ADDIS ABABA UNIVERSITY
COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES
SCHOOL OF EARTH SCIENCES

GIS-BASED ECOTOURISM POTENTIAL ASSESSMENT IN BAHIR DAR AND ITS SURROUNDINGS, ETHIOPIA

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Addis Ababa, Ethiopia
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A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF ADDIS ABABA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF SCIENCE IN REMOTE SENSING AND GEO-INFORMATICS

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Declaration

I hereby declare that the dissertation entitled "GIS-based ecotourism potential assessment in Bahir Dar, and its surroundings, Ethiopia" has been carried out by me under the supervision of Dr. K. V. Suryabhagavan, School of Earth Sciences, Addis Ababa University, Addis Ababa during the year 20121−2022 as a part of Master of Science programme in Remote sensing and Geo-informatics. I further declare that this work has not been submitted to any other University or Institution for the award of any degree or diploma.

Place: Addis Ababa

Date: January, 2023

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ADDIS ABABA UNIVERSITY
School of Graduate Studies
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A Thesis Submitted to

The School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Masters of Science in Remote Sensing and Geo-Informatics

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List of Acronyms

AHP	Analytical Hierarchy Process
CI	Consistency Index
CR	Consistency Ratio
EMI	Ethiopian Meteorology Institute
ESS	Ethiopian Statistics Service
GIS	Geographic Information System
ITF	International Transport Forum
LDC	List Developed Countries
LULC	Land Use and Land Cover
MCDA	Multi Criteria Decision Analysis
MCDM	Multi Criteria Decision Making
MCE	Multi Criteria Evaluation
NGO	None Governmental Organization
RI	Random consistency Index
SIDS	Small Island Developing States
SDG	Sustainable Development Goal
SSGI	Space Science and Geospatial Institute
TIES	International Society for Ecotourism
TIES	The International Ecosystem Society
UNESCO	United Nations Education, Science and Culture Organization
UNWTO	United Nations World Tourism Organization
WFP	World Food Program

GIS-based ecotourism potential assessment in Bahir Dar, and its surroundings, Ethiopia

Tewodros Kassahun, MSc. Thesis
Addis Ababa University, January 2023

Abstract

In Ethiopia, the population number was increasing continuously with agricultural land expansion and urbanization for the last five decades. The present study aimed to assess the changes in land Ecotourism has a strong connection with sustainable tourism. Sustainability depends on the relationship between tourism and environment. Ethiopia's sustainable tourism master plan (2015), has set a high growth objective of 5 million foreign tourists in 2025. The aim of this study is to explore the capability of AHP and GIS technique for identify potential ecotourism sites in Bahir Dar and its surroundings, Ethiopia. This is also an additional benefit achieved by integrating geo-scientific aspects in the land-use decision process and this area, having plenty of tourist attractions, could be a source for both domestic and foreign tourists. Thus, this is a crucial and pioneer work in this field of study, and it should be used as an ideal blueprint for ecotourism planner for ecotourism site development. a base map of the study area is constructed and used to generate a number of factor maps using various GIS approaches. In GIS, each factor is represented on a map as a layer. Each map reflects a single sub criterion and can be referred to as a theme layer or data layer. They represent how the traits are dispersed in space and how they help to achieve the goals. After creating a Digital Elevation Model map of the study region, elevation, slope, aspect, land use land cover class, and rainfall maps were created in GIS. an important factor has a greater impact on the outcome than other factors. Hence, the weight LULC map is 49 % and the remaining elevation map, slope map, aspect map, existing tourist destination sits and road network map are 19 %, 15%, 11 %, and 10% and 5%, respectively. With approximately 2,065 hectares of land, Bahir Dar and its surroundings have the potential to be ecotourism sites. According to the characteristics and parameters we used, the majority of the study area, about 52 percent, is moderately suitable for ecotourism. The 35 percent of the study area is not suitable for ecotourism tourist destination site. The studied area has a strong potential for ecotourism development in general. Despite the presence of various problems in the area, there are great potentials and chances to maximize the advantages of ecotourism activity in order to improve the livelihoods of the inhabitants.

Keywords: Ecotourism, GIS, Bahir Dar, AHP, Consistency, Weight factor

Chapter one

Introduction

1.1 Background of the study

Ecotourism has a strong connection with sustainable tourism. Sustainability depends on the relationship between tourism and environment (Azam *et al*., 2018; Ghorbanzadeh *et al*., 2019). Suitable management for ecotourism development is essential in order to conserve and maintain the biological richness of the area as well as economic upliftment of the local people. In addition, ecotourism can be defined as an opportunity to promote the values in the protected areas and to finance related stakeholders (Suryabhagavan *et al*., 2015; Knox *et al*., 2020). Over the past six decades, tourism has been steadily increasing worldwide. Tourism in Ethiopia has been critical for the national economy, and the results obtained in recent years confirm the growth trend (Berhanu *et al*., 2017; WTTC, 2021). In this context, the different types of sustainable tourism play a decisive role in projecting local identities and underpinning the economic development of many regions, particularly in the context of natural and protected areas.

Various researchers have attempted to draw a tourism business has a substantial impact on socioeconomic development and the growth of tourism-led economies from different study areas. (Berhanu *et al*., 2017; Azam *et al*., 2018; Ghorbanzadeh *et al*., 2019). Tourism contributes significantly by developing micro, small-scale, and medium-scale firms for the making of goods and services, creating significant employment opportunities, encouraging sustainable development, and alleviating poverty. Tourism has a significant role in accelerating development and reducing poverty, which is a major enemy of developing countries, and its impact is comparable to that of other major economic and social sectors. According to WTTC 2012, global tourism increased by 3.9% in 2018 and contributed $8.8 trillion to the global economy (Knox, Crawford, and Young 2020). In the first nine months of 2022, international tourism performed well, with arrivals reaching 63% of pre-pandemic levels (UNWTO, 2022).

Ecotourism has recently emerged as a driving factor for economic progress all over the world. It makes a significant contribution to economic growth, the creation of skilled and semi-skilled jobs, higher export returns, foreign investment, and the economic well-being and social stability of the local population (Ceballos-Lascurain, 1996; World Tourism, 2000). Ecotourism has the potential

to combine environmental responsibility with economic gains. It can be viewed as both a foundation for economic development and a motivator for environmental protection (Daily, 1997; Wilkie and Carpenter, 1999; Wilks and Moore, 2004).

Ecotourism, in addition to safeguarding the environment, can provide prospects for economic benefit to local communities (Gigovic *et al*., 2016). Local communities can increase their quality of life by engaging in various economic activities related to ecotourism (Hunt *et al*., 2015). As a result, some authors have proposed that ecotourism aims can only be met with effective planning and participation of the local population in management processes (Wishitemi *et al*., 2015; Ghorbanzadeh *et al*., 2019).

The growth of the tourism industry has raised household income and foreign exchange income, as well as improved the rural economy's prosperity (WTTC, 2012). Because the tourism sector is devoid of many limitations in various places of the world, it has been widely pursued globally (Telfer and Sharpley, 2015). According to STMP (2015), Ethiopia's tourism ambition of becoming one of Africa's top five tourist destinations by 2025. Ethiopia has experienced exceptional tourism growth in recent years as a result of major economic changes. Since the 1990s, international visitor visits have been steadily increasing, going from 64,000 in 1990 to 681,249 in 2013. This has been matched by an increase in the direct contribution of the travel and tourism sector to the country's GDP, which was 4.2% in 2013, equivalent to ETB 35,766.6m, and is predicted to expand by 4.8% per year, reaching ETB 59,495.2m (3.6% of GDP) by 2024.

Ethiopia’s sustainable tourism master plan (2015), has set a high growth objective of 5 million foreign tourists in 2025. Based on this high growth scenario, international arrivals are expected to increase from ETB 14.197 billion in 2012 to ETB 180 billion in 2025, with a corresponding increase in tourism-related jobs from 985,500 to 4.8 million. The master plan comprises ten strategic pillars to ensure that this growth is competitive and sustainable. The three pillars namely Investment in Tourism Facilities and Services, Tourism Support Infrastructure and Services, and Conservation and Preservation of Natural and Cultural Resources. Are related to ecotourism potential.

The Geographical Information System (GIS) has emerged as one of the most significant technological advancements for the planning and decision-making process regarding a potential tourist destination. Effective ecotourism development needs the fulfilment of some requirements. The study area still does not benefit as it is expected from the sector because of factors that hinder the development of ecotourism as compared to its potential. To address the characteristics of ecotourism in a region and identify ideal ecotourism places, it is necessary to use location-based systems such as GIS, which is known as the most efficient technology for spatial modelling and analysis (Longley *et al*., 2015). Researchers have recently used GIS to combine multiple methods and strategies in the zoning of ecotourism potential (Gigovic *et al*., 2016). This capability enables GIS to be used as a fast tool for finding suitable zones for ecotourism development (Ronizi *et al*., 2020). This capability leads to the application of GIS in ecotourism as a decision-making tool for planning sustainable tourism, enabling evaluation, managing tourist movement, and selecting appropriate tourism destinations. As a result, this technique has been widely used in the tourism sector. (Jokar *et al*., 2020). Furthermore, using a separate GIS-MCDA technique identifies places with potential for various environmental goals such as urban planning, susceptibility assessment for natural hazards, tourism sustainability study, and so on (Ronizi *et al*., 2020).

The study on the potential ecotourism site is essential to identify the possible future tourism investment in Bahir Dar and its surrounding areas. The assessment of the sits can help to expand the tourism destination sites of Bahir Dar city and distribute the load of tourists at the outskirts of the city. It is evident from the recent review of literature that no research work has been directed towards the study of the ecotourism potential assessment in study areas. The aim of this study is to explore the capability of AHP and GIS technique for identify potential ecotourism sites in Bahir Dar and its surroundings, Ethiopia. This is also an additional benefit achieved by integrating geo-scientific aspects in the land-use decision process and this area, having plenty of tourist attractions, could be a source for both domestic and foreign tourists. Thus, this is a crucial and pioneer work in this field of study, and it should be used as an ideal blueprint for ecotourism planner for ecotourism site development.

1.2 Statement of the problem

When we think of tourism, we typically envision people visiting a certain location for the purpose of sightseeing, visiting friends and relatives, enjoying a holiday, and having a nice time. They may spend their free time participating in various sports, conversing, singing, riding, sightseeing, reading, or simply relaxing. If we think about it further, we may include in our definition of tourism individuals who attend a convention, a business conference, or some other type of commercial or professional activity, as well as those who go on a study tour with an experienced guide or do scientific research or study. Ecotourism probably had its foundations in the ethics of conservation, but its recent surge has certainly been due to its economic benefits as developing countries begin to recognize that nature-based tourism offers a means of earning money with relatively little exploitation or extraction of resources.

Tourism can be the key to many worldwide solutions for challenges such as climate change, poverty reduction, and waste reduction, as well as protecting environment and transitioning the world to a more sustainable planet, which many individuals in the sector are unaware of. As a result, the concept of sustainable tourism has received more attention in recent years. (Safran, 2015). According to UNWTO and the International Transport Forum (ITF) report issued in December 2019, the tourism sector is expected to raise CO_2 emissions by at least 25% by 2030. (UNWTO and ITF, 2019). Aligning tourism operations with climate action is critical if the sector is to meet international goals (UNWTO, 2021).

The tourism business is critical to the development of any country; it helps countries increase economic growth, attracts more visitors, increases foreign investment, and so on. However, tourism development has a severe impact on the environment, causing soil erosion, air and water pollution, deforestation, and other problems. Ecotourism, on the other hand, is a solution to these detrimental effects. For a long time, the locations around Lake Tana have been popular destinations for travellers visiting Bahir Dar. The tourism sector in Bahir Dar and its surrounding areas, as well as its impact on the environment and cultural components, as well as the benefits of eco-tourism, have not been thoroughly researched in order to build eco-friendly tourist destinations. There is a study concern in identifying other tourist destination places that are not typical tourism emphasis areas. That is what ecotourism is all about. As a result, there is a research gap in addressing the problem of ecotourism sits. This study attempts to assess the ecotourism potential of Bahir Dar

and its surrounding area by applying GIS using AHP method. Therefore, this is important for making well-informed choices on management regimes for planners and decision-makers that can ensure the sustainability of environment and develop ecotourism destination sites.

1.3 Research objectives

1.3.1 General objectives

The main objective of this study is to explore the potential of ecotourism using Geographic Information Systems (GIS) and Analytical Hierarchy Process (AHP) methods for planning resources relevant to ecotourism development in Bahir Dar and its surroundings.

1.3.2 Specific objectives

The specific objectives of this research are as listed below:

- To evaluate ecotourism resources including land-use/land-cover, natural and cultural resources and tourist's facilities in and around Bahir Dar town and its surroundings, using GIS and AHP method.
- To identify the main ecotourism sites and to map the area, that is attractive by its nature in relation to ecotourism resources in the study area.
- To analyse changes in strategies could be used to strengthen the tourism-environment-community relationships at the destination.

1.4 Research questions

Based on the stated objectives, the following questions were used to guide the research process and answer from the findings of the study.

- Which areas are the possible ecotourism sites in and around Bahir Dar town?
- Are they mapped well for decision making?
- Are there any possible changes in strategies to strengthen tourism and community?

1.5 Scope of the study

The present study mainly deals with the ecotourism areas to map in Bahir Dar town and its surroundings. This study attempted to assess the ecotourism potential and map the potential sites. Ecotourism development is a broad topic, including every aspect of it in this thesis would be impossible. Therefore, the study was limited to assessment of ecotourism potential areas, mapping

the potential sites and contribution of ecotourism development planning in Bahir Dar town and its surrounding, Ethiopia. The result and the conclusion are drawn only form AHP and GIS methods used.

1.6 Significance of the study

The use of satellite data advanced techniques such as Remote sensing (RS) and Geographic Information System (GIS) can assist for ecotourism resources to map in detail in the study area. The finding of this study is expected to have contribution by showing ecotourism resources of the study area for all concerned bodies and stake holders. In addition to this the study bridges the gap which exists between the potential and actual ecotourism development in the study area by using GIS and AHP method. Furthermore, there are few researches in the area on tourism destination areas in general. Ecotourism potential assessment makes the study unique from other studies which are conducted in the area. Moreover, it may be helpful for researchers to support the effective participation and involvement of local communities in the development, operation and monitoring of ecotourism activities on natural resources. The methods and approaches developed will have wider application within and outside the country.

1.7 Limitation

The limitation of the study were Analytical Hierarchy Process (AHP) method is used for site selection, no comparison of other methods is used for the study and only one site selection criteria are applied.

1.8 Organization of the thesis

This study is organized into five chapters: chapter one is introduction, where the background, statement of the problem, objectives of the study, research questions, significance of the study a discussed. In the chapter two review of related literatures is presented. Chapter three provides an overall description of study area in terms of location, topography, and climate. This section also elaborates the source of data and software used and methodologies applied to achieve the desired objectives with details of the relevant parameters. In the fourth chapter, results and discussion are provided. Finally, in section; five, conclusion and recommendations and suggestions for further research work in the study area are provided.

Chapter two

Literature Review

2.1 Tourism

Travel is as old as mankind. Man, first explored the earth's surface in search of food, housing, security, and a better place to live. World Tourism Organization defines, Tourism is a social, cultural, and economic phenomenon that involves individuals traveling to nations or locations beyond their typical environment for personal or business/professional reasons. These people are known as visitors (tourists or excursionists; residents or non-residents), and tourism refers to their activities, some of which entail tourism expenditure (UNWTO, 2022).

2.1.1 Determinants of tourism destination

The competitiveness of a destination is defined as a country's ability to create added value and thus increase national wealth by managing assets and processes, attractiveness, aggressiveness, and proximity, and thus integrating these relationships within an economic and social model that takes into account a destination's natural capital and its preservation for future generations (Ritchie & Crouch, 2003). According to Ritchie and Crouch, the competitiveness of a tourism destination is determined by two factors: its resource endowments (assets) and its resource deployment (ability to use them) and thus transform them into an offer of tourism goods and services. It is widely accepted that a destination is a complex adaptive system that may be understood as a network of connected stakeholders directly or indirectly associated to tourism, the activity of which is critical for the proper operation of the destination system (Boniface and Cooper, 2009; Baggio, 2008).

2.1.2 Types of tourism

The World Tourism Organization specifies three primary forms of tourism in its glossary, according to the UNWTO.

Domestic Tourism: these are the activities carried out by a person within their country of residence as part of a touristic trip.

Inbound Tourism: carried out by a non-resident tourist in the destination as part of a touristic trip.

Outbound Tourism: tourism activities undertaken outside the country of residence.

There are many different types of travel motives (the reasons why individuals travel), but for inclusion in this study, they are classified based on their purpose of excursion. Table 2.1 present

the types of tourism for different requirements and desires, implying that there is a specific type of tourism for a given market segment.

Table 2.1 Types of tourism.

Type of tourism	Definition
Adventure tourism	Type of tourism, which is popular among those, who are looking for exciting activities
Beach tourism	A tourist travels to a beach for leisure, recreational or business purposes.
Birth tourism	Traveling to another country, in order to give a birth to a kid there.
Business tourism	Traveling to another place due to the business meeting, conference, training etc.
Celebrity tourism	Tourists visit places where a celebrity currently lives or has lived.
Culinary tourism	Traveling outside of your residence to another region/city/country, in order to taste local food.
Cultural tourism	Type of tourism, in which tourists visit cultural places of the specific place.
Dark tourism	Tourism, in which one visits places of dark past.
Doom tourism	Visiting the places, which are under the threat.
Drug tourism	Traveling to places, in order to purchase and consume drugs.
Ecotourism	Tourism, which attracts visitors with the beauty of nature, preservation of the environment and culture.
Educational tourism	It's the journey undertaken by a person to leave his hometown or country for educational or learning purposes.
Genealogy tourism	One visits various countries, where his/her ancestors lived.
Medical tourism	Traveling to another city/country for medical purposes.
Mountain tourism	Activity which takes place in hills or mountains that are inherent to a specific landscape, topography, climate, biodiversity (flora and fauna) and local community.
Nautical tourism	Merging holidays with in-water activities.
Religious tourism	Type of tourism, where one visits various countries due to the religious reason.
Rural tourism	A tourist spends leisure time in rural areas or villages.
Sex tourism	Traveling to another destination, in order to purchase sex.
Slum tourism	Traveling to the places, where people live in poverty.
Space tourism	Traveling to space.
Sports tourism	Tourism, in which one travels to another destination due to the athletic reasons.
Virtual tourism	Traveling to various places through technology.
War tourism	Traveling to the former/current war cities or countries.
Wellness tourism	Type of tourism, in which one travels due to the recreational reasons.

Source: Vacayholics, 2018, UNWTO, 2021 and Ruma, 2022

2.2 Ecotourism

The International Society for Ecotourism (TIES) defines ecotourism as "responsible travel in natural environments that maintains the environment and promotes local communities, integrating interpretation and teaching" (What Is Ecotourism, 2022). Ecotourism allows visitors to learn about nature and local culture; it follows the principles of sustainable tourism in social, economic, and environmental aspects; and it stresses education and environmental stewardship (Pleșoianu *et al*., 2018; Pavlidis *et al*., 2022).

The World Tourism Organization defines ecotourism as "all forms of nature-based tourism in which the main activities refer to the observation of it and the local culture in the immediate vicinity of the protected areas; educational and nature interpretation activities; activities with minimal negative impact on the natural and sociocultural environment, carried out in small groups; and activities that support the conservation of biodiversity and the environment" (World Tourism Organization Ecotourism and Protected Areas, 2022).

To safeguard ecosystems and biodiversity, as well as to conserve protected plant and animal species, tourism infrastructure and activities are essential. As a result, it is also vital to create nature tourism or ecotourism through activities that safeguard and regenerate natural functions, while also considering communities and local carrying capacity (Ardika, 2018). Ecotourism is a sort of environmentally friendly tourism whose major purpose is to recognize the importance of nature and its preservation through touristic socioeconomic activities (Ceballos, 1996). To get to the point, Ecotourism fosters moral responsibility for the environment and the well-being of local residents. Ecotourism is recognized to have several subtypes, including:

2.2.1 Principles of Ecotourism

Ecotourism, according to the International Ecotourism Society, is about bringing together conservation, communities, and sustainable travel. This means that those who implement, engage in, and sell ecotourism activities should adhere to the ecotourism principles outlined below.

- Reduce the physical, social, behavioural, and psychological consequences.
- Increase cultural and environmental knowledge and respect.
- Ensure that both guests and hosts have a great experience.
- Create, build, and operate low-impact facilities.

- Recognize the rights and spiritual beliefs of Indigenous Peoples in your community and engage with them to empower them.
- Provide immediate monetary advantages to conservation.
- Provide financial benefits to both local residents and private industry.
- Provide guests with meaningful interpretive encounters that assist raise sensitivity to the host. countries' political, environmental, and social climates.

2.2.2 Ecotourism and sustainable development goals

Boluk *et al*. 2017 advocated for a critical thinking system approach inside the global tourism system in order to assure sustainability. Tourism plays an important role in the economies of many developing nations, particularly in Africa; thus, any issues confronting the industry must be addressed in order for Africa to capitalize on the opportunities presented by the integration of SDGs (Dube and Nhamo, 2018). Trust, justice, social capital, power, and participation have not been fully instilled in sustainable tourist governance frameworks. (Siakwah *et al.*, 2019). Tourism has been recognized for its potential to help accomplish many of the 17 Sustainable Development Goals (SDGs), particularly in the areas of employment creation, sustainable consumption and production, and natural resource protection. Three of the SDGs particularly reference and call on the tourism sector to deliver on: (Romeo *et* al., 2021)

SDG 8, Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

"*By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products*". Tourism is one of the driving forces behind global economic growth, accounting for one out of every eleven employments worldwide. Society, particularly youth and women, can achieve Target 8.9 by providing access to excellent employment opportunities in the tourism sector.

SDG 12, **Ensure sustainable consumption and production patterns**

"*Develop and implement tools to monitor sustainable development impacts for sustainable tourism which creates jobs, promotes local culture and products*". A tourism sector that adopts sustainable consumption and production practices can play a significant role in accelerating the global shift towards sustainability. To do so, as set in Target 12.b.

SDG 14, Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

"*By 2030 increase the economic benefits to SIDS and LDCs from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism*".

Coastal and maritime tourism, tourism's biggest segments, particularly for Small Island Developing States' (SIDS), rely on healthy marine ecosystems. Tourism development must be a part of Integrated Coastal Zone Management in order to help conserve and preserve fragile marine ecosystems and serve as a vehicle to promote a blue economy, in line with Target 14.7. (Romeo, *et al*., 2021)

Due to the scale of the work that must be completed by 2030 and the priority connected to achieving the SDGs, there has been an increase in calls from renowned academics for the tourist sector to take immediate action to address and embrace the SDGs. (Scheyvens, 2018; Hall, 2019).

2.2.3 Sustainable ecotourism

Sustainable development is defined as meeting current demands without damaging or jeopardizing future needs (Missimer, 2017; Koirala, *et al*., 2019). Elkington (1998) also introduced the notion of "triple bottom line" for the first time. According to this notion, a sustainable society should have measurable environmental, economic, and social impact goals.

The tourism industry, and tourist behavior in particular, is extremely susceptible to disaster events, which can be divided into natural disasters, such as earthquakes, and manmade disasters for example, terrorist attacks (Ma *et al*., 2020). While pandemics such as COVID-19 can be considered natural disasters, they should be analyzed as a specific typology due to their dramatic impact on tourism activity (Moya Calderón *et al*., 2021; Villace -Molinero *et al*., 2021; Zenker *et al*., 2021), giving rise to many and relevant constraints in many countries, including mobility re- strictions, social distancing, and limited access to ser- vices and infrastructures. Under these circumstances, this paper considers it necessary to revisit the study of a topic that has received great attention in tourism research: tourist loyalty formation (Kim, 2018).

In particular, together with the antecedents most widely examined in literature, several pandemic related risks are expected to play an important role in loyalty formation. Loyalty, generally defined as the individual's commitment to a product or brand (Oliver, 1997), is usually

operationalized in tourism research as the intention to revisit a tourist destination in the future and the intention to recommend it to other people such as friends and relatives (Kim, 2018; Lee *et al*., 2011; Prayag and Ryan, 2012). According to Keyser (2002), there are three significant features that characterize sustainable tourism: quality, continuity, and balance.

- **Balance** - Sustainable tourism balances the demands of the tourism sector, environmental advocates, and the local population. It fosters cooperation among visitors, host communities, and destinations by emphasizing the achievement of shared goals.
- **Quality** - Sustainable tourism provides guests with high-quality experiences while also increasing the host community's quality of life and conserving the environment's quality.
- **Continuity** - Sustainable tourism ensures the survival of the natural resources on which it is founded, as well as the survival of the host people' cultures.

2.3 Remote sensing and tourism

The functionalities of GIS require inputs from different knowledge fields: computer engineering, network engineering, communication technology, application areas and methods, and end-product use (Burrough *et al*. 2015; Krumm *et al*., 2013). In a GIS system, the real-world features are represented using four cartographic data elements (Van Kreveld 2017; Yao and Li 2018) in two data models: vector data model representing Earth features as points, lines, and polygons and raster data model representing grid cell feature classes (Lena 2007; Lwin *et al*., 2012). The design of such data models supports thematic mapping, map analysis, tabular data processing, and automated cartography (Burrough 2001), all of which are represented in space as a set of features with locational and attribute data.

Satellite images with high resolution provide great options for assessing landscape change patterns, such as forest cover change at a structural scale (Wulder *et al*. 2008). In urban setting, remote sensing image analysis is useful in planning new infrastructure based on current and predicted future land cover and land use change patterns (Mahmoud and Ahmad 2013). Remote sensing methods, on the other hand, have been used to categorize landscape component types at an ecological scale relevant for wildlife and tourism management. (Keller and Smith 2014). The technique of image analysis is used to extract meaningful information from satellite imagery, using two approaches: image processing and pattern recognition (Blaschke 2010; Koprowski 2017). Real-world objects and features are represented in satellite photos by radiometric signatures that

can be classified based on their digital value clusters (Lu and Weng, 2007). Land use is the most visible of all environmental changes, and the analysis can be used to analyze any changes in ecosystems. (Vinodhini *et al*., 2016)

2.4 GIS and tourism

Geographical Information System (GIS) could be effective for tourism information management systems, tourism decision support systems, visitor impact assessment, tourism facility inventory studies, and tourism-based land management, according to Giles (2004). GIS is widely used in the industrialized world, while its application is relatively uncommon in the developing world (Tim and Martin, 1999; Raghuvanshi *et al*., 2006; Gross and Brown, 2008; Kalavar *et al*., 2014).

Tourism is becoming a frontline service sector that incorporates new technical expertise into strategic, marketing, and planning activities (Phillips and Moutinho, 2014; Buhalis, *et al*., 2019). GIS has been effectively used to handle the challenges of preconstruction planning and to enable a wide range of spatial analyses employed in the logistics viewpoint of construction activities. (Karan *et al*., 2016). GIS are distinct in that they emphasize providing users with a representation of objects in a cartographically accurate spatial system as well as aiding analysis and decision-making (Mennecke and Brian, 2000). They are intended to collect data about the globe, to make that data easy to view, analyze, and distribute, and to support a wide range of modeling and theory-building. (Longley *et al*., 2015).

Geographic information systems (GIS) and remote sensing methods are frequently utilized for determining location suitability and resource inventories based on environmental, socioeconomic, and spatial planning considerations (Jankowski and Richard, 1994; Malczewski, 2006, Charabi and Gastli, 2011; Gigović *et al*., 2016). GIS suitability mapping requires the use of several data sources with weights assigned to assess the importance of specific criteria (Janke, 2010; Bunruamkaew and Murayam, 2011; Al-Yahyai *et al*., 2012). Many experts have used multicriteria decision analysis (MCDA) or multicriteria decision making approach (MCDMA) in recent years to comprehensively analyze the feasibility of a certain land location for various uses, e.g., flooding prevention (Fernández and Lutz, 2010), A few efforts were also made to assess the possibility of ecotourism. (Bunruamkaew and Murayam, 2011; Koschke *et al*., 2012; Gigović *et al*., 2016; Jeong *et al*., 2016; Fang, 2017; Çetinkaya *et al*., 2018).

Geographic information system (GIS) uses and utilization areas are expanding on a daily basis due to the ease of storing, updating, grouping, analysing, correlating, and mapping data about evaluation factors in planning studies, as well as having a relatively low error margin depending on the accuracy of data stored. In reality, GIS is employed in tourism terrain planning for visualization as well as numerous analyses (Aklıbaşında, 2013). Historical information and treasures concerning culture, landscape, customs and traditions, and architectural monuments provided by GIS applications are critical for municipalities' efficient management of planning procedures such as landscape planning, project planning, and regional development (Zgura *et al*, 2012). That's why GIS and management-based ecotourism planning for a sustainable future has been discussed in this paper.

2.4.1 Site selection

When doing site selection analysis for diverse application demands, numerous criteria are analysed in the GIS environment at the same time. The goal of GIS-based site selection study is to identify potential locations for various facility activities. These assessments indicate not only the suitability of the site, but also the degree of suitability level (Ustaoglu and Aydınoglu, 2020a). Any site selection study process utilizing GIS-based MCDA methodologies can be broken down into five interconnected parts. (Suleyman, *et al*., 2021) These are;

First step, the criteria for the relevant site selection problem are established. The criteria are based on a review of the literature and expert opinion.

Second step, geographic and non-geographical data for the required criteria are acquired from public and private-sector databases, as well as open data portals.

Third step, criterion weights are determined, which represent the relative importance of the defined criteria. In GIS-based site selection studies, various MCDA approaches are frequently employed to derive criterion weights.

Fourth step, a GIS-based analysis implementation model is designed for the relevant site selection study.

Fifth step, the designed analysis models are run and a site selection suitability map is produced. Using the suitability maps produced, alternative areas are evaluated with a GIS perspective.

The employment of MCDA methodologies in conjunction with GIS can be viewed as a process that converts and associates geographical data and decision-makers' preferences to reach final knowledge in the decision-making process (Malczewski, 2007; Malczewski and Rinner, 2015). On the other hand, there are numerous MCDA methods available today., Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), Best Worst Method (BWM), Preference Ranking Organization Method for Enrichment of Evaluations are some of the methods that are commonly used (PROMETHEE), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), and Weighted Linear Combination (WLC).

Because of its flexibility, Saaty's (1980) AHP technique has been the most used method for criterion weighting in site selection studies. The key challenge in applying the AHP approach is defining the main criteria groups that are consistent with a purpose, as well as the sub-criteria related to these categories in a hierarchical structure. The AHP approach is based on a pair-wise comparison process and certain mathematical computations to improve preference scales among alternative decisions (Ustaoglu and Aydinoglu, 2020b). The AHP method is applicable to many groups of decision characters and can also be used in stakeholder analysis (Ramanathan, 2001; Taibi and Atmani 2017).

2.5 Ecotourism in Ethiopia

Tourism also plays a significant role to the economic development of many developing countries including Ethiopia (Torres, *et al*., 2004). Ethiopia possesses unique and highly valuable ecotourism resources. The balance of historical, cultural, and environmental ecotourism attractions is essential to the country's future success. (Meseret, 2010; Israel *et al*., 2017). Ethiopia's travel and tourism industry has a bright future and has been steadily expanding in recent years. (Bayou *et al*., 2014 and Israel *et al*., 2017). It can also contribute for socio-cultural development and sustainable use of the environmental sources (Aynalem, 2016).

The country boasts beautiful landscapes and wildlife, a diverse culture and heritage, and ancient historical sites that are deteriorating. Ecotourism plays an important role in addressing conservation issues and providing alternative income sources for local populations (Lemenih, *et al*., 2009). Similarly, ecotourism development and significance in social, environmental and economic aspect is low compared to the neighbouring countries (Dejene *et al*., 2014). However,

Ethiopian ecotourism is still in its infancy, and the country has not reaped the greatest benefit from its resources (Eshetu, 2014). Ecotourism is underdeveloped due to a lack of infrastructure and service availability. The lack of proper research on ecotourism potentials, as well as the lack of diffusion of ecotourism concepts and practices, impede the effective and sustainable growth of ecotourism in Ethiopia (Gebreigziabiher, 2015; Birhan, *et al*., 2015).

2.6 Analytical Hierarchy Process (AHP)

Multi-Criteria Decision Making (MCDM) is a process that combines and transforms geographical data into a decision (Malczewski, 1999). When paired with GIS data, MCDM is a useful tool for systematically and thoroughly analysing a problem. Human value judgment, trade-off evaluations, and criterion importance assessments are the core components of a multi-criteria problem. However, criteria with GIS capabilities can be employed to reach a desired goal (Moldovanyi, 2003). The primary purpose of multi-criteria evaluation techniques is to explore a variety of alternatives in light of various criteria and competing objectives (Voogd, 1983).

AHP is a widely used method in MCDM and was introduced (Saaty, 1977; Saaty and Vargas, 2001). It is simple to apply as one of the MCDM approaches. AHP is a decision support tool that can be used to address complex decision problems. It employs a multilevel hierarchical framework of objectives, criteria, sub-criteria, and options. AHP is based on three principles:

- **Decomposition** of the overall goal (suitability), construction of a structural hierarchy consisting of a goal and subordinate features,
- **Evaluation** of the criteria, establishment of pair-wise comparative judgments between elements at each level and
- **Synthesis** of priorities through propagation of level-specific, local priorities to global priorities. (Arabinda, 2003; Baniya, 2008).

AHP also gives quantitative tools to evaluate judgment inconsistency to ensure the credibility of the relative significance utilized. Cheng and Li (2001) constructed a method of AHP with eight steps as the followings;

1. Cleary define the decision problem.
2. Defining the criteria relating to the decision problem: This is achieved through a number of literature reviews in the studied areas.

3. Setting up the decision hierarchy in which the first level of hierarchy represents goal in making decision: The second level displays main criteria. The third level are secondary criteria (optional as if the main criteria is not clear) and the last level are choices.
4. Data collection from experts.
5. Construct matrix to employ pair-wise comparison.

To compare factors, intensity of importance of each factor is required since factors are not equally important. Saaty (1980) set up fundamental scale with 9 levels of intensity as shown in Table 2.2 and Table 2.3.

Pairwise comparisons of all factors are done in matrix. The intensity of importance of each factor can be compared only for a pair over diagonal line.

6. Estimating relative weight of elements on each level in the hierarchy from model analysis.
7. Calculating the consistency ratio (CR) to completely measure the consistency in the pair-wise comparison.
8.List the rating results of each criterion to prioritize the criteria.

Table 2.2. Random Index.

Matrix size	Random consistency Index (RI)
1	0.00
2	0.00
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49

Source: (Saaty 1980)

To communicate individual preferences or judgments, AHP employs a fundamental scale of absolute numbers (Table 2.3). This scale has a total of nine points. In general, nine things are the maximum that an individual can compare and consistently rank at the same time. The differential

scoring score assumes that the row criterion is as important as or more important than the column criterion. Where the row criterion is less relevant than the column criterion, the reciprocal values (1/3, 1/5, 1/7, 1/9) have been used.

Table 2.3. The preference scale for pair wise comparison.

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

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

2.6.1 Assigning weight to factors

AHP was used to determine the weight value for each criterion. It employed pairwise technique using consistency ratio index as a basis of acceptability (Saaty, 1980). In the study regions, the output of the pairwise comparison matrix and the computation of the consistency ratio are provided. The method used by numerous authors was used to construct the land suitability map for ecotourism (Bunruamkaew *et al*., 2011). Each factor was classified, and their suitability ratings were reported in a structured manner, namely four suitability classifications; Not suitable, less suitable, moderate suitable, and high suitable and 1 (Not suitable) to 4 (high appropriate). The entire compatibility score from each category was added together to create an ecotourism site

suitability map. The natural spectrum framework outlined below was used to divide the terrain into four appropriateness classes (Wu *et al*., 2015):

- **Not suitable class**: It indicates a land relatively low landscape that is not suitable for developing ecotourism. Mostly agricultural and settlements areas.
- **Less suitable class**: It is an intermediate level between the not suitable and moderate suitable classes.
- **Moderate suitable class**: It indicates a land of moderate landscape that may optimize the existing ecotourism resources to properly develop ecotourism.
- **Highly suitable class**: It denotes a high-landscape area appropriate for promoting ecotourism, which must conform to strong environmental restrictions.

As tourism becomes an increasingly important sector of the world economy, tourism related research can be expected to expand in both magnitude and scope as a critical supporting function for tourism industry (Baker *et al*., 1993).

Chapter Three

Material and Methods

3.1 Description of Study Area

3.1.1 Location and description

Bahir Dar is located 563 km by Bure and 460 km via Motta from Addis Abeba, the capital city. Dejazmach Belay Zeleke Airport is 8 kms from Bahir Dar city. Since 1993, the city has served as the capital city of the Amhara National Regional State. The study area geographically its absolute location extends between the coordinates of 11º 30' 11" - 11º 58' 11" N latitude and 37º 2' 2" - 37º 29' 4" E longitude. Lake Tana borders Bahir Dar to the north (Figure 3.1). It has a total area of 1073.53 km^2, of which 243.08 km^2 island (215.57 km^2 was an area of Bahir Dar city, whereas 27.41 and 0.09 km^2 was the area of Deq and Kibran Gebriel Islands, respectively).

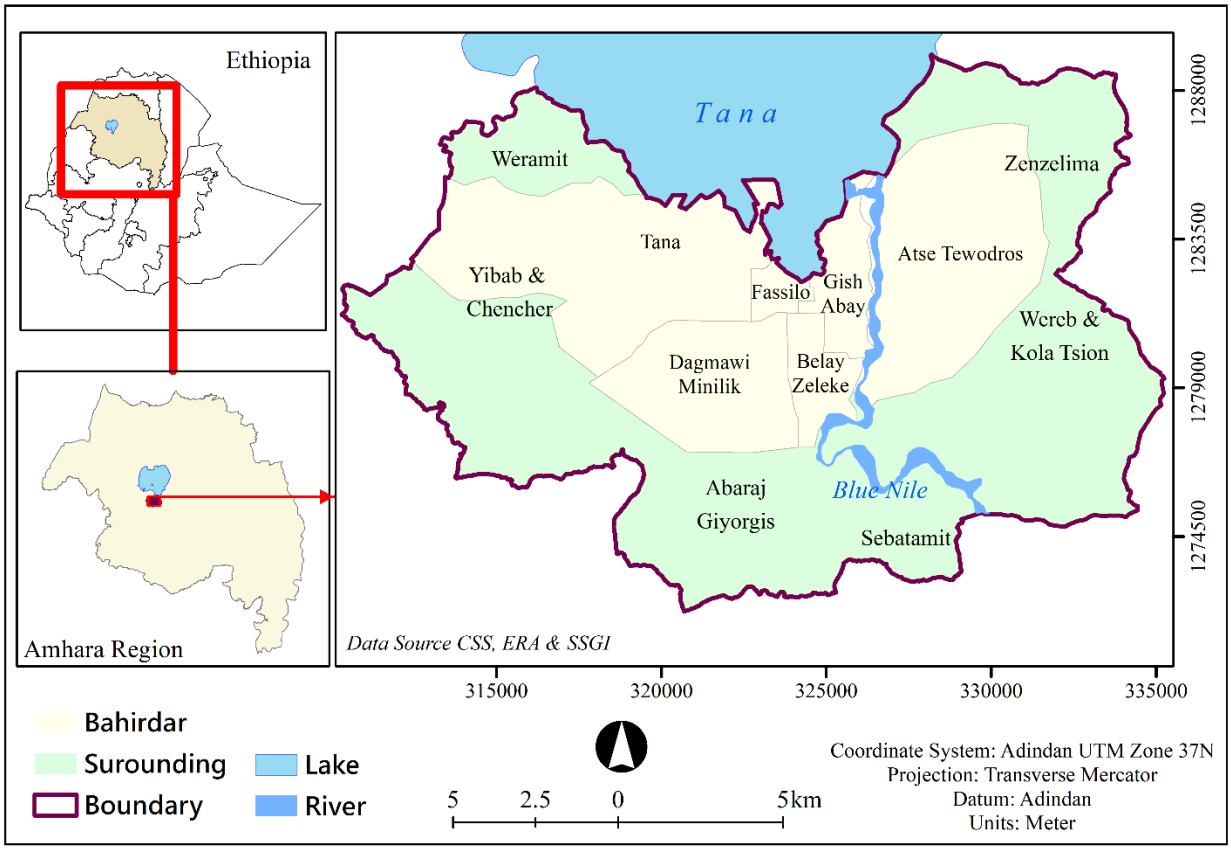


Figure 3.1. Location map of the study area.

Bahir Dar and its surrounding area's altitude ranges from 1,717 m in the southeast to 2034 m in the city's eastern and western outskirts. The topography of Bahir Dar city and its surroundings is

relatively flat though some places in the southeast direction are characterized by deep river gorge and escarpment in northeast and west. Given the overall position of the city, it is now one of the safest, most beautiful, well-planned, and leading tourist destinations in Ethiopia. Because of its strategic geographic location, the city also acts as a transit to the old historical cities of Gondar, Lalibela, Axum, and the Semien mountains by road and air transportation. Since 2015, the Lake Tana region has been designated a UNESCO Biosphere Reserve.

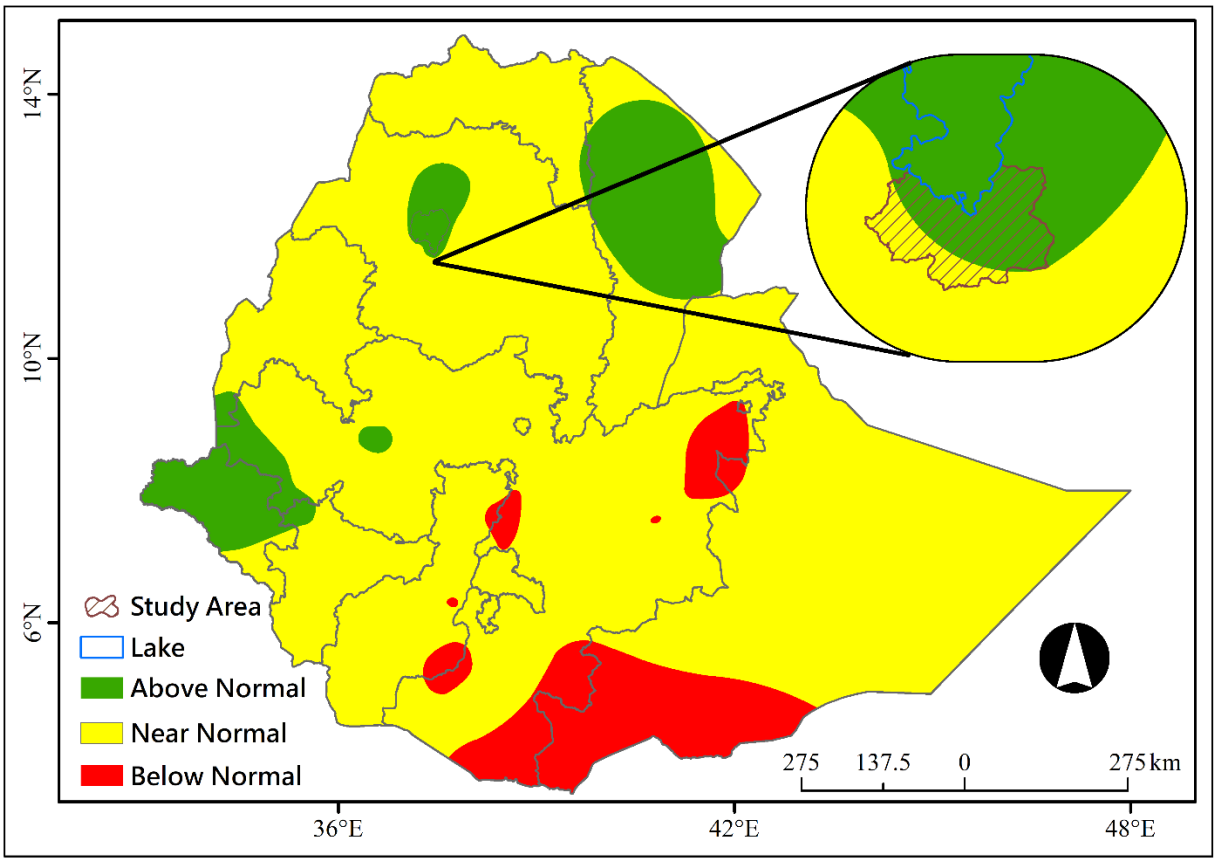
According to the Bahir Dar City Administration, Bahir Dar was established during the 13th century and, like the rest of Ethiopia, was ruled by representatives of the newly formed Solomonic dynasty from Lake Tana and its surrounds. The city's historical development began around the 14th century, with the establishment of Kidanemihret church on the current sites of St. Georegis church. Because of its proximity to Lake Tana and the Abay River, it was titled Bahir Dar, which means "near the sea," during the reign of Emperor Yikunoamlak. The city lies in the country's north western corner (Bahir Dar City Administration, 2021)

3.1.2 Demography

Regarding demography of Bahir Dar and its surroundings, Bahir Dar city administration official website states the population of the city is 356,757. According to the Ethiopian statistics service population projection the population of Bahir Dar zuriya is 214,691 (ESS, 2019). The population density is estimated at 0.12 per hectare. Ethiopian Orthodox Christianity is the most widely practiced religion in Bahir Dar, followed by Islam. Protestants and Catholics make up small proportion of the population. Other traditional religions, like as Judaism, are practiced by minority tribes surrounding Lake Tana. The Amhara are the majority ethnic group in Bahir Dar (96.23%). Tigrayans, Oromo, and various indigenous communities are among the other ethnic groupings (Typical Ethiopia, 2021).

3.1.3 Climate

Regarding rainfall the annual total rainfall amount for 2021 exceeded 1500 mm in the country's northwest, western, and southern regions. The yearly total rainfall quantity, on the other hand, was less than 500 mm over much of Afar and the southern and southeaster parts of Somalia. According to Ethiopian meteorological institute annual climate bulletin Bahir Dar has 1909.3 mm annual rainfall amount (EMI, 2021).



Source: (EMI, 2021).

Figure 3.2. Percent of normal rainfall for the year 2021.

In most areas of the country, rainfall activity in 2021 was near normal. Northern Afar, Gambella and neighbouring Oromia locations, as well as other parts of Oromia and Amahara, saw above-average rainfall. Rainfall is scarce in regions of south Oromia and Somali regions, as well as in other parts of Oromia (EMI, 2021). As illustrated above in figure 3.2 Bahir Dar and its surround fall under near normal and above normal rainfall the heavy fall was on July, 79.8 mm.

About temperature Bahir Dar and its outskirts are warm all year, with hot temperatures even on rainy days. The hot season lasts from February through May, with temperatures reaching 38 degrees Celsius in April and May. From July until September is the chilly season. Temperatures can drop as low as 5 degrees Celsius during this time of year, with August being the coldest month. Bahir Dar and its environs receive ample rainfall. May to September is the wet season. The rainiest months are July and August. (Typical Ethiopia, 2021; EMI, 2021).

3.1.4 Tourism

Bahir Dar and its surroundings are blessed with beautiful natural attractions popular tourist destinations in Ethiopia. After Addis Ababa and Dire Dawa, Bahir Dar is Ethiopia's third largest city. This bustling city is well-kept and clean, with a friendly atmosphere. Bahir Dar and its surroundings are well-known for their historic monasteries, the Blue Nile Falls, endearing lodges and Lake Tana. The scenery is breath taking, and the weather is mild all year. As a well-known tourist destination, Bahir Dar and its surroundings offer a variety of activities to keep visitors entertained throughout their stay. Bahir Dar serves as a gateway to 30 centuries-old monasteries. (Typical Ethiopia, 2021) Bahir Dar is undoubtedly the cleanest Ethiopian city and is recognized as one of the most beautiful cities in the country, particularly for its magnificent palm tree-lined avenues. Among the best tourist sites found in and around Bahir Dar and its surrounding Lake Tana and Island monasteries are most visited.

Lake Tana

Lake Tana, Ethiopia's largest lake, is 84 kilometres long and 65 kilometres wide at its widest point. The lake's colour changes depending on the season, from muddy green to clear to copper tan. The slow-moving lake, which comprises 37 islands, is the main source of the Blue Nile. The majority of the islands have medieval monasteries and churches. The lake is home to a variety of fish species, over 200 bird species, and hippopotamuses. It has 20 endemic fish species that are threatened by the fishing industry. The lake is threatened by habitat loss, exotic plants, and deforestation. To meet these issues, many measures are being pursued, and this magnificent lake is protected by the Lake Tana Biosphere Reserve.

Monasteries

On Lake Tana's islands and peninsulas, there are approximately 30 historical and religiously significant monasteries and orthodox churches. These monasteries were founded during the period when Christianity was introduced to the area. They are typically O-shaped, with vibrant paintings depicting biblical histories on the walls. Some are linked to museums that exhibit spiritual writings, handcrafted products, and crowns. Some monasteries are gender-specific. This study area includes Kibran Gebreal Monastery and Entons Iyesus Andinet Monastery.

Emperor Haile Selassie palace

Mount Bezawit is a forested peak located 7 kilometres from the city centre. Here is the former palace of Emperor Haile Selassie (Bezawit Haile Selassie palace). The mountain is covered in landscaped gardens. A panoramic view of Bahir Dar City may indeed be seen at the end of the mountain road. It is also an excellent chance to understand about the Blue Nile's origins in Lake Tana.

3.2 Data acquisition

3.2.1 Satellite image

Copernicus data hub was used to obtain a Sentinel 10 m resolution 12,2022 imagery. Using ERDAS Imagine 14, satellite image of the area was corrected and processed to create the thematic map, land-use and land-cover map for identifying ecotourism potential areas and attractive sites. As it shown in (Table 3.1) for this research the data sources are from opensource ALOSPALSAR, tourist maps, topographic map and orthophoto are obtained from organizations. The secondary sources of data were collected from different secondary data sources such as, report documents, various registers and publications like books, journals, research reports, papers, magazines, internet materials and official documents of the sector which is used to supplement the information gathered from many sources. Bahir Dar town and Bahir Dar Zuria wereda culture and tourism bureaus and Heritage Protection Authority is providing the researcher with broachers and maps which are important for the study.

Table 3.1 List of data sources.

Data	Format	Source	Purpose
Ortho-photo (25cm x 25cm resolution)	.tif	Space Science & Geospatial Institute	Feature extraction
Tourist/Topography map	.tif	Space Science & Geospatial Institute	Data extraction
Satellite image	.tif	Sentinel	Land-use/land-cover
Ground Control Points	.shp	Field visit	Accuracy assessment
Digital Elevation Model	.tif	ALOSPALSAR	Slope and Elevation

3.2.2 Image classification

Image classification is a technique of extracting information from image based on the reflectance value of an object (Gao, 2009; Lillesand *et al*., 2004; Richards and Jia, 2006). The information class in the image can be grouped into a thematic layer of similar LULC. Despite the availability of automatic image classification algorithms, human or visual image interpretation procedures were employed. This is due to a pixel mixing issue, which has adversely impacted the study's land-use and land-cover classification accuracy. Google Earth and aerial photographs were used to improve visual image interpretation and preserve classification accuracy. Thus, image digitalization and signature creation are carried out in the ERDAS Imagine environment to generate land-use and land-cover theme layers.

3.2.3 Accuracy assessment

Accuracy assessment is a comparison of image interpretation by a computer with the aid of ground truth data (Gao, 2009; Richards and Jia, 2006). Because the classified image is nearly thematically stratified, training sites for accuracy evaluation were found using the stratified method of sampling for this comparison. Stratified sampling ensures that a predetermined amount of assessment pixels is drawn from a given land cover, ensuring that all LULC classes are sufficiently represented in the evaluation samples. No matter how small a land cover is in size or limited in its spatial distribution, this specified number of evaluation pixels can always be selected, although not in a single pass (Gao, 2009). As a result, stratified training pixels were chosen for validation depending on the number of bands and LULC classes. Based on the error matrix produced from each classification result, the overall accuracy, producer's and user's accuracy, and kappa coefficient were computed. The fraction of correctly classified pixels divided by the total number of classified pixels is used to calculate overall accuracy.

3.3 Data analysis

Following the completion of the data collection the information gathered from different sources have been compiled in the way that is easy to manage. The analysis was carried out by using qualitative description and descriptive statistics with the help of ERDAS, ArcGIS, Percentage, tables, maps were used to present the results of the study. Furthermore, Information obtained through personal observations was also included in the analysis. The fundamental rationale, in economic development and conservation policies, is ecotourism's projected potential as an

effective instrument for sustainable development. This can be assessed using the criteria and indicators approach, which is essentially a sustainable ecotourism management concept built in a set of principles, criteria, and indicators. However, one of the main problems of decision theory is determining how to obtain the relationship weights of the criterion. The Analytic Hierarchy Process is a popular weight evaluation approach.

The AHP technique has been demonstrated to be a helpful and sensible method for determining weights for various destination criteria via prioritization utilizing pair wise comparisons. Specifying the hierarchical structure, finding the relative relevance weights of the criterion and sub-criteria, allocating preferred weights to each alternative, and determining the final score are all processes in this method. There were four critical steps in producing an ecotourism site suitability map: 1. finding suitable factors to use in the analysis, 2. assigning factor priority, weight, and class weight to the parameters involved, 3. generating an ecotourism land suitability map, and 4. determining potential areas for ecotourism. Figures 3.3 provide the details of the conceptual framework and each processing phase. ArcGIS is used to combine the spatial data with suitability index so that a continuous land suitability map is generated. The output is a suitability map for ecotourism development. The final part deals with the recommendations in order to determine the potential areas for ecotourism development.

Using GIS, a map of each factor was created in this step. Factor maps provide a result for the stage of identifying evaluated criteria and sub-criteria. This occurs immediately after information is entered into GIS (collection, reformatting, geo-referencing, synthesizing, and recording associated data) and saved in graphical and tabular form, manipulated, and analysed to obtain useful information.

In general, a base map of the study area is constructed and used to generate a number of factor maps using various GIS approaches. In GIS, each factor is represented on a map as a layer. Each map reflects a single sub criterion and can be referred to as a theme layer or data layer. They represent how the traits are dispersed in space and how they help to achieve the goals. After creating a Digital Elevation Model map of the study region, elevation, slope, aspect, land use land cover class, and rainfall maps were created in GIS.

3.3.1 Determination criteria and factor

The decision criteria and considerations are based on socioeconomic factors and bio-physical aspects of the land suited for ecotourism. Based on the information gathered, for this study MCE is performed using three criteria as indicators of suitability within the terrestrial ecosystem:

- landscape,
- topography, and
- accessibility characteristic.

Likewise, the ecotourism site was evaluated based on six critical factors: (a) visibility, (b) land use/cover, (c) elevation, (d) slope, (e) proximity to cultural sites, and (f) distance from highways. Pairwise comparison is any method of comparing entities in pairs to determine whether entity is preferable, has more of some quantitative feature, or whether the two entities are same. The pairwise comparison approach is employed in the scientific investigation of preferences geospatial decisions, attitudes, voting systems, social choice, public choice, requirements engineering, and multi-agent intelligent information systems. These criteria and factors were chosen based on professional opinion, experience, and competence, as well as data from numerous sources. Discussions with specialists in related fields of study, a survey of authorized literature, and an analysis of historical facts were used to acquire knowledge. MCDM was used to incorporate decision makers' judgment and preferences into AHP approach evaluations. Each criterion was assigned a weight and a score based on its relative importance in the appropriateness evaluation. The overall results were presented in the form of a pairwise comparison matrix.

The order n matrix's consistency is assessed. This method's comparisons are subjective, and the AHP tolerates inconsistency through the degree of redundancy in the technique (Saaty 1980). If this consistency index falls below a certain threshold, the answers to comparisons may be re-examined. The consistency index (CI) is calculated. The consistency ratio (CR) can be determined using the properties of reciprocal matrices. CR 0.1 denotes an adequate level of consistency in the pairwise comparison. According to Saaty (1980), if CR is less than 0.10, the degree of consistency is adequate. The consistency of the matrix of order n is evaluated. Comparisons made by this method are subjective and the AHP tolerates inconsistency through the amount of redundancy in the approach. However, if it is greater than 0.10, there are discrepancies in the evaluation process, and the AHP approach may not produce relevant results. More information on the CR calculation

may be found in Ma *et al*. (2005) and Hossain *et al*. (2007). The main eigenvalue is used to assess the consistency of the obtained weights. The pair-wise matrix's primary eigenvalue and related normalized eigenvector indicate the relative importance of the various criteria being compared. The elements of the normalized eigen vector are referred to as weights for the criteria or sub-criteria and ratings for the alternatives.

3.4 Methodology

As it is illustrated in (Figure 3.3), in order to achieve the objective of this study the following systematic step is proceeded; multi criteria was applied these criteria are land cover, accessibility and topography of the sites. Land use land cover is used to identify areas that has vegetation cover and settlement. Road and existing tourist destination site accessibility is used to evaluate the sites suitability for tourists or future developments for investors/local authorities. Euclidian distance was applied for the existing sits and for the road network. Topography has great impact on tourist preference specially for hiking and fresh air. AHP technique was applied to identify the suitable site. To do that weight of factor was assigned for each factor using pairwise comparison matrix and normalized pairwise comparison matrix is applied to give weight for the factors influence.

The consistency of a systematic strategy and analytical means for designing the property of matrices is evaluated in this step to assure the ecotourism potential. Decision-makers' judgments are consistent. According to our goal, seven characteristics were utilized to assess the ecotourism potential of Bahir Dar and its surroundings. The Consistency Index (CI) assesses the potential of an ecotourism site. With calculated as:

$$CI = \frac{\lambda max^{-n}}{\mathrm{n}-1} \qquad (1)$$

The consistency index of a randomly generated reciprocal matrix was been called to the random index (RI), with reciprocals forced. The last ratio that has to be calculated is the Consistency Ratio (CR), which is a comparison between Consistency Index (CI) and Random Index (RI). The formulation of CR is:

$$CR = \frac{\text{CI}}{\text{RI}} \quad (2)$$

If the outcome is that factor A is twice as important as component B and factor B is twice as significant as factor C, then this comparison is inconsistent. This issue can be resolved by modifying the study and recalculating the results. Furthermore, the average of the random index (RI) value for matrices of order 1 to 10 (Saaty, 1980). The Weighted Overlay tool solves multicriteria problems such as site selection and appropriateness models by utilizing one of the most widely utilized methodologies for overlay analysis. Each value class in each input raster is assigned a new, reclassified value on a scale of 1 to 5, with 1 being the least suitable and 5 representing the most suitable. Only discrete integer raster is supported. Before using weighted overlay, reclassify continuous raster (Esri, 2022). and weighted overlay then finally the ecotourism suitable sites was Identified.

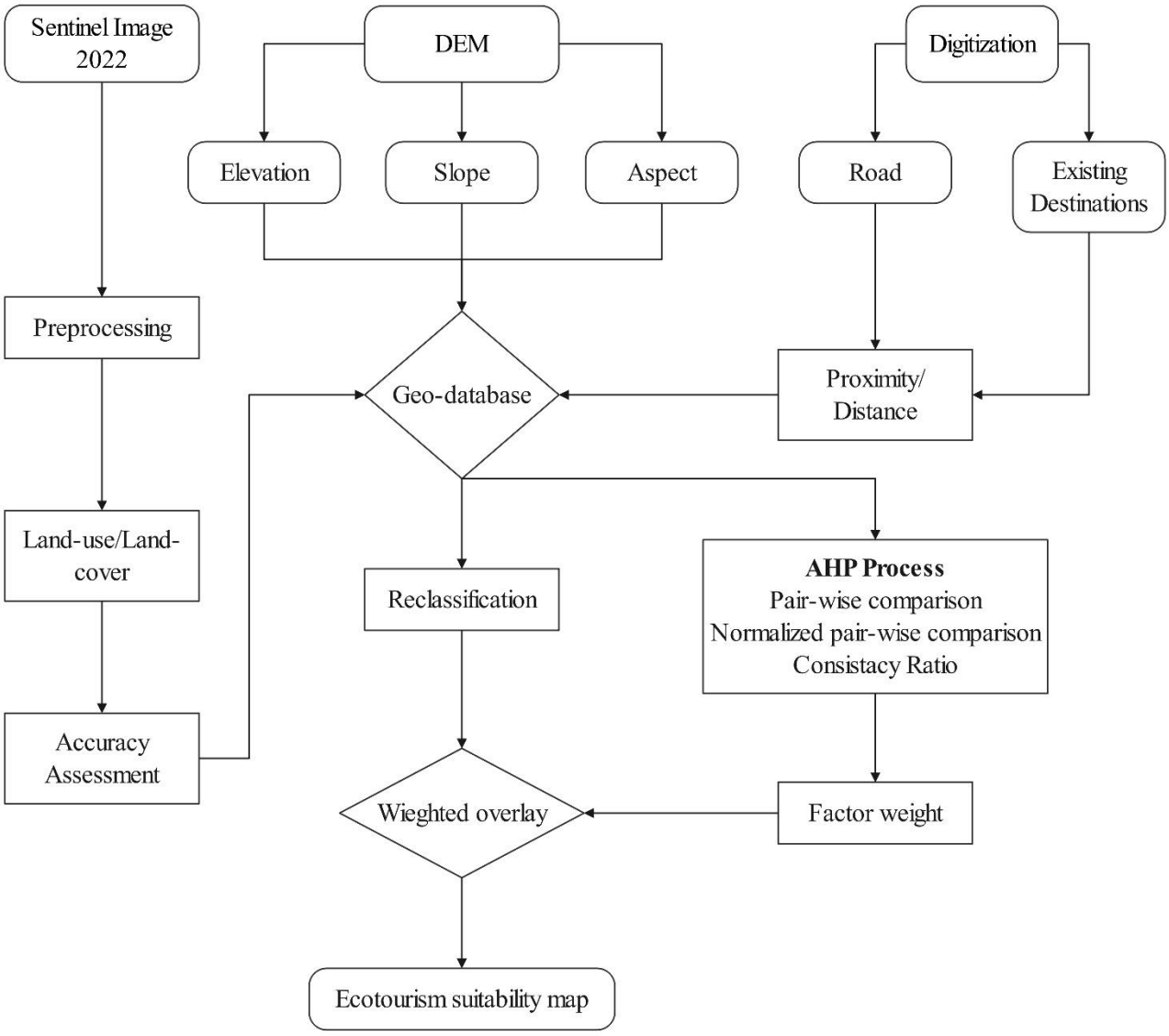


Figure 3. 3 Ecotourism suitability site

Chapter Four

Results and Discussion

4.1 Results

4.1.1 Land-use and land-cover

In this study the classification system was created by referring to (Anderson *et al*., 1976) classification scheme and has been designed to be as compatible as possible with other classification systems currently used by various institutes in land use inventory and mapping. The land use and land cover map classes are farmland, open area, Built-up area, vegetation and water body. The land-cover maps generated after running a maximum likelihood supervised classification are presented in (Figure 4.1 and Table 4.1).

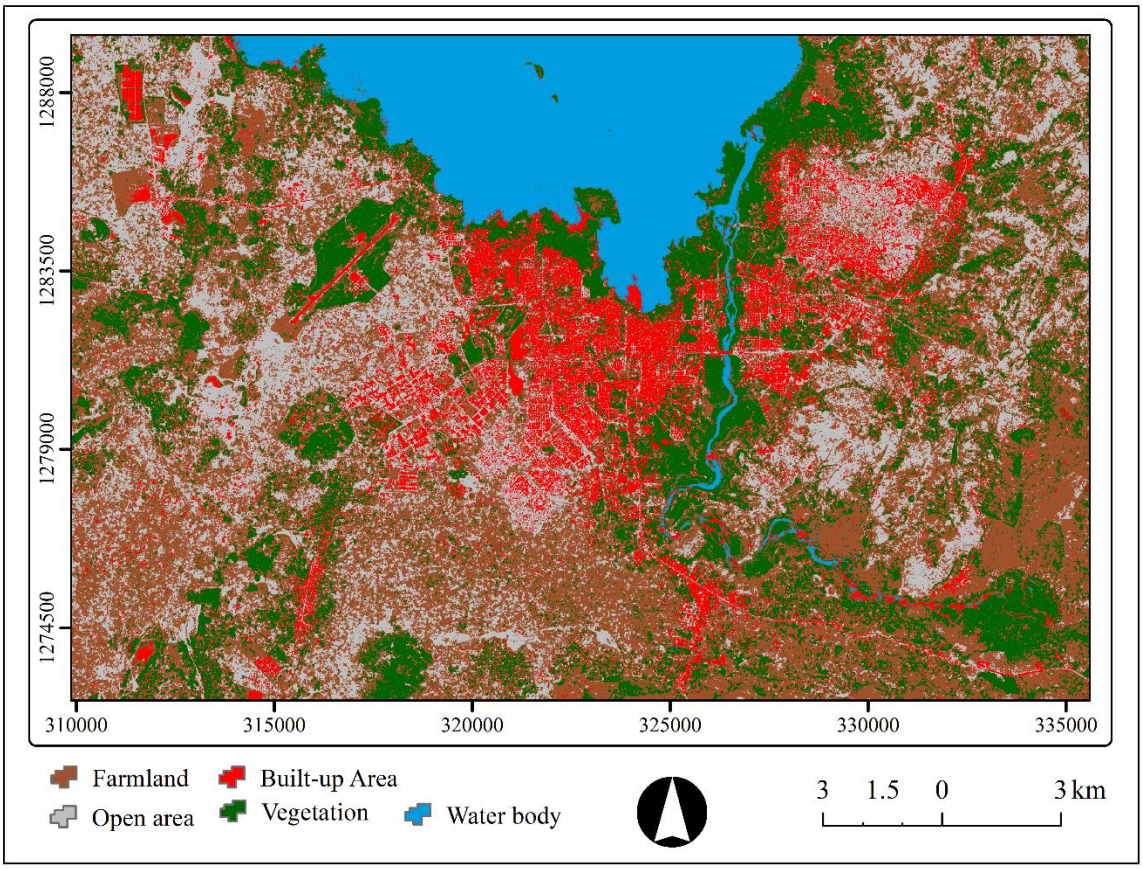


Figure 4.1. Lan-use and land-cover map.

Ethiopia has enormous ecotourism development potential. Because the country has a unique biodiversity, magnificent physical features, and rich cultural resources. Protected areas in Ethiopia, which include national parks, game reserves, animal sanctuaries, and other controlled hunting

grounds, cover around 14% of the country and are best suited for ecotourism development (Teressa, 2017). However, it is still in its early stages. For this study LULC studies (Lambin *et al*., 2001) revealed that socioeconomic and biophysical characteristics are the main forces behind land use changes. Driving factors are classified into two categories: proximal causes and underlying causes. Proximate causes are activities and acts that have a direct impact on land usage, such as clearing of forests or road construction. Furthermore, research on LULC in Ethiopia has focused on the dynamics of cover changes and their causes, with little emphasis paid to the effects of such changes on ecosystem services (Tolessa, *et al*., 2017). As shown in the Table 4.1, Farmland 39.7 percent, Open area 20.3 percent, Built-up area 9.4 percent, vegetation 18.8 percent and water body 11.8 percent of the study area.

Table 4.1. Extent of the land-use and land-cover classes

LU/LC class	Area (Ha)	Area (%)
Farmland	18,604.7	39.7
Open area	9,505.8	20.3
Built-up area	4,413.6	9.4
Vegetation	8,806.9	18.8
Waterbody	5,524.5	11.8

As indicated above the Bahir Dar and its surrounding area is 39.7 percent farmland and 20.3 and 18.8 percent area is covered with open area and vegetation respectively.

4.1.2 Accuracy assessment

Classified land-cover maps derived from remotely sensed images contain a variety of errors; it is the responsibility of the researcher to identify these errors so that the produced land cover maps are reliable and easily interpretable by users. Once the classified image has been integrated into a serve as an information source for urban planners and researchers, an accuracy assessment should be carried out because it limits the classification results of remotely sensed imagery data. To assess the classification's accuracy, the classification accuracy assessment land use land cover result was performed. The reference data were obtained from sample points that were prepared using random sampling from field observation, field observation information, aerial photograph and Google Earth. The accuracy assessment result is illustrated in (Table 4.2).

An accuracy evaluation is used to compare the findings of land cover classifications derived from remotely sensed data. An accuracy evaluation analysis was carried out by creating an error matrix that compared the interpreted land cover map to a map that contained the results of the ground truth investigation.

Table 4.2. Accuracy assessment of the classification map.

LU/LC Class	Reference	Classified	No. accuracy	Producer accuracy	User accuracy
Farmland	99	106	95	95.96%	89.62%
Open area	41	50	39	95.12%	78.00%
Built-up area	25	23	17	68.00%	73.91%
Vegetation	47	49	43	91.49%	87.76%
Water body	26	28	21	80.77%	75.00%
Overall Classification accuracy is 83.98%					

4.1.3 Road Infrastructure

According to Ethiopian Roads Administration data for 2021, there are four surface type roads available in Bahir Dar and its surrounding areas. As illustrated in Figure 4.2, Bahir Dar has a more extensive road network than its surroundings. This is due to its regional capital. To navigate through the surroundings of Bahir Dar the accessible road types are either asphalt or gravel roads. Bahir Dar is well connected to different cities and towns in Ethiopia by road trips. Minibus, Taxi and Tuk-tuk (Bajaj) provide transportation in the city. Cycling is popular in Bahir Dar. There are bike rentals accessible throughout the city, and the streets are tree-lined. You may take it a step further by riding to and from Bahir Dar and other adjacent towns. In figure 4.2 we look that forty percent of the study area is covered by farmland. These roads are built to connect the nine percent settlement area of the study area. So, form this we can understand that the area is not convenient for motorized mobility. For hiking lovers this is a wonderful situation to walk around the country side.

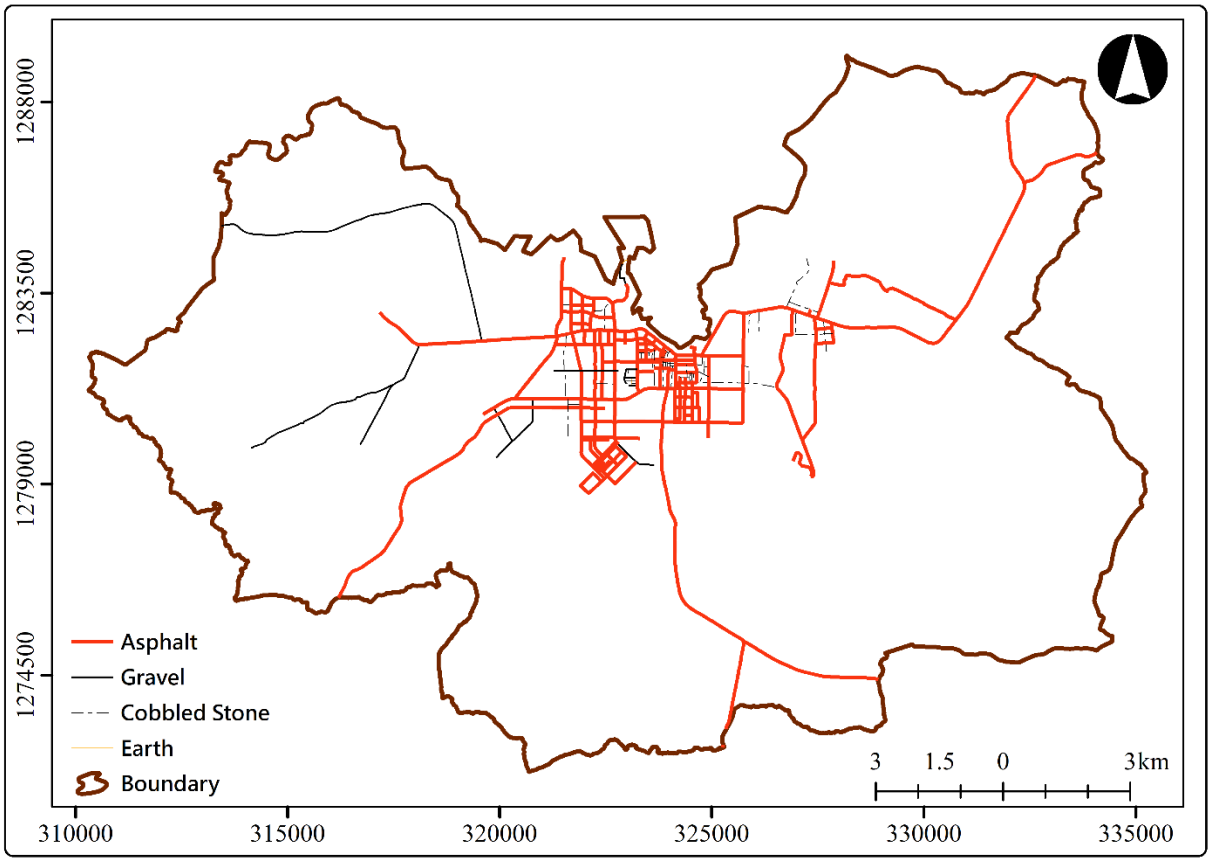


Figure 4.2. Road map.

4.1.4 Access to road

Self-drive tourist alternatives are frequently promoted as an economic development strategy in rural and regional communities. In many circumstances, providing iconic attractions, services, and infrastructure such as roads can improve an area's tourism appeal. Road infrastructure and tourism have both positive and negative implications for mutual relationships and limits. The effects of road infrastructure on tourism are more obvious today than ever before (Ramadan, 2020). Tourism has an impact on road infrastructure through the extensive construction and modernization of the road network, the expansion and modernization of modes of transportation, the increase in the number of passengers and commodities, and the introduction of new modes of transportation organization. The development of road infrastructure in tourism affects long-distance travel, lowering the duration of tourist journey.

The location of commercial destinations is primarily determined by three basic factors: availability, appeal, and organization. In figure 4.3 the longest distance to get road is 6.4 km, and

the shortest is 1.3 km. In Bahir Dar city the road network is higher than the surrounding because it is the regional capital. In relation to ecotourism road is essential but it must not disturb the environment and cause to deforestation. In the absence of road access to the tourism destination walking or hiking is promoted.

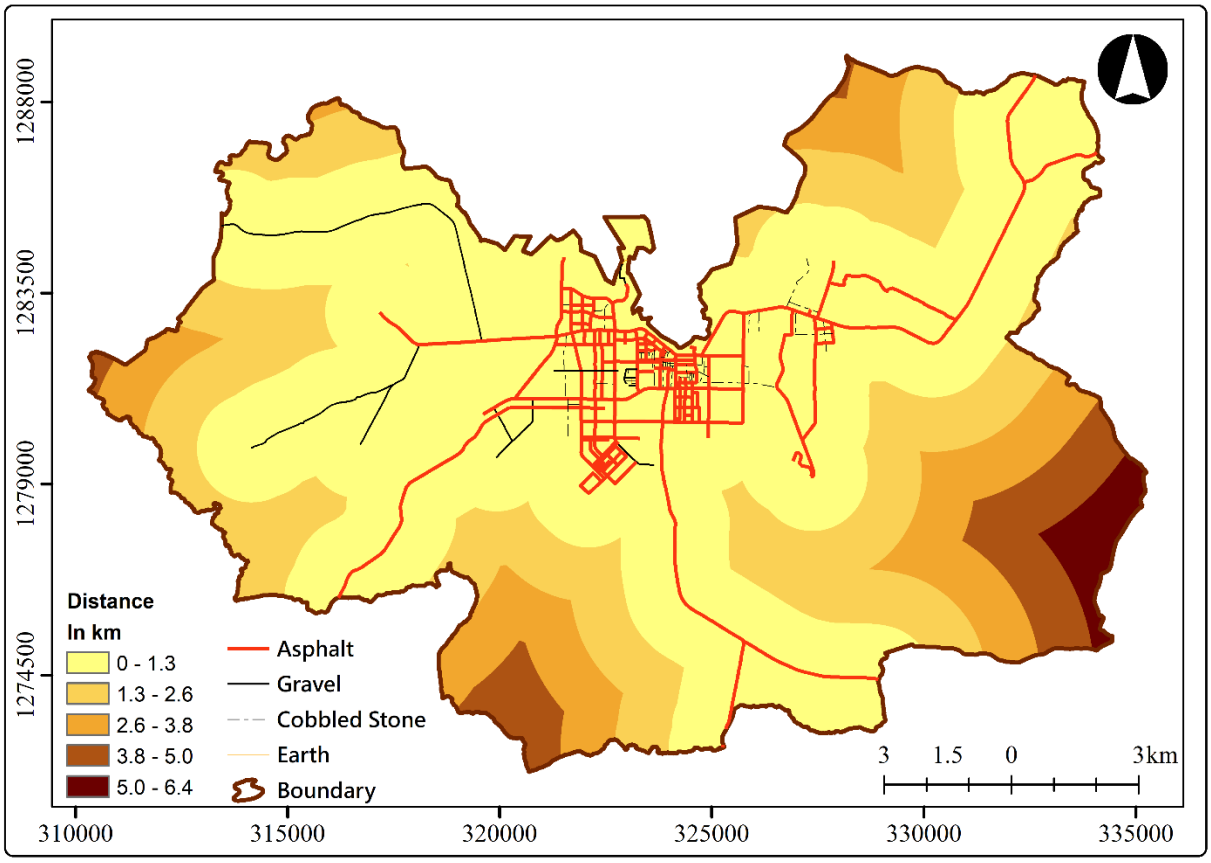


Figure 4.3. Distrance to reach a road

According to British Heart Foundation, 2022 walking speed will depend on your level of fitness and walking experience. Difficult terrain or travelling uphill and downhill also affects your overall speed. For a person with excellent fitness, an approximate moderate walking pace: 9 minutes per kilometre (6.4 kilometres per hour) and an average walking pace on country and forestry footpaths is: 12 minutes per kilometre (5 kilometres per hour). In this case 4.7 kilometre from main road will take less than an hour. The surrounding of Bahir Dar will take 45 minutes of hiking/walking. South east and west of Bahir Dar especially south east of mount Bezawit, it only takes 20 minutes. Even if the density of the road network is concentrated in Bahir Dar city navigation surroundings of Bahir Dar is easy and it is not time taking it is less than an hour.

Road infrastructure is a prerequisite for the development of tourism in Ethiopia. However, road infrastructure does not always imply that there is an adequate disposal of the tourist attraction, because it is dependent on access and transportation organization. Investment in tourism infrastructure is frequently evaluated in terms of prospective tourism base expansion, tourism expenditure, and contribution to economic growth (Banerjee *et al*., 2017) So, without further road construction development the study area accessed. Road infrastructure and access to road will not hinder tourists to go and interact with the local community and enjoy the natural beauty and landscape of Bahir Dar and its surrounding.

4.1.5 Health facility

Ecotourism facilities means any activity(s) which is taken to promote ecotourism, that is inclusive of lodging, camping, trail/trek, machan, pagoda, safari, public amenities, sit out etc. Health facility access is also included in availability of ecotourism facility. But we did not see much in researches. The rearrest thing that can happen to a tourist is being seriously sick. Sometimes minor injury or headache may happen but it may not lead to go to see a doctor. But in case of emergency and other cases tourists may need health centres specially hospitals. As it is shown above in figure 4.4 health centres are distributed better than hotels and police stations. It is obvious that hospitals and clinics are concentrated in towns but thanks to health extension and other programs health centres and health posts are distributed good. According to Ethiopian Statistics Service 2020 data there are 292 health centres in and around Bahir Dar. So, Bahir Dar and its surroundings may not be blamed by a tourist to get access to health centres in case of emergency.

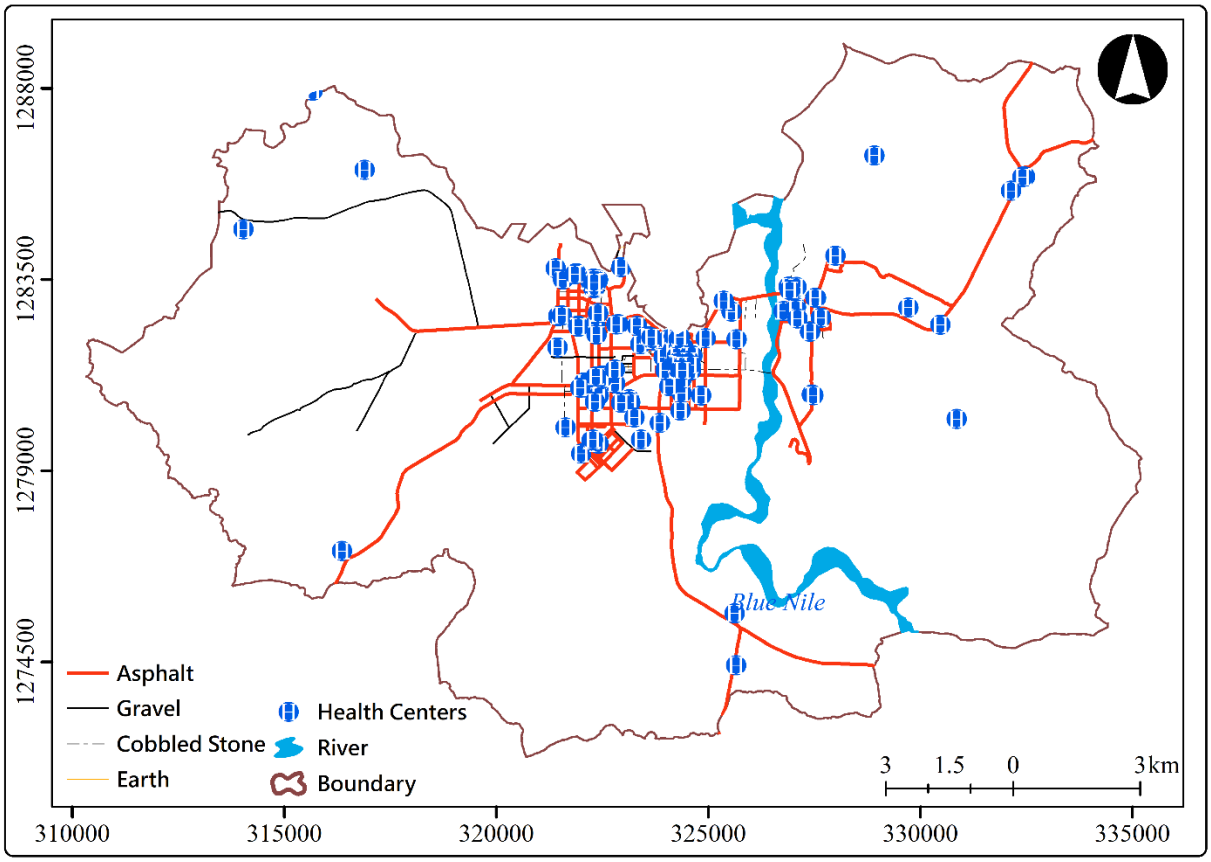


Figure 4.4. Health facility access map.

4.1.6 Topography

The surface shape and relief of the land are described by topography. It refers to numerous landforms (physical features) that represent the earth's physical shape (Tewodros, 2010). Topography is an elevation measurement, and slope is the percentage change in elevation over a given distance. Ecotourism is primarily concerned with experiencing and learning about nature, its landscape, flora, fauna, and their habitats, as well as local cultural artifacts (Rahman, 2010). Topography is the heart of this experience. Certain tourism activities, such as trekking, climbing, adventure, sports, and expeditions, rely heavily on altitude. Colder climates have a profound influence on mountain ecosystems, and different elevations have varied mountain ecosystems. High mountains are often less appropriate for agriculture and more suitable for forest exploitation and recreational activities such as hiking due to the less favourable terrain and temperature.

Studies have shown that topography is one of the most important factors of attractiveness in landscape, scenic potential, or topographic attractiveness for tourism, because it determines

patterns and forms for many other landform and land cover features (Linton, 1968; Bishop and Hulse, 1994; Miller *et al*., 1994). As shown in figure 4.5 below average Bahir Dar and its surrounding has flat surface ranging from 1,712 up to 1,906 meters above sea level. Majority of the landscape ranges from 1,717-1,841 meters above sea level. In figure 3 land use and land cover map the farm land is 40 percent this is clearly understood that it is because of the flat ness of the area that is suitable for agricultural activities.

For ecotourism perspective the topography of Bahir Dar and its surrounding is a dry land due to large area of farming land the vegetation cover is not convenient to keep the environment green and open to tourists. Altitude is the height of a location above or below a reference level such as mean sea level. To assess the character and elements of a landscape that are good for tourism, the position, angle, and stage must be considered. A Digital Elevation Model was used to generate the elevation factor in this analysis.

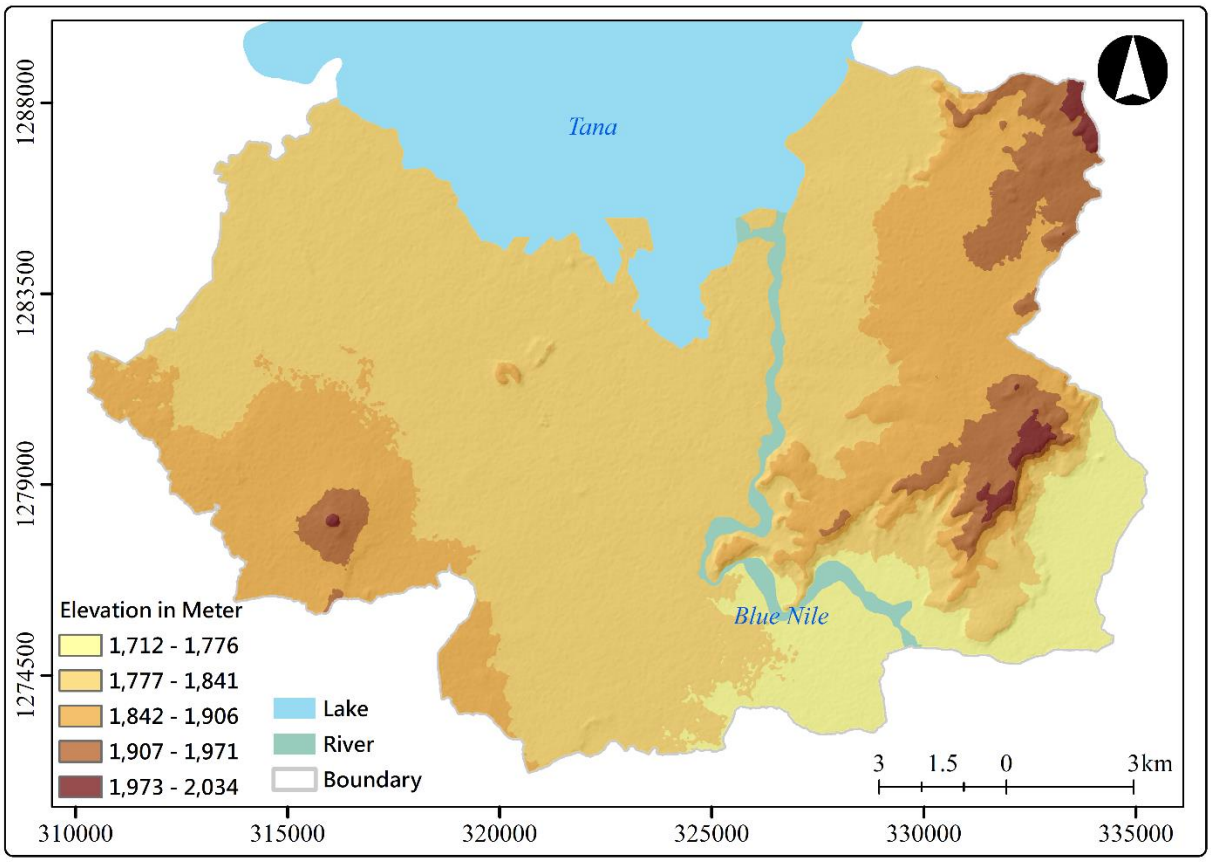


Figure 4.5. Elevation map.

4.1.7 Slope

Differences in temperature, humidity, heat, and daylight hours are linked to changes in latitude and altitude in mountain regions, all of which influence ecosystems, human communities, and, as a result, tourism attraction. In the above figure 4.6 the slope or the degree change of the elevation is clear that east of river Blue Nile is a place where there is a higher number of degree changes in slope ranging from 17.5 - 43.5 degree. In relation to elevation this area is also has higher altitude. The elevation changes and the angle of the topography contributes to a higher number of slope change. In relation to ecotourism a higher elevation and a higher slope change will benefit the perfect view of the surrounding land scape. Tourist's eye may rest in lake tana and the beautiful city of Bahir Dar. Areas like these are also used to hike more often than plan areas.

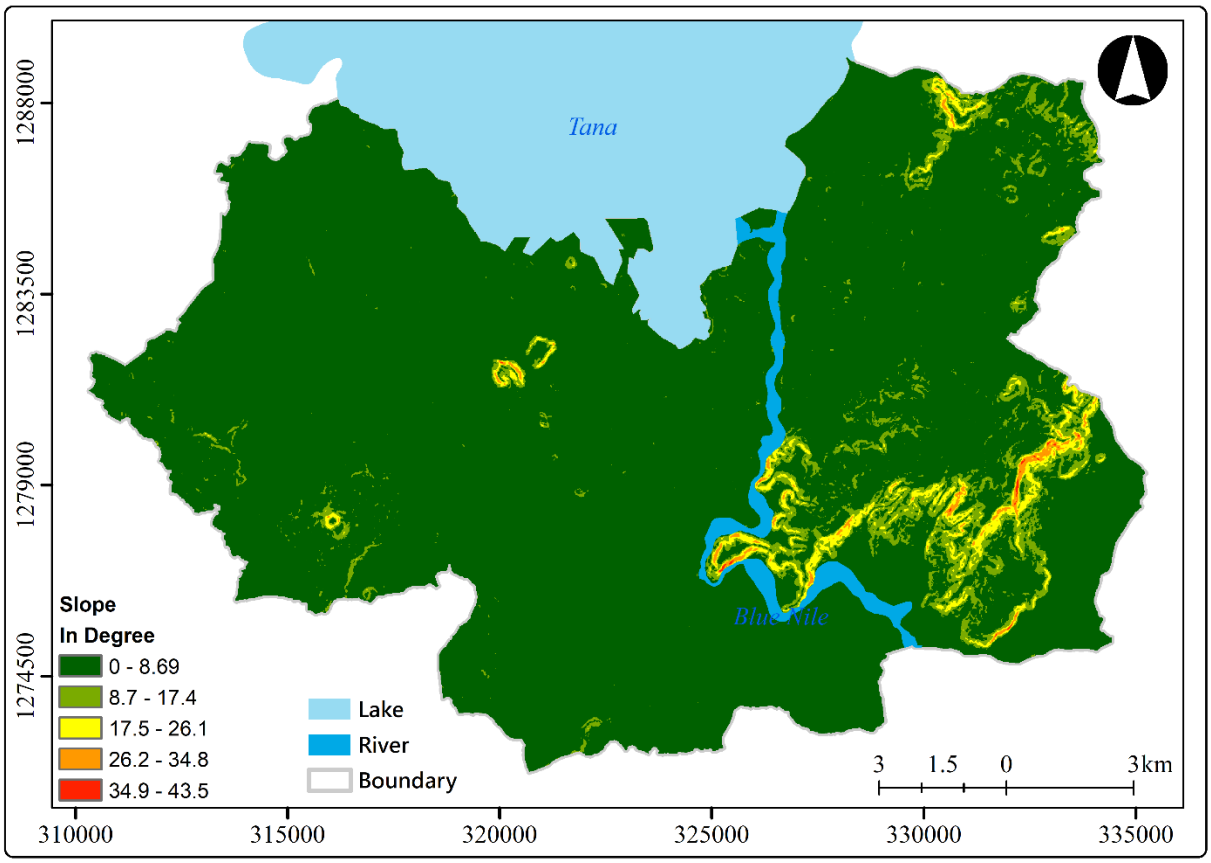


Figure 4.6. Slope map.

The slope profile is visually appealing to onlookers from a wider geographical area. The intricacy of a place in terms of slope is an important aspect in determining its appropriateness for ecotourism. This component demonstrates a different degree, the complexity of the area, and the slope of the area, which has an effect on the selected area by specifying the percentage of slope

that is associated to a site ideal for ecotourism. Furthermore, slope is a safety indicator, which means that the gentler the slope, the higher the safety factor, and vice versa. The reclassified slope map from the degree measurement unit was provided in this section for the ecotourism need. The most level places in the area are farmland, and the flat surface of a mountain plate is excellent for the research area ecotourism.

4.1.8 Existing Tourist destinations

Bahir Dar, graced with Lake Tana and the Blue Nile, is a nice visit in and of itself. From a tourist standpoint, the following attractions within the lake, and its surrounding are as follows (Figure 4.7):

- Entos Iyesu and Kebran Gabriel Monastery are the closest islands with churches.
- Blue Nile War Memorial,
- Emperor Haile Selasi Palace,
- Mango Park,
- The origin of the Blue Nile River,
- The Market
- Traditional Church School St. Georgis Church

Though it is frequently stated that the beauty of Lake Tana lies in traversing the lake. Lake Tana is the main attraction in Bahir Dar, according to the local tourism bureau. Almost all tourists have taken a boat trip to Lake Tana, visiting several locations on the lake. The War Memorial on the Nile's bank is another popular tourist destination. The third most visited site is the Blue Nile Waterfall. Other popular attractions include the open-air market, Haile Selassie place, galleries and the traditional church school. Boat Trip to Lake Tana, Blue Nile Waterfall, and Haile Selassie are the destinations for which tourists need have the courage and exert some effort to go out of Bahir Dar city, whilst rests are inside the town's premise. Regarding ecotourism sites there is not much places developed or under development for tourism destination. Currently the city administration is trying to develop lake side park development which is similar to Addis Ababa River side park development.

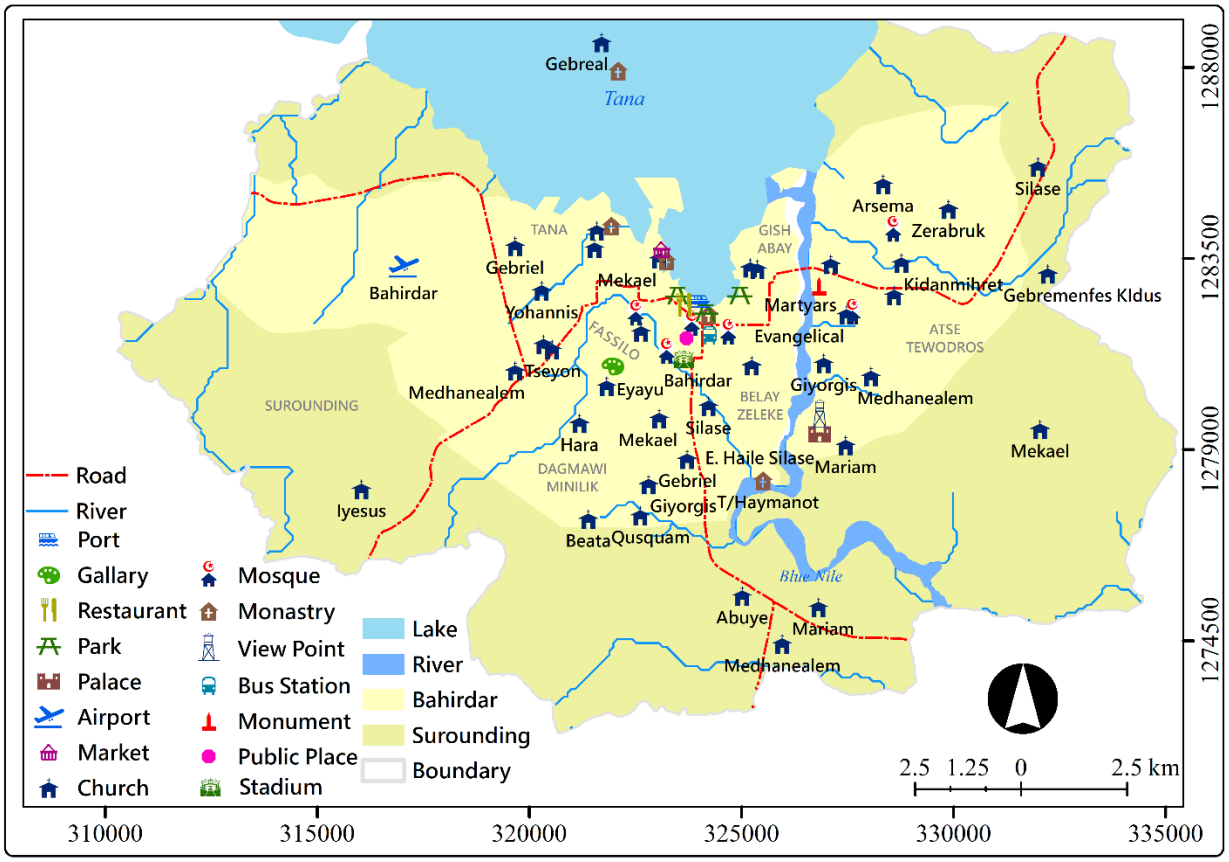


Figure 4.7. Existing tourist destination sites map.

Lake Tana is Ethiopia's largest inland body of water, covering around 3,000 square kilometres. The lake is populated with numerous islands, twenty of which include churches and monasteries of historical significance. It is true that as the distance increases from the lake's, attractions increase, so does the number of visitors decrease. In figure 4.7 we have understood that the common tourist attraction sites or places of Bahir Dar and its surrounding is distributed throughout the study area. In figure 4.8 the density of destinations is purely intense inside Bahir Dar town. According to Dharmendra 2012, Tourists' visits to a location are heavily influenced by the preceding information someone gathers from many sources or the locations presented to him by tour operators, but after viewing the locations, a person develops his own impression based solely on his own like and disliking of the location. This tourist opinion provides planners with a big clue as to which site should be the top priority for that area's tourism development strategy and which spot is losing importance, and why. It is clear that the outskirt of Bahir Dar is prone to lesser visitors due to the congestion of most common tourist sites in Bahir Dar.

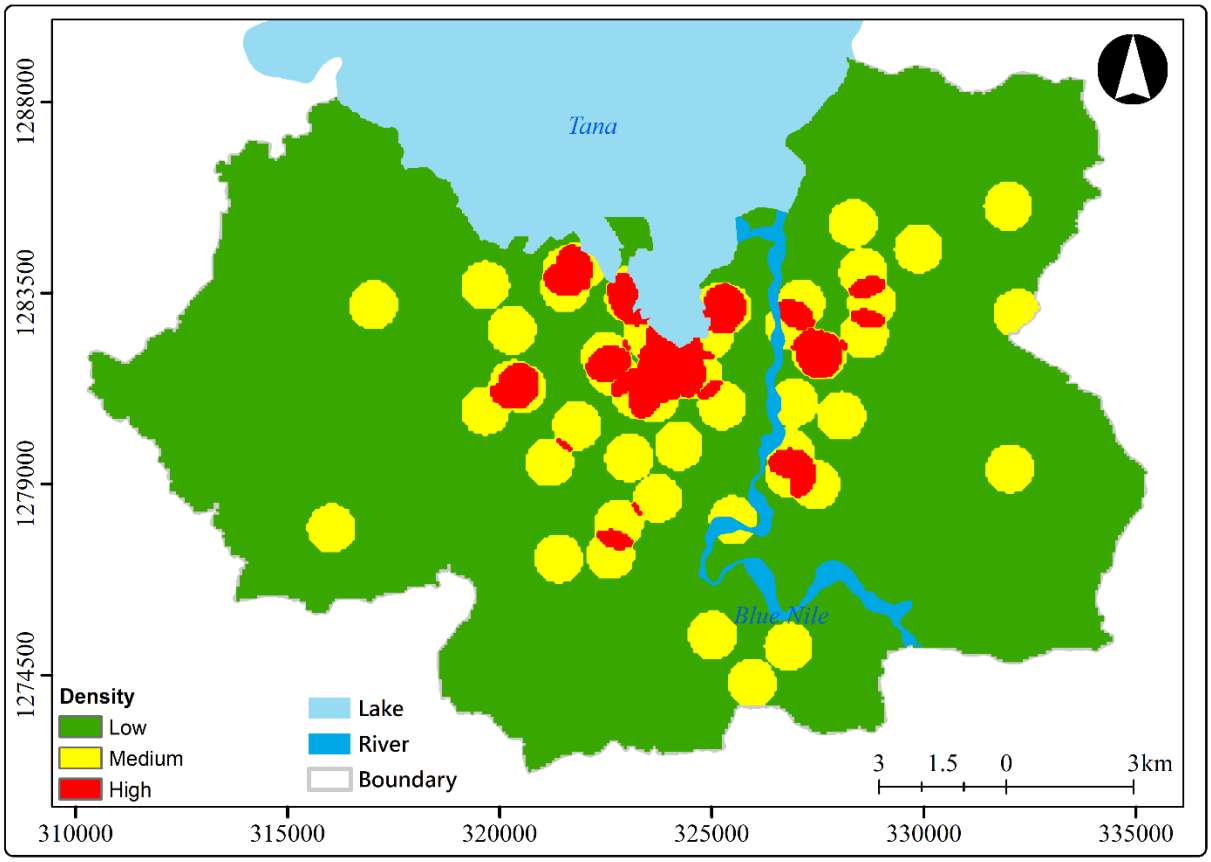


Figure 4.8. Existing tourist destinations density map.

4.2 Reclassification

In order to get the weighted overlay result for all the results except aspect map all are reclassified in to five classes. The aspect map was grouped by four classes. As illustrated in Figure 4.9. As indicated in Table 4.3 After the reclassification is done for land use land cover around 10,366.5 hectare of land became farmland it is about 40.1 percent and open area 5,758 hectare and 22.6 percent. The elevation values; from 1,777 to 1840 meter about 15,129.8 hectare of land 59.4 percent which is the low and from 1841–1905-meter elevation is moderate 6,022-hectare 23.6 percent suitable. Regarding slope 60.5 percent of the study area has low slope. Bahir Dar and its surroundings has about 5.6 percent high slope.

Regarding existing tourist site proximity Bahir Dar and its surroundings within 0-2 km proximity 66.6 percent of the existing tourist destinations are accessible. Road accessibility reclassification result shows that 74 percent area is accessible within 3-6 km distance to roads.

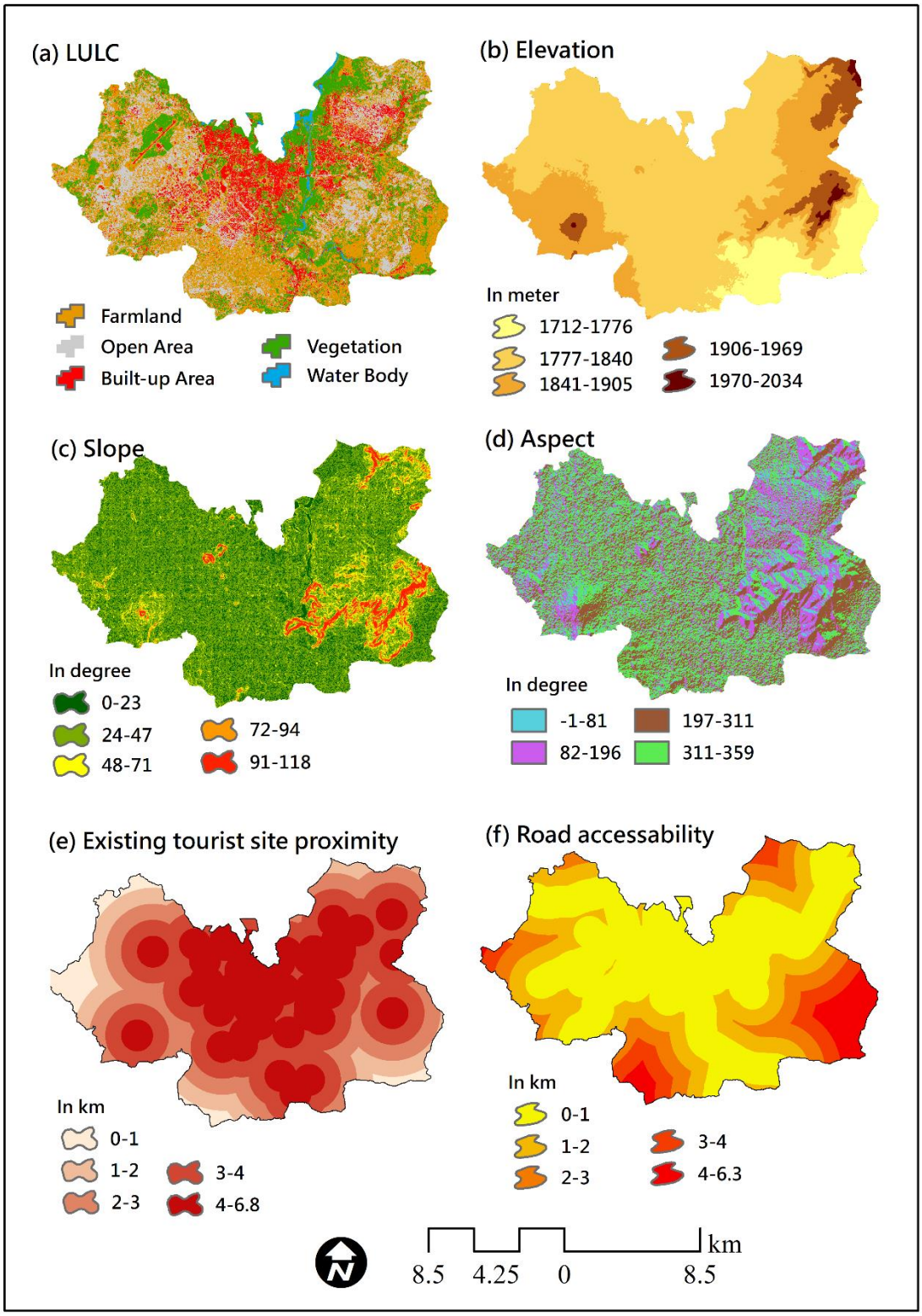


Figure 4.9 Reclassified factor maps.

Table 4.3 Reclassification factor maps of the ecotourism suitability.

Factors	Class	Ecotourism Suitability	Rating	Class pixels	Area (ha)	Area (%)
LULC	Water body	Very low	1	29,170	291.7	1.1
	Farmland	Low	2	1,036,654	10,366.5	40.7
	Built-up Area	Moderate	3	361,417	3,614.2	14.2
	Open Area	High	4	575,799	5,758	22.6
	Vegetation	Very high	5	546,204	5,462	21.4
Elevation (m)	1712-1776	Very low	1	257,867	2,578.7	10.1
	1777-1840	Low	2	1,512,981	15,129.8	59.4
	1841-1905	Moderate	3	602,201	6,022	23.6
	1906-1969	High	4	157,375	1,573.8	6.2
	1970-2034	Very high	5	18,688	186.9	0.7
Slope (degree)	0-23	Very low	1	656,018	6,560.2	25.8
	24-47	Low	2	1,536,589	15,365.9	60.5
	48-71	Moderate	3	203,088	2,030.9	8.1
	72-94	High	4	64,528	645.3	2.5
	95-118	Very high	5	78,567	785.7	3.1
Aspect (degree)	-1-81	Very low	1	265,775	2,657.8	10.5
	82-196	Low	2	611,709	6,117.1	24
	197-311	Moderate	3	704,978	7,049.8	27.8
	311-359	High	4	956,328	9,563.3	37.7
Site proximity (km)	0-1	Very low	5	903,186	9,031.9	35.4
	1-2	Low	4	792,042	7,920.4	31.1
	2-3	Moderate	3	483,258	4,832.6	19
	3-4	High	2	247,876	2,478.8	9.7
	4-6.8	Very high	1	122,837	1,228.4	4.8
Road accessibility (km)	0-1	Very high	5	93,910	939.1	5.8
	1-2	High	4	118,409	1,184.1	7.2
	2-3	Moderate	3	200,435	2,004.4	12.3
	3-4	Low	2	375,489	3,754.9	23
	4-6.3	Very low	1	843,200	8,432	51.7

4.3 Pairwise comparison

The pairwise comparison matrix for the six criteria is set up to compute the importance of weightings using the AHP approach, as shown in (Table 4.4). AHP analysis was performed to assign relative weight or influence of ecotourism factors subject to weighted overlay. Using a numerical scale of 9 points (Table 2.3), the judgment contributed by choosing the importance intensity of one criterion over another. To determine the priority vector relative to criterion weights, each criterion's eigenvalue is normalized to 1. Weights were assigned to the elements

used for ecotourism potential area mapping using multi-criteria decision-making based on the physical characteristics of the study location and an assessment of prior studies.

Table 4.4. Pair-wise comparison matrix.

Factors	LULC	Elevation	Slope	Aspect	Site proximity	Road accessibility
LULC	1	5	3	3	4	5
Elevation	1/5	1	2	2	3	4
Slope	1/3	1	1	2	2	3
Aspect	1/3	1/2	1/2	1	2	2
Site proximity	1/4	1/3	1/2	1/2	1	5
Road accessibility	1/5	1/4	1/3	1/2	1/5	1

The normalization of the pairwise comparison and the weight of each factor was computed (Table 4.5), and according to the procedures suggested by Saaty (1987). Table 4.4 shows the final criteria weight for each ecotourism mapping factor, which reflects the estimated relative influence of each factor on the study area.

Table 4.5. Normalized Pair-wise comparison matrix.

Factors	LULC	Elevation	Slope	Aspect	Site - proximity	Road accessibility
LULC	0.4317	0.6593	0.4091	0.3333	0.3279	0.2500
Elevation	0.0863	0.1319	0.2727	0.2222	0.2459	0.2000
Slope	0.1439	0.0659	0.1364	0.2222	0.1639	0.1500
Aspect	0.1439	0.659	0.0682	0.1111	0.1639	0.1000
Site proximity	0.1079	0.0440	0.0682	0.0556	0.0820	0.2500
Road accessibility	0.0863	0.0330	0.0455	0.0556	0.0164	0.0500

From the above comparison the criteria weight (CW) for each factor is calculated. Sum of the raw divided by the total of the factors it gives criteria weight. The results are as follows LULC 0.4019, elevation 0.1932, slope 0.1471, aspect 0.1088, destination site proximity 0.1013 and road accessibility 0.0478.

Since Thurstone (1927) proposed the pairwise comparison method in the psychological review in 1927, pairwise comparison matrices have become widely used in several well-known decision-making systems (Jaroslav, 2020). The consistency check of the comparison was performed (Table 4.6) according to the procedures suggested by Saaty (1987). The final outcome of the

research is based on the level of potential for ecotourism. Therefore, an important factor has a greater impact on the outcome than other factors. Hence, the weight LULC map is 49 % and the remaining elevation map, slope map; aspect map, existing tourist destination sits and road network map are 19 %, 15%, 11 %, and 10% and 5% respectively. This research revealed that, the calculated consistency ratio (CR) from pairwise comparison matrix is 0.08 (less than 0.1), which indicates that a reasonable level of consistency in the pairwise comparisons and weights is acceptable. From the values of criteria weight each factor will get its weight in percent and the percent of influence is calculated (Table 4.6).

Table 4.6. Criteria weight percent.

	LULC	Elevation	Slope	Aspect	Site proximity	Road accessibility
CW	0.4019	0.1932	0.1471	0.1088	0.1013	0.0478
Percent	49	19	15	11	10	5

The major eigenvector of the above pair-wise comparison matrix was computed using weights to produce the best fit set of weights. The relative relevance of each of the characteristics was calculated using the primary eigenvector computation; the larger the weight, the more influence a given component has on ecotourism potential. This means that half of the overlaying computation will be influenced by land use and land cover, the other half by elevation, and the third by slope. The AHP also includes mathematical metrics for determining judgment inconsistency.

4.3.1 Checking Consistency

According to our goal, six characteristics were utilized to assess the ecotourism potential of Bahir Dar and its surroundings. The Consistency Index (CI) assesses the potential of an ecotourism site. To calculate our Consistency Index, we used 6.50 the average of the consistency measure (Table 4.6) and subtract the number of elements (n), which is 6, we get a value of 0.50. Then 6-1=5 The value for CI (0.50/5) is 0.10. After calculating the consistency index, we can now compute the consistency ratio.

Table 4.7 Factors consistency

Factors	LULC	Elevation	Slope	Aspect	Site Proximity	Road Accessibility	Consistency Measure
LULC	0.4019	0.9659	0.4412	0.3265	0.4050	0.2389	6.92
Elevation	0.0804	0.1932	0.2941	0.2177	0.3038	0.1911	6.63
Slope	0.1340	0.0966	0.1471	0.2177	0.2025	0.1434	6.40
Aspect	0.1340	0.0966	0.0735	0.1088	0.2025	0.0956	6.53
Site Proximity	0.1005	0.0644	0.0735	0.0544	0.1013	0.2389	6.25
Road Accessibility	0.0804	0.0483	0.0490	0.0544	0.0203	0.0478	6.28

As shown in Table 2.3, It is generally suggested that the consistency ratio be smaller than 0.1, indicating that the assessments are consistent and that the resulting weights can be employed. if the value is higher than acceptable value then it is necessary to re-calculate or re-develop the assessment (Saaty, 1980). The CR for our ecotourism was evaluated and determined to be 0.08 in our case for this study, which is appropriate for utilization in the suitability analysis.

4.4 Weighted overlay

Based on its significance, each input raster might just be weighted or assigned a percentage effect. The overall influence for all raster's must be 100%. As shown in table 4.5, we determined the percentage influence in the Normalized Pair-wise comparison matrix for our case. For Bahir Dar and its surrounding area land use land cover has 49 percent influence in the overlay analysis, slope, aspect, existing destination sites proximity and road accessibility (Table 4.5) respectively has their decreasing percentage. After applying the weight of influence, Figure 4.10 illustrates the weighted overlay result.

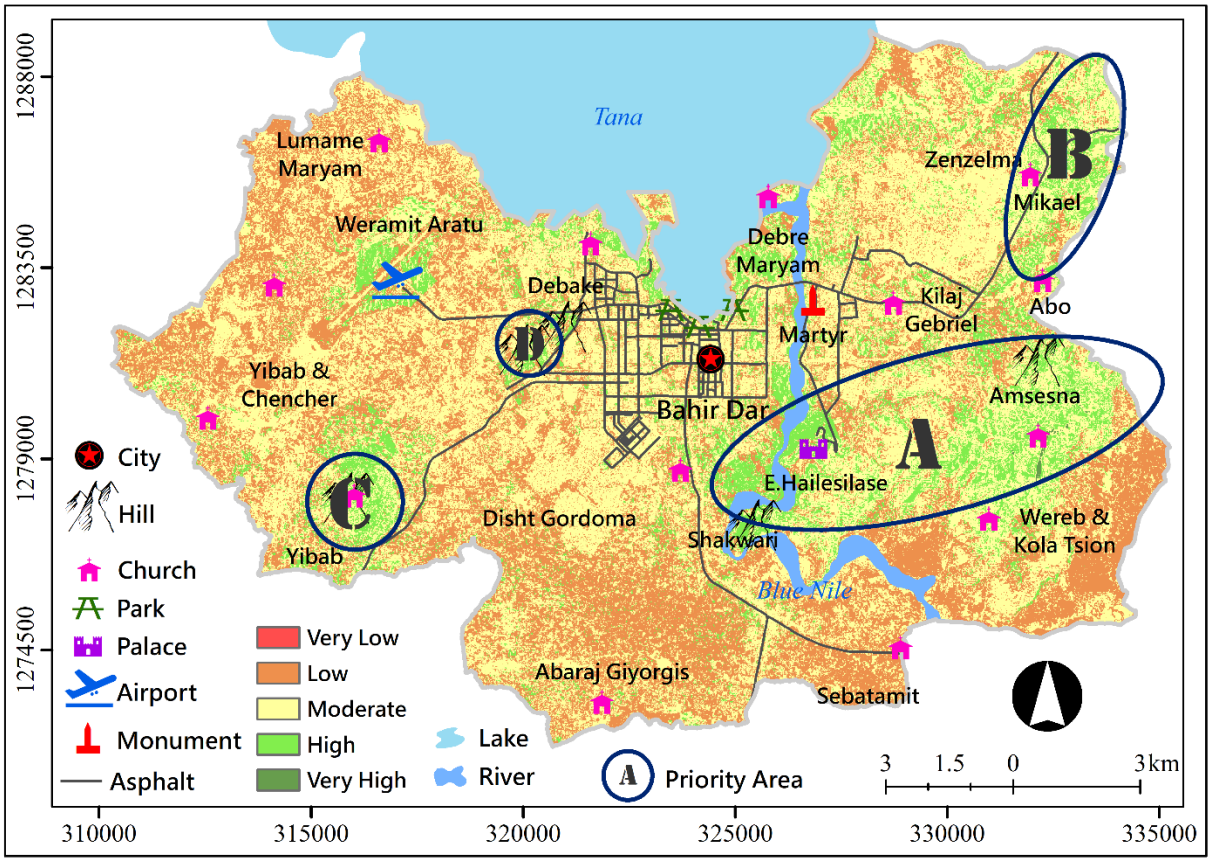


Figure 4.10. Ecotourism potential site map.

With approximately 2,065 hectares of land, Bahir Dar and its surroundings have the potential to be ecotourism sites. According to the characteristics and parameters we used, the majority of the study area, about 52 percent, is moderately suitable for ecotourism. The 35 percent of the study area is not suitable for ecotourism tourist destination site (Table 4.8).

Table 4.8. Statistical indications of the ecotourism suitability extent.

Suitability	Area (ha)	Area (%)
Very Low (1)	3.7	0.02
Low (2)	5709.1	35.14
Moderate (3)	8471	52.13
High (4)	2053.8	12.64
Very high (5)	11	0.07

4.5 Discussion

The major result of this study is suitable areas map for ecotourism (Figure 4.10) that classified in six categories. The main impact of this study was the identification criteria and factors of ecotourism by applying the AHP and GIS. Recently, the use of GIS in planning and managing the environment has been expanded to the tourism planning area. GIS has been useful in forming the tourism information systems (Vizi *et al*., 2008; Huang *et al*., 2010; Li and Duan, 2011; Fu, 2012), In this process, the research focuses to develop an integrated approach of ecotourism development by identification of ecotourism suitable sites. For ecotourism site selections, there is no uniform standard in the overall procedure of the operations; rather, it is applied based on nature, situation and available resource in a given geographic area. Therefore, in the case of this study, considering the nature of the study area and the available information, time and resource, the researcher tried to include three criteria and six-factor maps. Namely: land use land cover map, topography (elevation, slope and aspect map), existing tourist destination sits and road network.

Farmland 18,604.7 (39.7 %), Open area 9,505.8 (20.3%) Built-up area 4,413.6 (9.4%), Vegetation 8,806.9 (18.8%), and Waterbody 5,524.5 (11.8%) Bahir Dar and its surroundings has smaller area of potential sits farmland and built-up area has 49 percent coverage of the landscape. From this one can conclude that the vegetation covers around the hilly parts of the study areas are left for ecotourism activities.

The second criteria topography is another influencer in tourism site selection. From the elevation data starting from 1906 to 2034 msl the study area has a high potential but it only accounts 7 percent of the total area (Table 4.3). According to UNWTO, mountain tourism is a type of "tourism activity which takes place in a defined and limited geographical space such as hills or mountains with distinctive characteristics and attributes that are inherent to a specific landscape, topography, climate, biodiversity (flora and fauna) and local community. It comprises a broad range of activities associated to the need to be in open air areas and connect to nature in leisure time". Mountain ranges around the world provide opportunities for a diverse range of tourism activities, some of which are more established than others: winter and sports tourism, walking tourism and adventure and sports activities (Romeo, *et al*., 2021). In figure 4.10 “A” from the result river side and mountainous area has better vegetation cover than the plain area. In this regard Zenzelima

areas has a better vegetation cover with larger area coverage. The vegetation density of west of Zenzelima area as shown in Figure 4.11.

Figure 4.11. Forest cover of the Zenzelima area.

According to UNWTO and the International Transport Forum (ITF) report issued in December 2019, the tourism sector is expected to raise CO_2 emissions by at least 25% by 2030. (UNWTO and ITF, 2019). Aligning tourism operations with climate action is critical if the sector is to meet international goals (UNWTO, 2021). Mountain ecosystems include a wide range of small and unique habitats, with sometimes very short growing and breeding seasons for fauna and flora, and can be particularly sensitive to alterations produced by human activity. In this study the assessment for potential ecotourism site should focus on future green investment of Bahir Dar and its surrounding. In saying this the elements to be involved in selection of the area was vegetation and mountainous areas.

The establishment of ecotourism sites in this area will promote walking tourism. This allows tourists to enjoy mountain scenery, flora and animals, and local cultural heritage. It can provide a number of economic and social benefits to inhabitants and communities if properly designed and built. Walking tourism has the ability to highlight a destination as a whole, including its local culture and nature, as noted by UNWTO, given rising consumer demand for 'authentically experiencing' a site and the growing popularity of active travel (UNWTO, 2019a). In figure 4.10 “A” the open areas from the land use land cover in the mountainous part of Emperor Hailesilase place and its surrounding area are covered with vegetation mainly shrub and the area and its

surroundings has 1,777 meter up to 2,034-meter range of altitude (Figure 4.5). Green investment uses existing natural gifts of the investment area. But mount Bezawit has relatively less vegetation. But the river side of the mountain has good vegetation cover. Summer green legacy movement of tree plantation program should include this area (Figure 4.).

Figure 4.12 Emperor Hailesilase palace

In west of Zenzelima area it is forestry. South-east of Bahir Dar has been identified as high mountainous area (Yibabe Iyesus) initially it can be a destination site for religious tourism. The area ranges from 1,842 meters of up to 2,034 meters of altitude above mean sea level (Fig 4.13).

Figure 4.13. Yibabe Iyesus.

As illustrated in the Figure 4.10. having higher altitude and have relative vegetation coverage from their surrounding “C” is at the edge of the study area which is south-west of Bahir Dar city. Site “D” is almost inside the city. it known as Dibanke. The site has two hills one is a quarry site and the other site has a church at its top St. John the Baptist church (Figure 4.14). These areas are better

invested for religious tourism. Spiritual tourism is becoming more popular as a kind of cultural travel. Spiritual tourism is based on a variety of motivations, ranging from conventional religious tourism to alternative medicine to forms of deep immersion in nature, according to the UNWTO (2019b). Religious pilgrimages, trips to holy places, travel for worship and religious missions, and spiritual visits to natural habitats such as forests, lakes, gardens, bird and animal parks, botanical gardens, caves, and rocks are examples of activities. Mountains are frequently used as pilgrimage sites or for alternative healing, particularly in underdeveloped countries. It is believed that Ethiopia is a religious country, local tourists are more interested in this kind of tourism.

Figure 4.14. John the Baptist church.

Green investments and institutions are rapidly gaining market traction, particularly in the mountain tourism sector, where they may aid in ensuring a low-carbon, resilient, resource-efficient, and socially inclusive development. Water management, energy efficiency, waste management, conservation, and the preservation of natural and cultural heritage are just a few of the green investment choices accessible to address improved sustainability in tourism. Mountain tourism is built on natural and cultural assets. Mountain film and literary festivals, exhibitions, rituals, food and agricultural product events, guided tours, and forest bathing are all examples of initiatives that promote this key sector. These two sites are good for mountain tourism and spiritual tourism.

Generally, these mountainous locations can be used for adventure and sports activities both during and after the rainy season. They are affected by weather and site accessibility. Mountain biking, horseback riding, rock climbing, zorbing, and caving are examples of such activities. Freshwater

adventure and sports activities such as river and lake tours, canoeing, sailing, and freshwater fishing are also included.

According to the UNWTO, tourism activity in which the visitor's experience is related to a wide range of items often associated with nature-based activities, agriculture, rural lifestyle/culture, fishing, and sightseeing. Mountains are an ideal venue for rural tourism since activities take place in low-density areas with spectacular scenery and land use dominated by agriculture and forestry, as well as traditional social structures and lifestyles in consideration of this Bahir Dar and its surroundings are suitable. Shared activities may include agriculture, handicrafts, cuisine activities/sampling typical foods, learning about medicinal and native plants, planting, harvesting, making food, handling animals, and other activities related to daily life in rural communities, such as traditional ceremonies, dancing, and festivals, depending on the local community and the traveller's interests (Romeo, *et al*., 2021).

Another tourism activity that seeks to improve and balance all aspects of human existence, including physical, mental, emotional, occupational, intellectual, and spiritual well-being is well ness tourism (UNWTO, 2019b). Bahir Dar city is best candidate as far as wellness tourism is concerned.

4.6 Changes in strategies to strengthen ecotourism

As part of Ethiopia and victim of COVID 19 and the war, tourism industry is not growing as it is planned. It is true for Bahir Dar and its surrounding area there is ecotourism potential not utilized. The future prospects of ecotourism for the study area can consider the following:

- Local community concerns relating to livelihood and other related social problems may contribute to extreme poverty, which in turn contributes to the degradation of natural resources.
- It is critical to raise the understanding of local residents in and around the tourist region about ecotourism.
- Off-farm diversified livelihoods and introducing more alternative options is critical for sustainable natural resource management in Ethiopia.
- Developing and creating diverse livelihoods, promoting the development of ecotourism, encouraging benefit sharing and conservation of the natural resources.

- Degradation of natural resources near tourist locations, such as hot springs, seasonality in tourism, and leakages in and around are evidence of tourism's adverse effects. As a result, it is the responsibility of the concerned stakeholders to develop alternative options for local communities, to develop appealing tourist facilities and services.

According to Bekele and Tesfanesh 2017, Ethiopia has better future regarding ecotourism. Likewise, as part of Ethiopia Bahir Dar and its surroundings can benefits their residences and develop new tourist destinations that can go beyond visiting the usual destinations. Developing and creating diverse livelihoods, promoting the development of ecotourism, encouraging benefit sharing and conservation of the natural resources, and providing local people with a sense of ownership over ecotourism resources around them.

Chapter Five

Conclusion and Recommendations

The purpose of this research is to analyse the ecotourism potential of Bahir Dar and its surroundings. The studied area has a strong potential for ecotourism development in general. Despite the presence of various problems in the area, there are great potentials and chances to maximize the advantages of ecotourism activity in order to improve the livelihoods of the inhabitants.

5.1 Conclusion

The presence of natural and cultural resources in a given location does not imply that they will be used for the benefit of the community. All parties involved should commit to working together. The research area features unique tourism potentials, such as a lake, historic river, waterfall, attractive landscape, religious sites, and cultural practices, which will become a major tourist attraction. When properly planned and managed, the Bahir Dar and its surroundings area's ecotourism potential might be transformed into actual development. Ecotourism development is a complex activity that requires advance planning and fulfilment of preconditions. It is difficult to meet economic development and tourism development goals unless these conditions are addressed in considering environment protection and community participation.

This study demonstrated that land use land cover, topography, and infrastructure elements all have an impact on ecotourism development. Applying GIS methods in potential site selections like ecotourism can benefit a lot for local governments. AHP method has also plays significant role in giving ecotourism factors and be well utilized by researchers. Putting ecotourism on a really sustainable route is a significant issue that will require collaboration. Ecotourism is currently being used as a tool for generating green economy and environment protection. As a result, ecotourism development in Bahir Dar and its surrounding could help local community development and environmental protection if the community and other stakeholders play their respective roles appropriately and successfully. The selected potential sites can further be studied using geospatial technology to identify specific ecotourism activist that can be addressed in the study area.

5.2 Recommendations

The following recommendations are made based on the results:

- Awareness about the importance of ecotourism and collaborative approach and consultation among stakeholders; is needed in order to develop community sense of ownership over their resources.
- Ecotourism development demands comprehensive planning and collaborative strategy that includes multiple actors, stakeholders, decision makers, and implementers. In formulating ecotourism planning, the local or regional government should link all ecotourism components and characteristics to biodiversity conservation.
- The investor and localities in tourist areas should be encouraged to participate in ecotourism site developments.
- Recognizing local communities' feelings, interests, and engagement is critical when building a destination as a tourism attraction. Locals' and biodiversity's advantages cannot be overlooked, hence proper techniques for integrating local people in the development of tourism attractions are essential.
- Further studies should be made to identify which site suitable for specific tourism activity.

References

Aklbaşında, M. ve Bulut, Y. (2013). "Analysis of Terrains Suitable for Tourism and Recreation by Using Geographic Information System (GIS)", International Caucasian Forestry Symposium, 961-969.

Anderson.J.R., Hardy.E.E,Roach J.T.,and Witmer R. F. (1976), A land use A land cover classification system for use with remote sensing data, geological survey N.964,u.s.

Ardika, I.G. (2018). Sustainable tourism clear the path through communities. Jakarta: Kompas Penerbit Buku.

Aynalem S. (2016). Key stakeholders' roles and tourism development in Bale Zone, Ethiopia. World Acad J Bus Manag Admin, 1: 1-4.

Azam, M., Alam, M. M., and Hafeez, M. H. (2018). Effect of Tourism on Environmental Pollution: Further Evidence from Malaysia, Singapore, and Thailand. Journal of Cleaner Production 190, 330–338.

Baggio, R. (2008). Network analysis of a tourism destination. Thesis submitted for the degree of Doctor of Philosophy. School of Tourism, The university of Queensland. Queensland, Australia.

Banerjee, O., Henseler, M., Maisonnave, H., Beyene, L. and Velesco, M. (2017). An integrated model for evaluating investments in cultural heritage tourism in the Dominican Republic. Tourism Economics, in press. https://doi.org/10.1177/1354816617713229

Bayou HH, Bedane AF. (2014). Factors affecting development of tourism in Oromia Rift Valley lakes area, in Ethiopia. Int J Bus Manag, 4: 6388.

Berhanu, M., Raghuvanshi, T.K., and Suryabhagavan, K.V. (2017). Web-Based GIS approach for Tourism development in Addis Ababa City, Ethiopia. Malaysian Journal of Remote Sensing and GIS. 6, 26−38.

Birhan M, Gebreyes G. (2015). Review on problems, prospects and economic contribution of wildlife management and ecotourism in Ethiopia. J Vet Sci Technol, 6: 1-5.

Bishop, I.D. and Hulse, D.W. (1994). Predicting scenic beauty using mapped data and geographic information systems. Landscape Urban Plan, 30: 59-70.

Blaschke T. (2010). Object based image analysis for remote sensing. ISPRS J Photogramm Remotesens 65(1):2–16. https://doi.org/10.1016/j.isprsjprs.2009.06.004

Boluk, K. A., Cavaliere, C. T., and Higgins-Desbiolles, F. (2017). A critical framework for interrogating the United Nations Sustainable Development Goals 2030 Agenda in tourism. Journal of Sustainable Tourism, 25(9), 1201-1204.

Boniface, B. G., and Cooper, C. (2009). Worldwide destinations: the geography of travel and tourism. (5th Ed). Oxford, Butterworth Heinemann.

British Heart Foundation. (2022). Walks and treks FAQs. https://www.bhf.org.uk/how-you-can-help/events/training-zone/walking-training-zone/walking-faqs

Buhalis, D., Harwood, T., Bogicević, V., Viglia, G., Beldona, S., and Hofacker, C. (2019). Technological disruptions in services: lessons from tourism and hospitality. Journal of Service Management, 30(4), 484-506.

Bunruamkaew, K., and Murayama, Y., (2011). Site Suitability Evaluation for Ecotourism Using GIS & AHP: A Case Study of Surat Thani Province, Thailand. Procedia Social and Behavioural Sciences 21, 269-278.

Burrough, Mc., Donnell, R., McDonnell, R., Lloyd, C., (2015). Principles of geographical information systems.

Burrough. (2001). GIS and geostatistics: Essential partners for spatial analysis. Environ Ecology Stat 8

Ceballos-Lascurain, H. (1996). Tourism, ecotourism and protected areas: The state of nature-based tourism around the world and guidelines for its development: International Union for Conservation of Nature and Natural Resources, Gland, Switzerland.

Ceballos-Lascurain, H. (1996). Tourism, ecotourism and protected areas. IUCN (World Conservation Union). Switzerland: Gland.

Daily, G. (Ed.). (1997). Nature's services: Societal dependence on natural ecosystems. Island Press, Washington, DC. USA.

Dejene, S.W., Seyoum, H., and Ready, R.U. (2014). Ecotourism potential and its role for sustainable development and livelihood in Awash National Park, Ethiopia. Int J Sci Res, 3: 792-796

Dharmendra Kumar Dube. (2012). Challenges and Prospects for Promotion of International Tourism in Ethiopia: A Case Study of Bahir Dar. Science, Technology and Arts Research Journal

Dube, K., and Nhamo, G. (2018). Climate change and potential impacts on tourism: evidence from the Zimbabwean side of the Victoria Falls. Environment, Development and Sustainability, 1-17.

Elkington, J. (1998). Accounting for the triple bottom line. Measuring Business Excellence. 1998; 2(3):18–22.

Eshetu, A.A. (2014). Ecotourism as a viable strategy for livelihood diversification and sustainable natural resource management in Ethiopia (from eco-development paradigm point of view). J Environ Sci Water Res, 3: 40-52

Esri. (2022). Environmental Systems Research Institute (Esri) Weighted overlay. https://desktop.arcgis.com/en/arcmap/10.3/tools/spatial-analyst-toolbox/how-weighted-overlay-works.htm

Fu, C. (2012). The secondary development based on MapX-GIS of tourism design and implementation. Physics Procedia, 24(A), 651–659.

Gebreigziabiher AA. (2015). An assessment of potential resources of tourism development in Ethiopia. The case of Dejen Wereda. Afr J Hist Culture, 7:100−108.

Ghorbanzadeh, O., Pourmoradian, S., Blaschke, T., and Feizizadeh, B. (2019). Mapping Potential Nature-Based Tourism Areas by Applying GIS-Decision Making Systems in East Azerbaijan Province, Iran. Journal of Ecotourism 18 (3): 261–283.

Gigović, L., Pamučar, D. Lukić, and Marković, S. (2016). GIS-Fuzzy DEMATEL MCDA Model for the Evaluation of the Sites for Ecotourism Development: A Case Study of 'Dunavski Ključ' Region, Serbia. Land Use Policy 58, 348–365.

Giles, W. (2004). GIS applications in tourism planning. ISPRS Congress, Comm. II, 12-23 July 2004, Istanbul.

Gross, M., and Brown, G. (2008). An empirical structural model of tourists and places: progressing involvement and place attachment into tourism. Tourism Manage., 29: 1141−1151.

Hall, C. M. (2019). Constructing sustainable tourism development: The 2030 agenda and the managerial ecology of sustainable tourism. Journal of Sustainable Tourism, 1-17.

Hossain, M., Chowdhury, S.R., Das, N.G. and Rahaman, M.M. (2007). Multi-criteria evaluation approach to GIS-based land suitability classification for tilapia farming in Bangladesh. Aquaculture International, 15: 425-443. https://doi.org/10.1080/20964471.2018.1432115

Huang, J., Wan, J., and Xu, X. H. (2010). Development of a tourism GIS based on Web2.0. Beijing, China: 18th International Conference on Geoinformatics.

Hunt, C.A., Durham, W.H., Driscoll, L., and Honey, M. (2015). Can Ecotourism Deliver Real Economic, Social, and Environmental Benefits? A Study of the Osa Peninsula, Costa Rica. Journal of Sustainable Tourism 23 (3), 339–357.

Israel Petros Menbere and Timar Petros Menbere. (2017). Opportunities and challenges for community-based ecotourism development: A case study in Dinsho and Goba Woredas, Southeast Ethiopia.

Jaroslav Ramík. (2020). Pairwise Comparisons Method: Theory and Applications in Decision Making. School Business Administration Silesian University in Opava Karvina, Czech Republic. Spirnger. 690.

Jokar, P., Masoudi, M., and Karimi, F. (2020). An MCE-Based Innovative Approach to Evaluating Ecotourism Suitability Using GIS. Cuadernos de Investigación Geográfica.

Kalavar, J. Buzinde, C. Melubo, K. and Simon, J. (2014). Intergenerational differences in perceptions of heritage tourism, among the Maasai of Tanzania. J. Cross Cult. Gerontol., 29: 53−67.

Karan, E. P., Irizarry, J., and Haymaker, J. (2016). BIM and GIS integration and interoperability based on semantic web technology. Journal of Computing in Civil Engineering, 30(3), 401-412.
Keller, J.K., and Smith, C.R. (2014). Improving GIS-based wildlife-habitat analysis. https://doi.org/978-3- 319-09608-7

Keyser, H. (2002). Tourism development. Oxford: oxford university press.

Kim, J.H, (2018). The impact of memorable tourism experiences on loyalty behaviors: the mediating effects of destination image and satisfaction. Journal of Travel Research 57(7): 856–870.

Knox, M.W., Crawford, J., and Young. S. (2020). Ecotourism Emergence in Tasmania through Social Entrepreneurs and Authentic Leaders. In Global Entrepreneurial Trends in the Tourism and Hospitality Industry, edited by Debasish Batabyal, 84–111.

Koirala, B.S., and Pradhan, G. (2019). Determinants of sustainable development: Evidence from 12 Asian countries. Sustainable Development. 28(1):39–45.

Koprowski, R. (2017). Image pre-processing. Stud Comput Intell 682:21–38. https://doi.org/10. 1007/978-3-319-50490-2_3

Krumm, R.J., Erdmann, A.L., Joselyn, M.G. (2013). Geographic information system technology. Pit Quarry 85(12). https://doi.org/10.1007/978-1-4614-6439-6_1340-2

Lambin, E.F., Turner, B.L., Geist, H.J., Agbola, S.B., Angelsen, A., Bruce, J.W., Xu, J. (2001). The causes of land-use and land-cover change: moving beyond the myths. Global Environmental Change, 11:261-269.

Lemenih, M., Mesfin, D., Kindu, M., and Abebaw D. (2009). Benefit Sharing Mechanisms for the Bale Eco-Region Sustainable Management. Implemented by FARM-Africa/ SOS Sahel collaboration with the Oromia region Forest Enterprises Supervisory Agency, a Final Report. pp: 1–50.

Lena S. (2007). Models in Spatial Analysis: GIS information serious. Wiley & Sons, Incorporated, John

Li, C. and Duan, C. (2011). A study on the Web-GIS-based self- helped tourism information system–with a particular reference to Chengde City. International Conference on Strategic Management, DEC 21–23, 328–333, Phuket, Thailand.

Linton, D.L. (1968). The assessment of scenery as a natural resource. Scottish Geographical Magazine, 84(3): 219-238.

Longley, P.A., Goodchild M.F., Maguire D.J., and Rhind D.W. (2015). Geographic Information Science and Systems. UK: John Wiley & Sons.

Lu, D., and Weng, Q. (2007). A survey of image classification methods and techniques for improving classification performance. Int J Remote Sens 28(5):823–870. https://doi.org/10.1080/01431160600746456

Lwin KK, Murayama Y, Mizutani C. (2012). Quantitative versus Qualitative Geospatial Data in Spatial Modelling and Decision Making. J Geograph Inf Syst 4(3):237–241. https://doi.org/10.4236/jgis.2012.43028

Ma, H., Chiu, Y.H,, Tian, X, et al., (2020). Safety or travel: Which is more important? The impact of disaster events on touris.m. Sustainability 12(7): 3038.

Ma, J., Scott, N.R., DeGloria, S.D. and Lembo, A.J. (2005). Siting analysis of farm- based centralized anaerobic digester systems for distributed generation using GIS. Biomass Bioenergy, 28: 591-600.

Mahmoud, A-H, and Ahmad R. (2013). The smart city infrastructure development & monitoring. J Chem Inf Model 53(9):1689–1699. https://doi.org/10.1017/CBO9781107415324.004

Malczewski, J. (1999). GIS and multi criteria decision analysis. Wiley & Sons Inc., New York.

Malczewski, J. (2007). GIS-based multicriteria decision analysis: A survey of the literature. International Journal of Geographical Information Science, 20(7), 703–726. https://doi.org/10.1080/13658810600661508

Malczewski, J., and Rinner, C. (2015). Multicriteria Decision Analysis in Geographic Information Science. In Analysis methods (Issue Massam 1993). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-540-74757-4

Mennecke, Brian E., (2000). Understanding the Role of Geographic Information Technologies in Business: Applications and Research Directions, Journal of Geographic Information and Decision Analysis, 1(1), pp. 44-68.

Meseret C. (2010). Mammalian diversity in Borena Sayint National Park, South Wollo, Ethiopia. MSc. Thesis, Addis Ababa University, Ethiopia.

Miller, D., Morrice, J.G., Horne, P.L. and Aspinall, R.J. (1994). The use of geographic information systems for analysis of scenery in the Cairngorm Mountains, Scotland. In: Price, M.F. and

Heywood, D.I. (eds.). Mountain environments and geographical information systems. Taylor and Francis, London.

Missimer M., (2017). A strategic approach to social sustainability–Part 2: a principle-based definition. Journal of cleaner production. v. 140: pp. 11–52-2017 v.140.

Moldovanyi, A. (2003). GIS and multi-criteria decision making to determine marketability of pay pond businesses in West Virginia. Division of Forestry, West Virginia University. West Virginia.

Moya Calderón M, Chavarrı´a Esquivel K, Arrieta Garcı´a MM, et al., (2021). Tourist behaviour and dynamics of domestic tourism in times of COVID-19. Current Issues in Tourism 25: 2207-2211.

Pavlidis, G., Solomou, A., Stamouli, S., Papavassiliou, V., Kritsis, K., Kiourt, C., et al. (2022). Sustainable ecotourism through cutting-edge technologies. Sustainability 14, 800.

Phillips, P., and Moutinho, L. (2014). Critical review of strategic planning research in hospitality and tourism. Annals of Tourism Research. 48, 96-120.

Pleșoianu, D.-M., Grecu, E., and Popescu, A. (2018). The heritage of traditions and tourism facilities in Transilvania, Romania. Sci. Pap. Ser. Manag. Econ. Eng. Agric. Rural Dev. 18.

Prayag G and Ryan C. (2012). Antecedents of tourists' loyalty to Mauritius: the role and influence of destination image, place attachment, personal involvement, and satisfaction. Journal of Travel Research 51(3): 342-356.

Raghuvanshi, T.K. Belwal, R. and Solomon, N. (2006). An approach to develop Tourism Potential in Ethiopia through Geographical Information System. Conso. J. Hosp. Tour., 11: 35-42.

Rahman (2010). Applıcatıon of Gıs In Ecotourısm Development: A Case Study in Sundarbans, Bangladesh, Mid-Sweden University Master of Arts, Human Geography Focusing on Tourism.

Ramadan Mazrekaj. (2020), Impact of Road Infrastructure on Tourism Development in Kosovo, International Journal of Management, 11 (4), pp. 466- 474.

Ramanathan, R. (2001). A note on the use of the analytic hierarchy process for environmental impact assessment. Journal of environmental management, 63(1), 27-35.

Romeo R., Russo, L., Parisi F., Notarianni M., Manuelli S. and Carvao S., UNWTO. (2021). Mountain tourism – Towards a more sustainable path. Rome

Ronizi, S.R.A., Mokarram, M., and Negahban, S. (2020). Utilizing Multi-Criteria Decision to Determine the Best Location for the Ecotourism in the East and Central of Fars Province, Iran. Land Use Policy 99, 105095.

Ruma Dey Baidya. (2022). The Holiday Story: 18 Different Types of Tourism | Globally Accepted. https://www.theholidaystory.com/different-types-of-tourism

Saaty, T.L. (1977). A scaling method for priorities in hierarchical structures. Mathematical Psychology, 15: 231-281.

Saaty, T.L. (1990). Multi-criteria decision making: The analytic hierarchy process. RWS publication, Ellsworth Avenue, Pittsburgh, PA.

Saaty, T.L. and Vargas, L.G. (2001). Models, methods, concepts and applications of the analytic hierarchy process. International series in operations research and management sciences. Kluwer Academic Publisher.

Saaty. T. L. (1980). The Analytic Hierarchy Process, New York: McGraw Hill.

Saaty. T. L. (2003). Decision-making with the AHP: Why is the principal eigenvector necessary, European Journal of Operational Research, 145, 85–91.

Safran, P. (2015). Understanding Land Issues and Their Impact on Tourism Development: A Political Economy Analysis of Pohnpei, Federated States of Micronesia.

Scheyvens, R. (2018). Linking tourism to the sustainable development goals: a geographical perspective. Tourism Geographies, 20(2), 341-342.

Siakwah, P., Musavengane, R., and Leonard, L. (2019). Tourism Governance and Attainment of the Sustainable Development Goals in Africa. Tourism Planning & Development, 1-29.

STMP (2015). (Sustainable Tourism Master Plan), The federal democratic republic of Ethiopia sustainable tourism master plan 2015 – 2025. United Nations Economic Commission for Africa.

Suleyman Sisman, Irem Ergul, Arif Cagdas Aydinoglu. (2021). Designing GIS-based site selection model for urban investment planning in smart cities with the case of electric vehicle charging stations.

Suryabhagavan, K.V., Tamirat, H., and Balakrishnan, M. (2015). Multi-criteria evaluation in Identification of potential ecotourism sites in Hawassa town and its surroundings, Ethiopia. Journal of Geomatics. 9, 86−92.

Taibi, A., and Atmani, B. (2017). Combining Fuzzy AHP with GIS and Decision Rules for Industrial Site Selection. International Journal of Interactive Multimedia Artificial & Intelligence, 4(6).

Telfer, D.J., and Sharpley, R. (2015). Tourism and Development in the Developing World. London: Routledge.

Teressa, D.K. (2017). Ethiopia: changes from “People out Approach” protected area management to participatory protected area management. Insight from Ethiopian Protected Areas, 11:49–55.

Tewodros, K.T. (2010). Geospatial approach for ecotourism development: a case of bale Mountains National Park, Ethiopia. M.S. Thesis, Remote sensing and Geographic Information Systems (GIS) of Addis Ababa University, Addis Ababa.

Tim, B. and Martin, E.W. (1999). The application of geographical information systems (GIS) in sustainable tourism planning: A review. J. Sustain Tour., 7: 159–174.

Typical Ethiopian Blog, (2021). Bahir Dar -City History, Demographics, Climate & Tourist Attractions https://typicalethiopian.com/bahir-dar-city-history-demographics-climate-tourist-attractions/

Tolessa, T., Senbeta, F., and Abebe, T. (2017). Land use/land cover analysis and ecosystem services valuation in the central highlands of Ethiopia. Forests, Trees and Livelihoods, 26:111–123.

Torres, R., and Momsen, J.H. (2004). Challenges and potentials for linking tourism and agriculture to achieve pro- poor tourism objectives. Prog Devel Stud, 4: 294–318.
UNWTO (2011). (World Tourism Organization), World Tourism Barometer and Statistical Annex, November 2022 https://www.e-unwto.org/doi/epdf/10.18111/wtobarometereng.2022.20.1.6

Ustaoglu, E., Aydınoglu, A. C. (2020a). Site suitability analysis for green space development of Pendik district (Turkey). Urban and Urban Greening, 47, 126542. Forestry https://doi.org/10.1016/j.ufug.2019.126542

Ustaoglu, E., Aydınoglu, A.C. (2020b). Suitability evaluation of urban construction land in Pendik district of Istanbul, Turkey. Land Policy, 99, 104783. https://doi.org/10.1016/j.landusepol.2020.104783

Vacay Holics. (2018). Types of Tourism. Retrieved from: https://vacayholics.com/types-of-tourism

Van Kreveld, M. (2017). Geographic information systems. In: Handbook of Discrete and Computational Geometry, 3rd edn. 40(4):1555–1580. https://doi.org/10.1201/9781315119601

Villacé-Molinero, T., Fern´andez-Muñoz JJ, Orea-Giner A, et al., (2021). Understanding the new post-COVID-19 risk scenario: Outlooks and challenges for a new era of tourism. Tourism Management 86: 104324.

Vinodhini, E., Shanmugapriya, Veda S. Samhitha, and Geetha, P. (2016). A Case Study on the Land use Pattern of Kanyakumari District Using GIS. IOSR Journal of Applied Geology and Geophysics, 4(4), pp.36-41.

Voogd. (1983). Multi-criteria evaluation for urban and regional planning. Pion Limited, London.
Vizi, L., Marek, J., and Gejza, T. M. (2008). Tourism oriented GIS project for the district of Michalovce. Acta Montanistica Slovaca, 13(2), 248–253.

What Is Ecotourism? (2019). The international ecotourism society. What is ecotourism. https://ecotourism.org/what-is-ecotourism/

Wilkie, D., and Carpenter, J.F. (1999). Can nature tourism help finance protected areas in the Congo Basin? Oryx 33, 332-338.

Wilks, J., and Moore, S. (2004). Tourism risk management for the Asia Pacific region. An authoritative guide for managing crises and disasters. International Centre for Sustainable Tourism, Gold Coast, Australia.

Wishitemi, B.E., Momanyi, S.O., Ombati, B.G., and Okello, M.M. (2015). The Link between Poverty, Environment, and Ecotourism Development in Areas Adjacent to Maasai Mara and Amboseli Protected Areas, Kenya. Tourism Management Perspectives 16: 306–317.

UNWTO and ITF. (2019). World Tourism Organization International Transport Forum. Transport-related co2emissions of the tourism sector – Modelling results. UNWTO, Madrid. https://doi.org/10.18111/9789284416660

UNWTO. (2019a). World Tourism Organization. Walking tourism – Promoting regional development. https://doi.org/10.18111/9789284420346

UNWTO. (2019b). World Tourism Organization. UNWTO Tourism Definitions, UNWTO, Madrid, DOI: https://doi.org/10.18111/9789284420858.

UNWTO. (2021). World Tourism Organization. Recommendations for the transition to a green travel and tourism economy. https://doi.org/10.18111/9789284422814

World Tourism Organization Ecotourism and Protected Areas (2022). World tourism organization ecotourism and protected areas. https://www.unwto.org/sustainable-development/ecotourism-and-protected-areas

WTO (2021). World Tourism Organization, Recommendations for the transition to a green travel and tourism economy. https://doi.org/10.18111/9789284422814

WTO (2022). World Tourism Organization. Glossary of tourism terms, UNWTO. https://www.unwto.org/glossary-tourism-terms

World Tourism, (2000). Guide for local authorities on developing sustainable tourism. World Tourism organization, Madrid, Spain.

WTTC (2021). World Travel and Tourism Council, The Comparative Economic Impact of Travel and Tourism. https://wttc.org/Research/Economic-Impact

Wu, W., Zhang, X., Yang, Z., Qin, W., Wang, F., and Wang, C. (2015). Ecotourism suitability and zoning from the tourist perspective: A nature reserve case study. Polish Journal of Environmental Studies, 24(6), 2683– 2697.

Wulder, M.A, White, J.C., Hay, G.J., and Castilla, G. (2008). Towards automated segmentation of forest inventory polygons on high spatial resolution satellite imagery. Forestry Chronicle 84(2):221– 230. https://doi.org/10.5558/tfc84221-2

Yao, X, and Li, G. (2018). Big spatial vector data management: a review. Big Earth Data 2(1):108–129.

Zenker S, Braun E and Gyimóthy S. (2021). Too afraid to Travel? Development of a pandemic (COVID-19) anxiety travel scale (PATS). Tourism Management 84: 104286.

Zgura, D., Sabou, G.C., and Voicu A. (2012). Preserving the Heritage Using GIS Technologies, Proceedings of XXII International Conference of RESER: 136–143