

Final Report on  
**Potential impact and opportunities for ecotourism in Annapurana Conservation  
Area**

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Submitted to  
**Rufford Small Grant Foundation, UK**

**2011**



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## **Acknowledgements**

During this study at University of South Australia (UniSA), I enjoyed considerable support from many organizations and persons. To all of them, I wish to express my deep appreciation. Firstly, I am grateful to the Rufford Small Grant Foundation for providing funds for this project. Annapurna Conservation Area Project for granting permission to conduct the field survey. Similarly my sincere thanks go to my supervisor, Mr David Bruce (Associate Professor at UniSA) and Dr Sekhar (Assistant Professor) who constantly helped me from proposal preparation to report writing. I would also like to thank Dr Peter Garson, Dr Philip McGowan and Natile Clark from World Pheasant Association, UK for guiding me throughout the project.

Deep appreciation for Mr Laxman Paudyal from Department of National Park and Wildlife Conservation, Nepal for providing habitat modelling data of the study area. Special thanks for my field assistant, Rinjin Sherpa and Man Bahadur Gurung.

Last but not the least my sincere thanks to Josh Cole and Board Committee from Rufford Grant Foundation for accepting my proposal which was a major milestone in executing this project.

## **Abstract**

*Annapurna Conservation Area is the one of the most famous tourist destination for trekking and hiking. It has one of the world's most attractive landscapes with various famous mountain peaks like Annapurna, Machaapuchre, Daulagiri and Mardi. Recently Annapurna Conservation Area Project (ACAP) has opened various trekking routes but there is no any research done on how these routes will get affected once it gets visitors and which of these route will attract most visitors. So this study aims at finding out which trekking route will get most so that management operation can be applied. GIS along with pair wise ranking of Analytical Hierarchy Process (AHP) was used to identify the most preferable trekking routes. Results shows that overall all the routes will get visitors but Route 1 will have the highest number of visitors with the variables used. It is recommended that further study and test of this model is required and in future web based route selection model can be implemented.*

**Key words: GIS, Multi-criteria analysis, ACA, AHP, Trekking route, Ecotourism**



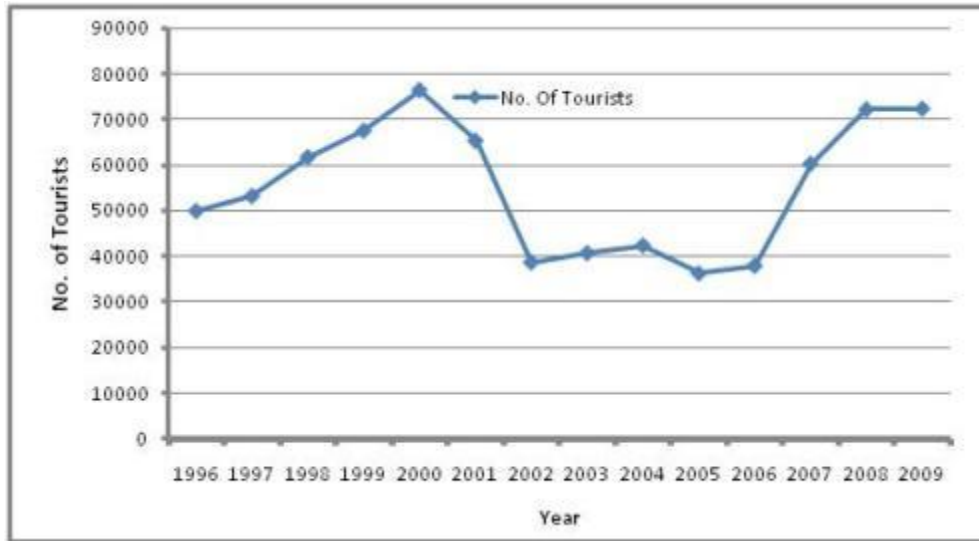
## **1. Introduction**

### **1.1 Tourism in Nepal**

Tourism is one of the largest industries in the world economy. The World Tourism Organization (WTO) predicts that by the year 2010 international tourism will involve 1 billion visitors and will contribute 11.6 percent of the global gross domestic product (GDP) (WTTC 1999). Similarly, it is estimated that mountain tourism constitutes 15 to 20 % of the global tourism (Agenda 1999). Mountain areas include more than 475 protected areas in 65 countries covering more than 264 million hectares. Additionally, 140 mountain areas have been designated as biosphere reserves by the United Nations Educational, Scientific and Cultural Organization (UNESCO). Protected areas include national parks where tourism is encouraged and promoted. In conservation areas in Nepal, as in game and wildlife reserves in many South African countries, sustainable forms of tourism are encouraged as a means of promoting wildlife conservation and meeting the livelihood needs of local people (Nepal 2000).

The mountain tourism in Nepal constitutes between 20 -25 percent of the total volume of tourism, but still it is a significant source of income for the many people living in and around mountain destinations such as Everest and Annapurna regions (Nepal 2007). Currently mountain tourism in Nepal is concentrated mainly in the Himalayan protected areas such as Annapurna, Everest and Lantang regions. The Annapurna region has been classified as conservation area, which is defined by its rich biodiversity conservation and traditional use of resources.

**Table1: Trend of number of tourist arrival in Annapurna Conservation Area from 1996 to 2009**



Data Source: Nepal Tourism Board, 2010

As seen on the table 1, the number of tourist arrival in Annapurna Conservation Area (ACA) was highest during 1999, which is significantly due to the government announcement of 1999 year as a visit Nepal year and since then due to internal arm conflict the tourist arrival has been decreased significantly till 2006 when the peace process started. Since then the number of tourist has been increasing in Annapurna Conservation Area. ACA offers number of attractions to the visitors which include its unique landscape with several high mountain peaks, rich biodiversity due to its great altitude variation and rich cultural significance.

## **1.2 Issues of sustainable tourism management in Nepal**

Trekking is the main mountain tourism activity in the Nepal. Although the ICDP approach of ACA project has done significant management practices, still there are various issues on sustainable tourism management in ACA such as dependency on firewood and timber for cooking and construction of tourist lodge (Nyaupane & Thapa 2004). In addition to deforestation, tourism have contributed to increased litter, inadequate sanitation and solid waste disposals in the mountain communities, while toilets built at the edge of local streams and rivers have resulted in water pollution (Wells 1994). Items such as paper, plastics, tins, glass bottles and other non-biodegradable material are frequently found on popular trekking routes (Nyaupane & Thapa 2004). Apart from the environmental issues, tourism has subsequently eroded traditional values and cultures. The commonly reported social-cultural impacts include, development of begging, commoditisation of traditional culture and arts, and changing family

and social structure and daily patterns of life (Wells 1994; Nyaupane & Thapa 2006; Nepal 2007). So there is always a need of proper management and implementation of tourism practices.

### **1.3 Geographic Information System (GIS) in sustainable tourism planning**

Looking back the history of application of GIS in tourism planning Boyd et al (1994) demonstrated the application of GIS in the identification of areas suitable for ecotourism in Northern Ontario, Canada. At first, a resource inventory and a list of ecotourism criteria were developed. At a next stage GIS techniques were used to measure the ranking of different sites according to the set criteria and therefore identify those with the best potential.

Mcadam (1999) reported the case of a GIS prototype application developed for monitoring the impacts resulting from the increasing number of trekking and special interest tourists in a remote region in Nepal. Shackley (1997) within her involvement in regional and site tourism management issues newly opened to visitors, Himalayan Kingdom of Lo (Mustang), Nepal, suggested the development of a GIS based spatially-referenced multimedia cultural archive. This archive, with data collected at an early stage of tourism development, would serve to monitor possible change through time. Rhind (1990) also described as routing a answering to a question, "Which is the best way?" The best way may be on the basis of diverse criteria such as shortest path, or the way that is passing through various key points. GIS can be powerful tool in such kind of analysis and better understanding of tourist flow in a given region or area. Tourism destinations are usually characterized by three different landscape features: points, lines, and polygons. Point features are individual tourist attractions, for example, a campground in a park, or a historic site along the highway. Streams and coastal beaches often follow a linear pattern, while habitat location or natural parks are characteristics of a polygon feature. These location attributes are essential to a Geographic Information System. It is apparent that GIS has tremendous potential for application in sustainable tourism.

Recently ACAP has opened various trekking route but there a lack of research on how many tourist will actually visit these trekking route and which route will be most preferred by the tourist so this study aim to find out which route will get busiest by the visitors so that proper management operation can be carried out before the area get deteriorated.



## 2. Study area

Annapurna Conservation Area (ACA) is located in the Western Development Region of Nepal. It was established in 1986 to protect the natural environment and to promote tourism through community participation. Covering an area of 7,629 km<sup>2</sup>, ACA is Nepal's biggest protected area, and includes some of the world's highest peaks, deepest gorge, most popular trekking destination, and rich biological, geographic, socioeconomic and cultural diversity. Ranging from subtropical to high Himalayas, ACA represents several eco-regions, including broad-leaf forests, pine forests, conifer forests and alpine meadows (Bajracharya, Gurung & Basnet 2007). It is an abode to more than 102 mammalian species, 488 bird species, 88 herpetofauna and 1,238 plant species, besides 100,000 human population and their livestock (Nepal 2000). The Annapurna region of Nepal is well known as a major tourist destination since the 1950s when Nepal opened its door to foreign visitors. Today it is the most trekked area in Nepal, attracting more than 60% of the total number of trekking tourists visiting the country annually (Nyaupane & Chhetri 2009).

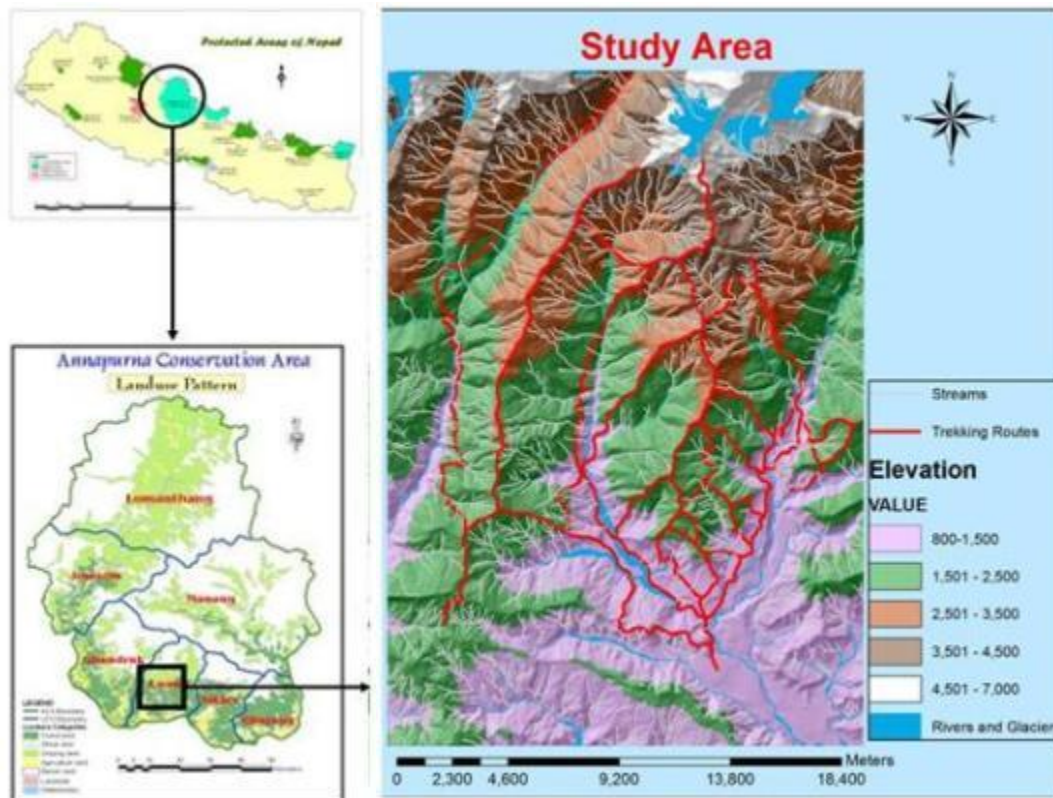


Figure 1: Map showing protected areas of Nepal and location of study area with different trekking routes, stream, rivers and elevation in metres

### 3. Methodology

#### 3.1 Multi-criteria decision making and GIS

Multi-criteria decision making (MCDM) is a term including multiple attribute decision making (MADM) and multiple objective decision making (MODM). MADM is applied when a choice out of a set of discrete actions is to be made. In MODM, it is assumed that the best solution can be found anywhere in the feasible alternatives space, and therefore is perceived as continuous decision problem (Jankowski 1994). GIS has good capabilities of handling spatial problems, and as such can be used to support spatial decision-making. Solving a complex multiple criteria problem without spatial analytical and visualization tools would be computationally difficult, if not impossible (Dye & Shaw 2007).

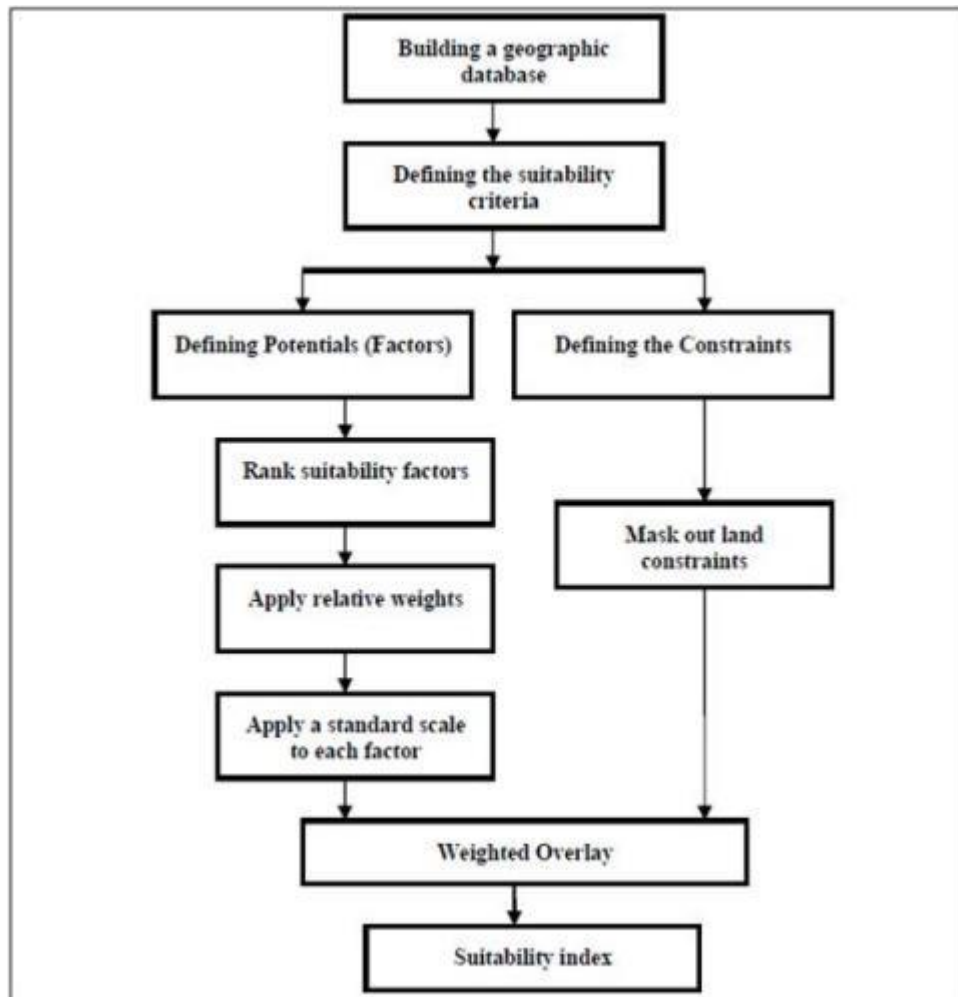


Figure 2: Flow chart of methodology adapted from Jankowski (1995), modified.

### **3.2 Selection of variables and criteria maps**

Selecting a proper variable (criteria) is always a difficult task in multi-criteria analysis. This can be done by means of literature study, analytical studies or survey of opinions. Literature can be found with some authors providing literature review of criteria to a specific spatial decision problem. Governmental agencies and governmental publications can provide guidelines for selection of criteria. Opinions' survey is aimed at people affected by decision or a group of experts, where several formalized techniques exists (Malczewski 2009). So, literature survey, analytical studies and expert opinions were used for the selection of variable for this study. The criteria selected for this study were slope of the route, length of the route, number of attraction point, number of facilities, scenic view and forest cover. All these criteria had natural measured scale, like meters, hectares etc. The field values were derived from spatial analysis. Another table was constructed to weight every criterion and then the total score for each alternative calculated (Jankowski 1994).

Criterion maps form an output of evaluation of variables identification phase. This follows after input of data into GIS (acquisition, reformatting, geo-referencing, compiling and documenting relevant data) stored in graphical and tabular form, manipulated and analysed to obtain desired information. Each criterion is represented at a map as a layer in GIS environment. The attributes need to be measured in certain scale, which reflects its variability. The scale can be classified as qualitative or quantitative. For example, in this study slopes, length of route were expressed in quantitative where as scenic view in qualitative.

### **3.3 Ranking or reclass of suitability factors**

Ranking of the criteria maps is a step prior to applying the relative weights. By looking at the various studies of the past, the ranking of the criteria maps was done. For this study Analytical Hierarchy Process (AHP) using of pair wise ranking method developed by Saaty (1980) was used. Analytical Hierarchy Process (AHP) uses pair-wise comparison method for criterion weighting. The method is carried out in three steps.

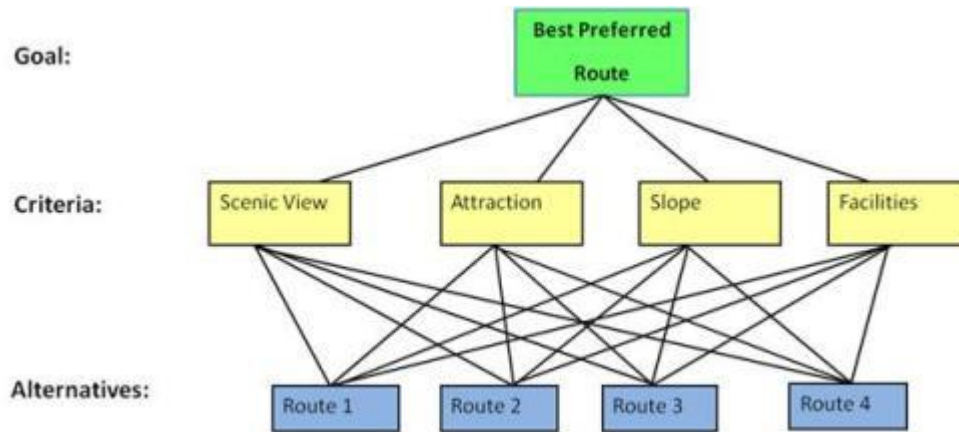


Figure 3: AHP process

Firstly, pair-wise comparison of criteria is performed and results are put into a comparison matrix. The matrix is populated with values from 1 to 9 and fractions from  $1/9$  to  $1/2$  representing importance of one factor against another in the pair. The values in the matrix need to be consistent, which means that if  $x$  is compared to  $y$  receives a score of 5 (strong importance),  $y$  to  $x$  should score  $1/5$  (little unimportant). Something compared to it gets the score of 1 (equal importance). The linguistic explanation of scores is attached to the table. The next step is to calculate criterion weights. Firstly, values from each column are summed and every element in the matrix is divided by the sum of the respective column. The new matrix is called normalized pair-wise comparison matrix. Finally, an average from the elements from each row of the normalized matrix is calculated. The consistency ratio is calculated in order to make sure whether the comparison of criteria made by decision maker is consistent. Weights received by this method are interpreted as average of all possible weights.

Table 2: Pair wise ranking of different variable using AHP

criteria preferences	view	length	slope	attraction	facility	forest_5m	forest_25m	forest_50m
view	1	3	4	5	5	7	8	9
length	1/3	1	3	5	5	7	8	8
slope	1/4	1/3	1	3	4	5	7	8
attraction	1/5	1/5	1/3	1	1	3	4	5
facility	1/5	1/5	1/4	1	1	3	4	5
forest_5m	1/7	1/7	1/5	1/3	1/3	1	3	5
forest_25m	1/8	1/8	1/7	1/4	1/4	1/3	1	3
forest_50m	1/9	1/8	1/8	1/5	1/5	1/5	1/3	1

CI: 0.1094 CR: 0.0781  $\lambda$ : 8.7658

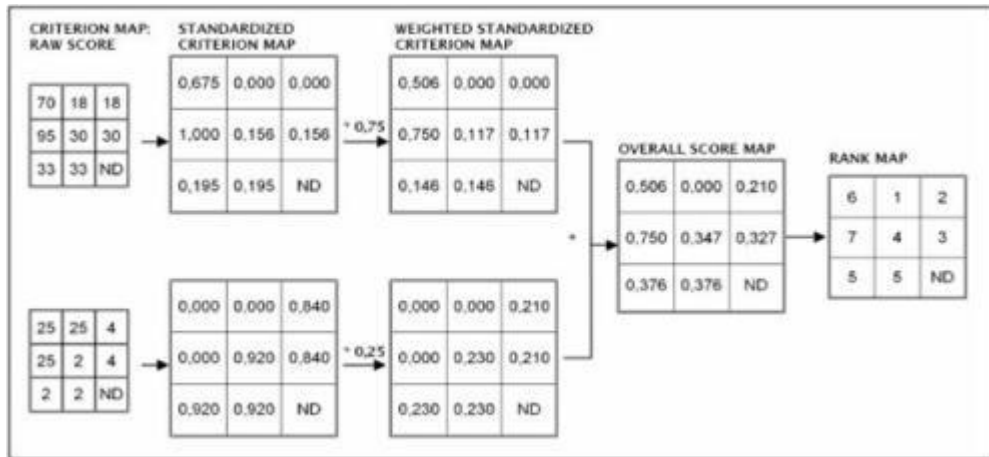


Figure 4: Simple additive weighting method performed in GIS on raster data adopted from (Malczewski 2009)

#### 4. Results and Discussions

##### 4.1 Criteria maps

Different criteria maps were prepared for the different variables selected for the study. These criteria or variables were selected from available literature. So slope criteria (Figure 5), similarly route length criteria, forest area criteria, attraction point criteria, Facilities criteria and scenic view criteria (Figure 6) were created. Later these criteria maps were re-classified for further analysis.

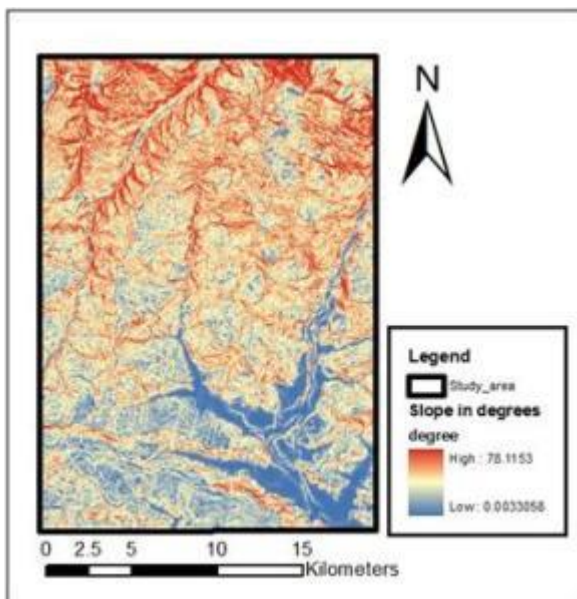


Figure 5: Slope criteria of the study area

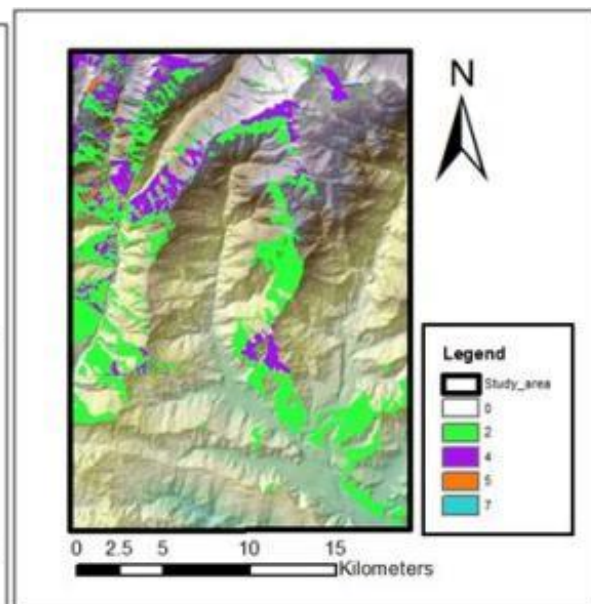


Figure 6: View shed analysis from different view point

#### 4.2 Reclass of the criteria maps

After the criteria maps were prepared these criteria maps were then reclassified with a certain uniform scale which was applied to all the criteria maps so that a certain standard was maintain, which helped in comparing these values of these criteria maps. While reclassing these criteria maps again available literatures were considered with expert opinion.

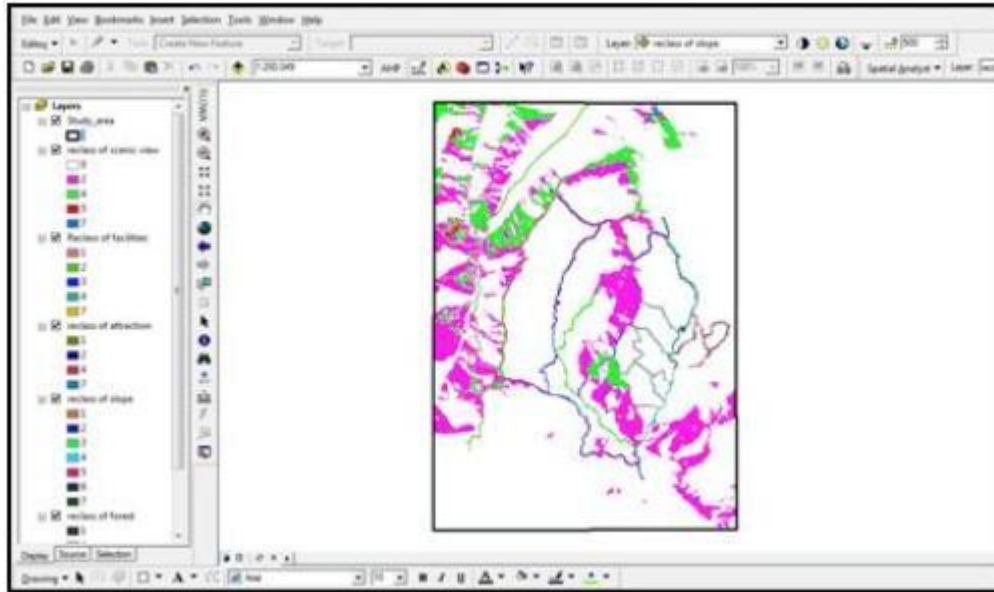


Figure 7: Reclass of different criteria maps in a certain uniform scale in ArcGIS interface

#### 4.3 AHP analysis

After each criterion maps were reclassified to a uniform scale (standardization), the calculated AHP was then multiplied to each of these reclassified criteria maps. The Figure 8 shows the output of the AHP pairwise ranking of different criteria with their relative weight. The Figure also shows the view/scenic has the high weight with forest with 50 meters far from each trekking route as least weight.





Figure 8: Result of the AHP analysis of different criteria from scale 0 to 1

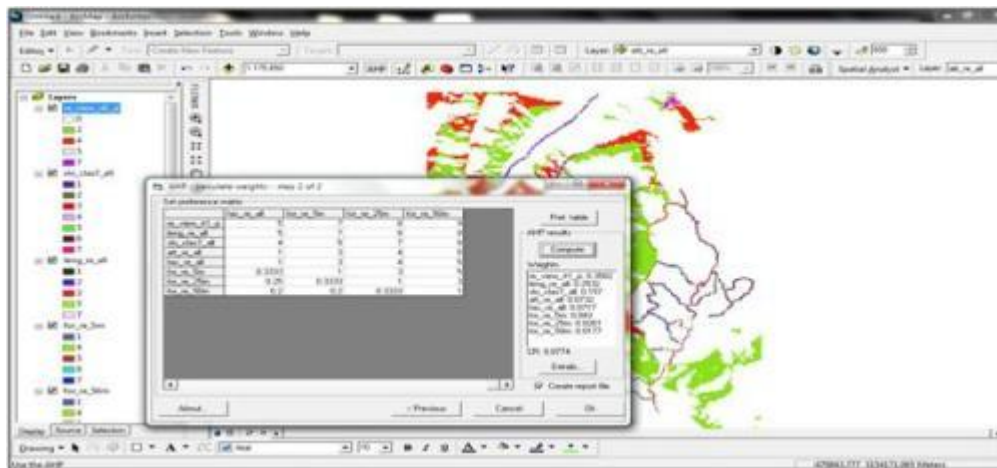


Figure 9: AHP analysis using ArcGIS script in an ArcGIS interface

#### 4.4 Final overlay and decision making

Once the weight of each variable was computed, it was then multiplied with the reclassified value of the criteria maps and over all weighted score map was created using the raster calculator. Finally these values were then divided by the length of each route for decision making.

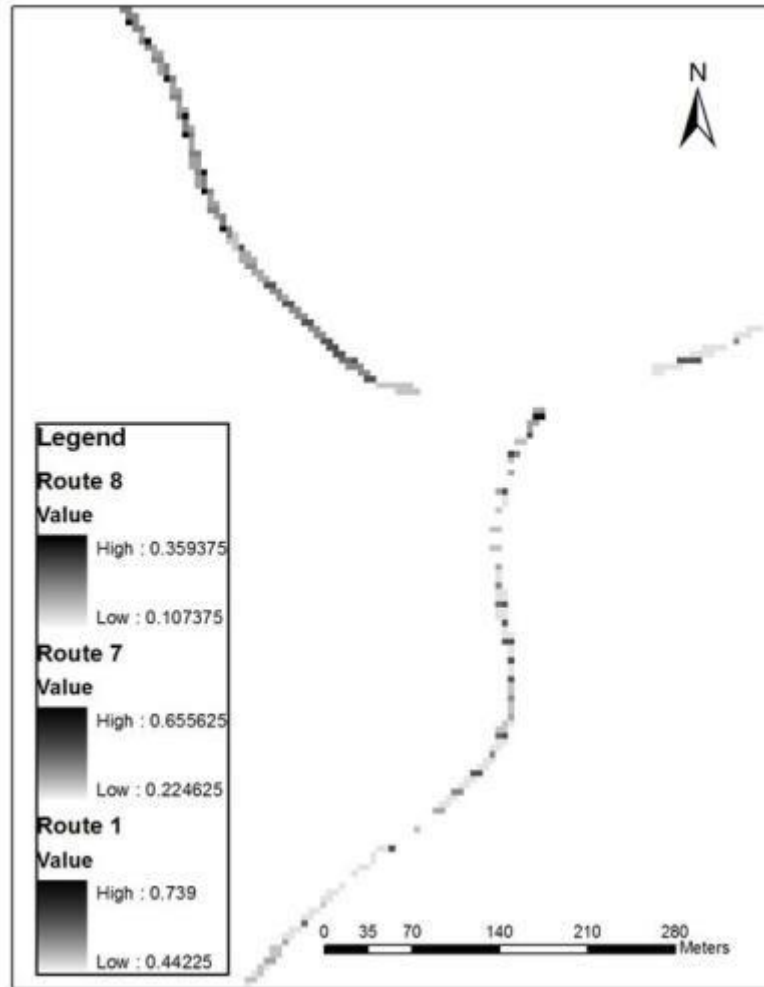


Figure 10: Result of overall weighted of Route 1, 7, 8 multiplied with AHP score on scale 0-1

Figure 10 shows the result of the multiplied reclassified criteria map and AHP value of three different trekking routes. Here we can see route one has value ranging from 0.44 to 0.73 while route 7 has value ranging from 0.22 to 0.65 and route 8 has value ranging from 0.10 to 0.35. These values assume that each trekking route is of same length. So assuming each of these is of same length by just looking at the values in first instance we can say route 1 has high value in compare to others.



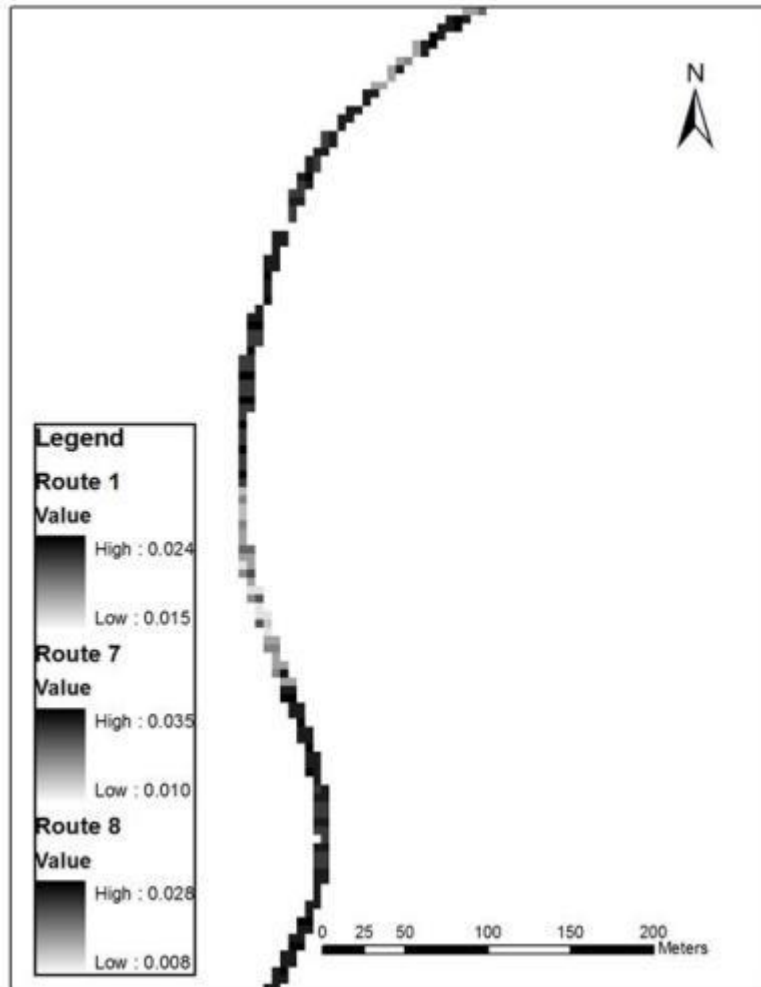


Figure 11: Result of overall weighted of Route 1, 7, 8 multiplied with AHP score and with weighted length of route.

The Figure 11 is a map showing each value derived by multiplying the overall weighted to the length of each route. So the value represents the value of each route per km. Now it can be seen that each of these routes has a very low number of differences in value from each other with the overall high value to low value representing the route 7, route 8 and route 1 respectively.

Table 3: Total weight of three different trekking routes

Routes	Value	Counts	value*Count	sum
Route 1	1	3166	3166	10082
	2	3458	6916	
Route 7	1	1323	1323	2861
	2	769	1538	
Route 8	1	1766	1766	3004
	2	619	1238	

The Table 3 shows the total value each route has given that value 1 represents low scale value from 0-3 and value 2 represents high scale value from 4-7 on a 0-7 scale. So here we can clearly see that Route 1 has the highest value so it has the capacity to attract highest number of visitors per km. It can be seen how the weight varies within the route with more and more decision rules are applied. It can also be seen from Figure 12 that if 100 tourists travel through those trekking route, route 1 will receive 19 tourists while route 6 will receive only 8 tourists.

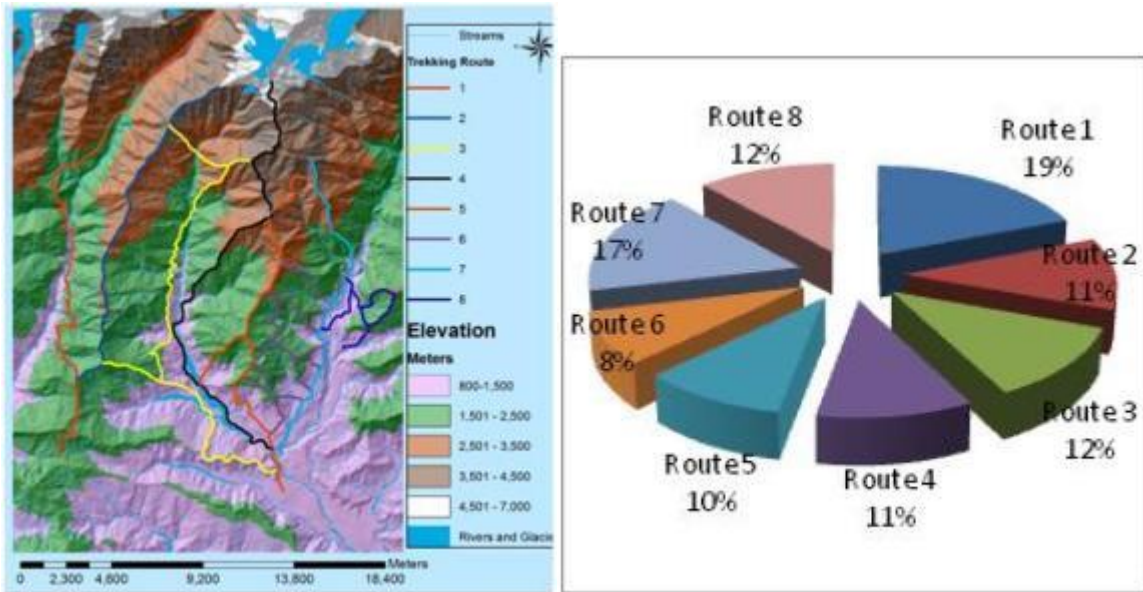


Figure 12: List of trekking route in the study area and pie-chart showing the attraction percentage of each route

#### 4.5 Impact of Trekking (Tourism) on Pheasant habitat

Once the trekking route was modelled, this map was then overlaid with threatened pheasant potential habitat studied by Paudyal (2008). The analysis shows that route 7 has the highest impact on pheasant's habitat in term of intensity but route 2 has the highest impact on pheasant habitat in terms of area (Figure 13). This concludes that more environmental precaution should be applied to the trekking routes which have the higher impacts on pheasants or alternative route should be discovered with less impact on threatened pheasant's habitat.

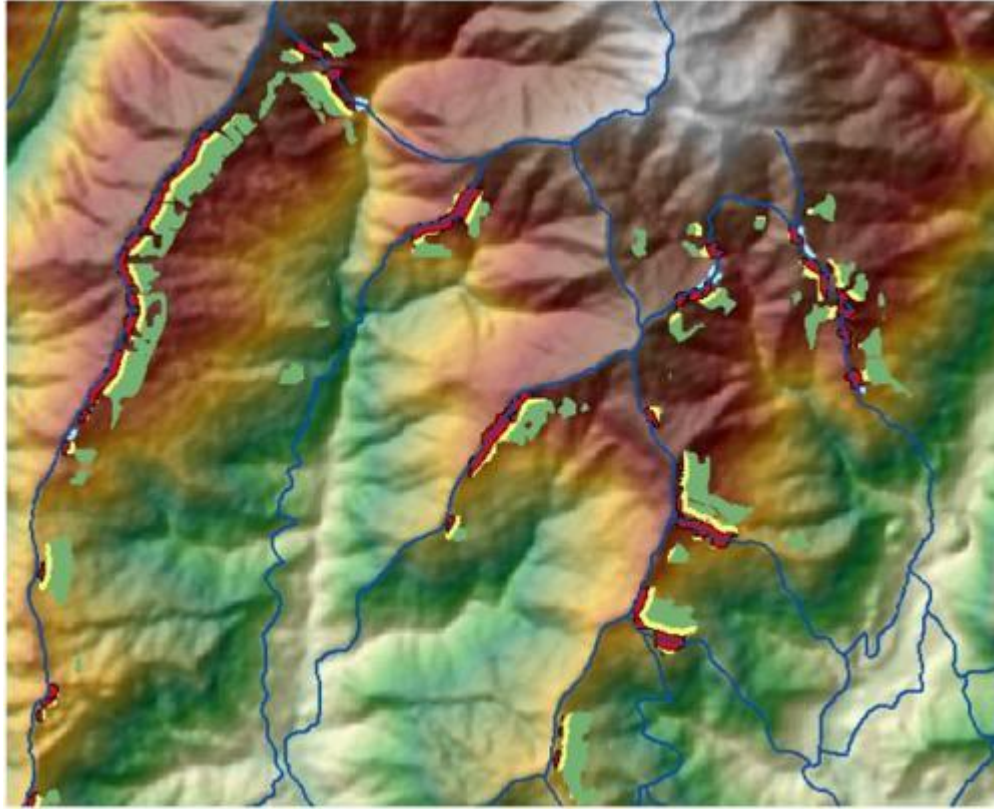


Figure 13: Impact of trekking route on pheasant's habitat where red, yellow and green indicate highest, moderate and low impacts respectively

## 5. Conclusions and Recommendations

Lastly, it can be seen how GIS along with multi-criteria analysis we can model the trekking route taking different variables in consideration. So, wise selection of variables along with robust reclassification and application of AHP trekking route of Annapurna conservation area can be modelled. Here Route 1 has the highest visitor attraction value and which is true as this route is the busiest route in the region. It can also be concluded that application of AHP script on ArcGIS is a very useful tool in analysis of weight of given variable. It is recommended that this model should be tested with the real flow of tourist and once it is proved, it model can be used in other protected areas of Nepal. It is also recommended that further study need to done with the field visit and once this model is proved it can be developed as a web base and help visitor to know actually which route they will prefer according to selection of different variables.

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