

An Assessment of Vegetation Cover and Tourism Potential in Kakoijana Reserved Forest, Bongaigaon District, Assam

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Abstract - Reserved forests play a vital role in biodiversity conservation, ecosystem regulation, and the provision of ecosystem services, while also offering opportunities for sustainable, nature-based tourism. This study assesses the spatial pattern of vegetation cover and evaluates the tourism potential of Kakoijana Reserved Forest, located in Bongaigaon district of Assam, using geospatial techniques. Vegetation cover dynamics were analyzed through the Normalized Difference Vegetation Index (NDVI) derived from satellite data for the years 2013 and 2023. NDVI values were classified into no vegetation, low vegetation, and high vegetation categories to examine spatio-temporal changes in forest condition. The results reveal a positive shift in vegetation health over the decade, marked by a reduction in non-vegetated and low-vegetation areas and a significant increase in high-vegetation cover. This improvement indicates enhanced forest regeneration, increased biomass, and improved ecological health, likely supported by conservation efforts and reduced anthropogenic pressure. In addition, the study evaluates the current tourism status and future potential of Kakoijana Reserved Forest. The forest is internationally recognized as a key habitat for the endangered Golden Langur (*Trachypithecus geei*), along with several other rare and threatened species, making it an emerging eco-tourism destination in western Assam. Existing tourism activities are well-managed and non-exploitative, with active community participation and basic infrastructure support. The findings suggest that Kakoijana Reserved Forest holds substantial potential for sustainable and community-based eco-tourism, which can simultaneously support biodiversity conservation and local livelihood development. An integrated approach to vegetation assessment and tourism planning is essential to ensure long-term ecological sustainability and responsible tourism growth.

Keywords - Reserved Forest, NDVI, Vegetation Cover, Eco-tourism Potential, Remote Sensing and GIS, Kakoijana Reserved Forest.

I. INTRODUCTION

Reserved forests play a vital role in conserving biodiversity, regulating local climate, and enhancing sustainable tourism potential. These forests act as repositories of floral and faunal diversity by providing critical habitats, maintaining genetic resources, and supporting ecological resilience (Millennium Ecosystem Assessment, 2005). Vegetation cover, often assessed through indicators such as forest density, species composition, and

vegetation indices, is a key determinant of ecological health and landscape attractiveness in forested regions (FAO, 2018). Dense forest cover influences local and regional climate by moderating temperature, increasing humidity, enhancing rainfall through evapotranspiration, and sequestering atmospheric carbon, thereby contributing to climate regulation and mitigation (Bonan, 2008; FAO, 2018). Dense and diverse vegetation not only enhances habitat quality and carbon sequestration but also increases the aesthetic and recreational value of forest landscapes, thereby influencing tourism potential (Gössling, 1999; Turner et al.,

2003). At the same time, rich biodiversity and healthy forest ecosystems enhance the aesthetic, recreational, and educational value of reserved forests, making them attractive destinations for nature-based and eco-tourism (Buckley, 2009). In recent years, geospatial techniques such as remote sensing and GIS have been widely used to assess vegetation dynamics and identify tourism-suitable zones in reserved forests due to their efficiency in monitoring spatial and temporal changes (Wulder et al., 2012).

An integrated assessment of vegetation cover and tourism potential is therefore essential for promoting sustainable forest management, balancing conservation objectives with livelihood opportunities for local communities, and ensuring long-term ecological resilience. When managed sustainably, tourism in reserved forests can generate local livelihoods while promoting conservation awareness and reinforcing the link between ecological integrity and socio-economic development (IPBES, 2019).

The assessment of vegetation cover and tourism potential reveals a complex interplay between ecological health and tourism development. Various studies highlight the significance of vegetation cover as a critical factor in promoting tourism, while also addressing the challenges posed by land-use changes driven by tourism activities. While vegetation cover can enhance the attractiveness of tourist destinations, it is also vulnerable to the pressures exerted by tourism activities. This relationship is evident in various studies that explore the impacts of tourism on ecological health and land-use changes.

Assam, renowned for its rich biodiversity and lush vegetation, presents a unique opportunity for tourism development. The assessment of vegetation cover reveals a diverse range of ecosystems, including dense forests, wetlands, and grasslands, which are home to numerous endemic species. This ecological wealth not only supports conservation efforts but also enhances the state's potential for ecotourism. The interplay between its natural beauty and cultural heritage attracts tourists seeking both

adventure and tranquillity. By promoting sustainable tourism practices, Assam can leverage its vegetation cover to boost local economies while preserving its invaluable natural resources.

Kakoijana Reserved Forest in Assam's Bongaigaon district is an ecologically significant protected area established as a reserved forest on 29 April 1966, support rich biodiversity and dense tree cover characteristic of the region's forest ecosystems. It is most renowned as a key habitat for the endangered Golden langur (*Trachypithecus geei*), a primate species listed in the IUCN Red List and one of the forest's flagship species that attracts wildlife researchers and nature-based tourism interest due to its rarity and striking appearance. This study aims to assess the spatial pattern and extent of forest cover within the Reserved Forest. The study also seeks to evaluate the potential for sustainable tourism development in the Reserved Forest.

Study area

Kakoijana reserved forest is located near Abhayapuri in Bongaigaon district of Assam. The forest is famous for its golden langur. The forest area is 19.92 km². The forest consists of around 1450 endangered Golden langurs as well as scheduled I endangered species. People and non-governmental organizations are pressing hard to convert it into a reserved forest. Golden langurs are listed in the category of "rare species" in the red data book of international union for conservation of nature. In addition to Golden Langurs, the forest hosts leopards, pangolins, porcupines, barking deer, binturong, and various bird species such as hornbills and storks. It is a, destination for, nature lovers, offering opportunities to spot wildlife in their natural habitat, and is often visited via local, guided, tours.

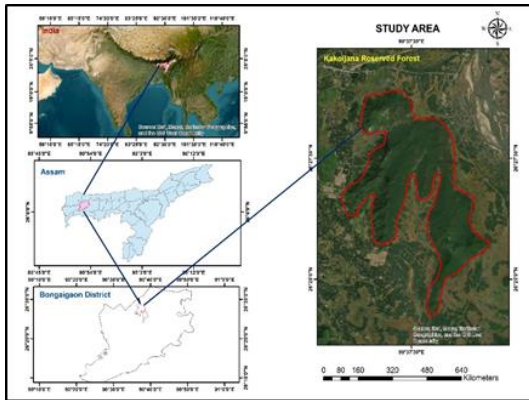


Figure 1: Locational extension of the study area

II. DATABASE AND METHODOLOGY

This study is based on both primary and secondary data sources. Primary data were collected through field surveys, field observations, and field photographs. Secondary data were obtained from various journal articles, published reports, and government websites. Satellite imageries used in the study were downloaded from the USGS website. In this study, Landsat-5 and Landsat-9 satellite imageries with a spatial resolution of 30 meters were used for the years 2013 and 2023 to analyze the spatio-temporal variation in vegetation cover of the reserved forest. Vegetation cover was assessed using the Normalized Difference Vegetation Index (NDVI). NDVI was calculated using the red band and the near-infrared (NIR) band of the satellite imagery, following the standard NDVI formula.

$$NDVI = \frac{Red - NIR}{Red + NIR}$$

Results and discussion

Assessment of vegetation cover using NDVI

The Normalized Difference Vegetation Index (NDVI) of Kakojana Reserved Forest for the years 2013 and 2023 reveal notable spatio-temporal changes in vegetation condition over a decade. NDVI values were classified into three major categories: No Vegetation, Low Vegetation and High Vegetation, enabling a clear assessment of vegetation health and density. High vegetation areas, represented by higher NDVI values, were confined to limited patches, mainly in relatively undisturbed interior zones. Overall, the 2013 scenario reflects a forest ecosystem under moderate stress, possibly due to

anthropogenic pressures such as grazing, fuelwood extraction, or earlier habitat disturbance. Areas with very low or no vegetation were minimal, suggesting that large-scale deforestation was not prominent during this period, although vegetation density remained sub-optimal.

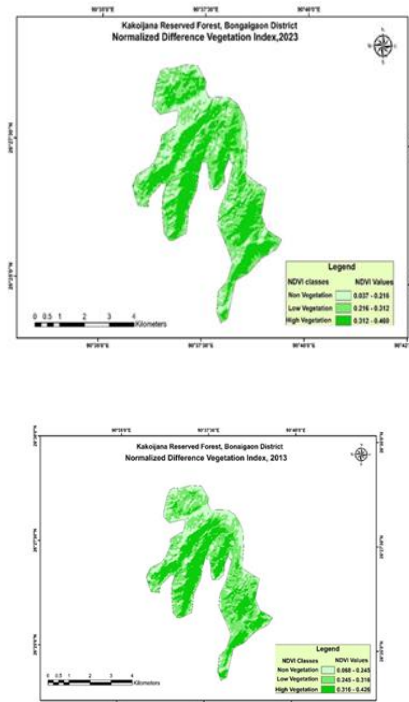


Figure 2: Vegetation analysis using NDVI

The 2023 NDVI indicates a visible improvement in vegetation condition across the forest. NDVI values range from approximately 0.027 to 0.460, showing a general upward shift compared to 2013. The 2023 NDVI map indicates a visible improvement in vegetation condition across the forest. NDVI values range from approximately 0.027 to 0.460, showing a positive change compared to 2013. High vegetation cover has expanded significantly, particularly in the central and southern portions of the forest reserve, indicating denser and healthier forest canopy. Low vegetation areas have reduced in spatial extent, suggesting regeneration and improved biomass. No vegetation zones remain negligible, confirming the absence of major land-use conversion within the reserve during the study period. The increase in NDVI values points towards enhanced

photosynthetic activity and improved vegetation vigor.

Table 1: Changing area under each vegetation categories

Vegetation categories	2013		2023		Change area in percent (2013-2023)
	Area in sq.km	Area in per cent	Area in sq. km	Area in per cent	
Non vegetation	4.24	21.263	3.88	19.45	-0.36
Low vegetation	8.65	43.416	7.97	40.02	-0.68
High vegetation	7.04	35.321	8.07	40.53	1.04
Total area	19.92	100	19.92	100	

The table presents the percentage change in vegetation categories in the study area between 2013 and 2023, clearly indicating a positive shift in vegetation condition over the decade. The area under non-vegetation shows a decline of 0.36%, suggesting a reduction in barren or sparsely covered land. Similarly, low vegetation has decreased by 0.68%, indicating that areas with poor or degraded vegetation cover have either regenerated or transitioned into healthier vegetation classes. In contrast, high vegetation exhibits an increase of 1.04%, reflecting a notable improvement in dense and healthy vegetation cover. This overall trend signifies enhanced vegetation regeneration and improved forest health, likely resulting from effective conservation measures, natural regeneration processes, and reduced anthropogenic pressure during the study period.

Tourism Status of Kakoijana Reserved Forest

At present, tourism in Kakoijana Reserved Forest is at a developing yet well-managed stage. The forest has gradually emerged as an important eco-tourism destination in western Assam, especially for nature lovers, wildlife enthusiasts, and researchers. The Tourism Department of the Government of Assam, in collaboration with local joint management committees, plays a significant role in maintaining the area. Basic tourism infrastructure such as approach roads, parking facilities, walking trails, and communication networks are adequately developed. The forest environment is kept clean and organized, with proper waste disposal systems and dustbins installed at key locations. Local youths actively assist visitors by guiding nature walks, facilitating birdwatching activities, and ensuring a safe and informative experience. Importantly, tourism in Kakoijana is non-exploitative in nature, with strict regulations to prevent ecological degradation and disturbance to wildlife, particularly the endangered Golden Langur.

Potentiality of Tourism in Kakoijana Reserved Forest
Kakoijana Reserved Forest possesses immense potential for sustainable and community-based eco-tourism. Its unique status as the only habitat of the Golden Langur outside Manas Tiger Reserve and Chakrashila Wildlife Sanctuary gives it exceptional scientific and conservation value, attracting researchers, students, and wildlife photographers. The rich biodiversity, including diverse flora, medicinal plants, butterflies, birds, reptiles, and mammals, provides ample scope for developing nature interpretation centres, biodiversity trails, butterfly parks, and birdwatching zones.

The tranquil forest landscape and dense vegetation offer opportunities for low-impact tourism activities such as eco-camps, guided forest walks, and environmental education programs. Furthermore, the strong involvement of local communities in conservation and management enhances the prospects of inclusive tourism that can generate livelihood opportunities while ensuring habitat protection. With improved signage, interpretation facilities, controlled viewing platforms near highways, and promotion at regional and national levels, Kakoijana has the potential to emerge as a

model eco-tourism destination rooted in conservation ethics and community participation.



Figure 3: Golden Langur (*Trachypithecus geei*), an endangered primate species found in Kakoijana Reserved Forest, Assam.



Figure 4: Traditional guest house at the study area

III. CONCLUSION

The spatio-temporal analysis of NDVI for Kakoijana Reserved Forest between 2013 and 2023 reveals a clear improvement in vegetation condition over the decade, indicating enhanced forest health and regeneration. The observed decline in non-vegetation and low-vegetation classes, coupled with a significant increase in high-vegetation cover, reflects improved biomass, canopy density, and photosynthetic activity within the reserve. These positive changes suggest effective conservation efforts, natural regeneration processes, and a reduction in anthropogenic pressures. At the same time, the forest's developing yet well-regulated eco-tourism framework has contributed to environmental stewardship without compromising ecological integrity. The involvement of local communities, non-exploitative tourism practices, and adequate basic infrastructure further support sustainable management. Given its unique ecological significance as a vital habitat of the endangered Golden Langur and its improving vegetation status, Kakoijana Reserved Forest holds strong potential to emerge as a model for sustainable, community-based eco-tourism that balances conservation objectives with livelihood generation.

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