sustainability

MDPI

Article

Assessing Sustainable Ecotourism Opportunities in Western Rajasthan, India, through Advanced Geospatial Technologies

Rajeev Singh Chandel [1], Shruti Kanga [2,*], Suraj Kumar Singh [3], Bojan Đurin [4], Olga Bjelotomić Oršulić [5], Dragana Dogančić [6] and Julian David Hunt [7]

[1] Centre for Climate Change and Water Research, Suresh Gyan Vihar University, Jaipur 302017, Rajasthan, India; rajeevchandelsingh@gmail.com
[2] Department of Geography, School of Environment and Earth Sciences, Central University of Punjab, Bhatinda 151401, Punjab, India
[3] Centre for Sustainable Development, Suresh Gyan Vihar University, Jaipur 302017, Rajasthan, India; suraj.kumar@mygyanvihar.com
[4] Department of Civil Engineering, University North, 42000 Varaždin, Croatia; bdjurin@unin.hr
[5] Department of Geodesy and Geomatics, University North, 42000 Varaždin, Croatia; oborsulic@unin.hr
[6] Faculty of Geotechnical Engineering, University of Zagreb, 42000 Varaždin, Croatia; ddogan@gfv.unizg.hr
[7] Energy Climate Group at the Climate and Livability Initiative, King Abdullah University of Science and Technology, Thuwal 23955-6900, Mecca Province, Saudi Arabia; julian.hunt@kaust.edu.sa
* Correspondence: shruti.kanga@cup.edu.in

Abstract: The present study focuses on finding potential sites for ecotourism development using GIS and remote-sensing-based weightage sum overlay techniques in Western Rajasthan, India. Ecotourism is one of the fastest growing and revenue-making sectors incorporating a sustainable future. Western Rajasthan has a broad scope to develop tourism-based activity in various ways, mainly through cultural heritage, historical and archaeological wonders, and rare wildlife. Weightage sum overlay analysis is a useful and simple tool to compare each thematic layer. These values are based on various factors and understanding taken during the study. For this purpose, different data types have been taken from the USGS website. Arc GIS 10.8 and ERDAS Imagine software 2015 have been utilized to process the data. This research incorporates seven thematic layers, i.e., elevation, proximity to streams, land use/cover, population density, road connectivity, proximity to protected areas, and heritage hotspots. Based on the physical and cultural characteristics of Western Rajasthan, the weightage of each thematic layer has been decided, which is finally overlaid using Arc GIS software. After processing all the thematic layers, we finally get an outcome in the form of a suitability map. The final suitability map represents five suitability classes that divide the total area into the following categories, very high (37.31%), high (26.85%), moderate (7.89%), low (0.83%), and very low (27.12%), which represents the potential of ecotourism in Western Rajasthan.

Keywords: ecotourism; geographic information system; weightage sum overlay analysis; sustainability

Citation: Chandel, R.S.; Kanga, S.; Singh, S.K.; Đurin, B.; Oršulić, O.B.; Dogančić, D.; Hunt, J.D. Assessing Sustainable Ecotourism Opportunities in Western Rajasthan, India, through Advanced Geospatial Technologies. *Sustainability* **2023**, *15*, 11473. https://doi.org/10.3390/su151411473

Academic Editor: Tsung Hung Lee

Received: 15 June 2023
Revised: 11 July 2023
Accepted: 12 July 2023
Published: 24 July 2023

1. Introduction

Tourism has evolved as a fast-growing industry contributing significantly to the global economy. Many studies suggest that the tourism industry makes up 11% of the gross domestic product (GDP) from the global perspective and more than twenty crore people are indirectly and directly associated with tourism and related work, providing 3% of total employment to the world [1]. More than 700 million people travel to international locations annually [2]. The tourism industries also stand for about 12% of the total world exports [3], which is a huge amount. India is a large nation with many different cultures, customs, dialects, festivals, and ritual practices. When it comes to "unity in diversity", the country presents a fantastic example for the rest of the world [4]. Tourism is one of India's largest service sectors [5], which provides heritage, culture, business, medical, and sports tourism.

The tourist industry is estimated to generate about 7.85% annual GDP growth rate in the 2013–2023 period [5,6]. It also generates one-third of India's foreign currency profits. As per the World Travel and Tourism Council, India's tourism industry ranks seventh in terms of global share GDP. According to the latest data on the Ministry of Tourism website, travel and tourism generated nearly INR 14.1 trillion, which is USD 208.9 billion in 2018.

Rajasthan's economy is built on agriculture, with eleven agro-climatic zones and distinct soil types that aid in the development of various crops [6]. During 2020–2021, the production of food grains increased by 2.08% to nearly 27.13 million tons compared to 26.58 million tons produced in 2019–2020. Rajasthan's projected Gross State Domestic Product (GSDP) for 2022–2023 is INR 1334410 crore (at current prices). The current value represents an 11.6% increase from the revised estimated GSDP of INR 1196137 crore for the 2021–2022 period [7]. In 2019–2020, the service sector made the largest contribution (46.63%) to the state's economy, followed by agriculture (25.56%), and industries (27.81%). Western Rajasthan is known for its art, literature, songs, and folk culture [8]. In terms of natural resources and indigenous human culture, hardly any other part of India is so prosperous. Western Rajasthan's cultural wealth mainly includes palaces, forts, temples, pilgrimage centers, archeological sites, mining, a natural attraction like a sunshade, sand-dunes, etc. [9,10]. Western Rajasthan people are polite and welcoming, which also attract tourists to the region. All the necessary items are present at all the tourist locations here. Still, in some rugged and inaccessible places, it is difficult to get everything assessed, which generates a negative impact on tourists [8,10–12].

Governments and private organizations depend on the tourism sector, and both always try to utilize it to full advantage, ultimately resulting in the over-exploitation of natural resources. The tourism sector always relies on the number of tourists, and an increase in the number of tourists is dangerous for wildlife and natural beauty, and unsettles the existence of both nature and the environment [11,13]. An additional danger is an awareness among the tourists who often exploit more resources than they need to spend their holidays more pleasantly, thereby severely damaging both the environment and wildlife [12,14]. Over-exploitation of natural resources can be reduced with government policies to support the local community. These communities help maintain the environment more sustainably, but it also affects traditional and natural values [2,15].

The recent trends in tourism development have redirected the focus from mass tourism to sustainable tourism [16], which strictly controls tourism's effect on the environment [17]. This new and more sustainable tourism that supports the preservation of the environment is called "Ecotourism". As per McLaren 1998 [18], ecotourism is a versatile concept that combines different aspects of tourism like nature travel, adventure travel, birding, camping, archeological excavations, etc. Ecotourism, a widely recognized term, is closely associated with Nature-Based Solutions (NBS) that drive responsible tourism practices [19]. Ecotourism is a sustainable form of tourism that encompasses economic, ecological, and socio-cultural aspects. It offers visitors unique opportunities to appreciate and understand the natural environment while actively engaging in measures to protect it. NBS in ecotourism play a crucial role in income generation, and the conservation and management of protected areas and natural resources [12,20]. Additionally, these practices contribute to the creation of employment opportunities for local communities and promote environmental education. By integrating NBS into ecotourism, we ensure the sustainability and well-being of both the environment and the communities involved, making it a win–win solution for all stakeholders.

One of the main dimensions of ecotourism is sustainable growth [21,22] because ecotourism is generally nature-based activity with care of the environment [23,24]. In other words, preserving our natural resources for future generations without affecting the environment and wildlife is a crucial need of today because the lack of natural resources in the future may lead to war between different nations. For that, we need to be vigilant from now on, and our primary focus is on recycling and maximum utilization of minimum resources. Besides this, ecotourism protects nature, helps tourism stability, and plays a vital

role in conserving wildlife and other natural resources [25,26], because our main concern is to minimize the risk to nature and the environment [27,28]. Due to this, Geographic Information System (GIS) and Remote Sensing (RS) play a vital role in easily exploring rugged and inaccessible locations, and obtaining a comprehensive overview of the site [29]. There are various tools and techniques available in the market, which help in getting the best results with the minimum resources [30]. A Geographical Information System gives good results with minimum utilization of resources [31,32]. As per recent trends, GIS plays a crucial role in monitoring and minimizing the risk to wildlife and the environment with sustainable growth for society [2]. Sustainable management for ecotourism development is crucial to enhance, conserve, and maintain the biotic richness of the area and upliftment of the local people in terms of economy and jobs. The World Tourism Organization (WTO) has calculated that nature tourism creates nearly 7% of all international travel-based expenditures. Maintaining and generating revenue is a big challenge for any country and, for that, there is an urgent need for innovation and integration of new technology in the region [2,13,33]. In this new environment, youth can play an important role so that new dimensions of employment open up for them and society. Due to variability in social, cultural, and economic aspects, Western Rajasthan is considered an area of interest.

The existing literature on ecotourism in India and worldwide reveals a significant number of studies examining different facets, including socio-economic contributions and impacts as well as the evaluation of tourism infrastructure in various destinations. However, there is a notable research gap in adequately addressing the sustainable development of tourism through the effective utilization of natural and cultural resources. Specifically, there is a lack of focus on providing a robust support system utilizing geospatial technology to aid the Indian government in enhancing the tourism sector, particularly in Western Rajasthan. The primary objective of this study is to comprehend the ecotourism potential and generate a suitability map of Western Rajasthan using ArcGIS 10.8 software by utilizing both spatial and non-spatial data. Spatial data is vital for analyzing and mapping the distribution of suitability classes in ecotourism development. It enables the creation of visual representations, aiding in decision-making and communication. By utilizing spatial data, researchers can identify optimal locations, assess environmental impact, and evaluate connectivity and accessibility. It supports informed site selection, infrastructure planning, and resource allocation. The use of spatial data facilitates understanding, planning, and sustainable management of ecotourism resources in Western Rajasthan, while non-spatial data refers to information that is not directly associated with geographical locations or coordinates. It typically includes attribute data or characteristics that are not inherently tied to specific spatial coordinates, such as population density, demographic data, economic indicators, or any other data that provides context or additional information relevant to the study but does not have a spatial component. Remote sensing and GIS technologies are utilized to identify potential tourism sites that remain unexplored and pristine, employing weightage overlay analysis. This GIS-based technique enables the identification of optimal sites for future responsible tourism.

2. Literature Review

The aim of this paper is to assess sustainable ecotourism opportunities in Western Rajasthan, India, through advanced geospatial technologies. The strength of this approach lies in its foundation of diverse studies that have successfully applied geospatial technologies across various applications, such as site suitability analysis, potential ecotourism evaluation, and decision-making process enhancement.

Site suitability analysis serves as a critical phase in the identification of ecotourism opportunities. Al-Anbari, Thameer, and Al-Ansari [34] employed GIS and spatial overlay analysis to select suitable landfill sites, demonstrating how these technologies can effectively manage waste disposal, a crucial issue of global concern. Similarly, GIS, combined with the Analytical Hierarchy Process (AHP) as used by Pramanik [35], could be a powerful tool in evaluating the suitability of areas in Western Rajasthan for various ecotourism

activities. A study by Kaliraj, Chandrasekar, and Magesh [36] highlighted the versatility of geospatial technologies, demonstrating their utility in sustainable water resource management through the identification of potential groundwater recharge sites. Translating this approach into our study could ensure ecotourism developments do not strain local water resources in Western Rajasthan.

In terms of unveiling ecotourism potential, geospatial technologies have proven their effectiveness. Aliani et al.'s study [37] integrated fuzzy logic and the Analytical Network Process (ANP) into a multi-criteria evaluation method, providing a useful approach to quantify and prioritize multiple ecological and socio-economic factors that affect sustainable ecotourism. The studies by Waswa et al. [38] and Bhanwar V. R. Singh et al. [39] further demonstrated the application of GIS in evaluating ecotourism and geotourism potentials, respectively. By identifying and promoting lesser-known or under-utilized sites in Western Rajasthan, this approach can prevent overcrowding and associated environmental degradation.

Geospatial technologies also play a pivotal role in informed decision-making. Lazoglou and Angelides [40] proposed a Spatial Decision Support System (SDSS) combining ontologies, GIS, and object-oriented programming for land-use planning. Such a system could be valuable in Western Rajasthan to provide comprehensive spatial information to stakeholders. Mandić's literature review [19] underscored the potential role of geospatial technologies in sustainable tourism development. The review highlights nature-based solutions (NBS), a key tool in sustainable tourism, which could be especially valuable in preserving Western Rajasthan's rich biodiversity.

Masoudi's research [41] demonstrated the utility of geospatial technologies in informed spatial development planning. Through multi-criteria evaluation (MCE) and multi-objective land allocation (MOLA) GIS decision-making tools, the study showed how these technologies could help balance environmental, social, and economic factors integral to sustainable ecotourism development. In conclusion, the range of studies explored validates the pivotal role geospatial technologies play in identifying and assessing sustainable ecotourism opportunities. By applying these tools to the specific context of Western Rajasthan, this study seeks to stimulate local socio-economic development while preserving the region's unique cultural and natural resources. The ultimate goal is to ensure that the benefits of ecotourism are shared equitably and sustainably, contributing to the broader goals of sustainable development.

3. Study Area

The study area of Western Rajasthan mainly includes four main districts, which are Jodhpur (26.2389° N, 73.0243° E), Jaisalmer (26.9157° N, 70.9083° E), Bikaner (28.0229° N, 73.3119° E), and Barmer (25.7521° N, 71.3967° E) with a total area of 119,885 km^2 (Figure 1). Tourism accounts for nearly 15% of revenue in the Rajasthan economy and provides different economic benefits like foreign exchange earnings, infrastructure development, regional development, and local handicrafts promotion. The climate ranges from desert to semi-arid, and from tropical to humid. Western Rajasthan has around 61% of India's overall hot desert zone. Arid regions have a limited capacity for water retention due to harsh environments, unfavorable terrain, and inadequate surface drainage systems. West Rajasthan accounts for almost 62% of India's arid zone. In 2011, the population of this region was 9.324 million, with an average population density of 78 km^2, compared to 59 km^2 in 2001. It is estimated that, by the end of 2021, the population will increase to 13.53 million, resulting in a population density of 110 km^2. The primary source of water in the area is the monsoon season, which is highly unpredictable, with a coefficient of variation ranging from 40% to 60%. The region is characterized by sandy uplands in the west and south, with a small rocky upland in the eastern region. The highest elevation (290–330 m above mean sea level) is found in the eastern part of the region, mainly near Jodhpur district. The area receives an average annual rainfall of 366 mm, while the summer temperature ranges from 38 to 50 °C and the winter temperature ranges from 6 to 10 °C.

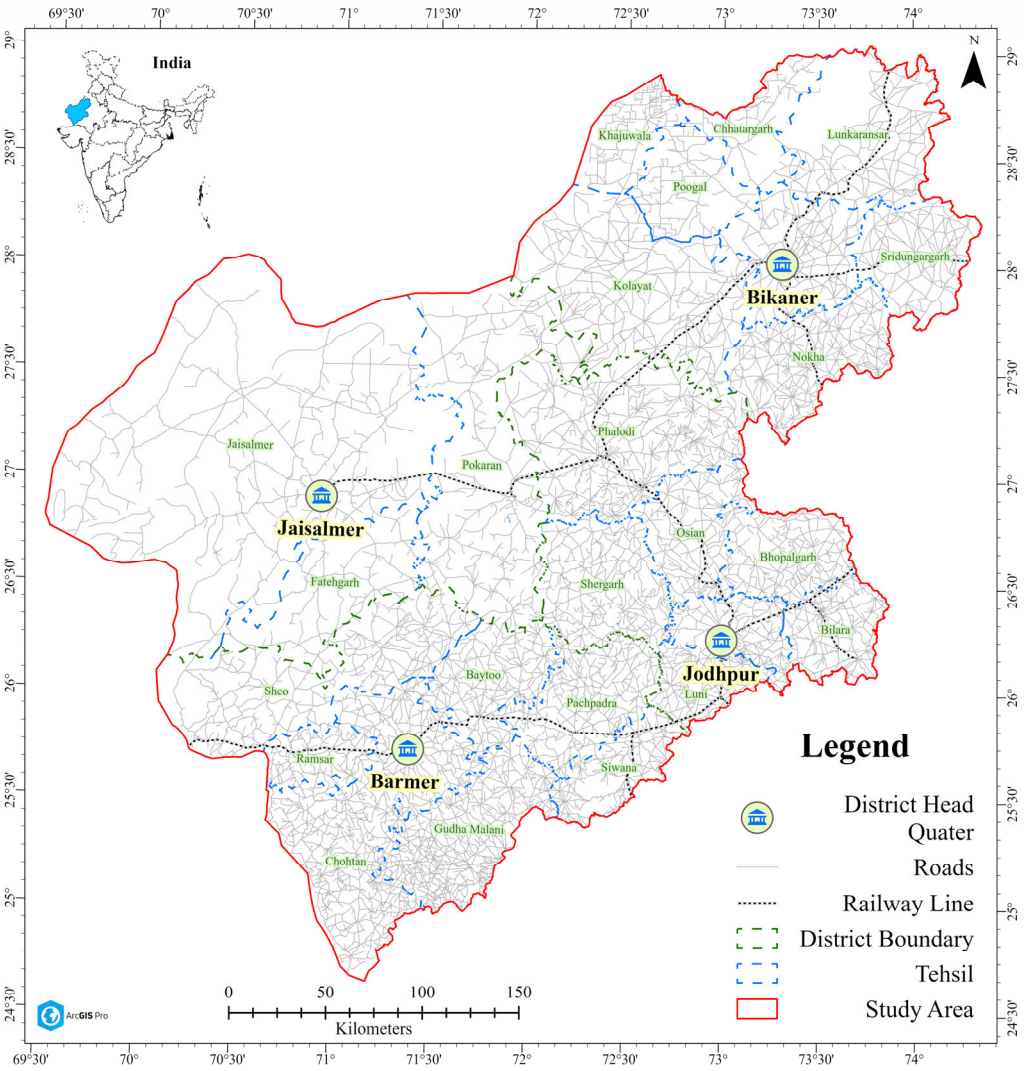

Figure 1. Location map of the study area in Western Rajasthan, India.

4. Data and Methodology

The spatial data used in this analysis are elevation, proximity to streams, land use/cover, population density, road connectivity, proximity to protected areas, and heritage hotspots. The non-spatial data include population density. All the thematic layers play a very vital role in this analysis; without them, it is not possible to give proper and sustainable results. Each thematic layer has equal importance in finding the final suitability map, which is discussed below. To process the data, Arc GIS 10.8 and ERDAS Imagine 2015 software have been utilized, and the technique used weightage sum overlay analysis. Site suitability analyses typically consider several eligibility criteria, with some being more important than others. Weightage sum overlay analysis is a method used to combine and analyze multiple thematic layers. It involves assigning weights or importance values to each layer, and then overlaying and summing them to obtain a composite suitability score for each location. This technique allows for the consideration of the relative significance of each thematic layer in the final suitability assessment. When conducting a location-based search to compare multiple suitable classes, it is expected that these criteria will have varying degrees of importance. The layering theory can be used to improve overlay analysis by assigning different levels of importance to each criterion. To accomplish this, a weightage factor is assigned to all thematic layers based on their importance relative to other layers. The weightage layers are then overlaid using a process known as "weightage sum overlay analysis". This study utilized data from different sources, which are cited below in Table 1.

Table 1. List of data and their sources.

S/N	Data	Sources
1	Boundary Map	Survey of India http://www.surveyofindia.gov.in/ (accessed on 14 June 2023)
2	District Head Quarters	Survey of India http://www.surveyofindia.gov.in/ (accessed on 14 June 2023)
3	Landsat 8 OLI (30 × 30 m)	U.S. Geological Survey (USGS) https://earthexplorer.usgs.gov/ (accessed on 14 June 2023)
4	DEM (SRTM) (30 × 30 m)	U.S. Geological Survey (USGS) https://earthexplorer.usgs.gov/ (accessed on 14 June 2023)
5	Population Data 2011	Census of India https://censusindia.gov.in (accessed on 14 June 2023)
6	Protected Areas	ENVIS Centre of Wildlife and Protected Areas https://www.wiienvis.nic.in/ (accessed on 14 June 2023)
7	Heritage Spots	Field Survey with GNSS

The study falls within the domain of geospatial research design. It also incorporates quantitative data in the form of suitability classes (very high, high, moderate, low, and very low) to quantify the degree of suitability for ecotourism in various areas and integrates elements of quantitative research design. The objective is to identify suitable ecotourism sites and evaluate their level of suitability based on predetermined criteria, utilizing both geospatial and quantitative methods. This study comprises three primary stages: data preprocessing, main processing, and the generation of the final suitability map, Figure 2.

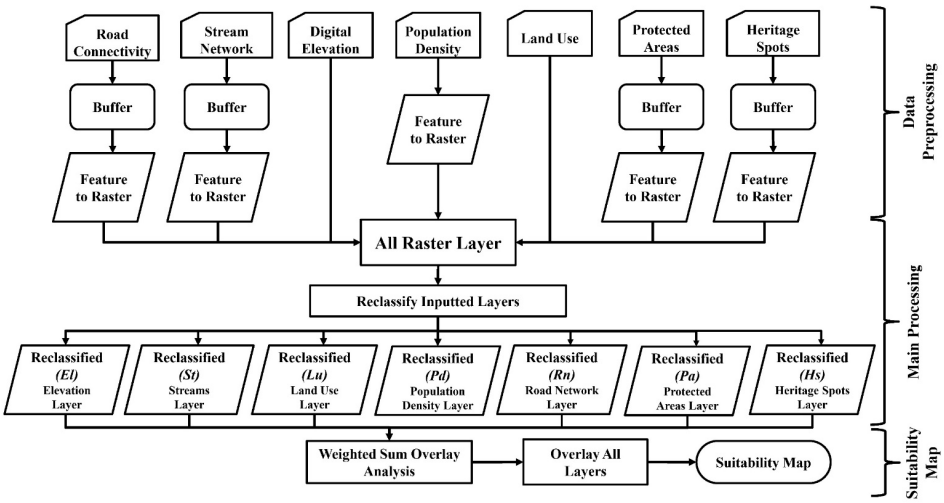

Figure 2. Methodology for the proposed study for ecotourism suitability map.

4.1. Data Preprocessing

In this stage, all types of raw data which were collected from different sources were converted into different thematic layers, which can be overlayed in the next stage. The main layer used during this study was as follows.

4.1.1. Elevation

SRTM DEM data were obtained from the USGS website with a 30 × 30 m spatial resolution for finding potential sites of ecotourism. They are in raster format that can be used directly in main processing at a later stage; the theme weightage was taken as 17 after carefully analyzing the variation in elevation values.

4.1.2. Stream Network

If we look to the past, people were keen to live near water resources. Water exerts a strong attraction for people. When planning vacations or traveling for leisure, many individuals are inclined to seek out water resources. Major tourist locations also fall near water bodies, so it is mandatory to check this proximity. Based on that, the buffer zone was created at 0.5 km, 1 km, 2 km, 3 km, and 5 km, and the theme weightage was taken as 19 here.

4.1.3. LULC Mapping

Land use and land cover maps denote spatial information on different types (classes) of physical coverage present on the Earth's surface. For the delineation of land-use categories, ERDAS Imagine 2015 was used for image processing and Arc GIS 10.8 software was used to get more precise information based on DN values. The entire area was classified by a supervised technique using the maximum likelihood classifier. In order to compare the classified image with the reference data, an accuracy assessment was conducted utilizing an error matrix. The assessment comprised the computation of several metrics, including the overall accuracy, producer's accuracy (omission error), user's accuracy (commission error), and Kappa coefficient. The Kappa coefficient was employed to gauge the level of agreement between interpretation and verification, considering both correctly classified units as well as commissions and omissions. Calculation of the Kappa coefficient was performed following Bishop's formula [42]:

$$k\frac{Nsum_{i=1}^{r}\ x_{ii} - sum_{i=1}^{r}\ (x_i+)(x+i)}{N^2} - sum^{r} \underset{i=1}{\rightarrow} \quad (x_i+)(x+i) \tag{1}$$

In this context, the symbol "r" refers to the total number of rows present in the matrix. The term "x_{ii}" denotes the number of observations located in the diagonal of the ith row and column. Additionally, $(x + i)$ and (x_i+) represent the total number of observations present in row "r" and column "i", respectively. The variable "N" signifies the overall number of observations in the matrix. Using the Kappa coefficient, an accuracy assessment was carried out, revealing that the LULC thematic map produced from satellite imagery had an overall classification accuracy of 90%. The Kappa coefficient statistics demonstrated a value of 0.8654. In the event of any erroneous pixel identification, corrective action was taken and the revised classified maps of LULC units were utilized for area calculations. During the study, the main categories taken were barren land, built-up land, cropland, fallow land, forest land, grassland, and water bodies based on coverage of land, with different types of scores given to each category. These categories have a final theme weightage given of 12.

4.1.4. Population Density

The population residing in tourist destinations is usually aware of the positive and negative impact of tourism development within their community. So, it is necessary to analyze this aspect. The population data were taken from the Census of India of the year 2011 which is most recent data available on the government site. It is crucial to understand the population statistics of the study area from the point of view of tourism. To compute the population density, divide the population by the area size. Mathematically, it is denoted as population density = number of people/land area.

4.1.5. Road Network

The state has a well-established network of roads, which enables easy access to the main tourist hubs. It is a very important part of the enhancement of tourism-based activity. It also gives freeness in terms of mobility from one region to another; it is crucial to understand this aspect. During the study, the buffer zone was created at a distance of 1 km, 2 km, 3 km, 4 km, and lastly 5 km. These distances clearly show the proximity to the various tourist spots; on that basis, the theme weightage was decided, which was taken as 9 here.

4.1.6. Protected Area

According to the International Union for Conservation of Nature (IUCN) "Protected areas are those in which human occupation or at least the exploitation of resources is limited". From the tourism point of view, protected areas are essential to understand natural wildlife more closely. Most tourists are attracted to natural beauty because it provides relaxation. From that point of view, protected areas are taken as the major thematic layer in Western Rajasthan. The information is taken from the ENVIS Centre on Wildlife and Protected Areas website, which clearly shows the major wildlife sanctuaries of Western Rajasthan, seen in Table 2. In this study, the buffer zone was created at 1 km, 10 km, 20 km, 30 km, and lastly 50 km, and the theme weightage taken was 10.

Table 2. Major protected areas present in Western Rajasthan, India.

S. No.	Name	District	Area (km^2)
1	Jorbeer Conservation Reserve	Bikaner	56.408
2	Desert National Park	Jaisalmer and Barmer	3162.356
3	Wildlife Guda Bishnoiyan	Jodhpur	2.338

Source: ENVIS Centre on Wildlife and Protected Area.

4.1.7. Heritage Hotspot

Heritage tourism can be defined as "the act of traveling to destinations that offer authentic representations of past stories, artifacts, and activities, in order to gain a deeper understanding of the people and cultures of the past" [43]. During tourism activity, these places play a very attractive role. It gets a lot of attention because people are enthusiastic to know and understand how people lived and spent their life at that time. Western Rajasthan is full of these heritage hotspots; because of this, it is essential to map these locations. So, the data was collected from GPS and mapped on the GIS platform for understanding the ecotourism prospect; these data were further analyzed and buffer zones created at 1 km, 10 km, 30 km, 60 km, and 100 km after analyzing the proximity; theme weightage given was 22.

4.2. Main Processing

In this part of processing, all the raw thematic layer was reclassified into an equal number of classes; for that equalization Arc GIS has a specialized tool named "Reclassify tool"; using the tool, we can easily equalize the class. This reclassified layer was used in weightage sum overlay analysis to get the final suitability map. The reclassified layers were elevation, proximity to water bodies, land use, population density, road connectivity, proximity to protected areas, and heritage hotspots.

4.3. Final Suitability Map

After the generation of all the reclassified thematic layers next step was to give theme weightage, which was already discussed in the preprocessing data stage. So, we directly input all the layers and the theme values in the space provided during the weightage sum overlay analysis process. This process took time to calculate and analyze the thematic layers to generate the final output as the final suitability map.

5. Spatial and Statistical Analysis

Western Rajasthan has several types of tourism that hold immense potential for future development through spatial and statistical analysis. This study is heavily reliant on GIS applications, which play a vital role in the analysis. Throughout the study, the following assumptions were made while analyzing (Ep) ecotourism potential sites based on seven main scales: (El) elevation, (St) proximity to streams, (Lu) land use/cover, (Pd) population density, (Rn) road network, (Pa) proximity to protected areas, and (Hs) heritage hotspots, as seen in Figure 3. These standards were taken as the parameters to evaluate the high

ecotourism potential zones in the "weighted sum overlay analysis". In this study, all the raw files were collected and arranged in Arc GIS 10.8 software. The next step is to reclassify all the vector and raster datasets into thematic maps. These thematic maps are used in weightage overlay analysis. There is an immense need to reclassify data because reclassification converts all pixel values of the thematic map into the same range; without that, we cannot perform weightage overlay analysis. After reclassification, we get new reclassified thematic maps, also called "index maps"; on the basis of different factors, relevance, such as expert opinion, and manual interpretation, we assign relative weightage (ranked from 1 to 9) to each thematic layer in Table 3. These index maps were further used in the final processing of Arc GIS. Finally, the ecotourism potential map was produced by using this logical formula in the Arc GIS 10.8 weightage overlay extension tool.

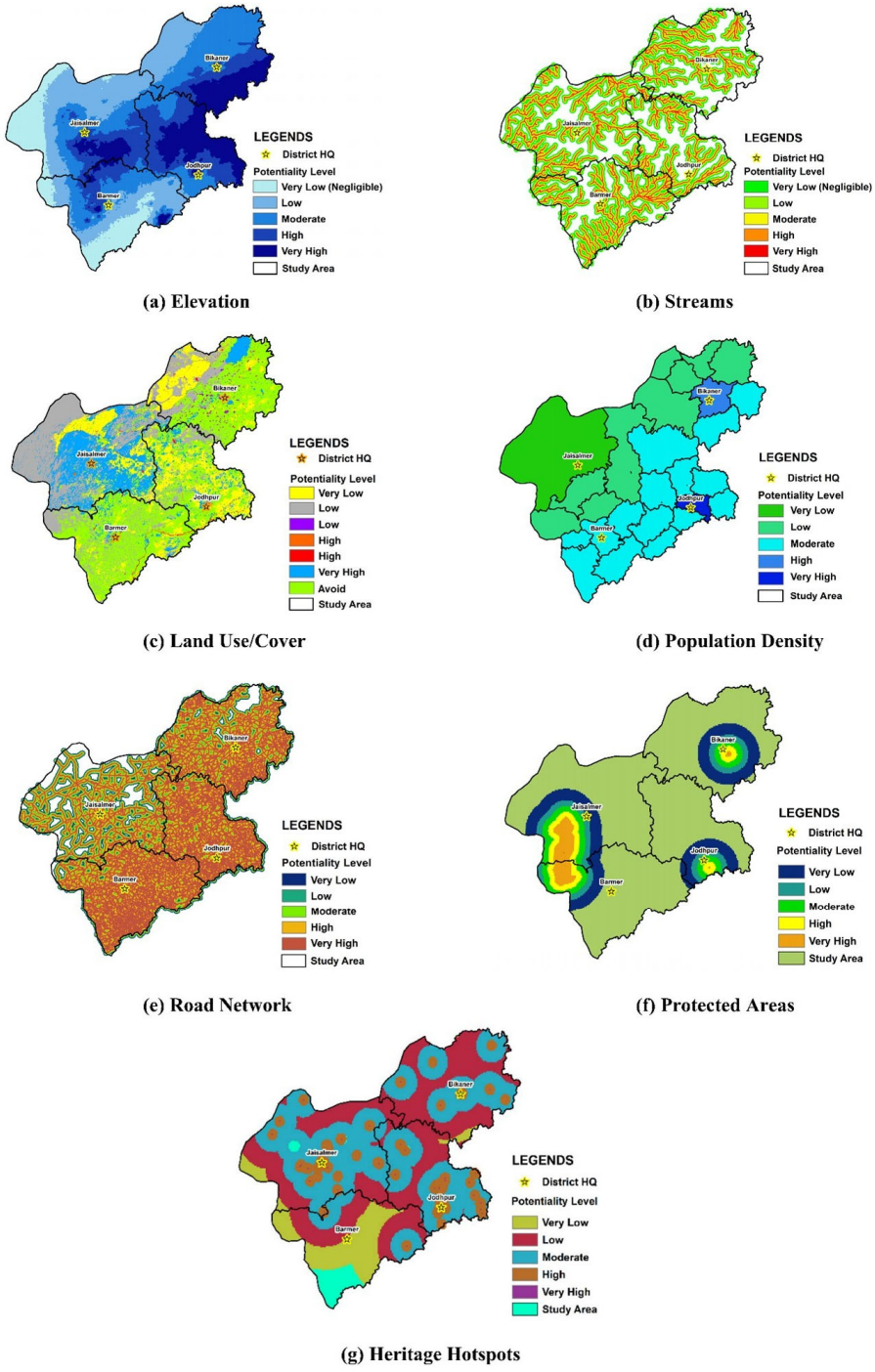

Figure 3. Index maps for finding potential ecotourism.

Table 3. Class weightage and theme weightage of the respective theme layers are assigned based on their influence/importance in ecotourism.

S. No.	Code	Layer Name	Class	Theme	Scale Value	Potentiality Level
1.	(*El*)	Elevation (Meters)	<107	17	1	Very Low Potential
			107–165		3	Low Potential
			165–217		7	Moderate Potential
			217–268		8	High Potential
			268–571		9	Very High Potential
2.	(*St*)	Streams Buffer (km)	5	19	1	Very Low Potential
			3		2	Low Potential
			2		6	Moderate Potential
			1		8	High Potential
			0.5		9	Very High Potential
3.	(*Lu*)	Land Use/Cover	Crop Land	12	3	Very Low Potential
			Barren land		1	Low Potential
			Grass Land		4	Low Potential
			Built-up Land		8	High Potential
			Water Bodies		7	High Potential
			Forest Land		9	Very High Potential
			Fallow Land		5	Not Considerable
4.	(*Pd*)	Population Density (ppl/km^2)	0–50	11	0	Negligible
			51–100		1	Very Low Potential
			101–150		2	Low Potential
			151–200		4	Moderate Potential
			201–250		8	High Potential
			Above 251		9	Very High Potential
5.	(*Rn*)	Road Network Buffer (km)	5	9	1	Very Low Potential
			4		2	Low Potential
			3		4	Moderate Potential
			2		7	High Potential
			1		9	Very High Potential
			50		1	Very Low Potential
			30		2	Low Potential

Table 3. *Cont.*

S. No.	Code	Layer Name	Class	Theme	Scale Value	Potentiality Level
6.	(*Pa*)	Protected Areas Buffer (km)	20	10	6	Moderate Potential
			10		8	High Potential
			1		9	Very High Potential
			100		1	Very Low Potential
			60		3	Low Potential
7.	(*Hs*)	Heritage Hotspots Buffer (km)	30	22	7	Moderate Potential
			10		8	High Potential
			1		9	Very High Potential

Mathematically, this can be represented following Stewart's equation [44] as:

$$E_p = sum W_i CV_i, \quad (2)$$

where (E_p) represents the ecotourism potential value, while (W_i) signifies the weightage or significance of each theme. Additionally, (CV_i) refers to the grade value of an individual class for a specific theme, which is ultimately used as the class weightage in the algorithm. Upon assigning the weightage to each theme, the aforementioned equation can be expressed as follows

$$Ep = sum(17 \times CVEl) + (19 \times CVSt) + (12 \times CVLu) + (11 \times CVPd) + (9 \times CVRn) + (10 \times CVPa) + (22\, CVHs) \quad (3)$$

6. Results

Western Rajasthan possesses a very strong potential for tourism-based activities all because of different types of adventurous and beautiful heritage sites. For the proper enhancement of tourism-based activities, there is an essential need to have a proper management system, which creates a ladder for creating various types of opportunities for the community's livelihoods. "Geographic Information System has demonstrated to be an effective and efficient tool for studying suitability analysis". This study is to assist the government, private players, and different types of policymakers in investing in those potential hotspots to provide socio-economic benefits to the local population by enhancing tourism-based activities. Utilizing the potential sites efficiently will not only ensure the sustainable use of nature-based resources but also enhance the livelihoods of the local community.

The present study strives to develop a unified approach to ecotourism development by identifying suitable ecotourism sites. The geospatial technique and weightage sum overlay analysis methods (Figure 4) were used to perform the research analysis, resulting in the production of a final suitability map. The reason for utilizing GIS-based weightage sum overlay analysis is that it offers a flexible and systematic approach to combining multiple spatial data layers and assigning relative importance to each layer, thereby facilitating decision-making based on the spatial relationships and characteristics of the analyzed data.

The study employs advanced scientific methodologies and data sources to comprehensively assess the potential for ecotourism within the study area. The primary dataset used is the SRTM DEM, a high-resolution digital elevation model obtained from the USGS website. This dataset provides detailed information about the topography and elevation of the region, which is crucial for identifying suitable ecotourism sites. Proximity to water bodies is a significant factor in determining the attractiveness of an ecotourism site. People are naturally drawn to water resources for various activities such as relaxation, leisure, and recreation. By analyzing the distance between potential sites and water bodies, buffer zones were created at intervals of 0.5 km, 1 km, 2 km, 3 km, and 5 km. These buffer zones help evaluate the degree of proximity and influence the theme weightage assigned to each site, with a higher weightage given to those closer to water bodies. The study also incorporates

land use and land cover analysis, utilizing Arc GIS 10.8 software tools and techniques. This analysis provides detailed information about the different types of land cover present in the study area, such as forests, agricultural land, and urban areas. By examining the distribution and composition of land cover classes, the study gains insights into the potential ecological value and suitability of different sites for ecotourism. Population density is another crucial factor considered in the study. By using population data from the Census of India, specifically from the year 2011, the study assessed the number of people residing in the ecotourism destinations. Understanding the population density helps in determining the potential impact of tourism on the local community and infrastructure. Road accessibility was evaluated to understand the ease of reaching the main tourist hubs within the study area. A well-established road network plays a vital role in facilitating tourism activities and improving mobility for both tourists and locals. Buffer zones were created at varying distances of 1 km, 2 km, 3 km, 4 km, and 5 km to evaluate the proximity of potential sites to major roads. The theme weightage was adjusted based on the distance to the road network, with higher weightage given to sites closer to main transportation routes. The study also takes into account the presence of protected areas, as defined by the International Union for Conservation of Nature (IUCN). Buffer zones were created at different distances to evaluate the proximity of ecotourism sites to these protected areas. Recognizing and considering the significance of protected areas helps in ensuring the conservation of natural resources and biodiversity while promoting sustainable tourism practices.

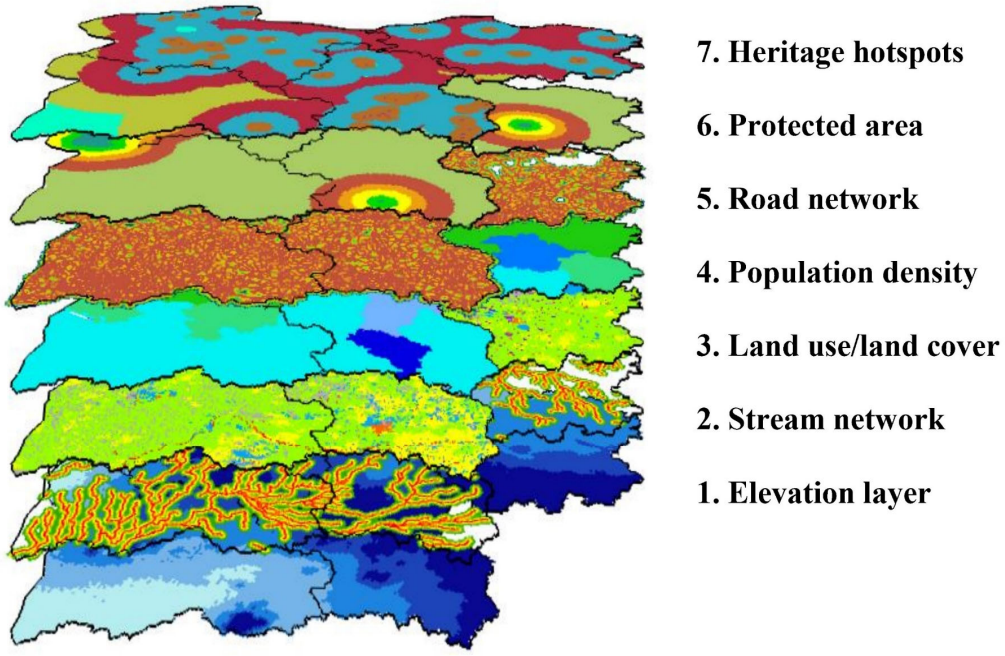

Figure 4. Overlaying of all the index maps.

This study revealed that the final suitability map depicts data divided into five distinct suitability classes: very high, high, moderate, low, and very low. Figure 5 illustrates the final suitability map for ecotourism development and management in Western Rajasthan. It is evident that the area with very high suitability covers approximately 37.31% of the region, primarily concentrated in the districts of Bikaner and Jaisalmer. The area with high suitability constitutes around 26.85%, predominantly found in three main regions: Jodhpur, Barmer, and Bikaner. The moderate suitability category encompasses 7.89% of the area, mainly located in the Barmer region. The low suitability area encompasses 0.83% and is situated in the Barmer region due to various unfavorable factors such as inadequate infrastructure development and limited road, rail, and air connectivity. Approximately 27.12% of the area falls under the category of very low suitability, primarily found in the Jaisalmer district. This is primarily due to the extremely high temperatures during

peak seasons and the lack of necessary infrastructure and amenities to support ecotourism activities effectively. Furthermore, Jaisalmer's natural characteristics and ecological features also face difficulties in aligning well with ecotourism's requirements and preferences. The region's ecological diversity, wildlife habitats, and conservation efforts are also relatively limited compared to other areas, resulting in lower suitability for ecotourism development.

Lastly, the study recognizes the importance of historical sites in attracting tourists. These locations offer insights into the rich historical and cultural heritage of the region. Using GPS data, the study identifies and maps these heritage hotspots, creating buffer zones at varying distances to assess their proximity to potential ecotourism sites. The theme weightage is adjusted accordingly to highlight the significance of these heritage hotspots. By integrating these scientific methodologies and considering various factors, the study provides a comprehensive evaluation of the ecotourism potential within the study area. The utilization of advanced data sources, analysis techniques, and thematic weightages ensures a holistic approach to identifying and assessing suitable ecotourism sites while promoting sustainable tourism practices. Proper planning is crucial for the development of ecotourism sites, ensuring sustainable utilization of both natural and man-made tourism resources.

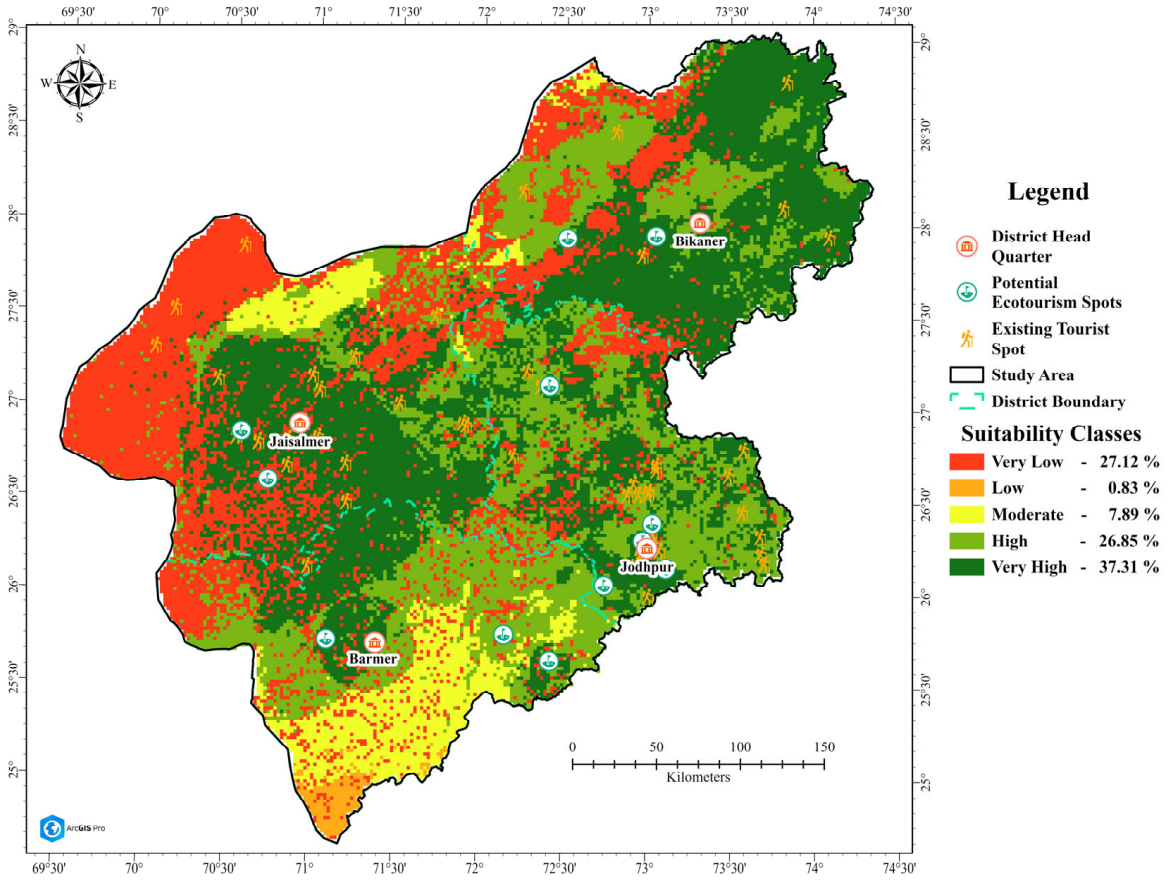

Figure 5. The suitability map for ecotourism in Western Rajasthan, India.

7. Discussion

The findings of this study reveal that Western Rajasthan exhibits significant potential for ecotourism development, as indicated by the results obtained through the utilization of the GIS and Remote Sensing applications. The GIS-based weightage sum overlay analysis technique employed in this research has contributed to clarifying this potential [45–47]. The analysis demonstrates that a substantial portion of the region, approximately 37.31% of the total area, falls within a significant potential zone, primarily concentrated in the districts of Bikaner and Jaisalmer, which are also highly favoured destinations among tourists. These results emphasize the importance of improving the development and maintenance

of ecotourism sites in Western Rajasthan [48–50]. By implementing appropriate measures to enhance infrastructure, connectivity, and facilities in these areas, we can unlock immense possibilities for tourism-based activities [51,52]. This, in turn, would stimulate economic growth, create employment opportunities, and support the preservation of the region's unique natural and cultural heritage [53–55]. Ecotourism, characterized by sustainable practices and a focus on minimal environmental impact, is an ideal approach for Western Rajasthan's development. It offers the opportunity to immerse visitors in the region's ecologically fragile and visually stunning landscapes, showcasing its extraordinary natural beauty, diverse wildlife, and unique ecosystems. By fostering an appreciation for the environment and generating support for conservation efforts, ecotourism can contribute to the long-term preservation of these delicate ecosystems for future generations. However, it is essential to address the challenges associated with ecotourism development. Without proper management and regulation, there is a risk of unintentionally causing harm to the very environments that ecotourism seeks to protect [56,57]. Issues such as uncontrolled foot traffic, disturbance of wildlife, waste generation, and strain on local resources can arise if not carefully monitored. Therefore, sustainable management practices must be implemented to balance tourism and conservation harmoniously. Implementing responsible tourism practices involves several key strategies. These include limiting visitor numbers to avoid overcrowding, establishing designated trails to minimize ecological disturbances, encouraging the use of eco-friendly transportation, and enforcing strict guidelines to preserve natural habitats [58]. Furthermore, the equitable distribution of benefits to local communities is vital for successful ecotourism development [59]. By involving and empowering these communities, ecotourism can foster economic development, improve infrastructure, and provide educational opportunities, thereby creating a sense of ownership and pride among locals [60]. Collaboration between governments, local stakeholders, and non-governmental organizations plays a crucial role in formulating and implementing sustainable ecotourism strategies [61]. These partnerships ensure that the planning and execution of ecotourism initiatives consider all stakeholders' diverse perspectives and interests. By working together, we can create a framework for responsible and well-managed ecotourism that maximizes positive outcomes for both the environment and local communities [62].

8. Conclusions

This study developed a unified approach to ecotourism development by utilizing geospatial techniques and weightage sum overlay analysis methods. The GIS-based analysis allowed for the integration of multiple spatial data layers, enabling informed decision-making based on their relative importance. The resulting final suitability map reveals five distinct suitability classes, ranging from very high to very low. The study identified regions with high ecotourism suitability, primarily concentrated in the districts of Bikaner and Jaisalmer. However, challenges such as inadequate infrastructure and limited connectivity in the Barmer region contribute to areas of low suitability. Additionally, extreme temperatures and insufficient infrastructure in the Jaisalmer district result in very low suitability. These findings provide valuable insights for promoting sustainable ecotourism in Western Rajasthan.

This study also gives a futuristic scope through which we can find many ecotourism hotspots, which can be developed on a large scale. Based on the outcome, some recommendations can be utilized by different government and non-government organizations, stakeholders, sustainable tourism planning activities, and different decision-making processes.

Within the Conclusion we would like to give recommendations and future scope:

- For sustainable ecotourism, there is a crucial need to create an effective balance between three elements: environment, tourist, and administration;
- Public and private ownership is required to enhance tourism-based services;
- Proper connectivity must be ensured to all the tourism-based locations;

- To maintain environmental harmony, it is essential to limit tourism activity in the eco fragile area. The administration must ensure it through proper channels;
- Rejuvenate the degraded forest by implementing various rules and regulations, and also limit access in that particular part;
- Educate the community regarding today's environmental conditions so that they care about a different aspect of life;
- Unemployment among the new as well as the old generation is also a major concern that must be removed by giving proper opportunity in tourism-based activity without harming nature;
- The administration must utilize human resources in different tourism activities by giving effective and essential training;
- The government must promote Rajasthani folk cultures by including them in different traveling packages;
- Encourage different co-operative societies to make agro-horticultural and animal-based products and run different types of businesses like canteen/restaurants in the tourist spots through those;
- It is essential to make an eco-friendly environment for sustainable ecotourism development;
- Advertisement and publicity are a crucial part of attracting tourists to the location; the government must take the initiative to give a proper allotment of funds from time to time in this regard;
- Utilize eco-friendly vehicles at a tourist location to make the environment free from pollution;
- Tourist circuit maps must highlight major tourist interest locations;
- In the sandy area, tourists may suffer a lack of connectivity and shortage of essential goods at major locations which must be neutralized by providing different rental-based bus and car operations;
- In contemporary times, the internet has become a crucial medium for exchanging geospatial data between users at various locations. It is imperative to enhance location-based information activities to enable tourists to provide feedback on their experiences at multiple scales. Such feedback can help to attract more tourists to the location and improve the image of the site among future visitors, making it an effective strategy for sustainable tourism development.

This study holds great promise for future research. The suitability map generated through this study can serve as a foundation for future planning and development of eco-tourism in Western Rajasthan. It can help in identifying specific areas with high ecotourism potential, and also assist in determining the types of activities that can be developed in these areas. Additionally, the study can be expanded by incorporating more thematic layers and using more advanced techniques for analysis. For example, incorporating socio-economic data can help in identifying areas with high tourism demand and potential for community-based ecotourism activities. Furthermore, incorporating climate change data can help in identifying areas that are vulnerable to climate change impacts, and can aid in developing climate-resilient ecotourism activities. Moreover, the study can also be extended to other regions of India or other countries that have similar characteristics, such as a rich cultural and natural heritage, and potential for ecotourism development. The techniques used in this study can be replicated and customized according to the specific context of each region, which can help in promoting sustainable tourism development and conservation of natural and cultural resources.

Author Contributions: Conceptualization, R.S.C., S.K. and B.Đ.; methodology, R.S.C., S.K., S.K.S., B.Đ. and J.D.H.; software, R.S.C., S.K., S.K.S., D.D. and J.D.H.; validation, B.Đ., O.B.O. and J.D.H.; formal analysis, R.S.C., S.K., S.K.S., B.Đ., O.B.O., D.D. and J.D.H.; data curation, R.S.C., S.K. and S.K.S.; writing—original draft preparation, R.S.C., S.K., S.K.S. and B.Đ.; writing—review and editing, O.B.O., D.D. and J.D.H.; visualization, O.B.O.; project administration, R.S.C., S.K., S.K.S., B.Đ., O.B.O., D.D. and J.D.H.; funding acquisition, B.Đ. and O.B.O. All authors have read and agreed to the published version of the manuscript.

Funding: The APC was partially funded by the scientific project "Determining the potential of watercourses for the production of electric energy from micro, mini, and pico hydropower plants" in 2023. year, funded by University North.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: All data available upon reasonable request to the corresponding authors.

Acknowledgments: This research is supported within the scientific project "Application of modern technologies and smart sensors in geomatics", as well as "Determining the potential of watercourses for the production of electric energy from micro, mini, and pico hydropower plants", both in 2023 year, from the University North, Croatia. The authors express deep gratitude to Shruti Kanga and Suraj Kumar Singh for their invaluable contributions towards the success of this research paper. Their insightful discussions and comments were instrumental in shaping the direction of this study and in ensuring its overall quality.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Singh, M.K.; Neog, Y. Contagion Effect of COVID-19 Outbreak: Another Recipe for Disaster on Indian Economy. *J. Public Aff.* **2020**, *20*, 2171. [CrossRef]
2. Boyd, S.W.; Butler, R.W.; Haider, W. Identifying Criteria and Establishing Parameters for Forest-Based Ecotourism in Northern Canada. In Proceedings of the 1994 Northeast Recreation Research Symposium, Saratoga Springs, NY, USA, 10–12 April 1994; pp. 211–216.
3. Borchert, I.; Mattoo, A. The Crisis-Resilience of Services Trade. *Serv. Ind. J.* **2010**, *30*, 2115–2136. [CrossRef]
4. Sheller, M.; Urry, J. *Tourism Mobilities: Places to Play, Places in Play*; Routledge: London, UK, 2004; ISBN 0203340337.
5. Narayan, B.; Rajendran, C.; Sai, L.P.; Gopalan, R. Dimensions of Service Quality in Tourism—An Indian Perspective. *Total Qual. Manag. Bus. Excell.* **2009**, *20*, 61–89. [CrossRef]
6. Chandel, R.S.; Kanga, S.; Singh, S.K. Impact of COVID-19 on Tourism Sector: A Case Study of Rajasthan, India. *AIMS Geosci.* **2021**, *7*, 224–243. [CrossRef]
7. Singh, A.; Phadke, V.S.; Patwardhan, A. Impact of Drought and Flood on Indian Food Grain Production. In *Challenges and Opportunities in Agrometeorology*; Springer: Berlin/Heidelberg, Germany, 2011; pp. 421–433.
8. Singh, R.B.; Kumar, A. Cultural Tourism-Based Regional Development in Rajasthan, India. In *Advances in 21st Century Human Settlements*; Springer: Berlin/Heidelberg, Germany, 2022; pp. 453–466.
9. Kanga, S.; Sharma, L.K.; Pandey, P.C.; Nathawat, M.S.; Sharma, S.K. Forest Fire Modeling to Evaluate Potential Hazard to Tourism Sites Using Geospatial Approach. *J. Geomat.* **2013**, *7*, 93–99.
10. Ranwa, R. Impact of Tourism on Intangible Cultural Heritage: Case of Kalbeliyas from Rajasthan, India. *J. Tour. Cult. Chang.* **2022**, *20*, 20–36. [CrossRef]
11. Kanga, S.; Thakur, K.; Kumar, S.; Gupta, H.; Geo-informatics, A.; Pradesh, H.; Pradesh, H.; Thakur, K.; Kumar, S. Potential of Geospatial Techniques to Facilitate the Tourist & Administration: A Case Study of Shimla Hill Station, Himachal. *Int. J. Adv. Remote Sens. GIS* **2014**, *3*, 681–698.
12. Chandel, R.S.; Rai, P.K.; Kanga, S.; Singh, R. An Assessment and Management of Ecotourism Based on Water and LULC: A Geospatial Approach of Jodhpur, Rajasthan, India. In *River Conservation and Water Resource Management*; Springer: Berlin/Heidelberg, Germany, 2023; pp. 233–251.
13. Boyd, S.W.; Butler, R.W. Seeing the Forest through the Trees: Using Geographical Information Systems to Identify Potential Ecotourism Sites in Northern Ontario, Canada. In *Practicing Responsible Tourism: International Case Studies in Tourism Planning, Policy, and Development*; John Wiley & Sons, Inc.: Hoboken, NJ, USA, 1996; pp. 380–403.
14. Wearing, S.; Neil, J. Ecotourism and Protected Areas: Visitor Management for Sustainability. In *Ecotourism*; Elsevier: Amsterdam, The Netherlands, 2009; pp. 63–93.
15. Barua, A.; Katyaini, S.; Mili, B.; Gooch, P. Climate Change and Poverty: Building Resilience of Rural Mountain Communities in South Sikkim, Eastern Himalaya, India. *Reg. Environ. Change* **2014**, *14*, 267–280. [CrossRef]
16. Singh, S.K.; Kanga, S. Sudhanshu Assessment of Geospatial Approaches Used for Classification of Crops. *Int. J. Math. Eng. Manag. Sci.* **2018**, *3*, 271–279. [CrossRef]
17. Nisa, Z. Potential Site Selection in Ecotourism Planning Using Spatial Decision Support Tool. *Int. J. Hum. Cap. Urban Manag.* **2017**, *2*, 251–258. [CrossRef]
18. McLaren, D. *Rethinking Tourism and Ecotravel*; Kumarian Press: West Hartford, CT, USA, 1998.
19. Mandić, A. Nature-Based Solutions for Sustainable Tourism Development in Protected Natural Areas: A Review. *Environ. Syst. Decis.* **2019**, *39*, 249–268. [CrossRef]

20. Weiler, B. Ecotourism and Nature-Based Tourism: What's Beyond the Names and Labels? In *Critical Debates in Tourism*; Channel View Publications: Bristol, UK, 2012; pp. 307–316.
21. Barna, C. Eco-Tourism for Sustainable Development. *Ann. Spiru Haret Univ. Econ. Ser.* **2009**, *1*, 99–108.
22. Blamey, R.K. Principles of Ecotourism. *Encycl. Ecotourism* **2009**, *2001*, 5–22. [CrossRef]
23. Goodwin, H. In Pursuit of Ecotourism. *Biodivers. Conserv.* **1996**, *5*, 277–291. [CrossRef]
24. Boyd, S.W.; Butler, R.W.; Haider, W.; Perera, A. Identifying Areas for Ecotourism in Northern Ontario: Application of a Geographical Information System Methodology. *J. Appl. Recreat. Res.* **1994**, *19*, 41–66.
25. Ormsby, A.; Mannle, K. Ecotourism Benefits and the Role of Local Guides at Masoala National Park, Madagascar. *J. Sustain. Tour.* **2006**, *14*, 271–287. [CrossRef]
26. Kanga, S.; Singh, S.K. Forest Fire Simulation Modeling Using Remote Sensing & GIS. *Int. J. Adv. Res. Comput. Sci.* **2017**, *8*, 326–332.
27. Dhami, I.; Deng, J. Classification of Forest-Based Ecotourism Areas in Pocahontas County of West Virginia Using GIS and Pairwise Comparison Method. In Proceedings of the Northeastern Recreation Research Symposium, Bolton Landing, NY, USA, 11–13 April 2010; pp. 215–223.
28. Smith, K. *Environmental Hazards: Assessing Risk and Reducing Disaster*; Routledge: London, UK, 2013; ISBN 9780203805305.
29. Chandel, R.S.; Kanga, S. Sustainable Management of Ecotourism in Western Rajasthan, India: A Geospatial Approach. *Geo-J. Tour. Geo-Sites* **2020**, *29*, 521–533. [CrossRef]
30. Charabi, Y.; Gastli, A. PV Site Suitability Analysis Using GIS-Based Spatial Fuzzy Multi-Criteria Evaluation. Renew. *Energy* **2011**, *36*, 2554–2561. [CrossRef]
31. Mallick, S.K.; Rudra, S.; Samanta, R. Sustainable Ecotourism Development Using SWOT and QSPM Approach: A Study on Rameswaram, Tamil Nadu. *Int. J. Geoheritage Park.* **2020**, *8*, 185–193. [CrossRef]
32. Singh, S.K.; Kumar, V.; Kanga, S. Land Use/Land Cover Change Dynamics and River Water Quality Assessment Using Geospatial Technique: A Case Study of Harmu River, Ranchi (India). *Int. J. Sci. Res. Comput. Sci. Eng.* **2017**, *5*, 17–24.
33. Boyd, S.W.; Butler, R.W. *Geographical Information Systems: A Tool for Establishing Parameters for Ecotourism Criteria*; Department of Natural Resources/Forestry, Ministry of Natural Resources: Sault Ste. Marie, ON, Canada, 1993.
34. Al-Anbari, M.A.; Thameer, M.Y.; Al-Ansari, N. Landfill Site Selection by Weighted Overlay Technique: Case Study of Al-Kufa, Iraq. *Sustainability* **2018**, *10*, 999. [CrossRef]
35. Pramanik, M.K. Site Suitability Analysis for Agricultural Land Use of Darjeeling District Using AHP and GIS Techniques. *Model. Earth Syst. Environ.* **2016**, *2*, 56. [CrossRef]
36. Kaliraj, S.; Chandrasekar, N.; Magesh, N.S. Evaluation of Multiple Environmental Factors for Site-Specific Groundwater Recharge Structures in the Vaigai River Upper Basin, Tamil Nadu, India, Using GIS-Based Weighted Overlay Analysis. *Environ. Earth Sci.* **2015**, *74*, 4355–4380. [CrossRef]
37. Aliani, H.; BabaieKafaky, S.; Saffari, A.; Monavari, S.M. Land Evaluation for Ecotourism Development—An Integrated Approach Based on FUZZY, WLC, and ANP Methods. *Int. J. Environ. Sci. Technol.* **2017**, *14*, 1999–2008. [CrossRef]
38. Waswa Wanyonyi, J.; Imwati, A.; Boitt, M. GIS In Analysis of Potential Sites For Ecotourism—A Case Study of Kwale County. *IOSR J. Environ. Sci. Toxicol. Food Technol.* **2016**, *10*, 43–49. [CrossRef]
39. Singh, B.V.R.; Sen, A.; Verma, L.M.; Mishra, R.; Kumar, V. Assessment of Potential and Limitation of Jhamarkotra Area: A Perspective of Geoheritage, Geo Park and Geotourism. *Int. J. Geoheritage Park.* **2021**, *9*, 157–171. [CrossRef]
40. Lazoglou, M.; Angelides, D.C. Development of a Spatial Decision Support System for Land-Use Suitability Assessment: The Case of Complex Tourism Accommodation in Greece. *Res. Glob.* **2020**, *2*, 100022. [CrossRef]
41. Masoudi, M.; Centeri, C.; Jakab, G.; Nel, L.; Mojtahedi, M. GIS-Based Multi-Criteria and Multi-Objective Evaluation for Sustainable Land-Use Planning (Case Study: Qaleh Ganj County, Iran) "Landuse Planning Using MCE and Mola". *Int. J. Environ. Res.* **2021**, *15*, 457–474. [CrossRef]
42. Bishop, Y.M.M.; Fienberg, S.E.; Holland, P.W.; Light, R.J.; Mosteller, F. Book Review: Discrete Multivariate Analysis: Theory and Practice. *Appl. Psychol. Meas.* **1977**, *1*, 297–306. [CrossRef]
43. Mckercher, B.; Du Cros, H. *Cultural Tourism: The Partnership between Tourism and Cultural Heritage Management*; Routledge: London, UK, 2012; ISBN 9780203479537.
44. Stewart Fotheringham, A.; Rogerson, P.A. GIS and Spatial Analytical Problems. *Int. J. Geogr. Inf. Syst.* **1993**, *7*, 3–19. [CrossRef]
45. Lahon, D.; Sahariah, D.; Debnath, J.; Nath, N.; Meraj, G.; Kumar, P.; Hashimoto, S.; Farooq, M. Assessment of Ecosystem Service Value in Response to LULC Changes Using Geospatial Techniques: A Case Study in the Merbil Wetland of the Brahmaputra Valley, Assam, India. *ISPRS Int. J. Geo-Inf.* **2023**, *12*, 165. [CrossRef]
46. Kanga, S.; Singh, S.K.; Meraj, G.; Kumar, A.; Parveen, R.; Kranjčić, N.; Đurin, B. Assessment of the Impact of Urbanization on Geoenvironmental Settings Using Geospatial Techniques: A Study of Panchkula District, Haryana. *Geographies* **2022**, *2*, 1–10. [CrossRef]
47. Shyam, M.; Meraj, G.; Kanga, S.; Sudhanshu; Farooq, M.; Singh, S.K.; Sahu, N.; Kumar, P. Assessing the Groundwater Reserves of the Udaipur District, Aravalli Range, India, Using Geospatial Techniques. *Water* **2022**, *14*, 648. [CrossRef]
48. Meraj, G.; Kanga, S.; Kranjčić, N.; Đurin, B.; Singh, S.K. Role of Natural Capital Economics for Sustainable Management of Earth Resources. *Earth* **2021**, *2*, 622–634. [CrossRef]

49. Fayaz, M.; Meraj, G.; Khader, S.A.; Farooq, M.; Kanga, S.; Singh, S.K.; Kumar, P.; Sahu, N. Management of Landslides in a Rural–Urban Transition Zone Using Machine Learning Algorithms—A Case Study of a National Highway (NH-44), India, in the Rugged Himalayan Terrains. *Land* **2022**, *11*, 884. [CrossRef]
50. Farooq, M.; Mushtaq, F.; Meraj, G.; Singh, S.K.; Kanga, S.; Gupta, A.; Kumar, P.; Singh, D.; Avtar, R. Strategic Slum Upgrading and Redevelopment Action Plan for Jammu City. *Resources* **2022**, *11*, 120. [CrossRef]
51. Bera, A.; Meraj, G.; Kanga, S.; Farooq, M.; Singh, S.K.; Sahu, N.; Kumar, P. Vulnerability and Risk Assessment to Climate Change in Sagar Island, India. *Water* **2022**, *14*, 823. [CrossRef]
52. Nath, N.; Sahariah, D.; Meraj, G.; Debnath, J.; Kumar, P.; Lahon, D.; Chand, K.; Farooq, M.; Chandan, P.; Singh, S.K.; et al. Land Use and Land Cover Change Monitoring and Prediction of a UNESCO World Heritage Site: Kaziranga Eco-Sensitive Zone Using Cellular Automata-Markov Model. *Land* **2023**, *12*, 151. [CrossRef]
53. Sajan, B.; Mishra, V.N.; Kanga, S.; Meraj, G.; Singh, S.K.; Kumar, P. Cellular Automata-Based Artificial Neural Network Model for Assessing Past, Present, and Future Land Use/Land Cover Dynamics. *Agronomy* **2022**, *12*, 2772. [CrossRef]
54. Singh, S.; Singh, S.K.; Prajapat, D.K.; Pandey, V.; Kanga, S.; Kumar, P.; Meraj, G. Assessing the Impact of the 2004 Indian Ocean Tsunami on South Andaman's Coastal Shoreline: A Geospatial Analysis of Erosion and Accretion Patterns. *J. Mar. Sci. Eng.* **2023**, *11*, 1134. [CrossRef]
55. Bhuyan, M.S.; Haider, S.M.B.; Meraj, G.; Bakar, M.A.; Islam, M.T.; Kunda, M.; Siddique, M.A.B.; Ali, M.M.; Mustary, S.; Mojumder, I.A.; et al. Assessment of Heavy Metal Contamination in Beach Sediments of Eastern St. Martin's Island, Bangladesh: Implications for Environmental and Human Health Risks. *Water* **2023**, *15*, 2494. [CrossRef]
56. Meraj, G.; Farooq, M.; Singh, S.K.; Islam, M.; Kanga, S. Modeling the sediment retention and ecosystem provisioning services in the Kashmir valley, India, Western Himalayas. *Model. Earth Syst. Environ.* **2021**, *8*, 3859–3884. [CrossRef]
57. Meraj, G.; Singh, S.K.; Kanga, S.; Islam, M. Modeling on comparison of ecosystem services concepts, tools, methods and their ecological-economic implications: A review. *Model. Earth Syst. Environ.* **2021**, *8*, 15–34. [CrossRef]
58. Alsahafi, R.; Alzahrani, A.; Mehmood, R. Smarter Sustainable Tourism: Data-Driven Multi-Perspective Parameter Discovery for Autonomous Design and Operations. *Sustainability* **2023**, *15*, 4166. [CrossRef]
59. Dangi, T.B.; Jamal, T. An Integrated Approach to "Sustainable Community-Based Tourism". *Sustainability* **2016**, *8*, 475. [CrossRef]
60. Yanes, A.; Zielinski, S.; Diaz Cano, M.; Kim, S.-i. Community-Based Tourism in Developing Countries: A Framework for Policy Evaluation. *Sustainability* **2019**, *11*, 2506. [CrossRef]
61. Al-Tokhais, A.; Thapa, B. Stakeholder Perspectives Towards National Parks and Protected Areas in Saudi Arabia. *Sustainability* **2019**, *11*, 2323. [CrossRef]
62. Feyers, S.; Stein, T.; Klizentyte, K. Bridging Worlds: Utilizing a Multi-Stakeholder Framework to Create Extension–Tourism Partnerships. *Sustainability* **2020**, *12*, 80. [CrossRef]