Research Article

GIS and Remote Sensing Based Site Suitablity Analyisis for Tourism Development in East Gojjam Zone, Ethiopia

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ABSTRACT

Ethiopia has an enormous potential for tourism development owing to its long history and diversified natural and cultural attractions. This study is aimed at assessing the tourism potentials, challenges and mechanisms of tourism development using Geographic Information System and remote sensing in East Gojjam Zone. Six criteria and thirteen factors were considered for land suitability evaluation for tourism. These are landscape (visibility, land use land cover), wildlife (wildlife areas), topography (elevation, slope), accessibility (proximity to cultural sites, natural attractions, roads, river and town), vegetation and climate (rainfall, temperature). Further, purposive sampling was employed to identify 70 respondents for interview. The result revealed that 5% of areas were highly suitable and 9% were moderately suitable for tourism. Less and not suitable areas, on the other hand, accounts for 14% and 72%, respectively. Accessibility is a prerequisite for tourism development; and major tourist attractions such as heritage site, natural attractions and water bodies or lakes showed high suitability. The study further disclosed that lack of infrastructure, natural resources degradation, lack of tourism professionals, and poor coordination on stakeholders are some of the challenges of tourism development. The potential tourism resources of the area needed to be developed and well promoted in a desired way.

Keywords: Tourism; Multi-criteria evaluation; Remote sensing; Site suitability; Accessibility

INTRODUCTION

Tourism is a complex set of processes that involve economic, constructed and natural ecosystems, patterns of ownership, relationships between countries that produce and receive, and the relationships between the places where tourism takes place and the broader society [1]. Tourism entails nonresident travel and stay that is not related to any earning activity [2]. It comprises of activities of individuals who, for leisure, business and other purposes, travel to and stay in places outside their typical environment for no more than one consecutive year (UNWTO, 2012).

According to UNWTO (2012), tourism has become one of the most important socio-economic phenomena of our modern times. It is among the largest economic sectors, providing income, job and foreign exchange in many countries, through its multiplier effect stimulating a range of other related sectors. Tourism is also a key force for development and poverty alleviation in developing countries. In many small island developing states, reliant on tourism for their national economy, this activity can constitute up to 40% of GDP.

Both tourism and GIS share in common characteristics like crossing the application areas and the boundaries of disciplines. The tourism field uses GIS as a decision supporting tool in many tourism issues such as visitors flow management, tourism site suitability analysis and selection and proposed development sites, impact evaluation and sustainable tourism plans. Most studies indicated that GIS tool is strong and effective in tourism and recreation planning which can aid in the development of tourism industry effectively.

Ethiopia has enjoyed international prominence with a home of varied natural, historical, and cultural attractions. Fifteen of its heritages (8 cultural, 2 natural and 4 intangible heritages) have been registered by UNESCO as world cultural heritages. The total foreign and domestic tourist arrival in Ethiopia annually was 849,122 and 23,863,423 respectively in 2019 and generates
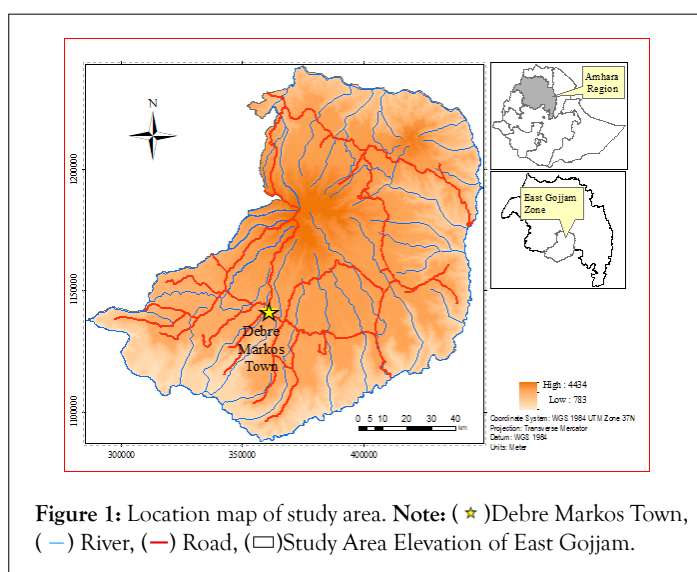
3,179,112,768 USA dollars. On the other hand the total annual foreign and domestic tourist arrivals in East Gojjam Zone was 2875 and 495188 respectively and generates 2,063,722.32 USA dollar in 2019. Ethiopia has great potential to develop the tourism industry.

There are plenty of natural beauty, cultural heritage and unique holiday celebrations that can attract international tourists. The study area is also rich in natural, historical, religious, traditional, and other tourist attractions. Due to its geographical location in and around Blue Nile (locally called Abay) Gorge, East Gojjam Zone is a naturally gifted area where many potential tourist attractions are found. The area is blessed with rich natural, historical, religious, traditional and other tourist attractions; though it's potential for tourism remains untouched.

Studies mentioned hereinbefore, focused on assessment of tourism potentials and they are depending on only existing tourist sites. Such studies did not attempt to identify potential tourist attraction sites of the Zone by employing any suitability analysis. Hence, the challenges and opportunities of tourism development in general are not yet explored in the study area and also none of them have used GIS and RS technology in their analysis. Therefore, the main objective of this study was to identify tourist attractions and the potential suitable areas of the Zone for tourism development using GIS and Remote Sensing.

Study area description and research methods

East Gojam Administrative Zone is one of the eleven Zones of Amhara National Regional State of Ethiopia. It constitutes 20 districts (also called Woredas) where 16 are rural Woredas while 4 of them are town administration Woredas. The Zone covers a total area of around 14,004 km². It is bordered on the south by the Oromia Region, on the west by West Gojjam Zone, on the north by South Gondar Zone, and on the East by South Wollo Zone. The bend of the Abay River defines the Zone's northern, eastern and southern boundaries. Its highest point is Mount Choqa (also known as Mount Birhan) which has an elevation of around 4100 meters above mean sea level (m a.s.l). Geographically, it extends from 9° 55' 01" to 11° 14' 12" north and from 37° 29' 37" to 38° 30' 18" east (Figure 1).

Figure 1: Location map of study area. **Note:** (★)Debre Markos Town, (─) River, (─) Road, (□)Study Area Elevation of East Gojjam.

East Gojjam Zone is characterized by different landscapes such as mountains (Choke Mountain and Aba Mentous Mountain), plateaus (Yetnora, Awabal and Anaded, Gozamin, Debre Elias) and

Gorges (Abay Gorge and Wamet). The study area occurs in the altitudinal ranges between 759 to 4100 m.a.s.l. The topographic variations coupled with diverse climatic conditions resulted in different vegetation types from Afroalpine and sub-afroal pine vegetations to Dry Evergreen Montane Forest and Combretum Terminalia Woodland [3]. There are about 85 plant species six of which are endemic to Ethiopia; 41 bird species including endemic Abyssinian Long claw (Macronyx Flavicollis), Wattled Ibis, Thick-billed Raven, White-collared Pigeon, and Black-winged Lovebird; and 16 large mammal species.

The total population of the East Gojjam Zone is 2,153,937, of whom 1,066,724 are men and 1,087,221 are women. With an area of 14705.36 square kilometers, this zone has a population density of 153.80/km². The urban population accounts 213,568 (9.92%) of the inhabitants. The largest ethnic group reported in this zone was Amhara (99.82%), and all the other ethnic groups combined were about 0.12% of the total population. Amharic is the primary language spoken by the total population. With respect to religion, 97.42% of the total population was followers of Ethiopian Orthodox Christianity, and the rest 2.49% were followers of other religions (CSA, 2007).

East Gojjam zone is endowed with varied natural and sociocultural tourist attraction sites. There are ancient monasteries with unique buildings possessing artifacts, spiritual belongings and gifts from Kings, traditional schools as well as indigenous trees and wild animals in a breathtaking landscape that date back to the 4th century. There are also several annual celebrations and festivities as well as bustling markets of touristic importance in the zone. There are ancient palaces that were used by the kings with throne beds and other artifacts; prominent battlefields. The Broken Bridge over River Abbay or Blue Nile built in the 17th Century used to cross over using a rope is also impressive.

The natural attractions of the Zone include beautiful lakes with sailing plants and floating stones, as well as large caves, nearby impressive gorge and natural forest. Impressive mountain chains that rise to 4000 meters above sea level such as Choke and Aba Menious, which are source of several streams, with diverse fauna and flora provide excellent attractions to the Zone. The magnificent Abay Gorgeis comparable in scale with the America's Grand Canyon, and is often cited to be the largest canyon in Africa. There are also spectacular water falls that drop to great depth and spray water droplets in align with birds' songs giving the place attractive features in the Zone.

MATERIALS AND METHODS

The main purpose of this study is to investigate the applicability of GIS and Multi-Criteria Decision Analysis (MCDA) in prioritizing locations for tourism development in East Gojjam Zone and perform a suitability analysis to achieve the study objective. In view of this, the most suitable criteria for tourism development were identified from literature and in consultation with tourism professionals and experts. The data for the criteria were mainly secondary data and primary data collected from fields. The spatial and statistical data that were used for this project was processed using Multi-Criteria Evaluation (MCE) methods and GIS tools [4-6]. A set of evaluation criteria were determined and indicators that are suitable for each criterion were selected for measurement. The related factors and criteria's are presented in spatial data layers and evaluated using different GIS analysis functionalities (reclassification, conversion

tools, raster analysis, weighted overlay etc.) in ArcGIS 10.5 suite [7]. The weighted layers were then summed up in a final suitability analysis and by developing web portal upload to internet for promotion of tourism.

Purposive sampling was used in identifying 5 woredas (out of the 20 Woredas in the zone) that have huge potentials of tourism resources and that were accessible for the researcher. These are Gozamn, Enemay, DejenDebere Elias and Machakel. Purposive sampling technique was used to select total of 70 samples from officials and experts working in the Zone and Woreda Culture and Tourism Department, the Zone and wereda communication department, hotel owners or managers and destination managers, and Church leaders of the study areas for the interview. In order to obtain full information, the participants of this study were selected purposely based on their work experience, position, educational background, skill and knowledge of experts on the subject of the research [8]. While collecting GPS data, interviews were also conducted with local residents in the vicinity of major tourist attractions [9]. The information gathered as such was analyzed to determine attraction sites, challenges, and mechanisms and tourism criteria's (Table 1 and Figure 2).

Table 1: Materials and software's for analysis of data.

| S No.	Data type	Sources	Resolution	Software for processing and analysis of the data
1	Landsat 8 image of the year 2020	United States Geological Survey (USGS)	30 m	ERDAS IMAGINE 2015
2	SRTM data or DEM	United States Geological Survey (USGS)	30 m	ERDAS IMAGINE.15 and ArcGIS10.5
3	GPS data	Filed survey		ArcGIS10.5
4	Vegetation	NDVI		ERDAS IMAGINE 2015
5	Topography data	EGII		ArcGIS10.5
6	Climate data	NMA (National Metrological Agency)		
7	Questionnaire	Filed survey		
8	Digital photo	Filed survey		
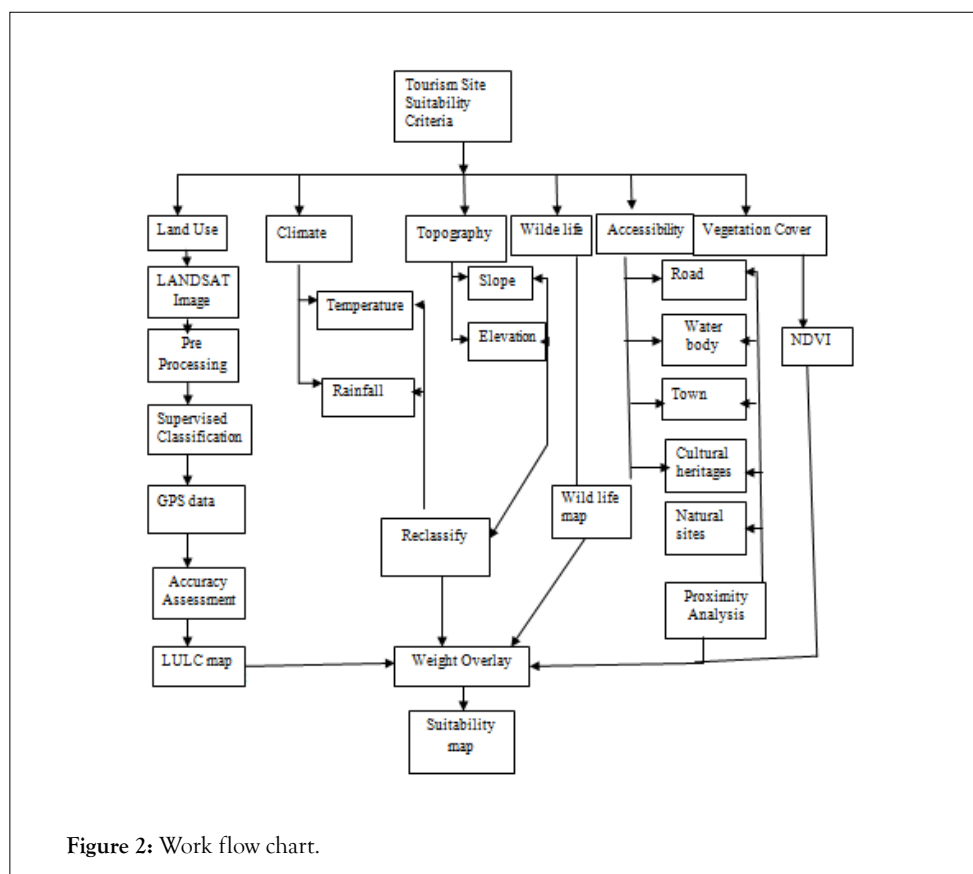
Figure 2: Work flow chart.

RESULTS AND DISCUSSION

Tourist attraction sites of east gojjam zone

According to the findings of this study, East Gojjam Zone has several tourism resources. The study assesses both the natural and cultural tourism potentials of the zone. The main natural tourist attraction sites of the study area which are registered by culture and tourism bureau of East Gojjam Zone were Merto Lemariam Monastery, Debre Work Maryam Monastery, Dimma Giyorgi Monastery, Saint Trinity Monastery, Debre Genet Elias, Aba Asrat Monasetery, Anktse Betshuan, Saint Lalibela Monastery,Washa Amba Abune Tekelehay manote Monastery, Kidus Markos Church, Abay Rufael Celebration, Aba Kostir Belay Zeleke and Associated Attractions, Aba Fakih Yasin Memorial, Yet Nora Market and King Tekle Haymanot Palace. There are also many natural attraction sites in the study area which includes Lake Bahire Giyorgis, Aba Menious Mountain, Minje Graveyard, Qebi Water Fall, Choke Mountains and Abbay Gorge (Figure 3) [10-12].

Suitability analysis for tourism development of the study area

Based on the acquired information from literature and experts/professionals opinion, there were 6 criteria determination and 13 factors classification for identifying and prioritizing the potential tourism sites. These are landscape (visibility, land use/cover), wildlife (species), topography (elevation, slope), climate (rainfall, temperature,) accessibility (proximity to cultural sites, natural attraction places, roads, towns, and water bodies) and vegetation cover [13-16]. Accordingly, suitability levels per parameters for tourism development were defined (Table 2 and Figure 4).

Suitability evaluation is the actual process of applying multi-criteria evaluation to different criteria or factors in order to arrive at certain decision. For tourism suitability, thirteen factor maps were produced and reclassified according to their degree of importance for tourism. According to this questionnaire, the prioritizing of factor maps (or simply factors or criterion) from highest to lowest is as follows: Cultural heritage map, Natural attractions map, wild life map, Rivers, Road, Town, NDVI, elevation, slope, land use, visibility, rainfall and temperature. Weight for each factor maps was assigned using Analytical Hierarchical Process (AHP). In practice, a CR of 0.1 or below is considered acceptable. Consistency ratio in this study was 0.047 which is less than 0.1. Therefore it is acceptable. The analysis was performed using AHP and GIS techniques. The AHP method was applied to determine relative importance of all selected factors [17]. For the final output, all factor layers were multiplied with their respective weights and added together. MCE is done based on 13 factor maps to produce the site suitability for tourism [18]. The total suitability scores range from 0 and 1. Finally, these values were further reclassified to create land suitability map for tourism (Table 3).

Figure 3: Some cultural and natural attractions of study area.

Table 2: Criteria and factors in land suitability analysis for tourism.

Tourism requirement factor suitability rating					
Criteria	Factors	Unit	Highly suitable	Moderately suitable	Low suitable	Not suitable
Landscape	Visibility	Line of sight	4-11 highly visible	0.75-4 middle visible	0-0.75 low visible	0 not visible
	LULC (land use/land cover)	Class	Forest, wetland and water body	Shrub and grass land	settlement	Farm land and bare land
Wildlife	Wild life areas	Class				
Accessibility	Proximity to cultural sites	KM	0-5 km	5-10 km	15-20 km	>20 km
	Proximity to natural sites	KM	0-5 km	5-10 km	15-20 km	>20 km
	Roads	KM	0-2 km	2-6 km	6-10 km	>10 km
	Towns	KM	0-10 km	10-20 km	20-30 km	>30 km
	Rivers	KM	0-2 km	2-4 km	4-6 km	>6

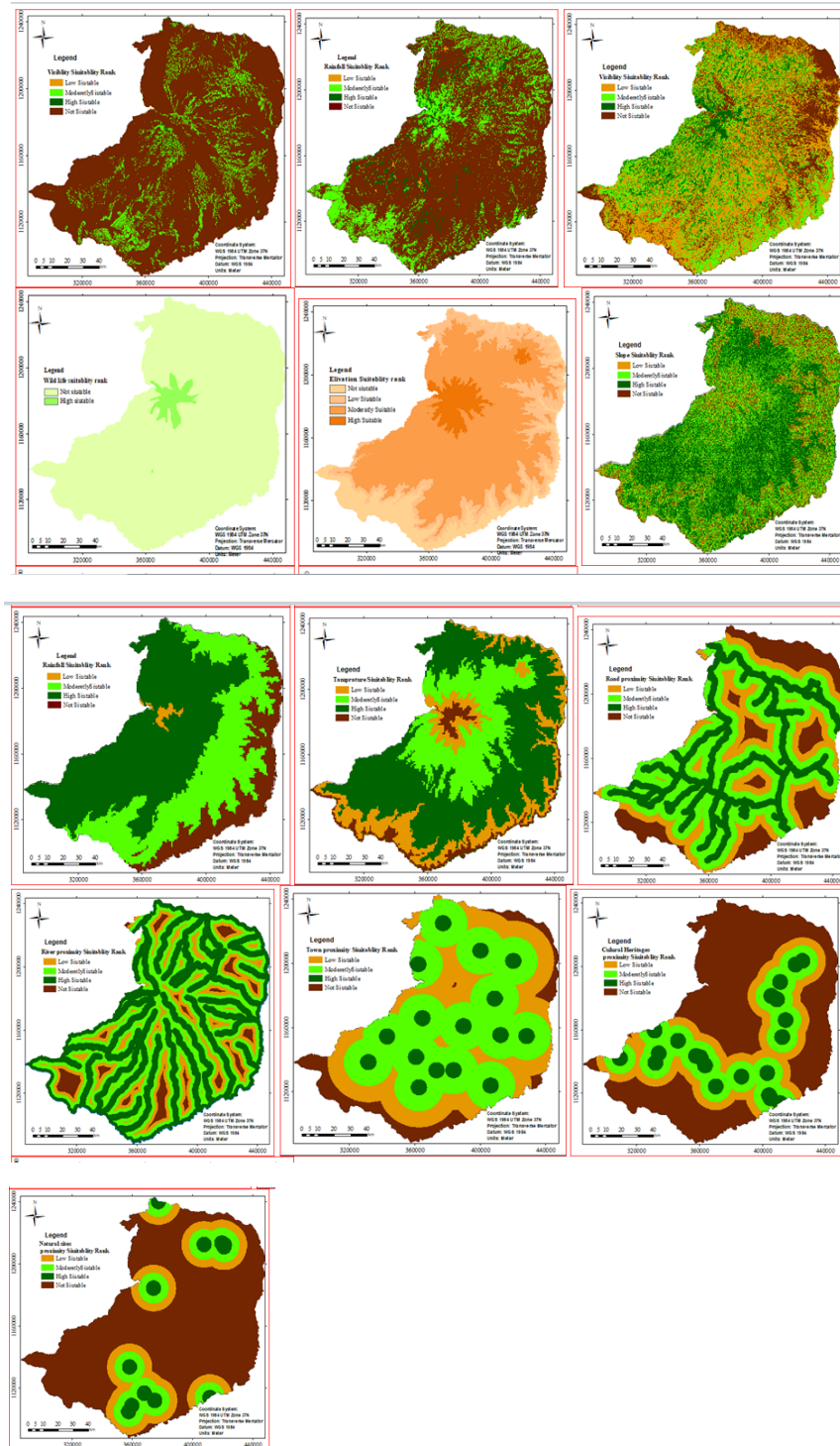| Topography	Elevation	Meter	>3000	2000-3000	1500-2000	<1500
	Slope	Degree	0-10%	10-20%	20-35	>35
Climate	Rainfall	MM	100-130 mm	85-100 mm	>135 mm	<85 mm
	Temperature	ᵒC	12-20	09-12	20-22	<9&>22
Vegetation	vegetation	Digital photo	Digital photo	Digital photo	Digital photo	Digital photo
cover	density	NDVI value	0.2-0.99	0.15-0.2	0.1-0.15	(-0.2)-0.1

Figure 4: Factor maps of each criteria's of suitability. **Note:** (■) Low Suitable, (■) Moderately Suitable, (■) High Suitable, (■) Not Suitable.

Table 3: Criteria's and their weight.

Criteria	Weight	Factors	Weight	Total suitability score
Accessibility	0.585	Proximity to cultural heritages	0.28	0.164
		Proximity to natural attractions	0.26	0.152
		Proximity to river	0.191	0.112
		Proximity to road	0.144	0.084
		Proximity to town	0.125	0.073
Wildlife	0.134	Wildlife areas	1	0.134
Topography	0.1	Elevation	0.55	0.055
		Slope	0.45	0.045
Landscape	0.07	LULC	0.543	0.038
		Visibility	0.457	0.032
Vegetation	0.061	NDVI	1	0.061
Climate	0.05	Rainfall	0.52	0.026
		Temperature	0.48	0.024

Finally, the total suitability scores from each factor were assembled to create site suitability map for tourism.

Suitability map=0.164 (cultural heritage map)+0.152 (natural attractions map)+0.134 (wildlife map)+0.112 (river map)+0.084 (road map)+0.073 (town map)+0.061 (vegetation map), 0.055 (elevation map)+0.045 (slope map)+0.038 (lulc map)+0.032 (visibility map), 0.026 (rainfall map)+0.024 (temperature map).

Highly suitable area for tourism development lies in the area where suitable capacity of locations is high and satisfies almost all criteria set up. The area is characterized by availability of forests, wildlife sanctuary, as well as rich cultural and natural heritage. The moderately suitable areas are found nearby the highly suitable areas where suitable capacity of locations is medium and satisfies most of the criteria set up, but some criteria are not satisfied. These are largely nearby natural and cultural heritages with green area, vegetation cover and great tourism potential with unique natural resources. So this area can be developed as tourism destination by facilitating proper tourism infrastructure and services under policy guidelines [19]. The least suitable areas are found in all parts of the study area where suitable capacity of locations is low and satisfies some of the criteria set up, but most of the criteria are not satisfied. These are predominantly covered by agricultural lands and located far from tourism infrastructures [20]. The not-suitable areas assume that all of the criteria are not satisfied. Accessibility is a prerequisite for tourism development. Major tourist attraction such as heritage site, natural attractions and water bodies or lakes showed strong green color on the map depicting high suitability (Figure 5).

In order to show the actual suitable sites for tourism, it is better to extract constraint factors from the suitable area. Agriculture is the dominant economic activity of farmers in East Gojjam Zone. Therefore agriculture or farm lands were considered as constraints for tourism development in the study area. This constraint/farm land/was extracted from land use land cover of 2020 and by clipping it from the suitable map the final suitable areas for tourism (Figure 6) [21].
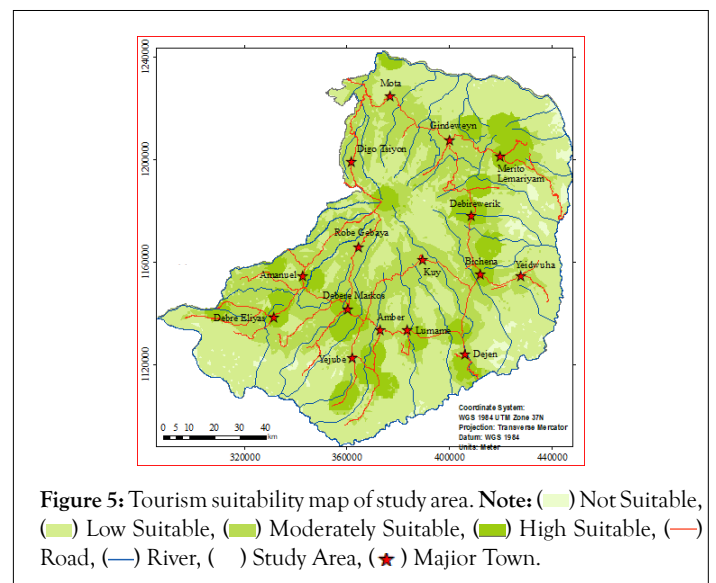

Figure 5: Tourism suitability map of study area. **Note:** ( ) Not Suitable, ( ) Low Suitable, ( ) Moderately Suitable, ( ) High Suitable, (—) Road, (—) River, ( ) Study Area, (★) Major Town.
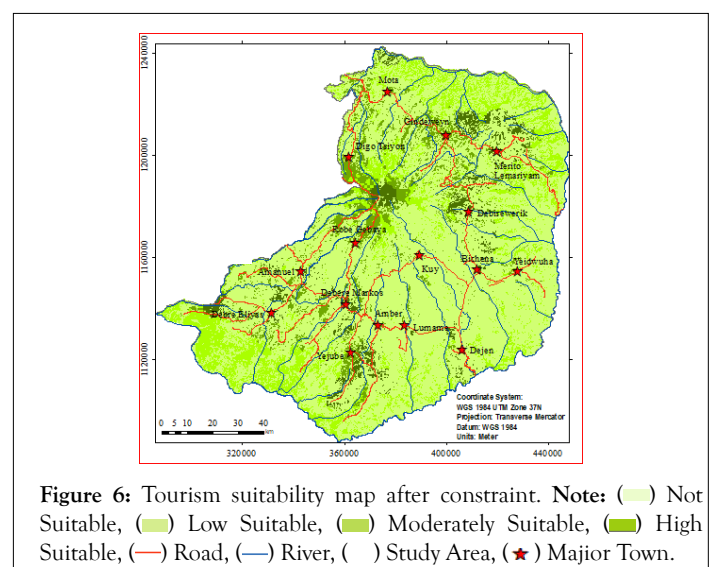

Figure 6: Tourism suitability map after constraint. **Note:** ( ) Not Suitable, ( ) Low Suitable, ( ) Moderately Suitable, ( ) High Suitable, (—) Road, (—) River, ( ) Study Area, (★) Major Town.

It was found that the area of highly suitable was about 5% (75009.92). The moderately suitable areas make up about 9% (124284.87 ha).Low suitable area accounts 14% (200441.78) and not suitable areas account the highest percentage of the area which is 72% (1001098.35 ha) (Figure 7).
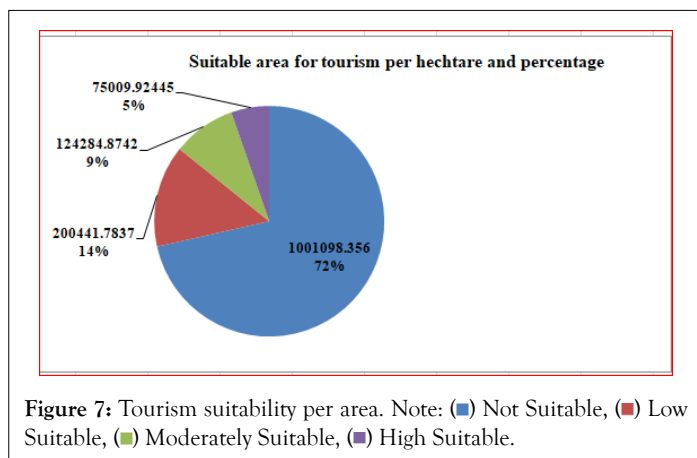

Figure 7: Tourism suitability per area. Note: (■) Not Suitable, (■) Low Suitable, (■) Moderately Suitable, (■) High Suitable.

That there is high tourism potential area around Choke Mountain and it is followed by Aba Montous Mountain and cultural heritage areas like Dima Gyorgis and Merto Lemariam [22,23]. This indicates that mountainous areas have high potentials because these areas have waterfalls, varieties of vegetation, wildlife and birds and amazing landscape that offer excellent attractions.

Without the constraint factor, the study area has high potential for tourism development. As such, based from the suitability map, it was found that the highly suitable areas comprise about 14% (189580.5 ha). The moderately suitable areas make up about 37% (523968.0 ha).Low suitable areas account the highest percentage of the area which is 47% (652937.6 ha). Only a small percentage (2%) of the area was classified as not suitable (Figure 8) [24].
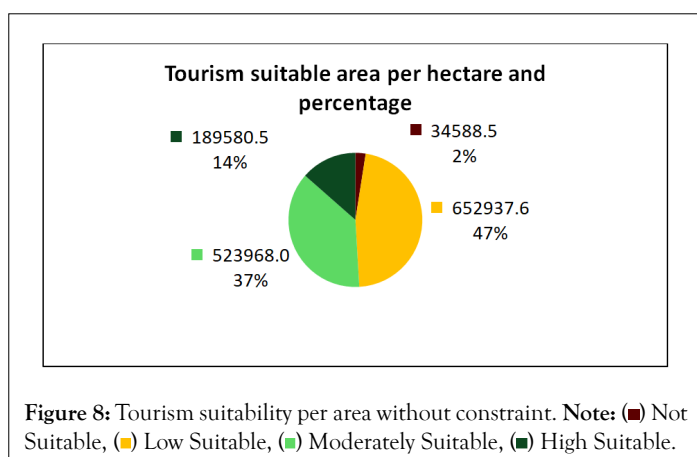

Figure 8: Tourism suitability per area without constraint. **Note:** (■) Not Suitable, (■) Low Suitable, (■) Moderately Suitable, (■) High Suitable.

Most of the respondents of the study disclosed that lack of transport service is the main challenge for the development of tourism in the area. Furthermore, respondents indicated lack of efficient telecommunication service as a challenge in the area. Other constraints that need to be addressed for the development of tourism in the Zone include expansion of health services for the residents and visitors; and provision of sufficient accommodation (hotel, restaurant, and pension) [25]. Lack of community awareness towards tourism resources of the area; and poor promotion of tourism resources are critical challenges for tourism development that need

to be addressed. Respondents also indicated the coordinated effort of different governmental and non-governmental stakeholders as pivotal for tourism development in the Zone. Preservation and conservation of heritages; and research undertaking on tourism are also possible mechanisms for tourism development in the Zone.

CONCLUSION AND RECOMMENDATIONS

East Gojjam Zone (EGZ) has huge cultural and natural potentials of tourism resources. These includes, beautiful landscape, wildlife species, attractive nature, indigenous plant species, caves, waterfalls and mountains, church school, indigenous hand crafts, monasteries (like Dima Gyiorgis and Mertule Maryam) and other tangible and intangible cultural tourism resources.

This study presents an integrated approach of GIS with AHP and MCE to assess the tourism suitability by matching the characteristics of an area with those attributes most appropriate for tourism. There were six criteria and thirteen factors in the form of 13 GIS-based layers incorporated for land suitability evaluation for tourism. These are landscape (visibility, LULC), wildlife (wildlife areas), topography (elevation, slope), accessibility (proximity to cultural sites, natural attractions, roads, river and town), vegetation (NDVI) and climate (rainfall, temperature). Highly suitable was about 5% (75009.92). The moderately suitable areas make up about 9% (124284.87 ha).Low suitable area accounts 14% (200441.78) and not suitable areas account the highest percentage of the area which is 72% (1001098.35 ha).

The most suitable tourism site identified according to the analysis is the area characterized by availability of forests, wildlife sanctuary, as well as rich cultural and natural heritage. Likewise, accessibility is a prerequisite for tourism development. Major tourist attractions such as heritage sites, natural attractions that include water bodies or lake showed high suitability.

Without the constraint factor, the study area has high potential for tourism development. There is high tourism potential area around choke Mountain and it is followed by Aba Montous Mountain and cultural heritage areas like Dima Gyorgis and Merto Lemariam. This indicates that mountainous areas have high potentials because these areas have waterfalls, varieties of vegetation, spectacular landscape, as well as wildlife and birds.

The findings of the study suggest the development of basic tourism infrastructural facilities and services (accommodation establishments) as well as improvement of road and transportation systems. It also calls for wildlife and environmental conservation; and the conservation and promotion of cultural resources such as monasteries and churches. The expansion of agricultural activities towards tourist attraction sites also needs appropriate attention and management.

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