally suitable class. The marginally suitable site is an area which satisfies some of the criteria set up, but most of the criteria are not satisfied (Taye, et al., 2019). In the study, the marginal suitable site located in some part of the Harena forest which is far from the road accessibility, areas with water resources shortage, and areas in the afro-alpine which are sensitive to degradation, have steep Slope, higher altitude and known by its cold weather.

The last identified class is the not suitable site where almost all of the criteria are not satisfied, located at the central part of the plateau and Afro-alpine areas, Erica shrubs and Erica forest areas which are the most sensitive parts of the parks. The afro-alpine areas are the most important area for the conservation of the most endangered and endemic Ethiopian Wolf with the abundant rodents which plays an important role in the hydrological system, important area for several bird species and the area includes Sanete Plateau which is an area known by having many mountain peaks like Tulu Dimtu the second-highest point in Ethiopia at an altitude of 4,389 m a.s.l, Wassema (4,220 m a.s.l) and Batu Tiko (4,000 m a.s.l), It has a feature of a steep slope and near to cliff at a higher elevation which makes hard for facility development due to the safety issue, the weather condition and coast of constriction. The afro-alpine and Erica forest areas have a high value of natural resources which makes the most important areas for research and education as well as conservation of biodiversity and maintenance of the ecosystem in the area so this area is identified as not suitable for Ecotourism facility development.

5. Conclusion and recommendation

5.1. Conclusion

Tourism is one of the world's most important economic sectors which have become a more competitive business. To make this business sustainable, it requires the development of infrastructures and facilities that can accommodate customers. Ethiopia possesses a varied potential natural, historical and, cultural tourism attraction, which have social, economical and environmental importance but these potential resources has not been adequately protected, developed and used. In most of existing and potential tourist destinations there is a serious shortage in number and type of tourist facilities (Ministry of Culture and Tourism, 2009.).

Tourism infrastructure and facilities are one of the most important components of tourism product that includes buildings and service institutions which add value and make the stay satisfactory for the tourists (Panasiuk, 2007). While, ecotourism areas are fragile and sensitive for any development activities held within which makes tourism highly complex activity requesting a complex decision making for sustainable development of economic, social, and environmental demands of the current as well as the future generation. The promotion of practical policies and actions within the tourism industry is important to encourage and pursue sustainability in the development and operation of tourism facilities and services (UNWTO, 2013). Thus, tourism decision making requires a tool like GIS that helps to simplify the complexity of decision making.

Generally in Ethiopia, the use of Geographic Information System in the Ecotourism development is lagging behind most of the Ecotourism development activities are done manually and even if there is some information systems used in few destinations, either the information are poor or not simply compatible with computer programs.

This research aimed to evaluate the suitability of areas in BMNP for Ecotourism facility development. To achieve this, MCDM/AHP and GIS-based weighted overlay methods were adopted. Based on research and publication review, tourism regulations, and expert opinion five criteria were selected. The weights for the criteria were determined using an AHP analysis adopted from Saaty (1980). The site suitability model and suitability maps were generated using ArcMap Geoprocessing model builder and spatial analyst tool weighted overlay.

The site suitability of BMNP for ecotourism facility development was divided into five classes, where class 1 is the more suitable areas for ecotourism facility development covers 1.6% (35.6 km^2) of the study area. Class 2 areas as suitable makeup about 26.2 % (571.6 km^2) located in the Afro-alpine area and Harena forest. Majority of the study area identified as 3rd class which is moderately suitable covers 52.5 % (1143.8 km^2). 19.2 % (417.4 km^2) is less suitable located in the Afro-alpine and Erica forests areas. An area of 0.5 % (10.5 km^2) belongs to class 5 as not suitable located at the central part of the plateau and Afro-alpine areas. But further study must be undertaken to avoid potential impacts on the ecology due to its sensitivity and there have a time and resource limitation. And the study also revealed the LULC and some problems on natural resources like settlement, grazing, farming, deforestation which result depletion of wildlife in the study area.

Therefore, this study demonstrated the use of geographical information systems and multi-criteria decision-making framework as a solution for complicated decisions making in ecotourism development of the BMNP and other protected. It can also provide important guidance for future land use planning and effective allocation of scars resources. In this case, it is very important to make full use of the GIS in the Ecotourism development and management to make sustainable Ecotourism development.

5.2. Recommendation

Based on the study some important issues are recommended as follows:

- The park tourism infrastructure is underdeveloped and it is important to improve the tourist facilities in the park and its surroundings.
- The study provided a methodology with the GIS application and MCDM/AHP for identifying suitable location for ecotourism facility development which can be applied in other protected areas and the findings in this research can be applied in the study area which will minimize the coast and time.
- The implementation of GIS and remote sensing technologies following the presented strategy will allow the stratifications of alternative land use in general and of facility development in particular. Therefore, it is recommended that GIS can be used for monitoring tourism development and its effects over time in an environmentally sensitive area.
- The park area faces a critical danger due to human encroachment that can affect the whole ecosystem this needs joint management with all responsible bodies. In this regard the study showed that GIS and Remote Sensing application can play an important role in identifying the LULC and the distribution of settlements, which would help to support the conservation practice.
- Finally I recommend that further study should be done by using a more improved image for land use land cover classification and by involving other criteria's such as viewshed , distance to wildlife duns and other that this study has not involved due to time and resources which will maximize the outcome and reduces the negative impacts of the development.

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APPENDIX

APPENDIX A: CHECKLIST FOR KEY RESPONDENT

As part of my MA research Thesis at the Addis Ababa University I am conducting a study that investigate on, The application of GIS and Remote Sensing for site suitability analysis of Ecotourism facility development: The case of Bale Mountains National Park, Ethiopia. This will help the park management and the concerned bodies to seek possible solutions for the problems which hinder the park Ecotourism facility development. So you are kindly requested to fill this questioner.

Dear Participant, I will appreciate if you could fill in the required information which will remain confidential and any information obtained in connection with this study that can be identified with you will only to be used for academic purposes.

Section A: General Information (Tick where appropriate).

Respondent details

1. Name _____
2. Your gender? Male ☐ Female ☐
3. Age bracket? 18- 25 ☐ 26- 35 ☐

   36 – 45 ☐ above 45 ☐
4. Education level?

   Elementary ☐ High school ☐ Diploma ☐

   Undergraduate ☐ Postgraduate (MA/MSC) ☐

   Postgraduate (PHD) ☐
5. Organization (work place)?

   Government ☐ Nongovernment ☐

   Private ☐ Other ☐
6. Organization Name? _____

7. Your occupation? _____
8. Working experience _____ year.

Section B

Research Area Questions

Land suitability

1. Do you think ecotourism facilities be construct in Parks such as Lodges, campsites with mountain hut, toilet, kitchen etc.? Yes ☐ No ☐
2. If your answer for question number 1 is yes what criteria you will recommend be considered on the ecotourism facility developments in Parks?

_____

_____

_____

_____

3. Kindly indicate your level of agreement with the following statements on factors determining land suitability for ecotourism facilities development such as campsite?
Use the following key and circle your choice:

1=Totally Disagree 2= Disagree, 3= Neither 4= Agree, 5= Totally Agree

Existence of unique attractions and distance from watching site	**1 2 3 4 5**
Topography (elevation, slop)	**1 2 3 4 5**
Accessibility/ distance from road.	**1 2 3 4 5**
Availability of water	**1 2 3 4 5**
Distance from wildlife duns.	**1 2 3 4 5**
Settlement/Community influence	**1 2 3 4 5**
Land use land cover type.	**1 2 3 4 5**

4. Have you been in the campsites of the Park? Yes ☐ No ☐
5. How do you rate the overall ecotourism facilities of the park?

Poor ☐ Fair ☐ Good ☐ Very good ☐ Excellent ☐

6. Kindly provide your overall opinion about the facilities in regard to sustainability?

_____

_____

_____.

Land use Land cover

1. How do you see the present status of the park (BMNP) in comparison to the past 10 year?

_____

_____

_____

_____.

2. What are the factors that contributed for the changes?

_____

_____

_____

_____.

3. Do this changes affects the Ecotourism Activity of the park

Yes ☐ No ☐

4. If your answer for question number 3 is yes please explain how?

_____

_____

_____

_____.

5. What is your recommendation about the development of ecotourism in the park?

_____

_____

_____

_____.

Thank you in advance for your cooperation

APPENDIX B: Questionnaire for Experts

Dear Participant first of all I would like to thanks for participating in this study for second time and this is to do Pair-wise comparisons, where each criterion is compared with the other criteria relative to its importance on a scale from 1 to 9. So I will appreciate if you could fill in the required information by circling.

C1: slope C2: Elevation C3: land use land cover

C4: Distance to River C5: Distance to Road

Factor	**Factor weighting score**																**Factor**
	More importance than								**Equal**	**Less importance than**							
C1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C2
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C3
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C4
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C5
C2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C3
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C4
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C5
C3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C4
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C5
C4	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C5

Thank you for your participation.

APPENDIX C: BMNP Data collection sheet

Date _____. Data collector: _____.

Area Name: _____. GPS,No._____.

Way point No	GPS Location		Elevation	Observation	Land use land cover category
	Longitude (X)	Latitude (Y)			