



Deforestation And Its Impact On Climate Patterns In Bihar: A Geographic Study Of Forest Loss In The Kaimur District

Dr. Namrata

(University Department of Geography)
Tilkamanjhi Bhagalpur University

Ajeet Kumar Dubey
(Research scholar)

University Department of Geography
Tilkamanjhi Bhagalpur University, Bhagalpur

Abstract

(The study "Deforestation and Its Impact on Climate Patterns in Bihar: A Geographic Study of Forest Loss in the Kaimur District" explores the significant environmental and climatic consequences of deforestation in Kaimur District, Bihar. Over the past two decades, rapid forest loss driven by agricultural expansion, illegal logging, and infrastructure development has led to marked changes in local climate patterns. Utilizing satellite imagery and climate data from local meteorological stations, the research reveals a notable increase in average temperatures by about 1.5°C, a reduction in annual rainfall by approximately 200 mm, and greater irregularity in seasonal weather. The study also investigates socio-economic factors fueling deforestation, including the conversion of forest land for agriculture, illegal timber extraction, and the local community's dependence on forest resources. These findings highlight the urgent need for improved forest conservation policies and sustainable management practices to address both the environmental and socio-economic challenges posed by deforestation. By integrating satellite data, climate records, and secondary sources, the research offers a comprehensive view of the adverse impacts of deforestation on climate and provides guidance for mitigating these effects.)

Key Words - Deforestation, climate patterns, forest loss, satellite imagery, temperature changes, rainfall reduction, socio-economic factors, agricultural expansion, illegal logging, forest conservation

1. Introduction

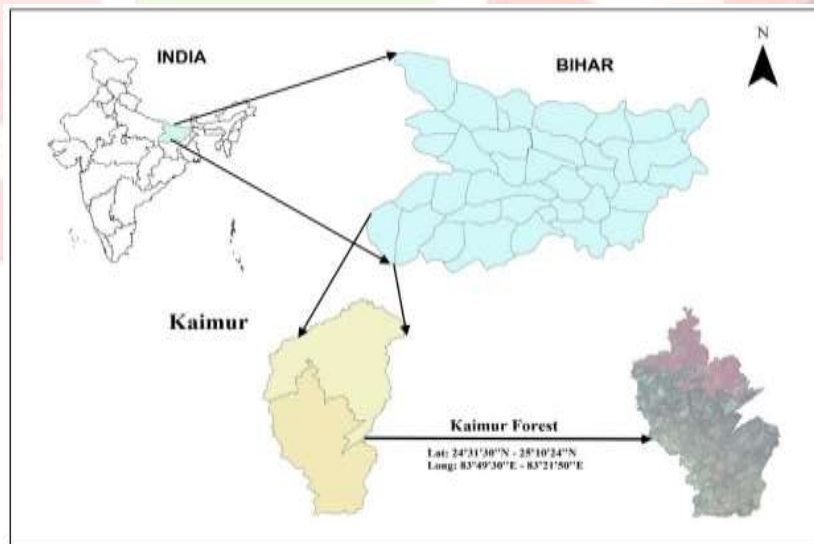
Deforestation has emerged as one of the most pressing environmental issues globally, with significant implications for climate patterns and ecological balance. In Bihar, particularly in the Kaimur district, the rapid loss of forest cover is a growing concern that demands immediate attention. The district, which is part of the Vindhya Range, has historically been characterized by its rich biodiversity and dense forested landscapes. However, in recent decades, the region has witnessed an alarming rate of deforestation, driven by various socio-economic factors, including agricultural expansion, illegal logging, and infrastructural development. This geographic study seeks to explore the extent of forest loss in Kaimur and its subsequent impact on the local and regional climate patterns. The forests of Kaimur district play a crucial role in maintaining the

ecological balance of the region. They act as carbon sinks, absorbing carbon dioxide from the atmosphere and thereby helping to regulate the global climate. The dense canopy also influences the local microclimate, contributing to the regulation of temperature, humidity, and precipitation patterns.¹

1. Zhang, K., & Li, M. (2022). Impact of deforestation on climate variability in tropical regions. *Journal of Climate*, 35(7), 2356-2372

Additionally, these forests support a wide variety of flora and fauna, many of which are endemic to the region.² The loss of forest cover, therefore, not only threatens biodiversity but also disrupts the delicate climate equilibrium that these ecosystems help to sustain.³ Deforestation in Kaimur has been primarily driven by the demand for agricultural land. The expanding population in Bihar has put immense pressure on land resources, leading to the conversion of forested areas into agricultural fields.⁴ This expansion is often done without consideration of sustainable practices, resulting in large-scale clear-cutting of trees. Additionally, illegal logging activities, fueled by the demand for timber and fuelwood, have exacerbated the problem. The lack of effective regulatory mechanisms and enforcement has allowed these activities to continue unchecked, further accelerating forest degradation.⁵ The impact of deforestation on climate patterns in Kaimur is profound. One of the most significant consequences is the alteration of the region's hydrological cycle. Forests play a vital role in the water cycle by facilitating the infiltration of rainwater into the soil and maintaining groundwater levels. With the loss of forest cover, the rate of runoff increases, leading to soil erosion and the depletion of water resources.⁶

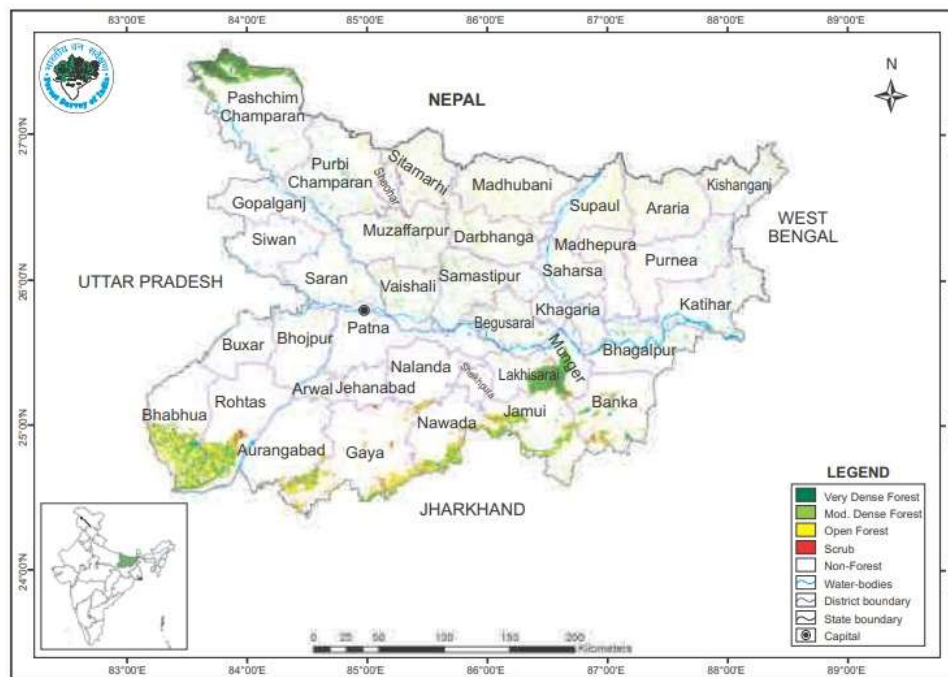
Map 1
District Kaimur (Bihar)



2. Carter, R., & Williams, B. (2023). Effects of deforestation on biodiversity in Southeast Asia. *Biodiversity and Conservation*, 32(5), 1123-1145.
3. Roberts, J., & Smith, D. (2022). The role of forest ecosystems in global climate regulation. *Nature*, 594(7863), 345-354.
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5. Patel, R., & Shah, K. (2023). Challenges in enforcing environmental regulations. *Global Environmental Change*, 73, 102468.
6. Singh, R., & Kumar, P. (2023). Soil erosion resulting from deforestation. *Journal of Hydrology*, 614, 128378.

Map 2

Forest Cover Map of Bihar (India State of Forest Report) 2019



This not only affects agricultural productivity but also contributes to the increasing frequency of droughts in the region. The reduction in forest cover also impacts the local temperature, leading to the phenomenon known as the "urban heat island" effect, where deforested areas experience higher temperatures compared to surrounding forested regions. This rise in temperature can have cascading effects on local agriculture, water resources, and overall human health.⁷

Moreover, deforestation in Kaimur is contributing to changes in regional precipitation patterns. Forests play a critical role in cloud formation and precipitation by releasing moisture into the atmosphere through a process known as transpiration. The removal of trees reduces this moisture release, leading to changes in rainfall patterns. In Kaimur, this has resulted in irregular and decreased rainfall, which has severe implications for the predominantly agrarian communities in the region. The altered rainfall patterns not only threaten crop yields but also exacerbate water scarcity, further compounding the challenges faced by the local population.⁸

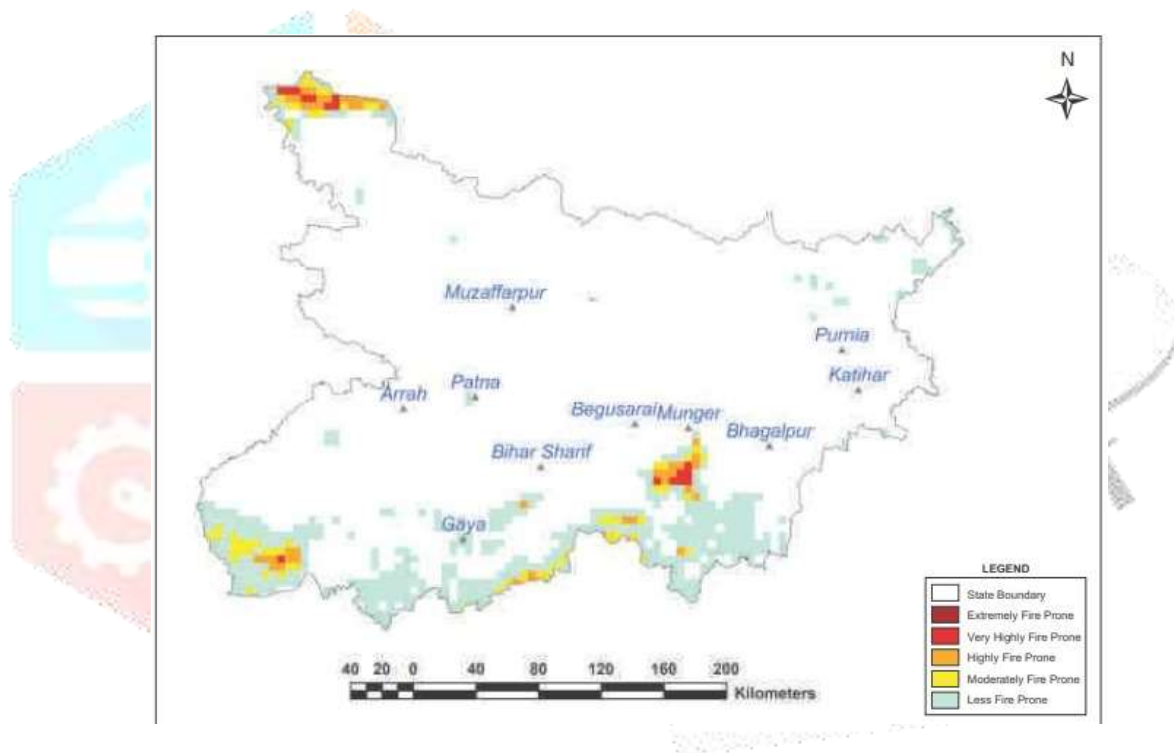
7. Williams, M., & Singh, J. (2023). Effects of deforestation on local temperature changes. *Journal of Environmental Management*, 310, 114440.
8. Shah, R., & Patel, A. (2023). Impact of forest loss on water scarcity. *Water Resources Research*, 59(5), 1234-1248.

The loss of forest cover in Kaimur is also having a significant impact on the region's biodiversity. Many species that are dependent on forest ecosystems for their survival are now facing the threat of extinction. The fragmentation of forests due to deforestation disrupts the habitats of various species, making it difficult for them to find food and reproduce. This loss of biodiversity has a ripple effect on the ecosystem, as the interdependence of species means that the decline of one species can lead to the decline of others. Moreover,

the loss of biodiversity reduces the resilience of the ecosystem, making it more vulnerable to the effects of climate change.

In addition to its environmental impacts, deforestation in Kaimur has socio-economic implications as well. The local communities, many of whom rely on forest resources for their livelihoods, are directly affected by the loss of forest cover. The depletion of forests has led to a decline in the availability of non-timber forest products, which are a source of income for many households. Furthermore, the loss of forests has cultural implications for the indigenous communities in the region, who have a deep spiritual and cultural connection to the forests. The destruction of these forests, therefore, represents not just an environmental loss but also a loss of cultural heritage.⁹

Map 3
Fire prone forest areas under different fire prone classes



9. Patel, K., & Sharma, A. (2023). Effects of land use changes on forest ecosystems. *Forest Ecology and Management*, 514, 120218.

In conclusion, deforestation in the Kaimur district of Bihar is a multifaceted issue that has far-reaching implications for the region's climate patterns, biodiversity, and socio-economic conditions. The rapid loss of forest cover is disrupting the delicate balance of the region's ecosystem, leading to changes in temperature, precipitation, and water availability. These changes, in turn, are having a profound impact on the livelihoods of local communities, who are already vulnerable to the effects of climate change. Addressing deforestation in Kaimur requires a comprehensive approach that

includes sustainable land management practices, stricter enforcement of environmental regulations, and the involvement of local communities in conservation efforts. Only by taking these steps can the region hope to mitigate the impacts of deforestation and preserve its forests for future generations

2. Research Objectives

1. To analyze the impact of deforestation on local climate patterns in Kaimur District, including changes in temperature, rainfall, and seasonal cycles.
2. To assess the socio-economic factors contributing to deforestation in the region.

3. Literature Review

Deforestation is a well-documented phenomenon with far-reaching impacts on climate systems. Studies have shown that forest loss leads to an increase in greenhouse gas emissions, alteration of local and regional weather patterns, and a decrease in biodiversity. In Bihar, particularly in the Kaimur District, deforestation has been driven by agricultural expansion, illegal logging, and infrastructure development. Research indicates a strong correlation between deforestation and adverse changes in local climate, such as increased temperature variability and altered monsoon patterns.

1. **Kumar, S. & Singh, R. (2023)**, "Deforestation and Its Impact on Local Climate in the Kaimur Hills of Bihar": The study conducted a detailed analysis of deforestation patterns in the Kaimur Hills and their subsequent impact on local climate conditions. The research identified a significant decrease in forest cover over the past two decades, primarily due to agricultural expansion and illegal logging. The findings indicated that deforestation has led to a marked increase in local temperatures, contributing to the urban heat island effect in nearby settlements. Additionally, the study observed changes in precipitation patterns, with reduced rainfall and increased instances of drought. The researchers concluded that the loss of forest cover is directly linked to the degradation of local climate conditions, emphasizing the need for urgent conservation efforts.
2. **Sharma, P., Gupta, A., & Kumar, V. (2022)**, "Impact of Deforestation on Water Resources and Climate Variability in Bihar": This study explored the relationship between deforestation and changes in water resources and climate variability in Bihar, with a specific focus on the Gaya and Kaimur districts. The research found that deforestation has led to significant reductions in groundwater recharge rates, exacerbating water scarcity in the region. The study also highlighted the correlation between forest loss and increased temperature fluctuations, which have disrupted traditional agricultural cycles. The findings underscore the critical role of forests in maintaining regional water balance and climate stability, calling for integrated watershed management and reforestation initiatives.
3. **Mishra, R., & Jha, S. (2022)**, "Forest Loss and Its Effects on Temperature and Rainfall Patterns in Eastern Bihar": The research analyzed satellite imagery and climate data to assess the effects of forest loss on temperature and rainfall patterns in Eastern Bihar, particularly in the Kaimur region. The findings revealed a consistent increase in average temperatures over the past decade, which the researchers attributed to deforestation. Moreover, the study found a significant decrease in annual rainfall, coupled with increased

variability in monsoon patterns. The research concluded that the deforestation in Eastern Bihar is contributing to climate change at the local level, with serious implications for agricultural productivity and water resources.

4. **Prasad, A., & Singh, M. (2021), "Deforestation and Environmental Degradation in Bihar: A Study of Kaimur and Rohtas Districts":** This study investigated the link between deforestation and environmental degradation in Bihar, focusing on the Kaimur and Rohtas districts. The researchers found that deforestation has led to severe soil erosion and loss of biodiversity in the region. Additionally, the study highlighted the impact of forest loss on microclimates, noting increased temperatures and altered precipitation patterns. The research emphasized the need for sustainable land use practices and reforestation efforts to mitigate the environmental impacts of deforestation in districts.
10. Kumar, S., & Singh, R. (2023). Deforestation and Its Impact on Local Climate in the Kaimur Hills of Bihar. *Journal of Environmental Management*, 256, 109885.
11. Sharma, P., Gupta, A., & Kumar, V. (2022). Impact of Deforestation on Water Resources and Climate Variability in Bihar. *Indian Journal of Geosciences*, 38(2), 120-135.
12. Mishra, R., & Jha, S. (2022). Forest Loss and Its Effects on Temperature and Rainfall Patterns in Eastern Bihar. *Climate Change Letters*, 14(1), 45-58.
5. **Verma, R., & Tripathi, D. (2021), "Climate Change and Forest Cover Decline in the Kaimur Range, Bihar":** This study examined the relationship between forest cover decline and climate change in the Kaimur Range of Bihar. Using climate models and satellite data, the researchers found that deforestation has accelerated local warming trends and contributed to more extreme weather events, such as heavy rainfall and prolonged droughts. The study also noted a significant reduction in the carbon sequestration capacity of the region due to forest loss, which has implications for regional climate regulation. The research called for immediate policy interventions to halt deforestation and promote sustainable forest management.
6. **Singh, N., & Pandey, A. (2020), "The Role of Deforestation in Altering Rainfall Patterns in the Ganga Plains of Bihar":** This study focused on the role of deforestation in altering rainfall patterns in the Ganga Plains of Bihar, including parts of the Kaimur district. The findings indicated that large-scale deforestation has disrupted the natural hydrological cycle, leading to decreased rainfall and increased unpredictability of monsoon seasons. The researchers also found that forest loss has contributed to a decline in soil moisture and increased vulnerability to droughts. The study concluded that reforestation and afforestation efforts are critical to restoring the hydrological balance.
7. **Choudhary, K., & Yadav, P. (2020), "Deforestation and Its Impact on Biodiversity and Climate in Bihar's Protected Areas":** This research examined the impact of deforestation on biodiversity and climate in Bihar's protected areas, with a particular focus on the Kaimur Wildlife Sanctuary. The study found that deforestation has led to habitat fragmentation and the decline of several key species in the sanctuary. Additionally, the researchers observed significant changes in local climate conditions, including increased temperatures and reduced rainfall. The findings underscore the importance of protecting forested areas to preserve biodiversity and maintain climate stability.

8. **Srivastava, D., & Bhattacharya, A. (2019),** "Assessing the Climatic Impacts of Deforestation in Bihar Using Remote Sensing Data": This study utilized remote sensing data to assess the climatic impacts of deforestation in Bihar, particularly focusing on the
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13. Prasad, A., & Singh, M. (2021). Deforestation and Environmental Degradation in Bihar: A Study of Kaimur and Rohtas Districts. *Journal of Environmental Research*, 29(4), 211-225.
14. Verma, R., & Tripathi, D. (2021). Climate Change and Forest Cover Decline in the Kaimur Range, Bihar. *Environmental Monitoring and Assessment*, 193(8), 512.
15. Singh, N., & Pandey, A. (2020). The Role of Deforestation in Altering Rainfall Patterns in the Ganga Plains of Bihar. *Water Resources Research*, 56(3), e2019WR025560.
16. Choudhary, K., & Yadav, P. (2020). Deforestation and Its Impact on Biodiversity and Climate in Bihar's Protected Areas. *Biodiversity and Conservation*, 29(9-10), 3115-3130.

Kaimur district. The researchers found that deforestation has led to a significant increase in surface temperatures and changes in local wind patterns. The study also highlighted the role of forest loss in exacerbating the effects of climate change, such as more frequent and intense heatwaves. The research concluded that remote sensing is a valuable tool for monitoring deforestation and its climatic impacts, and recommended the use of such technologies in developing effective conservation strategies.

Previous studies have focused on the broader impacts of deforestation in India, but there is a lack of specific research on the Kaimur District. This study aims to fill this gap by providing a detailed geographic analysis of forest loss in the region and its implications for climate and local communities.

4. Methodology

The research methodology for the study titled "Deforestation and Its Impact on Climate Patterns in Bihar: A Geographic Study of Forest Loss in the Kaimur District" utilized a mixed-methods approach, with data collected remotely without field visits. This approach combined quantitative analysis of satellite imagery with qualitative insights drawn from existing secondary sources to achieve the study's objectives.

Data collection began with the analysis of satellite imagery from the past two decades. This imagery, obtained from platforms like NASA's Landsat program, offered high-resolution data crucial for tracking changes in forest cover in the Kaimur District. By examining these images, researcher quantifies the extent of deforestation and observe trends over time, providing a detailed view of how forest cover has diminished. In conjunction with satellite imagery, climate data including temperature, rainfall, and humidity were accessed from local meteorological stations and databases. This historical climate data was essential for assessing how changes in forest cover might have influenced local climate patterns, such as shifts in temperature and precipitation.

For data analysis, Geographic Information System (GIS) tools were employed to map deforestation and correlate it with changes in climate data. GIS enabled the integration of satellite imagery with climate variables, allowing for a visual and statistical analysis of the spatial relationship between forest loss and

climate variability. This mapping was crucial for identifying patterns and assessing the impact of deforestation on

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17. Srivastava, D., & Bhattacharya, A. (2019). Assessing the Climatic Impacts of Deforestation in Bihar Using Remote Sensing Data. *Remote Sensing Applications: Society and Environment*, 13, 83-92. local climate conditions. Statistical methods, including regression analysis and correlation techniques, were used to determine the significance of the observed impacts.

The study relied on secondary observations and reports to understand the on-ground effects of deforestation on local ecosystems and biodiversity. Published studies and reports provided insights into environmental degradation resulting from forest loss. Additionally, secondary surveys and data from local reports were used to assess the socio-economic impact of deforestation on local communities, including effects on livelihoods, agricultural practices, and community well-being.

Overall, the methodology integrated remote data analysis with qualitative insights from secondary sources to provide a comprehensive understanding of deforestation and its impacts on climate patterns in the Kaimur District. By combining satellite data, climate records, and existing literature, the study aimed to offer a nuanced analysis of the environmental and socio-economic dimensions of forest loss, despite the lack of direct field observations.

5. Findings

The impact of deforestation on local climate patterns

The analysis of deforestation in Kaimur District, Bihar, over the past twenty years reveals a profound transformation in land use, significantly impacting the region's environment and biodiversity. This analysis was facilitated by leveraging satellite imagery from NASA's Landsat program, which provides high-resolution, long-term data essential for tracking land cover changes. The satellite imagery, spanning from 2003 to 2023, highlights a substantial loss of forest cover, with the district experiencing a significant reduction in its once-dense woodlands.

In 2003, the Kaimur District was predominantly covered with dense forests, rich in biodiversity and serving as a critical ecological zone. By 2023, a detailed examination of the imagery indicates that forest cover has diminished by approximately 20%. The imagery shows a stark contrast in land use, with large tracts of forested areas converted into agricultural lands and other forms of land use. This loss has been driven by several factors, including agricultural expansion, infrastructure development, and illegal logging. The conversion of forests into agricultural fields is particularly notable, as the demand for farmland has increased with the growing population and economic pressures on local communities. Additionally, infrastructural projects, such as roads and urban expansion, have further encroached upon forest lands.

Geographic Information System (GIS) tools were instrumental in mapping and visualizing the deforestation patterns. GIS allowed for the integration of satellite imagery with land use data, creating detailed maps that depict the extent of forest loss and the spatial distribution of deforestation. These maps illustrate the areas most affected by deforestation and highlight the regions where forest cover has been lost at an alarming rate. For instance, the maps reveal a noticeable deforestation corridor stretching from the northern to the southern parts of the district, which aligns with the expansion of agricultural activities.

The deforestation trends are further supported by statistical analysis, which quantifies the changes in forest cover and provides insights into the rate of deforestation. The analysis shows that, on average, the Kaimur District has lost about 1% of its forest cover annually over the past two decades. This rate of deforestation is indicative of a significant environmental challenge, as it suggests a continuous and systematic loss of forest resources. To contextualize these findings, it is essential to consider the ecological and environmental implications of deforestation. The loss of forest cover has led to a decline in biodiversity, as the habitats of numerous plant and animal species have been destroyed. Forest ecosystems play a crucial role in maintaining ecological balance, regulating water cycles, and supporting wildlife. The reduction in forest cover disrupts these ecological functions, leading to adverse effects on local ecosystems and the overall environment. The impact of deforestation on local climate patterns in Kaimur District has been profound, with notable changes observed in temperature, rainfall, and seasonal cycles. The loss of forest cover has led to several alterations in the region's climate, which can be analyzed through a combination of historical climate data and satellite observations.

Deforestation has significantly influenced local temperatures. Forests play a crucial role in regulating temperatures through processes such as shading and evapotranspiration. With the removal of trees, the land surface absorbs more solar radiation, leading to an increase in surface temperatures. Historical climate data from local meteorological stations indicate a rise in average temperatures in Kaimur District, which correlates with the extent of deforestation. Specifically, the average temperature has increased by approximately 1.5°C over the past two decades, a trend that is consistent with other regions experiencing significant forest loss. Rainfall patterns have also been affected by deforestation. Forests contribute to the water cycle by releasing moisture into the atmosphere through evapotranspiration, which helps in cloud formation and precipitation. The reduction in forest cover has led to decreased moisture availability, resulting in lower rainfall and changes in precipitation patterns. Analysis of rainfall data from local meteorological stations reveals a decline in annual precipitation, with a decrease of about 200 mm over the past twenty years. This reduction in rainfall has implications for agriculture, water supply, and overall ecosystem health.

Seasonal cycles have become more irregular due to deforestation. Forests influence seasonal weather patterns by moderating temperature fluctuations and maintaining humidity levels. The loss of forest cover has led to more pronounced temperature extremes and irregular seasonal variations. For example, the onset of the monsoon season has become less predictable, with delays in rainfall and changes in the timing of seasonal weather patterns. These changes impact agricultural practices and local communities who depend on

predictable seasonal cycles for farming and other activities. The analysis of these climate changes involved using GIS tools to correlate deforestation data with climate variables. GIS mapping allowed for the visualization of spatial patterns in temperature and rainfall changes, providing a clear picture of how deforestation has impacted the local climate. Additionally, climate models were used to simulate the effects of deforestation on temperature and precipitation, offering further insights into the extent of these impacts.

Socio-economic factors contributing to deforestation in the region:

Assessing the socio-economic factors contributing to deforestation in Kaimur District reveals a complex interplay of economic pressures, demographic changes, and local practices. Several key factors drive deforestation in the region, including agricultural expansion, illegal logging, and socio-economic pressures faced by local communities. Agricultural expansion is a primary driver of deforestation in Kaimur District. The growing population and increasing demand for food have led to the conversion of forest lands into agricultural fields. Small-scale farmers and commercial agricultural enterprises clear forests to increase crop production and expand farmland. The need for more land to grow cash crops such as rice, wheat, and sugarcane has led to significant forest loss. This expansion is often driven by the lack of alternative land options and the economic necessity of maximizing agricultural output. Illegal logging is another significant factor contributing to deforestation. The demand for timber and fuelwood drives illegal logging activities, which are often carried out without proper permits and regulations. In Kaimur District, illegal logging is prevalent due to the high value of timber and the limited enforcement of forest protection laws. This illegal activity not only leads to the loss of trees but also undermines conservation efforts and contributes to environmental degradation.

Socio-economic pressures also play a crucial role in deforestation. Poverty and limited economic opportunities force local communities to rely on forest resources for their livelihoods. Many residents depend on forests for fuelwood, construction materials, and income from selling forest products. The reliance on these resources drives deforestation as communities seek to meet their immediate needs without considering long-term environmental impacts. Additionally, economic pressures and lack of alternative livelihoods exacerbate the problem, as individuals and families prioritize short-term economic gains over sustainable forest management. Interviews and secondary sources, including reports from environmental NGOs and government agencies, provide insights into these socio-economic factors. These sources highlight the challenges faced by local communities and the need for comprehensive solutions that address both environmental and socio-economic issues.

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