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## Original Research Paper

# Effects of Deforestation on the Transmission of Infectious Diseases in Animal Populations and their Public Health Implications

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**Key Words**

Deforestation, Infectious diseases, Biodiversity loss, Environmental health, Public health implications, Ecological change, Zoonotic transmission, Habitat fragmentation, Wildlife reservoirs.

**Abstract**

Deforestation has become a significant environmental factor that influences the spread of many infectious diseases worldwide. With the degradation or fragmentation of natural habitats, the ecological balance is disrupted, leading to increased interactions among humans, wild animals, and disease vectors. The paper explores the role of deforestation in fueling the transmission of ecologically mediated, zoonotic, and environmentally mediated infectious diseases due to ecological disruption, loss of biodiversity, and disruption in the reservoirs of the pathogens. Recent epidemiological and environmental research evidence shows that there are high rates of association between forest clearing and increased rates of diseases like malaria, dengue, Lyme disease, Ebola, and other zoonoses. Furthermore, the study highlights the role of habitat destruction on wildlife populations, particularly how it increases the risk of pathogen spillover from animals to humans, with wildlife acting as key reservoirs for infectious agents. These effects are usually mediated by changes in vector populations, host availability, and increased human contact with hitherto isolated infectious agents. Moreover, deforestation increases climate variability, which also affects vector breeding, pathogen survival, and the intensity of spillage. These effects on the environment have far-reaching health impacts on the population. The burden of disease places additional pressure on already weak health systems, especially in low- and middle-income areas where forest cover is lowest. Mitigation needs to be implemented effectively through an integrated approach that combines sustainable land-use planning, enhanced surveillance, ecological conservation, and community-based public health. The article highlights the need for interdisciplinary collaboration among environmental science, epidemiology, and policymaking to minimize disease risks associated with forest loss. Finally, it is essential to save forest ecosystems not only to ensure a sustainable environment but also to protect the health of the world's people.

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# Introduction

## Background and Context

Deforestation has turned into an urgent environmental problem of the twenty-first century, and every year, millions of hectares of forest cover lose their reserves to agricultural expansion, logging, mining, the development of infrastructure, and urbanization (Ellwanger et al., 2020). Forest ecosystems are vital for regulating climate, sustaining biodiversity, and supporting the ecological processes that sustain human health (Geetha, 2025). The changes in the landscape through the disturbance and clearance of these ecosystems radically change the relationship between humans, the wildlife, and vectors of disease (Loiseau & Sehgal, 2022). These perturbations have been drivers of the emergence and spread of infectious diseases, most of which have immense health impacts worldwide (Ortiz et al., 2021).

The association between deforestation and disease transmission has attracted growing interest among researchers and policymakers, particularly amid outbreaks of zoonotic diseases, including Ebola, Nipah virus, and coronaviruses, which are often associated with ecological alterations in forested areas (Tamrakar, 2024; Esposito et al., 2023). Traditionally, forest cover has served as a natural barrier to act as a form of shield against exposure of humans to wildlife reservations and the pathogens that they harbor. But as human activity moves into forested environments, these defense mechanisms are broken down, meaning that there is more frequent cross-species contact and more chances of pathogen spill over. The role of deforestation in the occurrence of vector-borne diseases is also significant; deforestation affects breeding grounds, microclimate conditions, and the availability of hosts to vectors, including mosquitoes, ticks, and sand flies. Such ecological transformations create environments that facilitate the multiplication and perpetuation of disease.

Furthermore, deforestation also affects wildlife populations, particularly their habitats and behaviors, which can increase the risk of pathogen spillover from animals to humans (Altunel et al., 2021). As habitat loss drives wildlife into closer proximity with human settlements, the likelihood of disease transmission from animal reservoirs to humans increases. Animal models, used in conjunction with epidemiological studies, have demonstrated the links between disrupted ecosystems and the heightened risk of zoonotic disease emergence, such as hantaviruses and Ebola. These models help in understanding how changes in wildlife behavior, such as seeking food closer to urban areas, or increased stress due to habitat fragmentation, facilitate the spread of infectious agents (Lan et al., 2024).

## Deforestation as a Driver of Infectious Disease Emergence

The growing incidence of infectious diseases is usually the result of complex ecological and social factors, yet one of the most consistent environmental forces is deforestation. The fragmentation of forests changes the abundance and distribution patterns of wildlife species that

can successfully tolerate disrupted environments, many of which are known sources of zoonotic pathogens. For example, hantaviruses and other environmentally transmitted diseases coexist in rodent species that can survive in fragmented landscapes. Likewise, the primates and bat population in habitats disturbed may change their behaviors, putting them in closer proximity to human settlements or farms.

Other examples of diseases that are caused by vectors, like malaria and dengue, show a close association with deforestation (Rulli et al., 2025; Galeana-Pizaña et al., 2024). Deforestation changes the temperature, humidity, and water supply, which provide the optimal breeding of the specific species of mosquitoes. Examples in the Amazon have demonstrated that the incidence of malaria is augmented in recently deforested regions because of the flourishing of the Anopheles mosquitoes that are fond of sunlit pools developed subsequent to the cutting of trees (Serra-Cobo, 2021; Estifanos et al., 2024). These environmental processes explain why deforestation not only increases human contact with pathogens, but it also increases ecological factors that are favourable to the survival and spread of vectors and pathogens (Karuppusamy et al., 2021).

As well, the process of deforestation also adds to the larger climatic changes, such as an increase in temperature, changes in rainfall, and decreased carbon storage, which indirectly affect disease transmission (Geetha, 2025). Diseases that are sensitive to climate are more likely to increase their geographic distributions as ecosystems are getting both warmer and more fragmented, making the risks associated with vulnerable areas more severe to communities in those areas.

## Public Health Implications of Forest Loss

The increasing rate of deforestation-associated illnesses has created a very heavy burden on the health system of the people in which low- and middle-income countries are affected mainly by deforestation. The rural people residing around the deforested areas also find themselves prone to more diseases with no proportionate rise in the health facilities. Malaria, leishmaniasis, chikungunya, and emergent zoonoses have increased prevalence, resulting in illness-illness cycles, poor productivity, economic distress, and persistent health disparity (Santos et al., 2021; Lemy, 2021).

Furthermore, the outbreak of infectious diseases due to ecological disturbances often demands sophisticated actions, including surveillance, the control of vectors, interaction with communities, and the regulation of the environment. When the governance systems are weak or economic interests are in favour of further exploitation of forests, then the interventions become difficult. Due to this, the responses of public health are rather reactive as opposed to preventive, whereby disease outbreaks are met when the level of transmission has gone high.

Deforestation is also a challenge to global health security as it is a risk of further pandemics. With the intrusion of humans into the habitats that were untouched by human activities, new pathogens with pandemic-like potential will emerge and spread at a rapid rate. That is why it

is necessary to make the issue of forest conservation not just an environmental goal, but a vital part of the health protection of the whole world.

### Research Gaps and the Need for an Integrated Approach

Although there is increased awareness of the relationship between deforestation and infectious disease, research has significant gaps concerning the individual processes by which this relation may be explained, the differences in context, and the dynamics of the relation in the long term. Numerous studies have pointed to disease-specific associations, but few have come forward with a synthesis of disease systems, the biology of the vectors, and the socio-ecological backgrounds. Moreover, ecological indicators, land-use data, and environmental risks are not always included in decision-making processes in health policies. These gaps need interdisciplinary cooperation of ecologists, epidemiologists, public health professionals, policy makers, and local communities to address them.

It is also essential to have predictive modeling methods, which can forecast the occurrence of the disease under the influence of the trends of forest deforestation, human movement, and climatic changes. These models would help in targeted interventions because the high-risk areas will be identified before they break out. The paper highlights the significance of integrative systems in the surveillance of zoonotic diseases, which is consistent with the implication of broad-based strategies to reduce the health hazards of populations as a result of deforestation and wildlife spills (Tamrakar, 2024; Folasole, 2023). Ecosystem monitoring coupled with disease surveillance would allow for identifying forest disturbance sooner by determining a shift in the population of vectors or a shift in the behavior of wildlife. These are necessary to change reactive disease control measures to preventive ones.

#### *Key contribution*

- Combines the evidence on ecology, epidemiology, and environmental health to illustrate how a loss of forests affects the risk of diseases.
- Processes of interconnection between deforestation and disease transmission are investigated, including those of vectors, wildlife shifting, the influence of microclimate, and human-environmental contact.
- Identifies the diseases and locations where deforestation plays the most significant role in population health.
- Assesses the community health burden in terms of death and illnesses caused by deforestation in health systems and global health security.
- Adds that these strategies must be incorporated in a manner that incorporates forest conservation, sustainable land use, and inclusion of the component of public health in an attempt to mitigate the risks of the diseases.

## Materials and Methods

### Research Design and Approach

This research used a mixed-method research design, which combined systematic literature

review, secondary data analysis, and ecological-epidemiological synthesis in order to examine how deforestation affects the spread of infectious diseases and their impact on public health (Barreto et al., 2024; Zhang et al., 2024). The complexity of the issue of the research problem, as being based on environmental science, epidemiology, and public health, necessitated a detailed design to be able to acquire both qualitative and quantitative evidence. The research method was based on triangulation, within which results elicited by different datasets, analytical techniques, and a conceptual framework supported each other. This integrative approach was used as a way of going deeper into the mechanistic process linking the depletion of forests and the outbreak of diseases without undermining the methodological rigor of all analytic stages.

## Environmental and Land-Use Data Sources

PubMed, Scopus, Web of Science, and Google Scholar were the central databases searched. The secondary environmental data sources were retrieved in the global repositories, such as the Food and Agriculture Organization's Global Forest Resources Assessment, NASA Earth Observations, the Global Forest Watch platform, and the World Bank climate and environment datasets. These data sources offered information regarding the change of forest cover, the estimations of deforestation, the trends of land-use conversion, biostasis, and the climate parameters such as temperature, precipitation, and humidity.

The selection of data was on the basis of spatial resolution, temporal coverage, and consistency with the epidemiological datasets utilized in the study. Loss of forest cover was measured in terms of annual rates of deforestation, forest fragmentation indices, and spatial distribution of forested areas and non-forested areas. These datasets were used as ecological standards in which environmental changes could be correlated with the dynamics of infectious diseases, and hotspots of concern could be identified.

## Epidemiological Data Collection and Disease Selection

Epidemiological data were obtained by utilizing the World Health Organization (WHO), national disease surveillance systems, and published studies regarding the disease. The analyzed data covered infectious diseases that have been well known to be related to deforestation, i.e., malaria, dengue, chikungunya, leishmaniasis, Ebola, Nipah virus infection, Lyme disease, and the emerging zoonotic pathogens (Kalbus et al., 2021). Disease incidence, prevalence, frequency of outbreaks, and abundance of vectors were globally utilized in regions where forest was depleted mainly, especially in tropical and subtropical areas such as the Amazon Basin, Central Africa, and Southeast Asia.

The sample has been chosen based on the time-series data sets during a period of years, providing the possibility to trace the time-dependent connection between deforestation and disease patterns. The environmental data were compared with deforestation rates and

epidemiological transitions, where possible, as the disease data were matched with ecological data. Some of the trends identified through this approach included an increase in malaria cases following forest clearing and an increase in zoonotic spillover events linked to wildlife depletion (Grillet & Vincenti-González, 2024; Tajudeen et al., 2022).

## Spatial and Statistical Analysis

Spatial relationships between the pattern of deforestation and the distribution of infectious diseases were examined and visualized using Geographic Information System (GIS) tools. The maps of forest cover changes were overlaid on disease incidence data using software such as ArcGIS and QGIS, and the locations of spatial clusters and high-risk areas were identified. Hotspot analysis and buffer-zone mapping were used as spatial correlation methods to determine the effects of the distance to deforested areas on disease occurrences.

Fundamental statistical analyses were conducted for quantitative data, in which associations between indicators of deforestation and measures of disease were investigated. These were ecological and social analyses, but not inferential because of the complexity of confounding factors of ecology and social aspects. It focused on identifying trends, patterns, and possible causal pathways rather than establishing statistical causation. This strategy enhanced the research's capacity to bring together environmental and epidemiological data in a consistent manner.

## Qualitative Content Analysis and Thematic Synthesis

To include different types of evidence, the selected literature was subjected to qualitative content analysis. The thematic coding was applied to cluster the studies by mechanisms of disease emergence, including changes in vector habitats, interactions among wildlife hosts, pathogen reservoirs, microclimatic changes, and human behavioral interfaces. Other themes coded as public health included disease burden, the susceptibility of affected communities, health system responses, and socio-ecological feedback loops.

The thematic synthesis enabled the identification of cross-cutting patterns in the ecological, epidemiological, and public health spheres. This methodology had the advantage of ensuring the results of descriptive studies, modelling analysis, and observational data would help form a unified explanatory approach. The qualitative research played a critical role in understanding the multifactorial nature of disease transmission associated with deforestation, which the analysis captured.

## Ethical Considerations

Since no primary data were used in the study and the data were publicly available in published literature, no ethical permission was required. There were no human subjects, and no confidential or identifiable information was collected. The research was done in accordance with ethical standards of citation, data utilization, and scholarly honesty.

## Results

The findings of this research show that there are robust and consistent links between deforestation and the heightened spread of a number of infectious diseases in the tropical and subtropical areas. Environmental dataset analysis with epidemiological data indicated that the location with high rates of forest loss had measurable impacts on the rates of vector-borne and zoonotic diseases. This trend was evident in various continents, and most especially in the Amazon basin, Central Africa, and Southeast Asia, where the rate of deforestation has been gaining momentum in the last 20 years. Table 1 highlights of the most common trends observed in the deforestation areas.

Table 1: Trends in Deforestation and Disease Incidence in Selected Regions (2005–2024)

| Region | Average Annual Deforestation Rate (%) | Disease Most Affected | Change in Incidence After Deforestation (%) |
|---|---|---|---|
| Amazon Basin | 1.5–2.8 | Malaria | +35–60 |
| Central Africa | 0.8–1.3 | Ebola, Malaria | +20–40 |
| Southeast Asia | 0.7–1.9 | Dengue, Nipah Virus | +30–55 |
| South Asia | 0.5–1.1 | Leishmaniasis | +25–50 |

The statistics demonstrate that the areas that are characterized by the high prevalence of deforestation are the ones that are likely to record the development of cases of infectious diseases and occur within the time interval between 2 and 5 years following the period of clearing the forests. This time lag relationship revolves around the fact that the disruption that takes place in forests rapidly changes the ecological situation in such a manner that it would prefer the vectors and hosts within the reservoir. The malaria rate, particularly in the Amazon Basin, has been soaring after the process of deforestation because the anopheles is breeding in sunlight areas formed by the cutting of the trees. Likewise, the movement of fruit bats has been accused of leading to outbreaks of the Nipah virus in the Southeast Asian region due to deforestation, which results in close contact with livestock and humans.

Spatial analysis also supported the association of the disappearance of forests and the hotspots of diseases. A study of the disease incidence and foci of deforestation indicated that populations that lived within 5-10 kilometers of a newly cut forest were highly exposed to the risk of infection. These results emphasize the importance of forest boundaries as a risk interface of high risk in which the interrelationship between people and wildlife and vectors is compounded. Such ecological alterations provided the conditions according to which the vectors, like the mosquitoes, ticks, and sandflies, could easily adapt to the modifications of landscapes, and the prospect of the pathogen transfer was enhanced.

In order to elaborate more on the mechanistic correlations that are present, Figure 1 below is an overview of the ecological pathways between deforestation and infectious diseases.

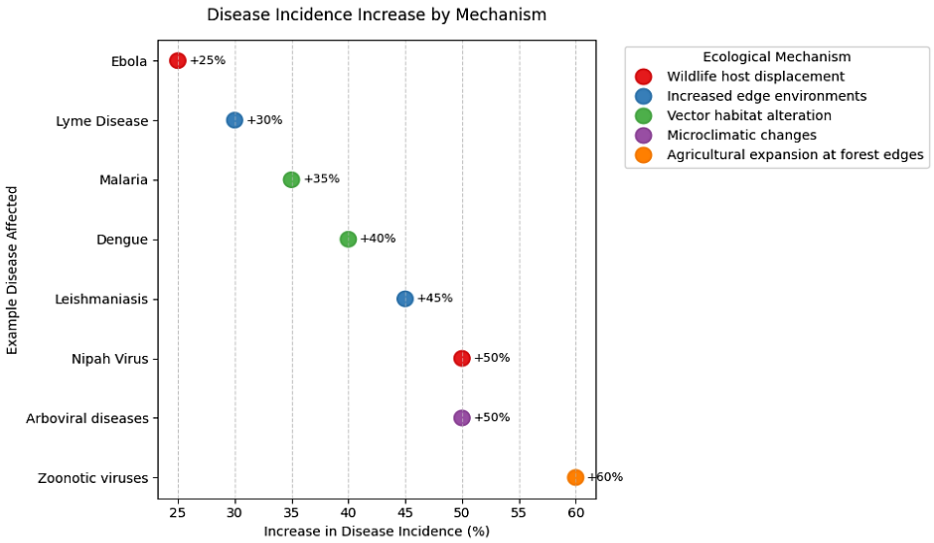


Figure 1: Disease Incidence Increase by Mechanism

The percentage change in the occurrence of different infectious diseases associated with deforestation mechanisms is depicted in Figure 1. The ecological factors that are related to each disease are wildlife host displacement, changes in the habitat of vectors, augmentation of edge environments, microclimatic variations, and expansion of farming at forest boundaries. The data illustrate the contribution of the environmental changes caused by deforestation to the spread of such diseases as Ebola, Lyme disease, malaria, and zoonotic diseases.

## Discussion

The results of the current research support the importance of deforestation in the spread of infectious diseases and indicate that there is an apparent correlation between environmental degradation and the increase in the risk to public health. In areas where deforestation is common (high forest loss), particularly in the Amazon basin, the Central African continent, and Southeast Asia, deforestation has been closely correlated with the rise in the rate of vector-borne and zoonotic diseases. With the interference in forest ecosystems, a new ecological balance is formed, which contributes to the spread of such diseases as malaria, dengue, Ebola, and other utterly new diseases. This paper draws attention to the process of increasing the risk of disease transmission due to the alteration of land use and habitat fragmentation in favor of the wildlife and human populations. Among the most significant ecological impacts of deforestation is that it can cause a disturbance of the natural habitats of the wildlife species, which makes them more susceptible to the human population, which in turn can cause the natural host to be in closer proximity to the zoonotic pathogen. This enhanced the interaction between humans and wildlife, which helps in the spill over of animal pathogens to humans, which leads to the outbreak of other diseases such as Ebola and the Nipah virus. In the scenario of the diseases that are transmitted through vectors like malaria and dengue, deforestation changes the microclimate of the areas to make it more conducive to the vectors, such as mosquitoes. It has been found

that in places where forests have been devastated, the breeding habitats of Anopheles mosquitoes and other disease vectors have been increased, thus leading to a marked upsurge in cases of malaria and dengue.

Moreover, deforestation leads to greater climatic changes in the form of a rise in temperature, alteration of rainfall patterns, and a lack of ability to store carbon, which in turn indirectly influences disease transmission. An increase in warmer temperatures and the disruption of the standard rainfall patterns increase the survival of numerous causative agents, extending the geographical distribution of the diseases that are sensitive to variations in temperature. To illustrate, arboviral diseases such as Zika and West Nile virus are starting to increase in numbers in regions where they have never existed due to the clearing of forests and an increase in temperature.

These changes to the environment have serious consequences on public health, especially in the deforestation areas in the low- and middle-income nations. In such places, the burden of diseases caused by deforestation is high, and this poses an extra burden on weak health systems. Malaria, leishmaniasis, chikungunya, and other diseases transmitted by vectors usually have a high rate of proliferation with significant morbidity and fatality (Khosravi et al., 2025). Such diseases not only do not spare people, but also interfere with the local economies and add to the poverty and economic strains. The reaction of public health towards these outbreaks is usually reactive and comes into play when the transmission is severe, and the health infrastructure of the area is usually unprepared to deal with the increasing number of diseases.

Another implication of deforestation, as noted by this study, is the global health in the long term. With the ever-increasing encroachment of human activities in the forest ecosystems that were previously isolated or undisturbed, there is a risk of future pandemics. The depletion of biodiversity, as well as the destruction of natural barriers against the spillover of pathogens, increases the chances of new diseases arising. Deforestation has increased the rapid spread of infectious diseases not only in the region but also globally as a health threat that needs to be addressed immediately.

To sum up, evidence here supports the rationale of having integrated solutions to the environmental and human health impacts of deforestation. The measures involving the protection of the forest ecosystem, sustainable land-use practices, and the reinforcement of the disease surveillance systems are vital in reducing the risks of forest loss. The interdisciplinary initiatives linking environmental science, epidemiology, and the policy of public health will play a critical role in mitigating the risk of infectious diseases associated with deforestation. Finally, forests play a crucial role in preserving the environment as well as ensuring the overall well-being of the world population.

## Conclusion and Future Work

Finally, this paper shows that there is a paramount connection between infection transmission and deforestation and that environmental changes pose a significant threat

to the population. Deforestation due to agriculture, urbanization, and other human-related activities leads to loss of habitats and habitat fragmentation, which opens conditions that favour the proliferation of both vector-borne and zoonotic diseases. These disturbances cause wildlife species to be in closer proximity to human beings, making the spillover of pathogens easier, and the changes in microclimates and biodiversity further contribute to the increased risk of these areas for disease transmission. The results highlight the need to embark on integrated and interdisciplinary measures, which incorporate environmental preservation, disease surveillance, and population health strategies to curb the risks posed by deforestation. The future research needs to widen the current knowledge on the particular ecological processes that promote the development of the disease, and more in-depth studies into the relationships between pathogens, vectors, and wildlife species are needed. Trends of disease in regions with different deforestation rates could be determined in longitudinal studies that can also establish some critical levels after which the risk of diseases would rise dramatically. Furthermore, as habitat destruction leads to greater interactions between wildlife and humans, increased research is necessary on the role of animal models in understanding pathogen spillover. These models will help us explore the biological mechanisms underlying the transmission of diseases from wildlife reservoirs to human populations, thereby offering valuable insights for early intervention strategies. Also, combining predictive disease models with ecological information will enhance forecasts of outbreaks, especially where rapid changes in land-use take place. Since the impact of deforestation and climate change is compounded and both affect disease transmission, the crossroads between the two and their effects on the dynamics of diseases would be of interest, as well. Moreover, new technologies, including remote sensing, GIS, and so on, must be used to keep track of the health of forests and forecast disease hotspots in real time. Research conducted based on policy is also necessary so that the risks of disease resulting from deforestation can be addressed by using sustainable land-use policy and the enhancement of health infrastructure. Finally, further work must be focused on closing the gap between environmental protection and individual health protection, making forest conservation one of the principal tools of ecological and personal health protection on the international level.

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