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Impact of Human Activities on Forest Ecology and Biodiversity Conservation in India

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ABSTRACT

This research examined the different ways that human activities impacted forest ecology, biodiversity, and conservation. Using a descriptive-analytical research design, the analysis of data from 50 forest locations included protected forests, community forests, wildlife habitats, and watershed/riverine through field surveys, direct observations, and secondary sources including records from the Ministry of Environment, Forest and Climate Change (MoEF&CC) and satellite imagery of last several years. This analysis found that deforestation and agriculture are the first and second drivers of forest degradation with losses of considerable amounts of habitat, habitat fragmentation, and loss of species richness, both flora and fauna. Urbanization, forestry, mining, and tourism contribute to these ecological impacts; increasing habitat degradation and threatening ecosystem stability. The ecological state of forests is most affected from human activities in wildlife habitats and community forests with protected and watershed forests being least impacted due to regulations, including conservation and limiting human access in protected areas. Overall, the findings demonstrate the importance of developing a more comprehensive forest ecosystem management plan that resulted in a balance between protecting habitats, land use planning, community participation, reforestation programs, and strong policy standards to reduce the impacts of human activities on forest ecosystems. Developing and supporting resilient forest ecosystems that promote biodiversity, a diverse array of ecosystem services, and environmental sustainability are recommended.

Keywords: *Deforestation, Biodiversity Loss, Human Activities, Forest Conservation, Habitat Degradation, Sustainable Management.*

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1. INTRODUCTION

Forests are one of the most important ecosystems on Earth, with a variety of ecological, economic, and social benefits. They are essential for biological diversity, climate moderation, soil and water resources, and for the livings of millions of people. Unfortunately, in the last few decades, human activities have increasingly impacted the health and sustainability of forest ecosystems. Deforestation, agricultural intensification, urbanization, logging, mining, and tourism have profoundly impacted forests and as a result, their structural integrity, habitat fragmentation, and biodiversity is also disturbed widely. Not only do these human activities alter the amount or cover of forest, but they also compromise the provision of ecosystem services, which has cascading effects on ecosystem stability and therefore human well-being. Understanding the scale and extent of human impacts is crucial for planning effective management approaches for the conservation and sustainable use of our forests.

The interaction of human influence with forests is complicated, because human impacts are heterogeneous and variable in strength across different geographies. Deforestation and agriculture each impact the forest primarily through the loss of habitat and biodiversity. Urbanization and development usually lead to fragmented ecosystems and a breakdown of ecosystem connectivity (e.g. road networks) with all the consequences of ecological fragmentation and isolation. Human-created climate change, and land-use change, are listed among many other anthropogenic impacts, lead to forest degradation, increase fire danger, and species and ecosystem resilience are differentially affected. Understanding these human effects relative to ecological consequences will be helpful in conservation planning, policy development, and community engagement when it comes to forest protection. The study delivered products and understanding of the degree and impacts of human activity on forest ecology and conservation in India. This understanding allowed us to identify the principal harmful impacts and develop strategies to reduce ecological loss and advocate for sustainable forest stewardship.

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Subject: Zoology

2. LITERATURE REVIEW

Cruz et al. (2018) conducted an extensive analysis of medium and small felid species in the Atlantic Forest, with an aim to understand how human activities affected the habitat utilization, activity patterns and ecological relationships of felid species. The analysis showed that human-induced disturbances, including deforestation, urbanization, road development, etc., altered the space-use behavior of these animals. The fragmented landscape limited movement and prey access also disrupted predator-prey interactions, ultimately threatening the ecological balance of the entire community. This study illustrated that human-induced habitat fragmentation not only decreased the abundance of species, but also disrupted key ecological interactions and demonstrates the effectiveness anthropogenic activities can have on wildlife behavior and on the stability of forest ecosystems.

Jenkins and Schaap (2018) examined the impacts of human behaviors on ecosystem services of forests, and emphasized the equally important role forests play in maintaining environmental sustainability of the whole ecosystem. Their research indicated how unsustainable land-use practices, like intensive and/or unsustainable logging practices, agricultural expansion, and higher rates of urban sprawl contributes to the disruption of key ecological functions (e.g. carbon storage, water regulation, soil fertility, and biodiversity conservation). The researcher reiterated that once degraded, ecosystem services of forests has decline in their ability to be useful to local human populations and wildlife. Ultimately the connection and anthropogenic pressures on forests further reduces the ecological resilience of forests and biodiversity.

Liu et al. (2020) analyzed land use and land cover dynamics within the Mekong Delta over a 40-year span to understand long-term human impacts on forest ecosystems. The findings of the study showed that agricultural intensification, urban development and industrial development have substantially transformed landscapes originally in a natural state. The continued habitat loss, declines in biodiversity and increased stressors to the environment (for example, soil erosion, water pollution and alterations to natural hydrological regimes) provide insight into how human impacts accumulate through time, not only to forest ecosystems but to how policy can provide sustainable land management practices while reducing potential impacts to biodiversity and ecosystem health.

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Mahmoud and Gan (2018) investigated the dual role of climate change and human influences on ecosystems in arid conditions. They documented that human activities, like water extraction, land modification, and deforestation, compounded climate variability impacts. The compounded impacts resulted in reduced ecosystem productivity, less soil fertility, and reduced resilience of natural ecosystems, resulting in systems that are more vulnerable to environmental shocks. This study acknowledged that human-caused stressors have compounded the impacts of climate factors to further degrade ecosystems, illustrating the complicated ways anthropogenic activities and environmental change interact.

Mansoor et al. (2022) examined the impact of climate change on wildfire frequencies and emphasized how human involvement affected natural fire regimes. Their research showed that wildfires were influenced by the amount of deforestation, followed by land conversion and uncontrolled burning. Their findings also demonstrated how wildfires led to forest degradation, habitat fragmentation, and biodiversity loss. Importantly, the differential impacts of human-induced fire regimes threaten forest ecosystems, especially the variability and resilience of forest ecosystem types. These results further emphasized the importance of integrated conservation approaches that respond to anthropogenic and climatic influences on forest disturbances.

3. RESEARCH METHODOLOGY

This study used a descriptive-analytical design to investigate the effects of human activities such as deforestation, agriculture, and urbanization on aspects of forest ecology, biodiversity and conservation. Data were collected from 50 forest sites using field surveys, observations and secondary data sources. The data were analyzed using tables and graphs to produce considerable evidence of the most concerning threats to forest ecology, the most vulnerable types of forests and an understanding of how to target conservation efforts.

3.1. Research Design

Descriptive-analytical research design has been used in this study to explore the impacts of human activities on the ecology, biodiversity, and conservation status of forests. The study was focused on estimating the role of factors such as deforestation, agricultural expansion, urbanization,

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logging, mining, and tourism in the degradation of forests, and interpreting their effects on different types of forests in India.

3.2. Sample and Study Area

The study was conducted in selected forest sites of India comprising protected forests, community forests, wildlife habitats, and watershed/riverine forests. Fifty forest sites were recorded to evaluate human-induced disturbances. We collected data on flora and fauna diversity, changes in forest cover, conservation status, management documents, and information gathered from local communities.

3.3. Data Collection Methods

Data were obtained from and through both primary and secondary sources. Primary data were collected from field surveys, field observations of human activity, and field monitoring on several forest sites regarding ecological values. Secondary data were taken from the reports of the Ministry of Environment, Forest and Climate Change (MoEF&CC) from conservation documents, and from satellite imagery to quantify the percentage area of forest affected by human activity.

3.4. Variables and Measurement

This study examined three key variables: (i) forest area affected, defined as the percentage of forest land affected by each of the human activities, (ii) biodiversity impact, measured as the percentage loss of flora and fauna, and (iii) conservation status identified as severely affected, moderately affected, and minimally affected across various forest types.

3.5. Data Analysis Techniques

The data collected was arranged into tables and visualized using graphs to illustrate changes in forest disturbance, biodiversity loss, and conservation status. Comparative data analysis was accomplished to determine which human activities had the most impact on forests and the forest types that are the most impacted. The sections emphasised priority conservation actions that could best alter the impact of humans on forest areas.

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4. DATA ANALYSIS AND INTERPRETATION

In Table 1 the percentage of forest area impacted by different activities associated with human activities was demonstrated such as: deforestation, agricultural conversion, urbanization, logging and timber, mining, tourism. Deforestation had the strongest effect, impacting 40% of forest; Agricultural conversion was second most impactful at 25% of forest area; Urbanization was third at 15% of forest area; Logging and timber accounted for 10% of forest area; and mining activity and tourism activity had the lowest impact on forest area at 5% of the forest area respectively.

Table 1: Percentage of Different Human Activities Affecting Forest Areas

Human Activity	Percentage of Forest Area Affected (%)
Deforestation	40%
Agricultural Expansion	25%
Urbanization	15%
Logging and Timber Trade	10%
Mining	5%
Tourism	5%

Similarly, Figure 1 represented the disturbance caused by each activity such as trees removed, roads created, land converted, etc., based upon the spatial extent of forest impacted by these types of human activities.

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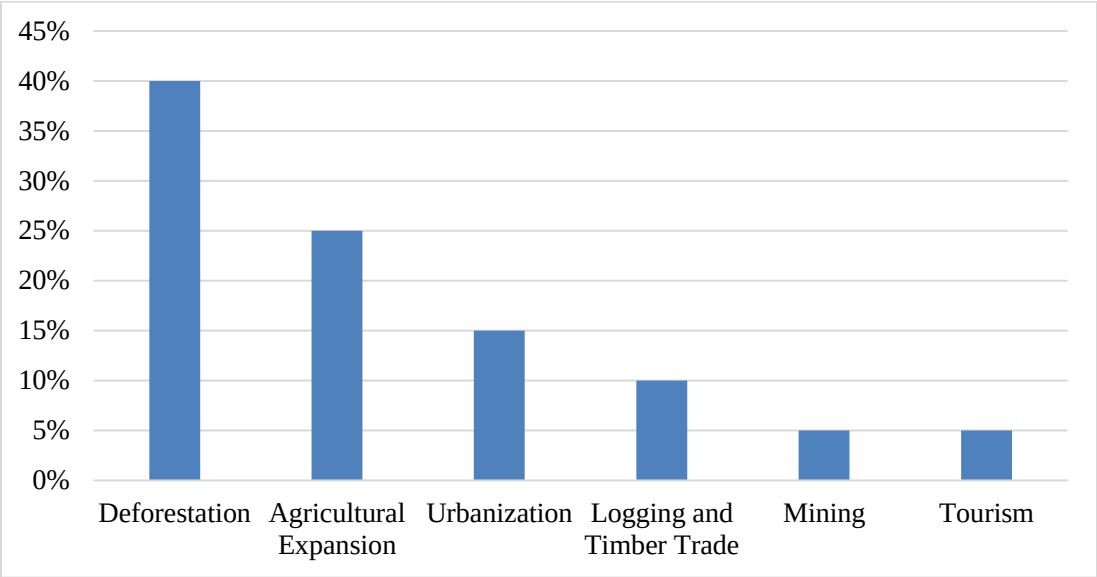

Figure 1: Graphical Representation of Percentage of Different Human Activities Affecting Forest Areas

The above information of the present study showed the human interference in land clearance, in the form of deforestation and especially agriculture, is the dominant form of forest area loss. Urbanization and commercial activity (e.g., logging) played a large role, but despite the large area impacted, it was considerably less than land clearance for agriculture. Mining and tourism had nearly no direct impact on forest area. Overall, it could be concluded that conservation should focus on tackling deforestation and managing agricultural encroachment to maintain forest ecosystems.

In Table 2 the percentage impact of human activities on forest biodiversity is demonstrated - that was, the loss of flora and fauna. Deforestation had the largest biodiversity impacts, with 50% of plants and 45% of animals affected. Agricultural encroachment impacted 30% of flora and 25% of fauna. Urban and settlement impacts 20% of flora and 15% of fauna. Logging and timber trade affected 25% of flora and 20% of fauna. Mining and tourism groups showed relatively lower impacts, 5% to 15% of flora and fauna lost.

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ISSN: 2320-3714
Volume: 3 Issue: 3
September 2025
Impact Factor: 10.2
Subject: Zoology

Table 2: Percentage Impact of Human Activities on Forest Biodiversity

Human Activity	Loss of Flora (%)	Loss of Fauna (%)
Deforestation	50%	45%
Agricultural Expansion	30%	25%
Urbanization	20%	15%
Logging and Timber Trade	25%	20%
Mining	10%	15%
Tourism	5%	5%

Simultaneously, Figure 2 presented a visual representation of the above-mentioned impacts studied during this research work.

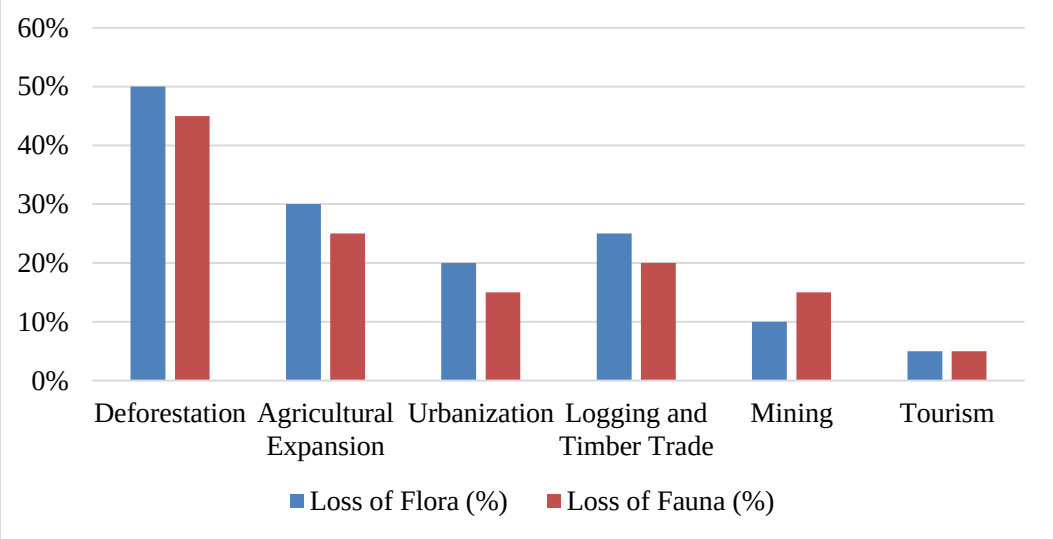

Figure 2: Graphical Representation of Percentage Impact of Human Activities on Forest Biodiversity

These results further helped to identify the primary threat to forest biodiversity which could be categorized as deforestation; the human impacts to biodiversity reduced the number of plants and animals' species that inhabit forests considerably. Other drivers of biodiversity loss include agricultural expansion, logging, urbanization, mining, and tourism, in order of seriousness. The

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proposed recommendations suggest implementing conservation measures to preserve forests from deforestation and unsustainable use and to balance ecological condition and maintain species richness.

In Table 3, a matrix of human impact to the various conservation components of forests has been provided. For protected forests, the conservation status was minimally impacted in 50% of measures, moderately impacted in 30%, and severely impacted in 20%. For community forests, 25% are severely impacted, 35% are moderately impacted, and 40% are minimally impacted. The wildlife habitats have the poorest condition with 30% severely impacted and 40% moderately impacted. Watershed and riverine forests have 60% minimally impacted, indicating lower human pressure influence.

Table 3: Forest Conservation Status Affected by Human Activities

Conservation Aspect	**Severely Affected (%)**	**Moderately Affected (%)**	**Minimally Affected (%)**
Protected Forests	20%	30%	50%
Community Forests	25%	35%	40%
Wildlife Habitats	30%	40%	30%
Watershed and Riverine Forests	15%	25%	60%

Researchers of the present study depicted the visualization of the above-mentioned impacts is in Figure 3.

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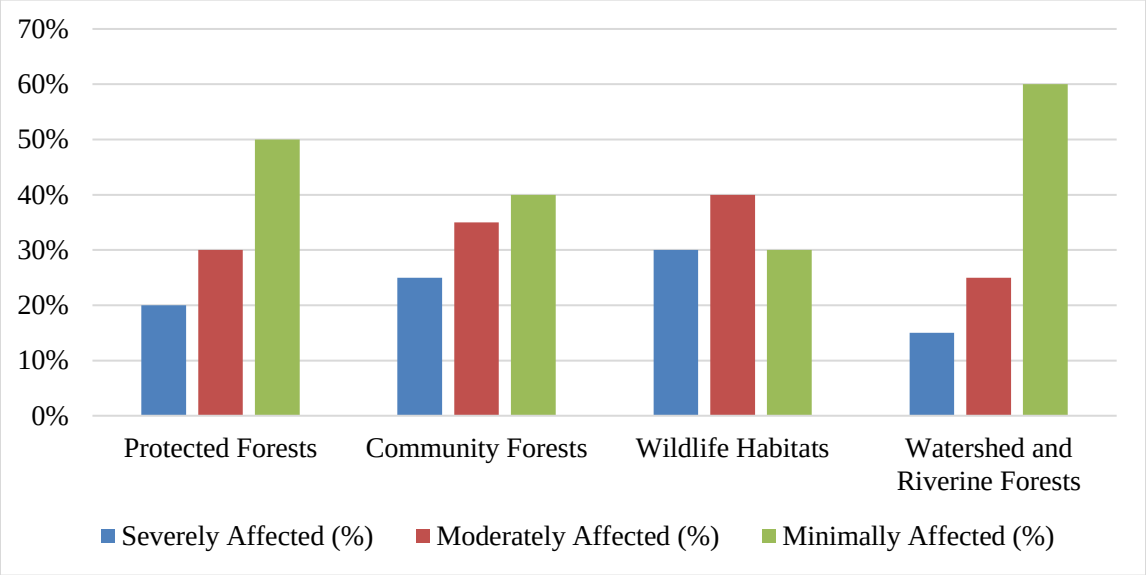

Figure 3: Graphical Representation of Forest Conservation Status Affected by Human Activities

The results indicated that wildlife habitats are the most susceptible to human actions and human-induced disturbances in a forested environment, which showed the vulnerability of these habitats. Community forests are inherently vulnerable to human pressures, but at the same time, protected forests showed a moderate degree of strength and resiliency. Watershed and riverine forests were affected by human actions, but indirectly and less than the other forest habitats. The results are called for a better understanding of human impacts to develop landscape and site-specific conservation plans to reduce human impacts, starting first with wildlife habitats in a forested environment and then with community-managed forests, to reduce human pressures to develop better sustainability and to implement a better forest management system and policy.

5. CONCLUSION

The results indicate that human actions have a severe multi-dimensional impact on forest ecosystems. Forest conversion for agriculture and deforestation was the single most damaging human action observed in this study, producing major losses in forest extent, fragmenting habitat, and causing considerable losses of species numbers and types. Although urban expansion, logging, mining, and tourism did not destroy habitat as extensively, their impact cannot not be discounted when considering other human actions, which act synergistically to further degrade habitats and

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reduce biodiversity. Overall, wildlife passageways and community forests were the human pressed forests ecosystem release the greatest in terms of threat, while government protected forests and watershed areas tended to be more resilient due to conservation efforts and lower human access. The findings provide an imperative for managing forests that consider both strict protection of at-risk ecosystems, sustainable land uses, and active community involvement. Moreover, while the enforcement features of legislation are critical to reducing human damage to forests, the ability to restore habitats through alternative land development and decommissioning, and ending human uses that destroy forest ecology, will be critical for maintaining biodiversity and long-term sustainability of ecosystem services that humans rely upon for a sustainable environment and wellbeing.

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Airo International Journal
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