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**India**

# Identification of Optimum sited for Ecotourism development in Nainital City, Uttarakhand.

**Dr. Zubairul Islam**
*Assistant professor, Department of Geography, Adikeih College of Arts and Social Science, P.O. Box 59, Eritrea, N. E. Africa, E-mail: zubairul@gmail.com

## Abstract

The objective of this work was to find out the most suitable places for eco-tourism development in Nainital city. Primarily this city was divided into two zones cultural and natural thereafter three most important components of ecology as vegetation, land surface temperature and land slope was studied with remote sensing techniques. Nainital is popular hill station for its moderate temperature, magnificent lake and its scenic surrounding. But unplanned and aggressive tourism development near Naini Lake has turned its natural Environment into buildup one which was marked as cultural zone. To diffuse tourism activities from cultural zone, suitable places were searched out in its surrounding from the view point of eco-tourism development.

Vegetation, land surface temperature were measured with pixel data of Landsat-7/ETM+ and slope was calculated with Aster data. Places with high vegetation density, low temperature and gentle slope were marked as suitable place for eco-tourism development in the surrounding of buildup area (cultural zone) named as natural zone.

**Keywords:** NDVI, LST, Eco –Tourism, Nainital

## 1 Introduction

GIS used for identifying location suitability and resource inventories according to environmental concern. Ecotourism development is a very sensitive issue in a particular destination in terms of complex ecosystem and local population habits. To identify untouched areas GIS can play an important role. By analyzing satellite images it is possible to identify complex areas inside the deep forest or trained mountain region even in the deep ocean where a general survey method is almost impossible. Impact analysis is related to this application as GIS can be used to evaluate potential impact of tourism development on the natural environment (Bahaire & White, 1999).

Globally, an ever increasing number of destinations have opened up and invested in tourism development, turning modern tourism into a key driver of socio-economic progress through the creation of jobs and enterprises, infrastructure development and the export revenues earned. As an internationally traded service, inbound tourism has become one of the world's major trade categories. The overall export income generated by inbound tourism, including passenger transport, exceeded US$ 1 trillion in 2010, or close to US$ 3 billion a day (UNWTO, 2011). Tourism exports account for as much as 30% of the world's exports of commercial services and 6% of overall exports of goods and services. Globally, as an export category, tourism ranks fourth after fuels, chemicals and automotive products. For many developing countries it is one of the main sources of foreign exchange income and the number one export category, creating much needed employment and opportunities for development (UNWTO, 2011). In over 150 countries tourism is one of the five top export earners, and in 60 it is the number one export. It is the main source of foreign exchange for one – third of developing countries and one - half of each Least Developed Countries (LDCs), where it accounts for up to 40% of their GDP (Ministry of Tourism Government of India, 2012) .

Global market trends indicate that long-haul travel, neighboring country tourism, rural and ethnic tourism, wellness and health holidays, cultural tourism, spiritualism, ecotourism, sports and adventure holidays, and coastal tourism and cruises are a few emerging areas of tourist interest (UNWTO, 2011) .

Tourism is one economic sector in India that has the potential to grow at a high rate and ensure consequential development of the infrastructure at the destinations. It has the capacity to capitalize on the country's success in the services sector and provide sustainable models of growth. In India, the travel and tourism sector is estimated to create 78 jobs per million rupees of investment compared to 45 jobs in the manufacturing sector for similar investment. Along with construction, it is one of the largest sectors of service industry in India. Apart from providing

employment to a wide spectrum of job seekers from the unskilled to the specialized, a higher proportion of tourism benefits (jobs, petty trade opportunities) accrue to women (Planning Commission, 2011).

The Ministry of tourism, Government of India will expand the scope and sweep of its training efforts to cover service providers on a range – drivers, tonga wallahs, valets, spa therapists, beauticians, bell boys, specialized masons (restorers of heritage and historical buildings), travel and tour facilitators and so on. The products covered could be: Rural Tourism, Adventure Tourism, Medical Tourism, Wellness Tourism, Eco Tourism, Development of Camp Sites, and Promotion of Caravan Tourism, Golf Tourism, Polo Tourism and so on. The ministry will take appropriate training initiatives in consultation with various stake-holders (Ministry of Tourism Government of India, 2012).

Uttarakhand State was carved out of the state of Uttar Pradesh on November 9, 2000. It is divided into two broad regions--Garhwal and Kumaon. The state is comprised of 13 districts, namely, Chamoli, Pauri, Tehri, Uttarkashi, Dehradun, Haridwar and Rudraprayag in the Garhwal region and Nainital, Almora, Pithoragarh, Udham Singh Nagar, Champawat and Bageshwar in the Kumaon region (Mittal et al. 2008).

Uttarakhand is a region of outstanding natural beauty. The high Himalayan ranges and glaciers cover most of the northern parts of the state, while the lower reaches are densely forested. The unique Himalayan ecosystem plays host to a large number of animals (including bharal, snow leopards, leopards and tigers), plants and rare herbs. Two of India's mightiest rivers, the Ganga and the Yamuna take birth in the glaciers of Uttarakhand, and are fed by innumerable lakes, glacial melts and streams in the region (Ministry of Tourism, 2000).

The formation of the new state had to fulfill the high expectations of the local people related to development and better living standards. However, within Uttarakhand there is a geographical inequality between the hills and the plains that divides the state critically. Districts in the plains are far ahead on various development indicators. In 2006-07 the state GDP grew by 10.15 per cent, the manufacturing sector grew by 17 per cent and the share of the primary sector has shrinked by 2.7 per cent. Industries have created about 2.8 lakh jobs but these are in the plains, and most of the growth due to industrialization has been restricted to the plains (Mittal et al. 2008).

The hill region districts are less developed in terms of infrastructure, i.e., electricity, roads and irrigation. The inter-district inequality in infrastructure leads to increasing disparity in terms of income and livelihood between the hills and the plains. Low levels of income not only result in low levels of consumption and material deprivation, but also constrain human potential by

restricting access to education and health facilities, thereby creating a vicious cycle of poverty (Mittal et al. 2008).

Nainital Lake, in the Nainital district called the Lake District of India, is one of the four Lakes of Kumaon hills; the other three lakes are the Sattal Lake, the Bhimtal Lake and the Naukuchiyatal Lake (Nainital lake, 2013). It has high potential of eco tourism development.

In ecotourism planning the first issue that emerges is the environment and its conservation. An ecotourism destination must in no way be developed without planning in terms of environmental concern. Referring to the Gray rocks reservoir in Wyoming US, for example Gribb (1991) described a planning endeavor where the aim was to come up with a recreation development plan that would contribute at the same time to environmental conservation.

**Site description**

The study area comprises the environment of Nainital Lake. It is located in Kumaon Himalayas of Uttarakhand, India. Coordinates of this lake are as 29°24′N 79°28′E& 29.4°N 79.47°E. It is situated at an elevation of 1,938 m. The lake is bounded by the high and steep Naina peak on the North West side, by the Tiffin Top to the south west side and snow view peaks on the north. Coniferous forest trees cover these hill ranges. The annual rainfall in the basin area of the lake is reported to be 1294.5 mm (43.15 inches). Tropical monsoon climate with maximum temperature 24.6 °C and minimum of 0.5 °C are recorded. The water is reported to be alkaline in nature (ph value of 8.4–9.3). The lake receives flows from the surrounding catchment basin which comprises the hill slopes and springs. The mean water retention time for the lake was computed as 1.16 years for the mean annual rainfall (Nainital Lake, 2013). Figure 1

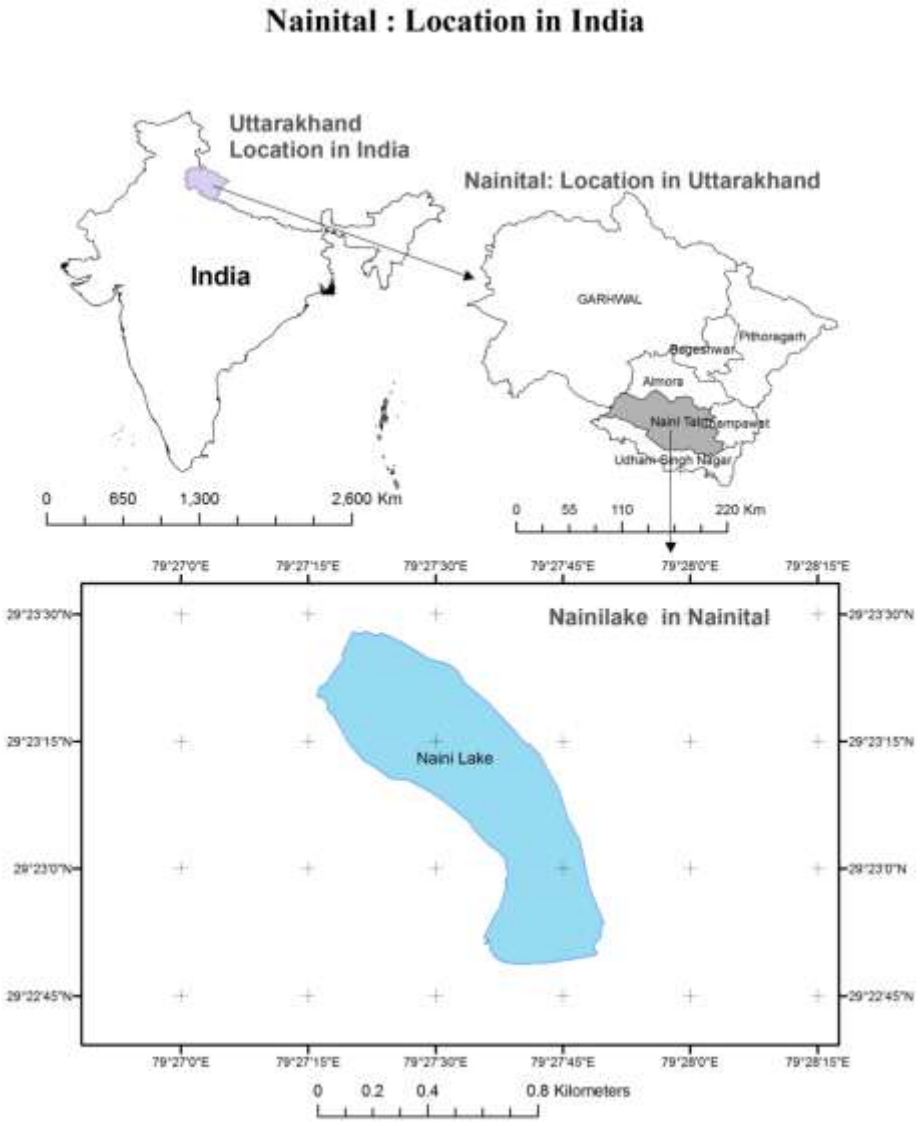


**Figure 1**

## 2 Materials and Methodology

## Material and software used

This research was carried out using software Erdas 11 & ArcGis 9.3; a vector based Geographical Information System. Erdas 11 was used for image preprocessing and ArcGis 9.3 was used for classification and mapping.

## Methodology

First Environment of Nainital Lake was divided into two zones cultural and natural to calculate the difference in terms of vegetation and land surface temperature in both the zones.

Cultural zone was marked with Google earth in kml and changed into shape file format to work on with ArcGis at Landsat data. Natural zone was developed around cultural zone at one km distance using buffering tool. To derive this research Landsat ETM+ images from 1999 October 15 and Aster image were used. Model adopted for GIS and remote sensing work is shown in figure 2.

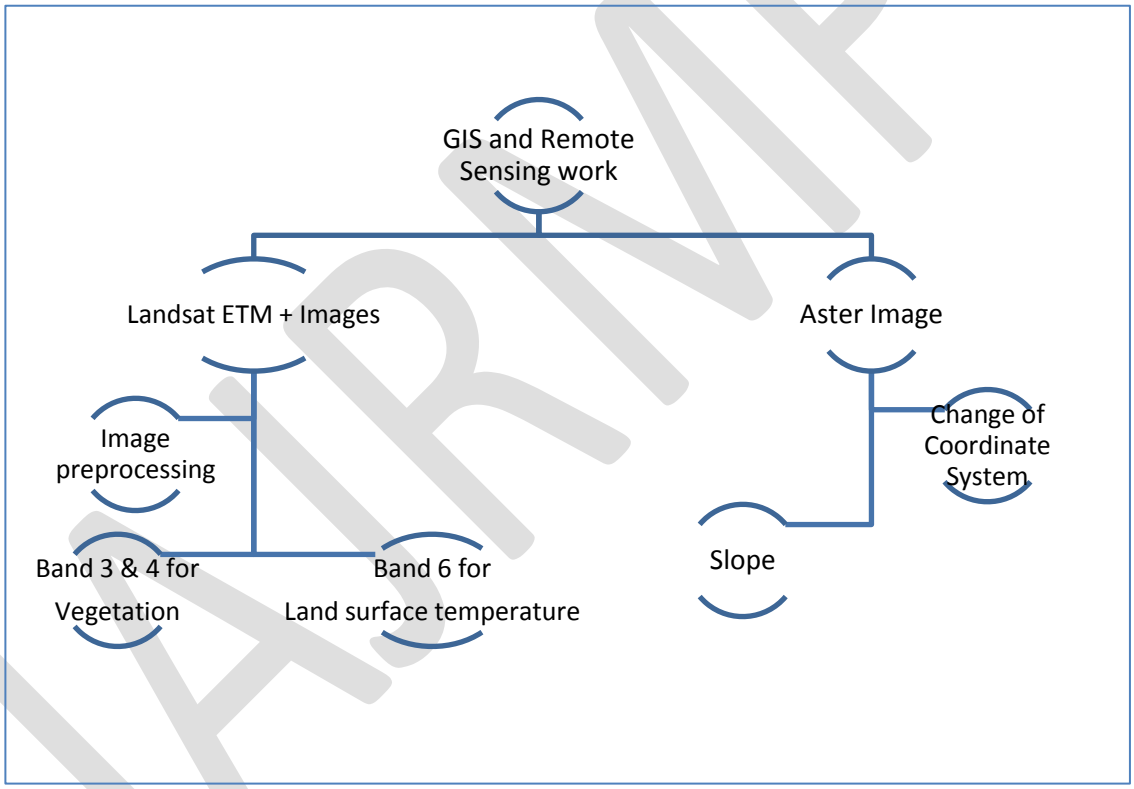


**Figure 2**

*Image preprocessing*

Atmospheric calibration

It is important to remove atmospheric effects, especially for scene matching and change detection analysis. The dark pixel subtraction technique was used for the same, it assumes that the pixel of lowest DN in each band should really be zero, and hence its radiometric value (DN) is the result of atmosphere-induced additive errors (Crane, 1971; Chavez et al, 1977).

*Measurement of vegetation distribution*

NDVI index has been applied for measurement of vegetation distribution and density in this research.

The NDVI algorithm subtracts the red reflectance values from the near-infrared and divides it by the sum of near-infrared and red bands (Eq. 1):

NDVI= (NIR-RED) / (NIR+RED)…….. (Eq. 1)
Where

NIR is the 3rd band image
RED is the 4th band image

Calculations of NDVI for a given pixel always result in a number that ranges from minus one (-1) to plus one (+1); however, no green leaves gives a value close to zero. A zero means no vegetation and close to +1 (0.8 - 0.9) indicates the highest possible density of green leaves (Frantzova, 2010). Study area's results were converted into 0-255 for an easier calculation and classifications of the vegetation type. Considering this value system, the calculated and normalized NDVI index for each pixel of the satellite images of regions were categorized in four groups which indicate the different ranges of the vegetation density (Table 1).

Table 1. Numerical range of NDVI

| **Numerical range of NDVI** | | **Vegetation Density** |
|---|---|---|
| **Old values** | **New values** | |
| -1 to - 0.242092 | 0-100 | No Vegetation |
| - 0.242092 to 0.089243 | 100-150 | Low to Medium |
| 0.089243 to 0.486845 | 150-210 | Medium to High |
| 0.486845 to 1 | 210-255 | Too High |

Study

*Measurement of land surface temperature*

To measure land surface temperature first calibrated DN values of Landsat image (band 6 ETM+) were converted into spectral radiance and spectral radiance was converted into surface temperature as following:

A. To get the spectral radiance, Lλ, the following algorithm (1) was applied

Lλ= Lmin + (Lmax – Lmin)* DN/255 ……. (1)

Where,

- Lmax= the spectral radiance that is scaled to DNmax
- Lmin= the spectral radiance that is scaled to DNmin
- DN = the quantized calibrated pixel value.

B. To convert spectral radiance to temperature the following algorithm (2) was applied

$$T_b = \frac{K2}{\ln\left(\frac{K1}{L\lambda}+1\right)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where,

- $T_b$ = Surface temperature
- $K_1$= Calibration constant 1 (607.76)
- $K_2$= Calibration constant 2 (1260.56)

To convert temperature in Celsius formula, $T_B = T_B - 273$ was used.

*Measurement of slope*

Slope identifies the steepest downhill slope for a location on a surface. Slope was calculated for each cell in raster using Aster data. Aster data was projected to projected coordinate system. Slope values were classified with spatial analyst tool. The area with slope less than 25 degree was extracted.

Model adopted for finding new sites for the development of eco - tourism is shown in figure 4.

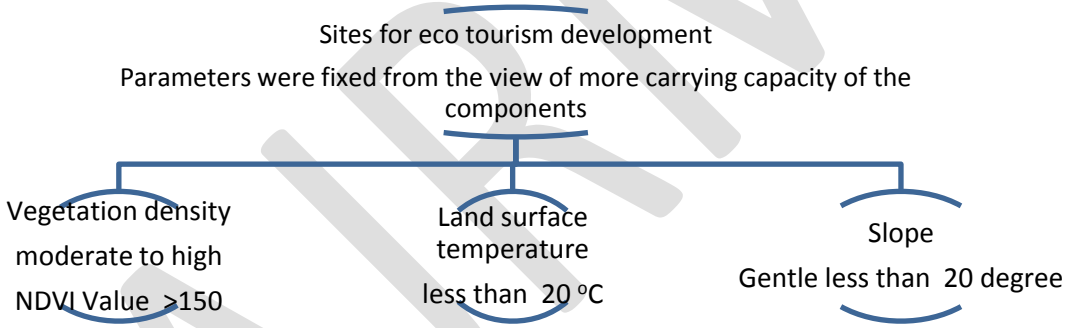


**Figure 3**

## Results and Discussion

Nainital Lake covers area of 0.462 $km^2$. The area of its demarcated cultural and natural zones was calculated 5.23 $km^2$ and 14 $km^2$ respectively. Figure 4

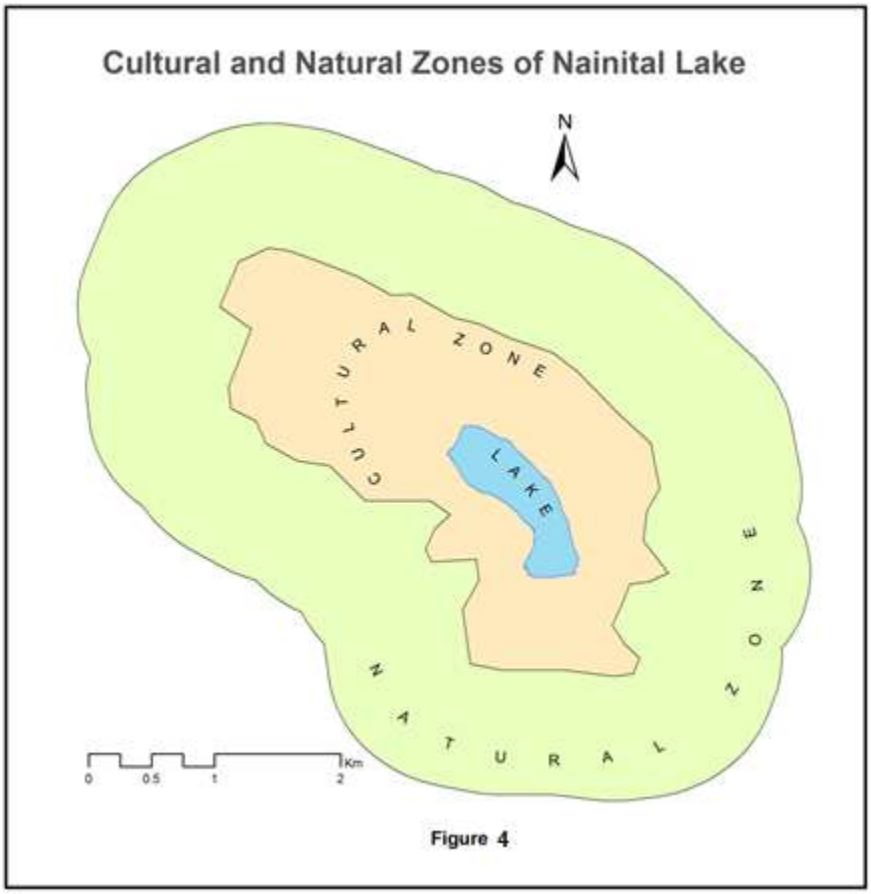


Figure 4

For calculation of vegetation density band 3 & 4 of Landsat ETM + (data of acquisition 1999, October 15) were used.

Optimum locations were calculated in natural zone of Nainital city. This zone covers an area of 14 $km^2$. Different type of geographical features at micro level were found in this zone. The area having slope less than 20 degree, vegetation moderate to high (NDVI classified value > 150) and temperature less than 20 degree centigrade are marked as potential areas for the development of eco-tourism. Two and half squire km area was identified as potential sites for the development of eco-tourism in this zone (Figure 5).

The major principles of Eco tourism are concern with ecology, local culture and its economy. From the view point of ecology, it is must to study the carrying capacity of the region. As per the carrying capacity of the proposed sites tourism development should be there.

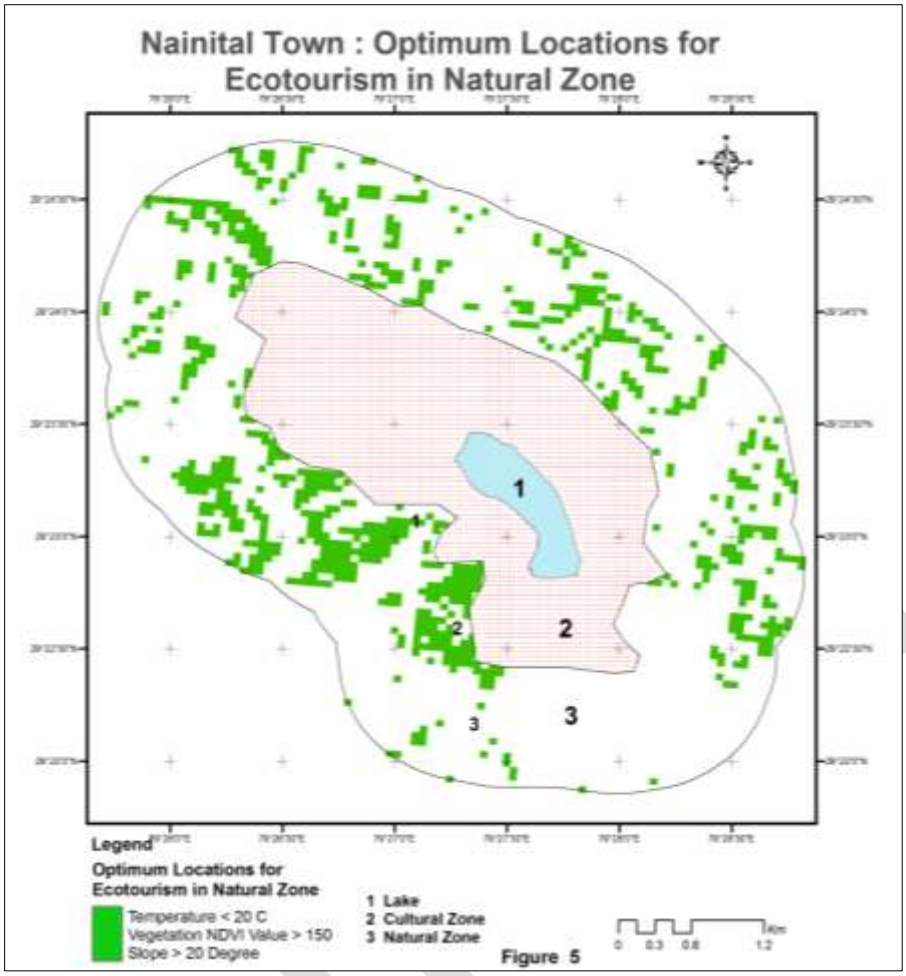


Figure 5

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