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IDENTIFICATION OF POTENTIAL ECOTOURISM SITE USING THE AHP TECHNIQUE: A STUDY ON BINPUR II BLOCK, JHARGRAM DISTRICT WEST BENGAL INDIA

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ABSTRACT

Safeguarding socio-economic development and maintaining biodiversity may be a challenge to developing countries in the present context. Ecotourism as a possible sustainable land use practice helps in socio-economic development in alternative ways beyond agriculture and manufacturing industry for the local people without disturbing the natural biodiversity. As a newly formed district, Jhargram, the remaining eroded part of the Chottonagpur plateau, has a great potential to expand Ecotourism of its natural beauty, cultural heritage, and historical importance. The present micro-level study has investigated the potential sites of ecotourism in, a tribal dominant block, the Binpur -II block, Jhargram district, West Bengal by AHP methods with the help of ArcGIS 10.8 software. To identify the potential sites of ecotourism eight criteria were selected by previous literature, field visits, and expert opinion i.e. Geo-sites, elevation, slope, proximity to the river, distance from forest, distance from cultural sites, distance from road, and distance from tribal villages. 30.44% (175.38sq. km) of the geographical area is selected as a highly suitable potential for ecotourism of the Binpur – II block, and 0.01% (0.06sq, km) is very highly suitable for the development of ecotourism, other 54.84% (315.95sq.km) is moderately suitable, 14.60% (84.09sq.km) is low suitable. Only 0.11% (0.65sq.km) is very low suitable. Finally, nine potential ecotourism spots have been identified within very high potential zones.

KEYWORDS: Ecotourism, Binpur -II Block, AHP Method, ArcGIS, Potential Sites

Poverty alleviation and environmental degradation are two interrelated significant issues that developing countries experienced in the last century. Promoting ecotourism as an alternative to traditional mass tourism helps alleviate poverty by increasing job opportunities for the local people (Ogutu, Z.A. 2002, C.A. Hunt, *et al*. 2015, Leonard, I. C. 2017, Rema. R, Dr. N. Karunakaran 2018, Saw, P.K. 2018). Mainly the indigenous community (Stronza 2007), and playing an important role in preventing environmental degradation (Wunder. S. 2000, Leonard, I. C. 2017). “Ecotourism is a journey to vulnerable, untouched, and usually protected areas that strives to be low impact and (usually) small scale. It helps educate the tourist; support funds for conservation; directly benefits the economic development and political empowerment of local people; and fosters respect for different cultures and human rights” (Martha Honey-1999). Since the 1980s, ecotourism has become one of the main approaches to biodiversity conservation (Nigar, N.-2018). Proper implementation of ecotourism a) creates new jobs for the dwellers, b) expands the different sectors of the economy directly or indirectly, c) improves women's empowerment (Manu and Kuuder 2012, Lenao and Basupi, 2016), d) earn foreign money, e) gives environmental education, f) conserves biodiversity g) protects the historical architecture and ancient culture i.e. in a word it helps in the sustainable development of a country improving the quality of life to the host community. Moreover, the proper development of ecotourism increased the production systems related to goods and services linked to tourism such as local handicrafts, agriculture, and services (Mustika, *et al*. 2012).

Recent trends in Ecotourism in India, particularly in West Bengal, have increased due to the negative impacts of traditional mass tourism on the environment and local cultures. (Sanu, Dolui., S., K., Chakraborty. -2022, Acharaya, Aditi 2022). The picturesque landscapes of West Bengal including green forests, rivers, and cultural uniqueness, offer significant potential for ecotourism development (Nazrul, Islam *et al*. 2022)

Properly implementing ecotourism in a place is a challenge in the present context of development and environment. The success of ecotourism partially depends on properly identifying potential ecotourism sites. Remote sensing and GIS have become essential for exploring and monitoring ecotourism resources. GIS is considered a powerful, cost and time-saving tool for mapping ecotourism potential with decent accuracy (Ali and Maryam 2014; Acharya *et al*., 2022). Different national and international researchers have applied remote sensing and GIS techniques to explore potential

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ecotourism sites (Boyd *et al*., 1994; Geremew *et al*., 2015; Taye *et al*., 2019). The Multi-criteria Decision-Making Process (MCDM) of Remote sensing and GIS is an important method that solves problems or makes decisions, quickly with less effort. (Javadian *et al*. 2011). Multiple-criteria decision-making (MCDM) techniques play a very important role in identifying potential ecotourism sites by evaluating various factors related to the development of ecotourism. This technique is especially helpful when decisions involve complex scenarios with different factors connected with a perfect decision. This technique is used in resource allocation, policy-making, environmental management, business strategy, healthcare, urban planning, etc. Various multi-criteria weightage techniques have been widely used for ecotourism resource identification for the last twenty years. (Kumari *et al*., 2010; Ghamgosar, 2011). The analytic Hierarchy Process (AHP) which was developed by Thomas L. Saaty in the 1970s, is a structured technique of MCDM for organizing and analyzing complex decisions, based on mathematics and psychology. (Gang, Kou *et al*-2017; Javad, Khazaii-2016). The AHP technique gains the attention of research scholars, planners, etc. for its' rapid judgmental ability and simple calculation (Velasquez and Hester, 2013; Akcan and Güldeş, 2019). Saaty's AHP model helps decision-makers select the best criteria by considering multiple criteria and priorities, ultimately leading to more effective and efficient decision outcomes (Table 1).

Table 1: Showing potential ecotourism site suitability using the AHP tool of MCDM methods

Authors	Study areas	Results
Kumari, S. *et al*(2010)	West District of Sikkim, India	Using 5 indicators i.e. wildlife distribution index, ecotourism attractive index, ecological value index, environmental resiliency index, and ecotourism diversity index they identify potential sites of ecotourism.
Bunruamkaewa, K. & Murayamaa, Y.(2011)	Surat Thani Province, Thailand	This study identifies nine criteria including visibility, LULC, species diversity, elevation, slope, proximity to cultural sites, distance from roads and settlement size by professional experts' opinions.
Omid Mobarakia *et al* (2014)	Isfahan Townships, Iran.	This study evaluates the capacities and power of ecotourism in Isfahan Township using GIS and the AHP.
Mahdavi, A. & Niknejad, M. (2014)	Lorestan province, Iran.	This study compared the two methods of AHP and FAHP in the evaluation of the ecotourism potential in Khorram-Abad country. The result of the study showed that the study area has a high potential for ecotourism.
S. Abdollahi *et al* (2019)	Arasbaran, Northwest Iran.	This study used GIS to find out potential ecotourism zones, standardizing criteria via fuzzy functions and AHP. By applying WLC and Zonal Land Suitability, 37 zones were selected, where 6.45% (5200.62 ha) being the most suitable.
Baykedagn *et al* (2019)	Menz-geramidir district, Ethiopia	Using the AHP method & MCDM tool to identify the potential ecotourism sites of the Menz-geramidir district, Ethiopia based on natural resources.
Shawky *et al* (2019)	Masirah Island of Oman	By the Analytic Hierarchical Process method they identified 13 criteria to find out suitable sites for ecotourism activities based on a review of literature, local people's knowledge, and fieldwork.
Sahani, N (2019)	Kullu district of Himachal Pradesh, India	He selected 13 criteria such as elevation, slope, topographic roughness, vegetation, protected area, surface water accessibility, soil, groundwater climate, visibility, road proximity, village proximity, and geology.
Sahani, N(2019)	GHNPCA, Himachal Pradesh, India	Using 12 thematic layers, by the AHP method he determined weights for various themes. Findings show high ecotourism potential in southwestern and central GHNPCA and the study identified 77 high-potential sites.
Salamawi *et al* (2021)	Kafta Sheraro National Park, Ethiopia	This study used GIS and AHP to identify potential ecotourism sites, using biophysical features, wildlife, and accessibility. Results show that 27.63% of the area is highly suitable for future ecotourism development.
Islam, N. *et al* (2022	Eastern Dooars region of West Bengal, India	The study applied TOPSIS and AHP methods, along with Entropy and CRITIC weighting, to identify ecotourism sites.
Dolui, S. and Chakraborty, S.(2022)	Purulia district, West Bengal, India	In this study, researchers used ARC-GIS 10.6.1 software to identify potential sites based on elevation, slope, river, distance from settlement, distance from railway, and distance from ecological sites.

Raha and Gayen(2022)	Bankura District, West Bengal, India	This study selects tourism potential zones in Bankura using AHP. Findings show 23.33% high, 58.74% moderate, and 17.92% low tourism potential areas in Bankura district.
Acharya, A. *et al*(2022)	West Bengal, India	Dividing the state into zones based on physiographic and LULC features this study identifies significant geo-ecotourism opportunities.
Ainon Nisa Othman *et al* (2022)	South Kelantan, Malaysia	This study identifies the definite criteria of the potential area for ecotourism and creates a map of a potential area of ecotourism in South Kelantan, Malaysia using AHP techniques and the Site Suitable Area for Ecotourism Model (SSME).
Prasandya & Satria(2023)	Bali	To prevent environmental and socio-economic degradation this study applies the AHP method to formulate criteria for ecotourism development and identify six key criteria: environmental, socio-cultural, community participation, education, economy, and institutional.
Das, R. *et al* (2023)	Chamoli district, Uttrakhand	This study applies GIS and AHP to select potential ecotourism zones in Chamoli, India, considering factors like slope, elevation, and proximity to roads and rivers.

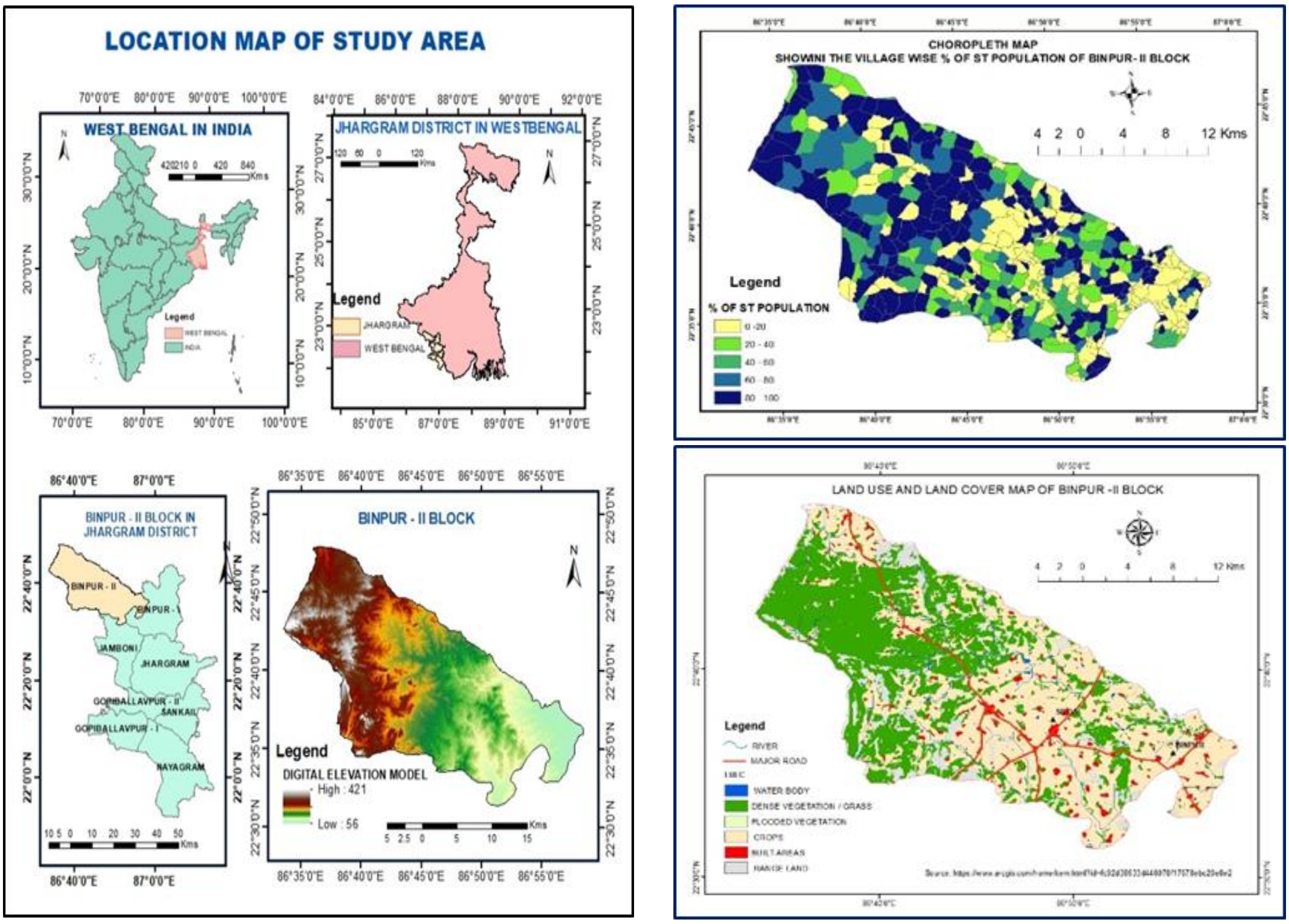
STUDY AREA

Jhargram is a newly formed (from Paschim Medinipur, 4th April 2017) 22nd West Bengal, India district. The study area is a tribal-dominated block located in the northwest part of Jhargram district. The latitudinal and longitudinal extension of the block is 22˚47´47.58″ N to 22˚28´36.00 ″ N & 86 ˚33´41.16 ″ E - 87˚07´32.72″ E respectively. Topographically this area is an eroded part of the Chotanagpur Plateau with undulating topography. The average elevation is 83 meters. Most of the area (95%) is covered by infertile laterite soil. Kangsabati is the major river flowing west to east in this block. It is a drought-prone block with a partially severe drought situation. 23.78% is covered by forest of the block's total area (583.50 km2). Among the total population (164522- census-2011), only 3.60% lived in census town (Shilda) areas and 96.40% lived in rural areas. Besides, among the total population, 15.77 and 39.95 per cent of people belong to the SC and ST community. Mundas, Bhumijs, Lodhas, and Sabars (aboriginals), etc. indigenous communities inhabited this block for many years ago. Jhargram is home to many dances such as Chuang, Chang, Chhau, Dangrey, Jhumur, Panta, Ranpa, Saharul, Tusu & Bhadu (Figure 1).

DATABASE

An extensive literature review related to ecotourism was done to understand the different aspects of ecotourism. Based on the literature review on the potentiality of ecotourism sites and necessary information and suggestions from ecotourism experts, field experience in the study area, as well as knowledge gained from field surveys in the Jhargram district eight criteria were selected for determining potential ecotourism sites of Binpur -II block i.e. Geo-sites, elevation, slope, proximity to river, distance from forest, distance from cultural sites, distance from road, and distance from tribal village (Table 2).

Spatial, and non-spatial data and necessary maps have been collected from primary and secondary sources to fulfill the research objective. To collect primary data, take expert's opinion by a questionnaire for the selection of variables of ecotourism site. Location information was collected using ArcGIS Pro and also using the GPS tool. The SRTM digital elevation model (DEM) with the 30-meter spatial resolution has been used to analyze elevation, slope, and drainage. Forest coverage map prepared from Sentinel-2 10-Meter Land Use/Land Cover (2023) shape file collected from Earth data of NASA. Geo-sites and Cultural sites were selected through expert opinion, and locations were defined by Google Earth Pro and GPS survey. Major road and railway data was collected from Open Street Maps (https://www.openstreetmap.org/). Above 99% of tribal people inhabited villages from the data downloaded from the Socioeconomic Data and Applications Center (SEDAC) of Earthdata- NASA.



Figuer 1: Shows the location map of the study block with the distribution of ST people and LULC

Table 2: Shows the database and methodology

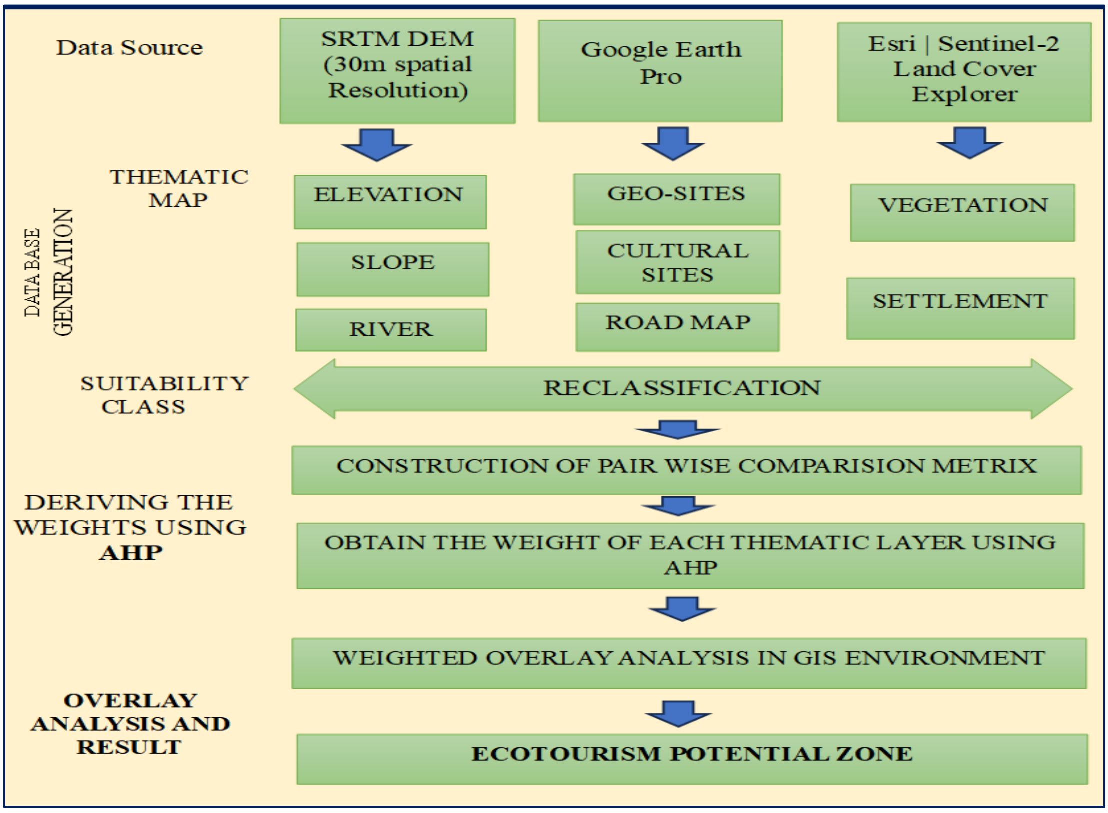


Table 3: Sources of data

Criteria	Data sources	Specification	Applications
1. Geo-Sites	Google Earth Pro: https://support.google.com/earth/answer/21955?hl=en	Imagery date: 10.04.2013	Extract the location from Google Earth Pro and put it in ArcGIS
2. Elevation	SRTM- DEM https://earthexplorer.usgs.gov/	30-meter global Publication Date: 2014-09-23	Reclassified five into classes according to elevation value.
3. Slope	SRTM- DEM https://earthexplorer.usgs.gov/	30-meter global Publication Date: 2014-09-23	Preparation of slope map from DEM and classified into five classes.
4. Proximity to river	SRTM- DEM https://earthexplorer.usgs.gov/	30-meter global Publication Date: 2014-09-23	Distance from the river is calculated and classified from DEM.
5. Distance from forest	The shapefile from: https://livingatlas.arcgis.com/landcover/	Sentinel-2 10-Meter Land Use/Land Cover(2023)	Distance from the vegetation was calculated using DEM and classified.
6. Distance from cultural site	Google Earth Pro: https://support.google.com/earth/answer/21955?hl=en	Imagery date: 10.04.2013	Extract the location from Google Earth Pro and put it in ArcGIS
7. Distance from road and railway	The shapefile from: https://www.openstreetmap.org/	Updated 2024	Distance from road calculated and reclassified
8. Distance from settlement	The shape file https://sedac.ciesin.columbia.edu/data/set/india-india-village-level-geospatial-socio-econ-1991-2001/data-download	Socioeconomic Data and Applications Center (sedan) Earth data-NASA	Distance from settlement calculated and reclassified.

METHODOLOGY

Geospatial Database Generation

There are several factors which influence the site suitability of ecotourism. It includes natural attractions, topography, climatic factors, overall cleanliness, local culture, shopping opportunities, transport and communication, and the quality of hotels and restaurants, etc. This study began with sixteen criteria, chosen based on a literature review and the physical, socio-economic, and cultural characteristics of the Jhargram district. However, after a field visit, and consulting local stakeholders and experts, eight key variables were selected as most relevant for assessing the ecotourism potential of the area. These are as follows.

Geo-Sites

Geo-sites, which include geological formations, landscapes, and natural features, play a significant role in the development of ecotourism. Without some beautiful Geo-sites development of tourism can't be imagined because travellers are attracted by these sites. The creation of new geo-sites cannot be possible by the government and private developers. Therefore, areas closer to existing geo-sites are often prioritized. In the Jhargram district, notable tourist attractions include the Kendua migrating bird site, Gadrasini hill, Khandararini lake, Ghagra waterfall, Tarafeni river dam, Spring of Ketki, Kankasor forest, Laljal cave, Kanaisor hill, Hatibari forest, and Jhilli lake, etc are significant from an ecotourism perspective. Maximum sites are located in the study block. The distances from these existing Geo-sites have been mapped and categorized into five ranges with their weighted (Table 7, Fig 2) 239.4 sq. km areas fall under below 4015meter which are located in the northwestern part and northern part of the block, 183.9 sq. km are in 4015 to 8210meter, 86.0 sq. km in 8210 to

12315meter, 49.8sq.km are 12315meter to 16420meter, and 28.7sq.km are 16420 metre to 20528 meter.

Elevation

High elevation always attracts tourists because of the natural beauty, many recreational opportunities and significant cultural history. The vertical relief features create diverse attractiveness, unique biodiversity, temperature and climatic variation (Kumari *et al*., 2010; Bunruamkaew *et al*., 2012; Ahmadi *et al*., 2015; Foggin, 2016;). Tourist of plain land highly enjoys the altitude of different types of activities like Hiking and Trekking, Wildlife Viewing, Photography, etc. The present study area Binpur - II, is enriched with undulating land with scattered hills like Gadrasini Hill which is an eroded part of the Chhotanagpur plateau. The height of this hill near about 421 meters. The elevation map was drawn from DEM data classified into five classes and weights were given based on the attractiveness of the landscape. A higher altitude is considered to be more suitable and vice versa. The entire study block has been divided into five categories based on elevation. (Table 7; Fig 2) elevation of 252.2sq. km areas fall under above 349 meters which are located in the northwestern part and northern part of the block, elevations of 187.8 sq. km are 277 to 349meter, elevations of 138.6 sq. km in 205 to 277meter, 8.7.km are 133meter to 205meter, and only elevation of 0.2 sq.km are 61 meter to 133 meters.

Slope

Topographical steepness and curvature in an area is depends on the degree of slope. A sloping surface is more favorable for any type of tourism activity, in this case, the steeply hilly region of the Himalayan Mountain chain is famous for tourism. This study calculates the slope from DEM data. Always higher slopes are better for the expansion of ecotourism because it is more attractive but extreme slopes could oppose tourism growth owing to transportation challenges (Sahani, 2019; Bunruamkaew; Kumari *et al*., 2010). The plain region has very little chance of dense forest cover and biodiversity, whereas the hilly and mountain offer the best possibilities for ecotourism. This map is also divided into five categories according to the slope of the study block and the degree of high slope gives better preference for ecotourism. (Table 7; Figure 2). 0.1 sq. km areas fall under 33.80 - 42.26 degrees which are located in the northwestern part and northern part of the block, 0.9 sq. km are in 25.36- 33.80 degrees, 6.2 sq km in in16.90- 25.36-degree, 42.1 sq. km are8.45 -16.9 degrees, and 534.5 sq. km are 0 - 8.45 degree.

Proximity to Rivers

Rivers are favorable destinations of ecotourism for water sports including rafting, kayaking, and swimming. All the historical civilization was formed on the banks of the river. The river character mainly in the hilly region attracts the traveller. The river creates waterfalls, steep landscapes, dams, etc. River-Kangsabati, Tarafeni, Subarnarekha, and Dulong, and their rivulets - Deb, Palpala, Ragium, kupon etc. flow west to the east direction in the Jhargram district. Tarafeni River flows on the study block. The drainage map is prepared from DEM data and Euclidean distance was calculated by ArcGIS 10.8. based on distance from different river networks this block is divided into five equal classes where closer distance gives better preference for the development of ecotourism (Table 3; Figure 3C). 309.7 sq. km areas fall under below 291.046 meters, 205.2 sq. km are in 291.046m- 582.092m, 64.9 sq. km in 582.092m- 873.139m, 7.3sq.km are 873.139 m- 1164.185m and 0.4sq. km are 1164.185m- 1455.231m.

Cultural Sites

Preservation of traditional culture is another important principle of ecotourism. Ancient culture and cultural heritages always are important variables of ecotourism. All the major ecotourism sites are inhabited by indigenous people. The cultural activities of these people are now a major attraction for modern people. The study block of Jhargram district is mainly for tribal people who perform different types of cultural activities like Chuang, Chang, Chhau, Dangrey, Jhumur, Panta, Ranpa, Saharul, Tusu & Bhadu which is unique in these areas. The present study identifies a remarkable cultural village: Dhangikusum which is famous for its cultural activities like Baha, Sohrai, and Tusu parab with natural beauty. Calculating the Euclidean distance prepared a map by ArcGIS and divided the block into five classes according to distance from this village.(Table 7, Fig 2)

Distance from Road

Accessibility is an essential precondition for the growth of ecotourism, and tourism-related activities. Adequate transport facilities between the point of origin and the tourist attraction are major variables of ecotourism. Comfortable and secure road access to the desired ecotourism destination increases visitor possibilities (Chandio *et al*., 2013; Istomina *et al*., 2016). Undulating topography makes it difficult to build other modes of transportation except roadways. Many potential ecotourism destinations such as deep forests, waterfalls, and lofty hills sites may remain unexplored without a poor transport network. As ecotourism activities are located far away from main road access. This study calculates the distance from major roads and divides the block into five major classes. (Table 7; Figure 2).

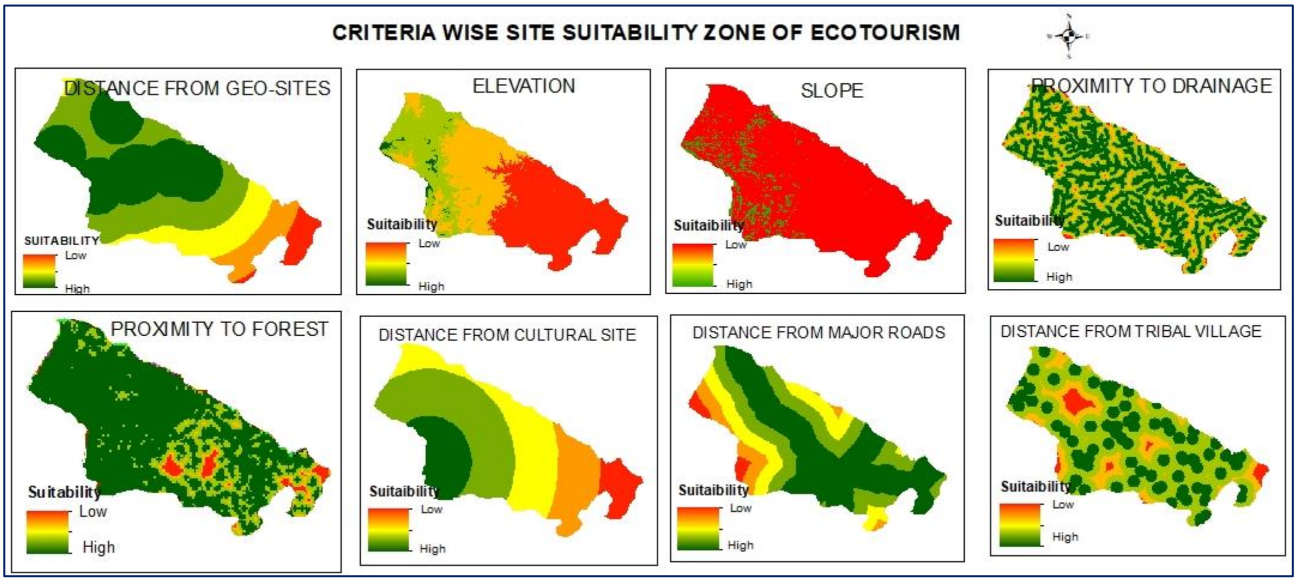


Figure 2: Criteria-wise site suitability zone of ecotourism.

Distance from Tribal Villages

Indigenous communities are a significant part of ecotourism. Ecotourism activities like food, lodging, guiding etc, are performed by the local people. In the study areas, probable ecotourism sites are inhabited by tribal people. So tribal village is another important variable of ecotourism. Extracted scheduled tribe population data from the district census book and identified tribal villages where above 99% of tribal people inhabited. A map of Euclidean distance is prepared by ArcGIS from the extracted data and reclassified by five categories based on distance i.e. below 815m, 815m to 1446m, 1446m to 2119m, 2119m to 3015m, and 3015 to 5196m. 207sq, km areas are in bellow 815m from tribal villages, 268.9sq. km in 815m - 1446m, 90.2sq,km in1446m - 2119m, 22.4sq. km in 2119m -3015m, and only 3.9 sq. km area in 3015m -5196m. (Table 7)

Normalized Weight for Different Thematic Layers

The Analytical hierarchy process (AHP) is widely used now in different multiple criteria decision analysis (MCDA) techniques in the various fields of resources and environmental management. AHP is used to determine the weights of the thematic layers (Saaty 1980) and is used for decision-making. For this analysis, eight thematic layers belonging to geomorphic, environmental, socio-cultural and infrastructure parameters i.e. Geo-sites, elevation, slope, proximity to the river, distance from forest, distance from cultural sites, distance from road, and distance from tribal village have been taken into consideration. For the selection of these elements to identify potential ecotourism sites, a questionnaire has been prepared and data collected from the experts (environmentalists, ecotourism experts, academicians, etc,) who work directly or indirectly in the study area. To calculate the weight of each thematic layer, Salty's 1–9 scale has been applied.

Based on Saaty's scale, a pairwise comparison of eight thematic layers was calculated according to this formula

$$\mathbf{Cij} = \begin{vmatrix} C_{11} & C_{12} \ldots & C_{1n} \\ C_{21} & c_{22} \ldots & c_{2n} \\ C_{1n} & C_{2n} \ldots & C_{nn} \end{vmatrix}$$

where, C11 mean criteria score of row ith (the first row) and column jth (the first column) in the pairwise comparison matrix.

and a comparison matrix ($Cij = \sum_{i=1}^{n} Cij$) was prepared for the selection of potential ecotourism sites. To normalise the pairwise comparison matrix- each column values need to be divided by its column total to develop a normalized pairwise matrix based on the following equation:

$$\mathbf{Cij} = \frac{Cij}{\sum_{i=1}^{n} cij} \begin{vmatrix} X_{11} & X_{12} \ldots & X_{13} \\ X_{21} & X_{22} \ldots & X_{23} \\ X_{31} & X_{32} \ldots & C_{33} \end{vmatrix}$$

The normalized weight of the eight thematic layers and consistency ratio (CR) was calculated. In the AHP method, a pairwise comparison of eight thematic layers was taken as the input, while the relative weights of thematic layers were the output. The final weights for the selected thematic layers are the normalized values of the eigenvectors that are related to the maximum eigenvalue of the matrix ratio (Jha *et al*. 2010; Adiat *et al*.

2012). The consistency ratio is measured using the following equation:

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

where CR = consistency ratio, RI = Random Index whose value depends on the order of the matrix, and CI = Consistency Index which can be expressed as follows:

$$CI = (\lambda max - n)/(n - 1),$$

Where, λ means the largest eigenvalue of the matrix and n indicates the number of thematic layers for ecotourism potentiality. The result of the consistency ratio (CR) is 0.0401 (less than 0.1 according to Saaty 1980)). It indicates that there is a reliable level of consistency in the pairwise comparison and the inconsistency is acceptable. The calculation of normalized weight and consistency ratio is shown in (Tables: 5 and 6).

Normalized Weight of Different Features of the Thematic Layer

The thematic layers were again classified on the basis of their importance such as very high, high, moderate, low and very low suitability zones for potential ecotourism sites. The ranks of each feature class of individual thematic layers are determined and feature normalized weights are extracted (Table 6.)

Table 4: Relative importance (Saaty, 1980) Intensity of importance

Intensity of importance	Numerical rating	Reciprocal	Explanation
1	Equal importance	1	Both criteria are contributing equally to the activities
3	Moderate importance	1/3	One criterion is slightly favoured over another in the activity concerned
5	Strong importance	1/5	Criteria Judgment strongly favour one criterion over another for activity concern
7	Very strong or demonstrated	1/7	A criteria judgment is favoured very strongly over another for activity concern
9	Extreme importance	1/9	The evidence favouring one criterion over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgments	1/2, 1/4, 1/6, 1/8	When compromise is needed
Reciprocals (Opposites): Used for inverse comparison			

RESULTS AND DISCUSSION

The AHP is used to explore a potential ecotourism zone in Binpur-II Block, Jhargram district as the method is one of the relevant methods for suitability analysis. Applying above matrix formula on the eight variables the AHP method was successfully implemented in order to calculate the weight of the variables. The resulting weights are as follows according to how significant they are in determining tourism potential: Distance from Geo-sites sites ranked 1st in influencing site suitability (32.07%), and distance from tribal village ranked 8th(3.13) (TABLE 6) The determined CR value is 0.0401, which indicates that the AHP matrix's weight values are consistent because it is below of 0.10 ((Saaty, 1980). Finally, a suitability map was produced using the Weightage Overlay of ArcGIS software in a GIS environment and reclassified into five equal classes i.e. Very low suitable zone, Low suitable zone, Moderately suitable zone, High suitable zone, and Very high suitable zone. As it is a very micro-level study for the development of Indigenous people, only 0,01% geographical area (0.06sq, km) is in the very highly suitable potential for ecotourism of the Binpur – II block, but 30.44% (175.38sq. km) are highly suitable for the development of ecotourism, others 54.84% (315.95sq.km) are moderately suitable, 14.60% (84.09sq.km) are low suitable, and only 0.11% (0.65sq.km) are very low suitable.

Table 5: Analytical Hierarchy Process (AHP) Pair-Wise Matrix

	1	2	3	4	5	6	7	8
VARIABLES	V1	V2	V3	V4	V5	V6	V7	V8
Geo-sites(V1)	1	2	3	5	4	5	6	7
Elevation(V2)	0.5	1	2	4	3	4	5	5
Slope(V3)	0.333	0.500	1	3	3	3	4	4
Proximity to river(V4)	0.2	0.25	0.333	1	2	3	3	4
Distance from forest(V5)	0.25	0.333	0.333	0.5	1	2	3	3
Cultural Sites(V6)	0.2	0.25	0.333	0.333	0.5	1	2	2
Distance from road(V7)	0.167	0.200	0.250	0.333	0.333	0.500	1	2
Distance from tribal village(V8)	0.143	0.200	0.250	0.250	0.333	0.500	0.500	1

Calculation of Consistancy Index (Ci) and (Cr) Consistancy Ratio

VP	CP	D*	E=(D/CP)	ʎ max	CI	RI	CR=(CI/RI)
3.550	0.3267	2.73149	8.36127	8.396	0.0566	1.41	**0.0401**
2.426	0.2233	1.86425	8.34938				
1.707	0.1571	1.32550	8.43841				
1.023	0.0941	0.81726	8.68087				
0.841	0.0774	0.64467	8.33202				
0.570	0.0524	0.43395	8.27713				
0.418	0.0384	0.32130	8.36068				
0.332	0.0306	0.25591	8.36771				
TOTAL = 10.865							

Table 6: Normalize Matrix

	1	2	3	4	5	6	7	8
VARIABLES	V1	V2	V3	V4	V5	V6	V7	V8
V1	1	2	3	5	4	5	6	7
V2	0.5	1	2	4	3	4	5	5
V3	0.333	0.500	1	3	3	3	4	4
V4	0.2	0.25	0.333	1	2	3	3	4
V5	0.25	0.333	0.333	0.5	1	2	3	3
V6	0.2	0.25	0.333	0.333	0.5	1	2	2
V7	0.167	0.200	0.250	0.333	0.333	0.500	1	2
V8	0.143	0.200	0.250	0.250	0.333	0.500	0.500	1
Total	2.793	4.733	7.499	14.416	14.166	19	24.5	27

9	10	11	12	13	14	15	16	17	18	19	20
V1	V2	V3	V4	V5	V6	V7	V8	Sum of weightage	Weightage	Weighted %	Rank
0.3581	0.4226	0.4001	0.3468	0.2824	0.2632	0.2449	0.2593	2.5772	0.3207	32.07	5
0.1790	0.2113	0.2667	0.2775	0.2118	0.2105	0.2041	0.1852	1.7461	0.2173	21.73	4
0.1194	0.1056	0.1334	0.2081	0.2118	0.1579	0.1633	0.1481	1.2475	0.1552	15.52	3
0.0716	0.0528	0.0444	0.0694	0.1412	0.1579	0.1224	0.1481	0.8079	0.1005	10.05	3
0.0895	0.0704	0.0444	0.0347	0.0706	0.1053	0.1224	0.1111	0.6484	0.0807	8.07	2
0.0716	0.0528	0.0444	0.0231	0.0353	0.0526	0.0816	0.0741	0.4356	0.0542	5.42	2
0.0597	0.0423	0.0333	0.0231	0.0235	0.0263	0.0408	0.0741	0.3231	0.0402	4.02	1
0.0512	0.0423	0.0333	0.0173	0.0235	0.0263	0.0204	0.0370	0.2514	0.0313	3.13	1
								8.0370	1	100	

Table 7: Criteria, sub-criteria, ranking, weights and influence

Criteria	Sub-Criteria	Area(km^2)	Suitablity Ranking	Suitablity Level	Sub-criteria Weights	Influence %
Geo-Sites	0 m - 4015m	239.4	5	Very high suitable	0.5160	32.07
	4015m - 8210m	183.9	4	High suitable	0.3171	
	8210m - 12315m	86.0	3	Moderate suitable	0.1113	
	12315m - 16420m	49.8	2	Low suitable	0.0429	
	16420m - 20528m	28.7	1	Very low suitable	0.0124	
Elevation	61m - 133m	0.2	1	Very low suitable	0.0001	21.73
	133m - 205m	8.7	2	Low suitable	0.0071	
	205m - 277m	138.6	3	Moderate suitable	0.1699	
	277m - 349m	187.8	4	High suitable	0.3070	
	349m - 421m	252.2	5	Very high suitable	0.5159	
Slope	0 - 8.45 (degree)	534.5	1	Very low suitable	0.0000	15.52
	8.45 - 16.9	42.1	2	Low suitable	0.0006	
	16.90 - 25.36	6.2	3	Moderate suitable	0.0065	
	25.36 - 33.80	0.9	4	High suitable	0.0588	
	33.80 - 42.26	0.1	5	Very high suitable	0.9338	
Proximity to River	0m - 291.046m	309.7	5	Very high suitable	0.5999	10.05
	291.046m - 582.092m	205.2	4	High suitable	0.3183	
	582.092m - 873.139m	64.9	3	Moderate suitable	0.0755	
	873.139m - 1164.185m	7.3	2	Low suitable	0.0057	
	1164.185m - 1455.231m	0.4	1	Very low suitable	0.0002	
Distance from forest	0.00m - 627.88m	449.8	5	Very high suitable	0.8274	8.07
	627.88m - 1255.77m	96.4	4	High suitable	0.1421	
	1255.77m - 1883.65m	18.0	3	Moderate suitable	0.0199	
	1883.65m - 2511.54m	11.5	2	Low suitable	0.0085	
	2511.54m - 3139.42m	3.8	1	Very low suitable	0.0014	
Cultural Sites	0m - 6820m	85.4	5	Very high suitable	0.2162	5.42
	6820m - 13641m	213.0	4	High suitable	0.4314	
	13641m - 20461m	158.5	3	Moderate suitable	0.2404	
	20461m - 27281m	90.1	2	Low suitable	0.0913	
	27281m - 34102m	40.7	1	Very low suitable	0.0206	
Distance from road	0.00m - 2166.81m	272.9	5	Very high suitable	0.5706	4.02
	2166.80m - 4333.61m	157.5	4	High suitable	0.2634	
	4333.61m - 6500.42m	98.8	3	Moderate suitable	0.1236	
	6500.41m - 8667.22m	43.6	2	Low suitable	0.0364	
	8667.22m - 10834.03m	14.6	1	Very low suitable	0.0061	
Distance from tribal village	0m - 815m	207.0	5	Very high suitable	0.4267	3.13
	815m - 1446m	268.9	4	High suitable	0.4428	
	1446m - 2119m	90.2	3	Moderate suitable	0.1115	
	2119m - 3015m	22.4	2	Low suitable	0.0184	
	3015m - 5196m	3.9	1	Very low suitable	0.0016	

Table 8: Five classes of site suitability of ecotourism by Weighted overlay methods.

Suitability zone	Area (sq.km)	% Area
Very low	0.6462	0.11
Low	84.0888	14.60
Moderate	315.954	54.84
High	175.3776	30.44
Very high	0.0612	0.01

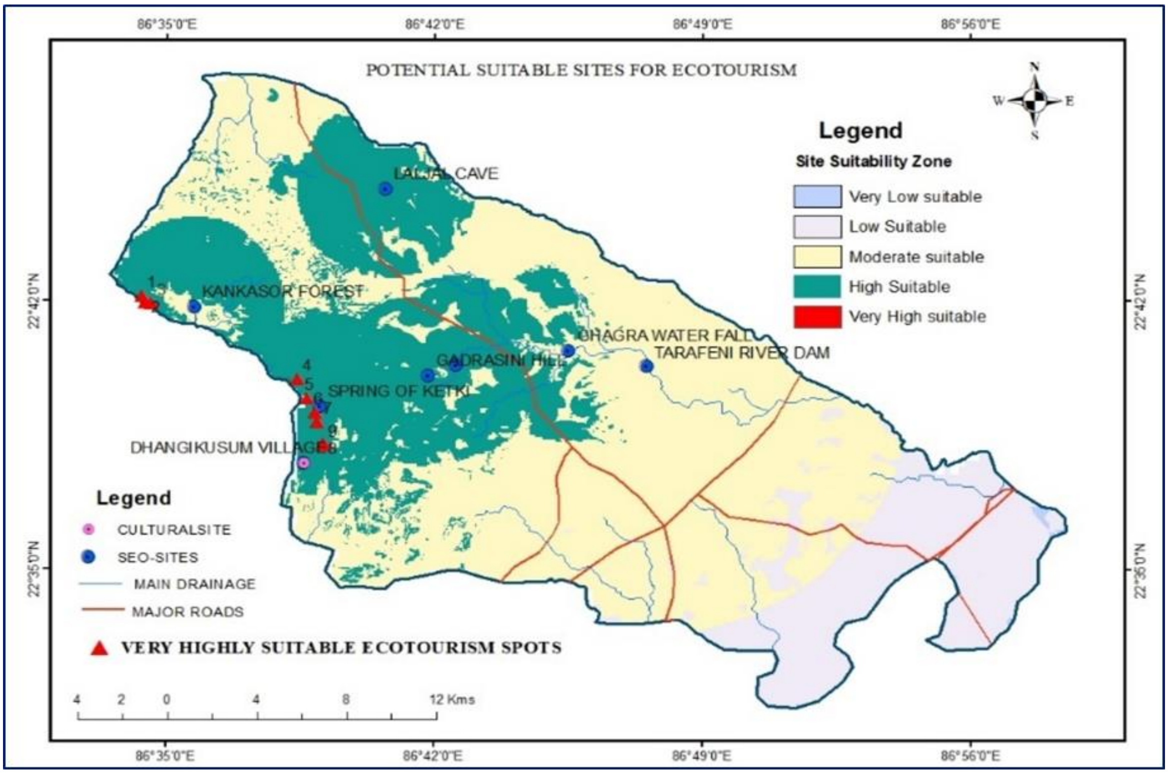


Figure 3: Potential site suitability of ecotourism by AHP

The southwestern part, near the Jharkhand border, is very highly suitable for developing eco-tourism. Undulating topography with high altitude (300m) and forest cover made this area picturesque. Location of Geo-sites, Cultural sites and tribal villages near the areas will help these areas to develop ecotourism. After a field visit, 9 spots in Amjharna, Kadamdiha, Singaduba, Dhangikusum and Banspahari villages in this zone are selected for proposed ecotourism development (Table 9). Five buffer (1km, 2km, 3km, 4km, and 5km) areas around these spots are also selected for ecotourism activities (Figure 4). Northwestern, the northern part of the block mainly the western side of Belpahari are covered by forest and indigenous people live in these areas. These parts fall under highly suitable potential ecotourism sites. Undulating topography, green forest, tribal livelihood, good transport facilities, and some attractive Geo-sites i.e. Gadrasini hill, Kankrajhor forest, Spring of Ketki, Laljol cave etc. make these areas highly suitable for ecotourism. The rest of the block except the southeastern part falls under moderate suitable for ecotourism where are relatively feature less topography, the presence of agricultural land, compact settlement and the absence of Geo-sites.

Table 9: latitudinal and longitudinal location of very highly suitable ecotourism spots and buffer zone around the very highly potential sites of ecotourism

Sl No.	Latitude	Longitude
1	22.70224	86.57274
2	22.69927	86.57439
3	22.6987	86.57703
4	22.66589	86.64063
5	22.65764	86.64486
6	22.65138	86.64817
7	22.64727	86.64927
8	22.63839	86.65181
9	22.63724	86.65181

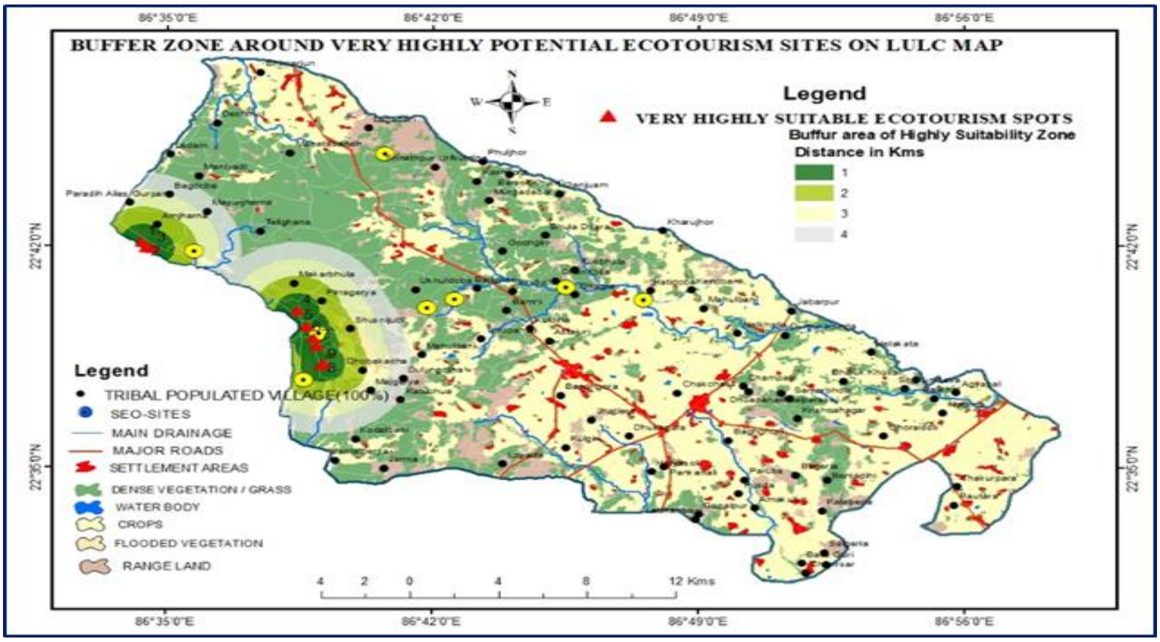


Figure 4: latitudinal and longitudinal location of very highly suitable ecotourism spots and buffer zone around the very highly potential sites of ecotourism

CONCLUSION

Identifying ecotourism potential zones has become significant for ecotourism planning and sustainable environmental management authorities. This study uses an integrated approach utilizing RS & GIS, and MCDA techniques to identify ecotourism potential zones. The MCDA method is now widely used for such evaluations. This study uniquely integrates multiple physical, and socio-economic factors for identifying ecotourism potential in the Binpur -II block, Jhargram district. This micro-level, comprehensive, multi-criteria-based assessment is being applied to this region for the first time, revealing that 30.44 of the total geographical area falls into the high ecotourism potential zone and 0.01% fall in the very high ecotourism potential zone. Additionally, 9 sites within the very high potential zone have been identified for ecotourism development at the micro-level. The research can assist decision-makers in formulating strategies for ecotourism development in the Jhargram district and sustainable land use in the study area.

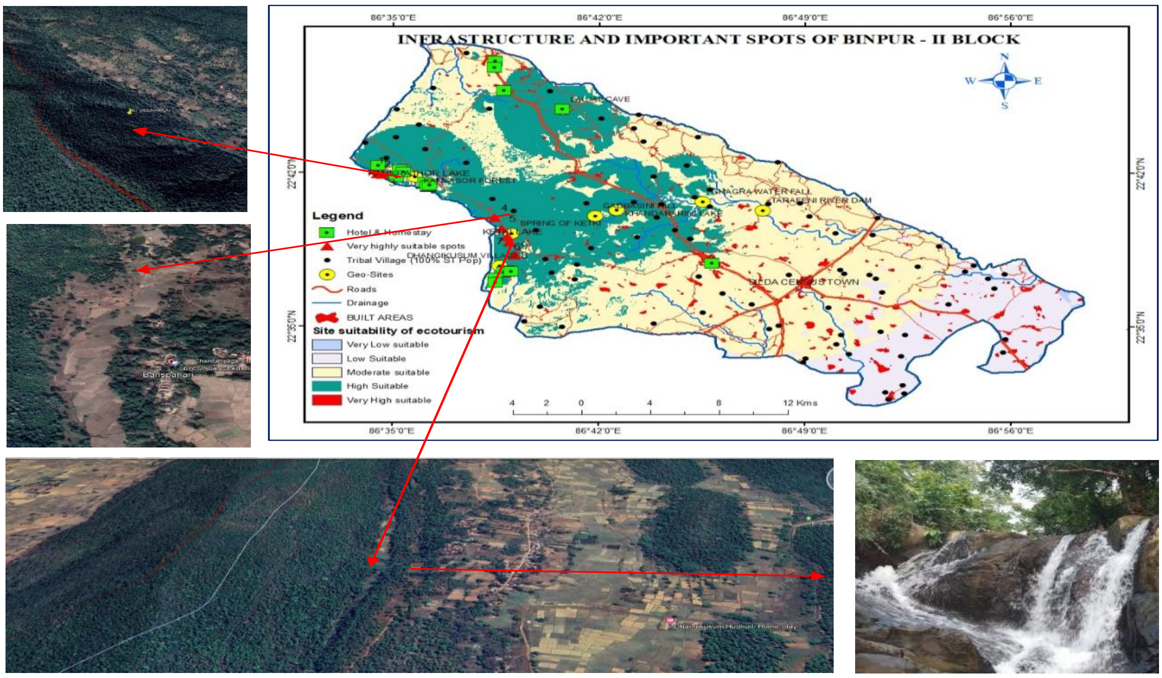


Figure 5: Image and Photos of very highly potential ecotourism spots.

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