An analysis of the development of Eco tourism based on the tourist and Geographical components using AHP - A case study of the Nilgiris District.

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***Abstract*—Eco tourism is a type of nature friendly tourism. Eco tourism plays an important role in the conservation of bio diversity and nature areas. They are many parameters which contribute to the growth of eco-tourism. In this study the tourists and geographical components promoting tourism in the Nilgiris district are identified and factor weights for each parameter using AHP are calculated. And the role of each parameter in the development of eco-tourism in the Nilgiris district is analyzed. The AHP is a partially quantitative technique which helps in making decisions by assigning weights to the parameters used, by computing the pair wise comparison matrix. In this study the CR value is 0.05 hence the factor weights derived using AHP is accepted for eco-tourism development.**

***Index Terms*—Eco tourism, AHP, Slope, Proximity to water and proximity to settlements.**

I. INTRODUCTION

Eco tourism is a type of tourism which aims to educate the travellers about the importance of conservation of the area at the same time allowing them to explore the nature. It is a type of nature friendly tourism. Eco and sustainable tourism are strongly connected with each other. The study area, The Nilgiris District of Tamilnadu is rich in eco tourist sites. The Government of Tamilnadu is taking all conservative measures in promoting tourism. The tourist spots in the Nilgiris district have been surveyed by the Government of Tamilnadu and it has planned to add a greater number of tourist spots including the forest areas.

The unique feature of the tourism industry is that the tourist product once developed is fixed in space and it cannot be easily transferred. Planning and development is very important stages in the tourism industry. The basic components and geographical components play an important role in the development of eco-tourism. The Tourism Industry includes the basic as well as geographic components Transport, Hotel Industry and local are considered as the basic components, while the geographical location, space, scenery, weather and climate, forest, landscape, wildlife, important settlement features are the Geographical components of tourism.

This paper attempts to evaluate the parameters in the eco-tourism development in the Nilgiris district by computing weights using AHP.

II. REVIEW OF LITERATURE

The subject of Geography has a great influence on tourism. Geographers study tourism on the basis of number of factors like landforms, climate, water bodies, the natural attractions, location of the tourism spot, vegetation and so on apart from studying tourism as an industry.

Pearce (1981) identified seven factors indicating the tourism potential of an area. Out of the seven factors climate is one of the important one in the mountain areas which attracts tourists. Robinson (1976) listed the Geographical components of tourism. Indrani Radhakrishnan (2021) has traced the history and heritage of the Nilgiris District, the tourism places, the events held in the district to attract tourists, the plants in the district their origin, the Toda tribes and the tea estates.

Vasanthi S (2012) as listed factors which affects the people to visit Nilgiris. The most preferred criteria is the Climate and natural beauty of the hills which draws a lot of tourists towards the hilly district. Swaminathan C (2017) has studied about the contribution of tourism in the economic development

of the Nilgiris district through the tax collection in the district by the Government, how the hotels, travel agencies are benefitted by the tourist. The shop keeper's income, the impact of tourism on agriculture also has been studied.

Ramamoorthi. D, Udaya kumar (2019) studies how mass tourism can destroy the natural landscape of Ooty by increasing pollution, soil erosion habitat loss and many more. The solution is sustainable nature-based tourism in Ooty which must be practised to reduce the negative effects.

Lakshumanan Chokkalingam, Pradeep Kishore.V, Viveganandan S, Krishna Kumar (2012) in their study about the land use land cover changes in the Nilgiris district using Remote sensing and GIS technology has found that the Nilgiris hill area is the most industrialized and commercialized hill area in the state. The swift commercialization of the Nilgiris district without improvements in the facilities will be a concern of the carrying capacity of the hills.

The scenic beauty of the hills is an important criterion in the hills. Cooke R U & Doornkamp JC (1974) highlights the importance of the Linton method which says that the scenic beauty of the hills raises as the altitude, slope and relative relief increases.

Imtiaz Ahmed Chandioa,, Matorib A N , Yusofb K, Hussain Talpurb M A ,Aminub M (2013) used GIS and Multi criteria Decision Analysis for finding out the land suitability in the hill areas for development in Malysia. Weights were given for the different factors and this result would be useful for planners. This method of combination of GIS and MCDA worked better in finding out the land suitability in hill areas.

Sanja Bozic, Miroslav Vujicic, James Kennel, Besermenji Senzana, Solarevic Milika (2018) has used the analytical hierarchy process in finding out the best cultural tourist destinations in Phuket Islands of Thailand. Six destinations in the island were selected and AHP process was applied. Twenty tourism experts' answers were used in the study and also from other tourists. Survey and questionnaire were used in identifying the preference for the cultural tourism. The study has found out that Phuket Old Town, Wat Chalong and the Big Buddha are the most attractive cultural sites. Accessibility and location is another important criteria for evaluation of cultural sites which occupies the first place in weight in AHP method followed by artistic value, infrastructure, aesthetic and other tourism assets.

Shrinwantu Raha, Madhumita Mondal, Shasanka Kumar Gayen (2021) has applied the Analytical Hierarchy Process and Geographical Information system in mapping of eco-tourism potential zones in West Bengal. The combination of three indicators physical, social and scenic beauty along with infrastructure has been used in the study. The methodology consists of four steps, framing hierarchy structure, pair wise comparison matrix, weights for the factors and eco-tourism potential mapping. About 61.65 percent area of West Bengal is suitable for eco-tourism.

III. AIM AND OBJECTIVES

The main aim of the study is about eco-tourism development in the Nilgiris district. The following are the objectives

- To identify the basic and geographical components of tourism in the Nilgiris district.
- To calculate the weights for each parameter using AHP and analyze the role of each parameter in the development of eco-tourism in the Nilgiris district.

A. Data sources and Methodology

Table 1: Tourist and Geographical Parameters used for study

Parameters	Data	source	Resolution
Slope (G)	SRTM DEM	USGS, USA	30 m
Topographical Roughness (G)	SRTM DEM	USGS, USA	30 m
Vegetation (G)	Landsat 8 Satellite Image	USGS, USA	30 m
Proximity to Road (PR) (T)		Bhukosh, Geological Survey of India	
Proximity to Settlement	Landsat 8 Satellite Image	USGS, USA	30 m

(PS) (T)			
Proximity to Water (PW) (T)	Landsat 8 Satellite Image	USGS, USA	30 m
Elevation (G)	SRTM DEM	USGS, USA	30 m
Visibility (G)	SRTM DEM	USGS, USA	30m
Rainfall (G)	Secondary Data	Ground water board Taramani	-

G – Geographical component T – Tourist component

B. Analytical Hierarchy Process

The AHP is a partially quantitative technique which helps in making decisions by assigning weights to the parameters used, by computing the pair wise comparison matrix.

The ranking of the relative priority of the parameters is performed by allotting a weight between 1 that signifies equal importance of the parameter and 9 that indicates extreme importance to the more important criterion, whereas, the reciprocal of this value is assigned to the other factor in the pair (Table 2).

To compute an average weight for each factor, the columns are initially normalized by dividing the elements of every column by the sum of the column and then summing all the elements in each resultant row and divide this sum by the number of elements in the row.

Table 2: Scale of relative importance in AHP

Preference Factor	Degree of Preference	Explanation
1	Equally	Two factors contribute equally to the objective
3	Moderately	Experience and judgment slightly to moderately favour one factor over another
5	Strongly	Experience and judgment strongly or essentially favour one factor over another
7	Very Strongly	A factor is strongly favoured over another and its dominance is showed in practice
9	Extremely	The evidence of favouring one factor over another is of the highest degree possible of an affirmation
2,4,6,8	Intermediate	Used to represent compromises between the preferences in weights 1, 3, 5, 7 and 9
Reciprocals	Opposites	Used for inverse comparison

Source: Satty table

To create a pair-wise comparison matrix (B), factors of each level and their weights are shown as: B1, B2, …, Bn and Y1, Y2, …, wn. The relative significance of bi and bj is shown as bij. The pairwise comparison matrix of factors B1, B2, …, Bn as B=[bij] is expressed as:

$$B = \{b_{ij}\}_{n\,x\,n} = \begin{bmatrix} 1 & b_{12}\cdots & b_{1n} \\ b_{21} & 1\cdots & b_{2n} \\ \vdots & \vdots\vdots & \vdots \\ b_{n1} & b_{n2}\cdots & 1 \end{bmatrix} = \begin{bmatrix} 1 & \frac{Y_1}{Y_2}\cdots & \frac{Y_1}{Y_{Nn}} \\ \frac{Y_2}{Y_1} & 1\cdots & \frac{Y_2}{Y_n} \\ \vdots & \vdots\cdots & \vdots \\ \frac{Y_n}{Y_1} & \frac{Y_n}{Y_2}\cdots & 1 \end{bmatrix}$$

In this matrix, the element, $b_{ij} = 1/b_{ji}$ and thus, when i=j, $b_{ij} = 1$. A matrix is normalized using equation as:

$$b_{ij} = \frac{b_{ij}}{\sum_{i=1}^{n} b_{ij}} \qquad i, j = 1,2, \ldots\ldots, n$$

And finally, weights of factors are computed using following equation:

$$y_i = \left(\frac{1}{n}\right) \sum_{j=1} n\, b_{ij}\ i \quad = \quad 1,2, \ldots\ldots, n$$

Subsequently, the quality of a matrix-based comparison among different factors is measured by the consistency ratio (CR), which is the consistency index of the matrix. The models with a CR value larger than 0.1 will be rejected (Malczewski, 1999) CR can be estimated by the following equation.

$$CR = \frac{CI}{RI}$$

where RI is the mean random consistency index, which depends on the order of the matrix given in Table 3; CI is the consistency index used to measure the deviation of the matrix, as expressed in the following equation.

$$CI = \frac{\partial_{max} - a}{a - 1}$$

Where ∂_{max} is the largest or principal eigenvalue of the matrix and can be easily calculated from the matrix, and n is the order of the matrix.

Table 3: Values of Random Consistency index

Order, n	1	2	3	4	5	6	7	8	9
RI	0.00	0.00	0.58	0.9	1.12	124	1.32	1.41	1.45

C. Geographical Parameters in eco-tourism development

Slope

Slope of the Nilgiris district plays an important role in the eco-tourism development. Classification of the slope is based on the degrees. Less than 8 degrees, 8 to 30 degrees and greater than 30 degrees. The low slope of 8 degrees and moderate slope of 8 to 30 degrees is considered important for the eco-tourism. Areas of low slope of 8 degrees are considered as high potential areas for eco-tourism. The figure 1 shows the map of slope variation in the Nilgiris district.

The following table 4 shows the percentage of slope variation in the Nilgiris district. The Northern part of the Nilgiris district shows the area in low slope. Less than 8 degrees of slope is noticed in 35.61% of the total area of the Nilgiris district. Moderate slope of 8 to 30 degrees is noticed in43.61% and high slope of greater than 30 degrees falls under 20.77% of the total area of the Nilgiris district.

Table 4: Area under different category of slope in the Nilgiris District

S.No.	Parameter	Category	Area (Sq.Km)	Percentage
1	Slope in degrees	< 8	918.74	35.61
2		8 -30	1125.22	43.61
3		> 30	536.02	20.77

Computed by the researcher

D. Topographical roughness

The topographical roughness is the second parameter used in identifying the eco-tourism suitability analysis in the Nilgiris district. If the elevation variation is more the place is not suitable for the eco-tourism. The region with higher topographic roughness indicates lower suitability for eco-tourism and the lower topographic roughness indicates higher suitability for eco-tourism site suitability analysis.

Table 5: Area under different category of topographical roughness in the Nilgiris District

S.No.	Parameter	Category	Area (Sq.Km)	Percentage
1	Topographical roughness	Low	676.98	26.23
2		Moderate	1001.35	38.81
3		High	902.06	34.96

Computed by the researcher

The above table 5 shows that about 26.23% of the total area of the Nilgiris district is suitable for eco-tourism development. The Figure2 shows the map of topographical roughness in the Nilgiris district.

E. Vegetation

The normalized differential vegetation index (NDVI) is used as an important parameter to calculate the forest cover. Higher NDVI values indicates the presence of forest areas. The NDVI values of the Nilgiris district is divided into three categories low, moderate and high. The higher values of NDVI is found in 27.83% of the total area of the Nilgiris district (Table 6). This area is falls in the Northern region and also in the central Nilgiris district. The figure 3 shows the map of vegetation cover of the Nilgiris district.

Table 6: Area under different category of NDVI in the Nilgiris District

S.No.	Parameter	Category	Area (Sq.Km)	Percentage
1	NDVI	Low	1158.41	44.89
2		Moderate	703.38	27.26

3		High	718.19	27.83

Computed by the researcher

F. Elevation

The most important physical parameter in the analysis is elevation. The Nilgiris district is identified as one of the hill districts of Tamilnadu by the Government of Tamilnadu. In this analysis the whole district is divided into three categories as less than 1000 meters, 1000 to 2000 meters and greater than 2000 meters. For identifying suitability rating for eco-tourism, 1000 to 2000 meters is considered highly suitable, less than 1000 meters as moderately suitable and greater than 2000 meters as low suitable. The interior of the Nilgiris district is highly suitable area where the elevation is around 1000 to 2000 meters. Overall, 26.49% of the Nilgiris district is having an elevation of 1000 to 2000 meters. The figure 4 shows the elevation map of the

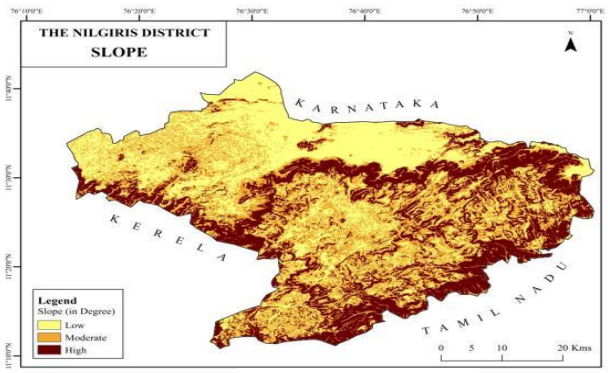
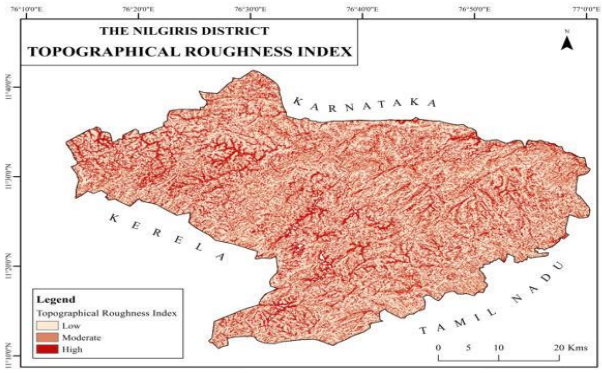


Fig. 1



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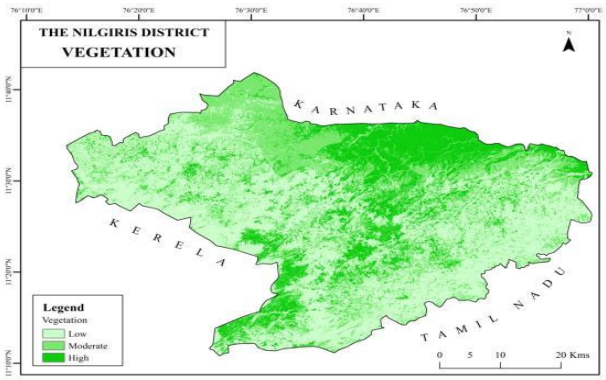

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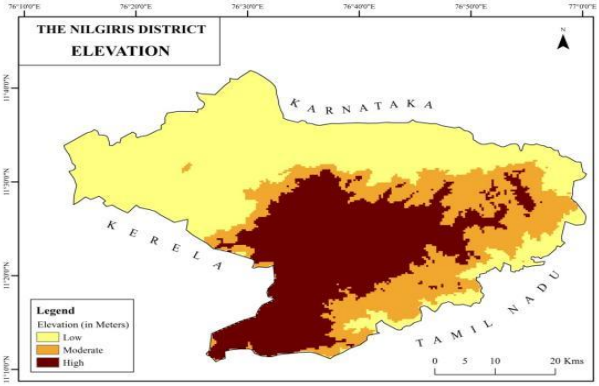

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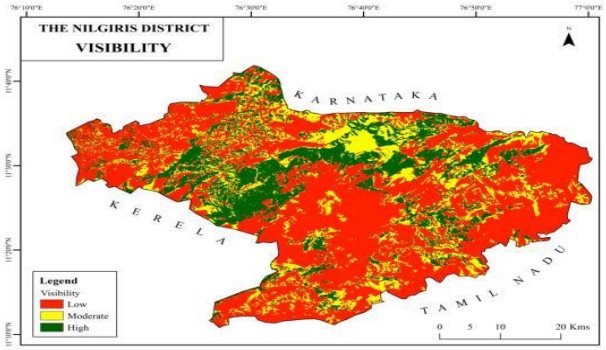

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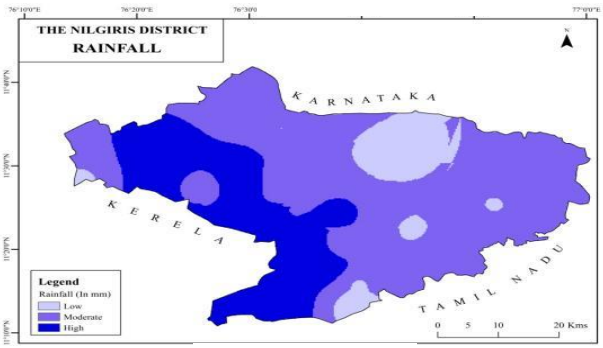

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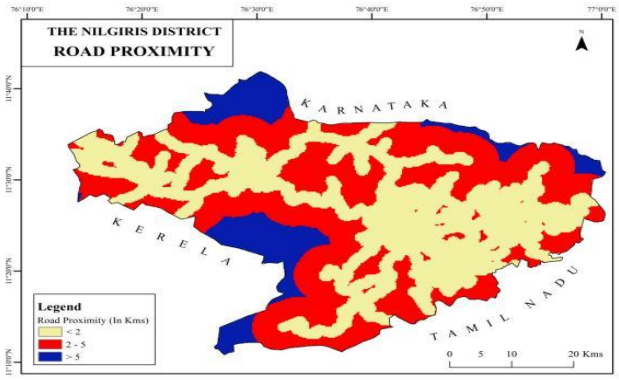

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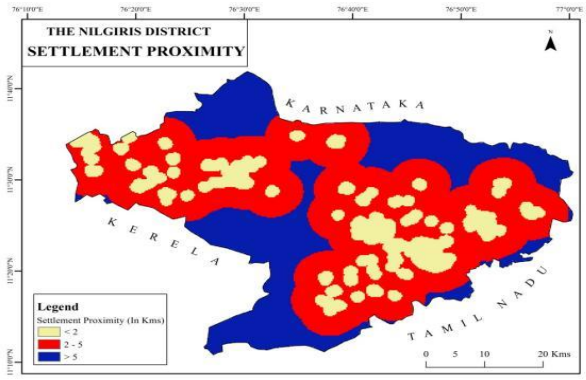

Fig 8

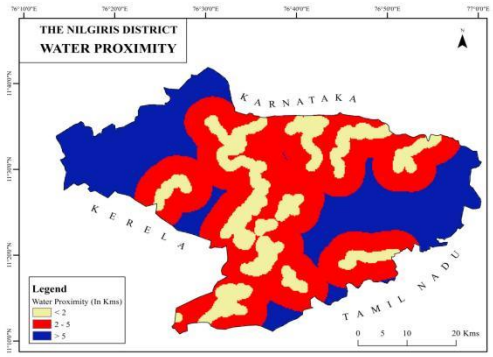

Fig 9

Nilgiris district. The following table 7 illustrates the area under each category of elevation in the Nilgiris district.

Table 7: Area under different category of elevation in the Nilgiris District

S.No.	Parameter	Category	Area (Sq.Km)	Percentage
1	Elevation	< 1000 m	1121.45	43.46
2		1000 m – 2000 m	683.54	26.49
3		> 2000 m	775.02	30.03

Computed by the author

G. Visibility

Visibility is also one of the most important factors for eco-tourism development. Only 20.05% of the total area of the Nilgiris district is near range and highly suitable for eco-tourism development. Table 8 and figure 5 shows the visibility of the Nilgiris district.

Table 8: Area under different category of Visibility in the Nilgiris District

S.No.	Parameter	Category	Area (Sq.Km)	Percentage
1	Visibility	Low	1555.13	60.27
2		Moderate	507.52	19.67
3		High	517.34	20.05

Computed by the author

H. Rainfall

The eco-tourism potential zone increases with increasing rainfall. Rainfall map is classified into three groups as low, moderate and high. Areas of high rainfall are noticed in the western side of the Nilgiris district (Figure 6). About 28.58% of the district is receiving high rainfall which has high eco-tourism suitability index (Table 9).

Table 9: Area under different category of Rainfall in the Nilgiris District

S.No.	Parameter	Category	Area (Sq.Km)	Percentage
1	Rainfall in cm	Low	378.76	14.68
2		Moderate	1463.75	56.73
3		High	737.48	28.58

Computed by the author

I. Tourist components

Proximity to road

Transportation plays an important role in the development of tourism. Tourists prefer the areas which are easily accessible. If the destination is less than 2 kms radius it is considered as the highly suitable site. About 31.02% of the total area of the Nilgiris district is highly suitable for the eco-tourism development (Table 10). The figure 7 shows the road proximity of the Nilgiris district.

Table 10: Area under different category of road proximity in the Nilgiris District

S.no	Parameter	Category	Area in sq.kms	Percentage
1	Proximity to road	> 5 Km	880.77	34.13
2		2km - 5 km	898.85	34.83
3		<2	800.36	31.02

Computed by the author

J. Proximity to settlement features

Settlement feature is one of the important components of tourism. It can be a town, city, village, historical remains, monuments and archaeological sites. Mans impact on the natural landscape is seen on the above features. For the development of eco-tourism, the settlement features must be far away from the natural areas. In this analysis three categories of proximity to settlement are taken into consideration. If the proximity to settlement is greater than five kilometer it is considered as the highly suitable factor for eco-tourism. The map 8 shows the map of proximity to settlement features. The following table 11 shows the percentage of area under different category of proximity to settlement features.

Table 11: Area under different category of settlement proximity in the Nilgiris District

S.No.	Parameter	Category	Area (Sq.Km)	Percentage
1	Proximity to settlement	> 5 Km	1032.56	40.02
2		2km - 5 km	732.81	28.40
3		<2	814.61	31.57

Computed by the author

From the above table it is found that about 40.02% of the total area of the Nilgiris district is suitable for the eco-tourism development.

K. Proximity to water

Waterfalls, lakes and dams are the water features that attracts the tourists to the Nilgiris district. If the eco-tourism site is near to any water feature it be an added advantage. Proximity to water is divided into three categories, less than 2 kms, 2 to 5 kms and greater than 5 kms. If a particular site is reachable in less than 2 kms it is considered as high suitable factor, 2 to 5 kms moderate and greater than 5 kms low suitable. In this way it is found from table 12 that only 28.76% of the total area is accessible from less than 2kms radius which is highly suitable for eco-tourism site suitability. The figure 9 shows the map of water proximity map of the Nilgiris district.

Table 12: Area under different category of water proximity in the Nilgiris District

S.No.	Parameter	Category	Area (Sq.Km)	Percentage
1	Proximity to water	> 5 Km	1090.02	42.24
2		2km - 5 km	747.78	28.98
3		<2	742.19	28.76

Computed by the author

L. Analyzing the eco-tourism suitability factors for the Nilgiris distict

The consistency of the matrix created using AHP is checked by the consistency ratio. The Consistency

ratio (CR) must be less than 0.10 for the matrix to be accepted. In this study the CR value is 0.05 hence the factor weights derived using AHP is accepted for eco-tourism development.

Table 13: Measures of Consistency ratio

S. No.	Parameters	Consistency measure	Consistency Index	Random Index	Consistency Ratio
1	Slope	3.10	0.10	0.58	0.09
2	NDVI	3.09	0.09	0.58	0.08
3	Elevation	3.07	0.07	0.58	0.04
4	PW	3.06	0.06	0.58	0.05
5	PS	3.00	0.00	0.58	0.00
6	PR	3.06	0.06	0.58	0.03
7	Rainfall	3.11	0.11	0.58	0.04
8	TRI	3.12	0.12	0.58	0.03
9	Visibility	3.09	0.09	0.58	0.07

Computed by the author

Table 14: Weights for the factors

S.No	Variables	Weights	Percentage
1	Slope	0.224	22.409
2	NDVI	0.162	16.235
3	Elevation	0.081	8.085
4	PW	0.155	15.532
5	PS	0.046	4.595
6	PR	0.070	7.032
7	Rainfall	0.045	4.491
8	TRI	0.139	13.921
9	Visibility	0.077	7.700
10	Consistency Measure		9.64
11	Consistency Index		0.08
12	Random Index		1.45
13	Consistency Ratio		0.055

Computed by the author

Out of the nine factors used slope plays an important role followed by vegetation and water proximity in the eco-tourism development in the Nilgiris district. The scenic beauty increases with mountain slopes, the Nilgiris district has a low slope of less than eight degrees with a percentage of 35.61 and with 43.61 percentage of moderate slope with eight to thirty degrees (Table 4). These areas of slope contribute to various landscapes, unique bio diversity, trekking and wild life. Vegetation contributes to the development of eco-tourism. About 27.83 percent (Table 6) of the Nilgiris has high vegetal cover. These areas can be used as nature walk area for promoting tourism. Water features can be used as the boating areas.

Out of the nine components two are Geographical components and one is the tourist components which are gaining higher priority weights.

IV. CONCLUSION

The Nilgiris district of Tamilnadu is the hill district with high tourism resources like scenic beauty, waterfalls, lakes, forts, temples, churches, museums, botanical gardens, telescope houses and more. Analytic hierarchy process is used to identify the weights for the factors. Totally nine parameters are used they considered are as geographical and tourist. The slope, topographical roughness, vegetation, elevation, visibility and rainfall are the Geographic and proximity to road, proximity to settlement and proximity to water is the tourist. A three-step analysis is used in this study. The first step was defining the

parameters, the second step started with the formation of the matrix and the third step is finding out the weights. This study used nine parameters for the analysis. Some more parameters like number of tourist spots in each taluk, accommodation units and road density of the taluks can also be included which will give more perspectives on the eco-tourism potential zones.

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