# Impacts Of Changes in Vegetation Structure on Elephant Habitat and Relationship to Human Conflict

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**Abstract.** With global climate change, ecosystems and biodiversity are facing unprecedented threats. Yunnan, as an important region for biodiversity, is experiencing significant vegetation structural changes, which have far-reaching impacts on its endemic elephant populations. This study focuses on how climate change-induced changes in vegetation structure affect Yunnan's elephant habitat and its conflict with humans. The study found that the elephants' traditional habitats have been severely fragmented due to climate change-induced forest degradation and grassland changes, forcing them to engage in more frequent conflicts with the local residents. This ecological change not only threatens the survival of elephants, but also puts enormous economic and livelihood pressures on the local communities. In addition, elephants' migration routes and behavioral patterns have been significantly altered as a result. This study reveals the complex impacts of climate change on biodiversity and human life, and emphasizes the urgency of taking appropriate measures to protect the ecological balance.

**Keywords:** Climate change, Yunnan elephants, vegetation structure, human-elephant conflict, habitat change.

## 1. Introduction

With global climate change, the impacts of the various environmental changes it triggers have gradually become the focus of public attention, and anthropogenic global change poses a threat to global biodiversity, ecosystem functioning, and human well-being. Climate change intensifies human-wildlife encounters, which are primarily characterized as direct interactions resulting in adverse effects. These confrontations vary, leading to harm to both humans and animals, damage to possessions, and disruption of livelihoods, significantly affecting our socio-ecological balance. Such disputes play a key role in the reduction and disappearance of large mammal populations, causing ecosystem shifts. Concurrently, these unfavorable engagements with wildlife pose risks to human safety, heighten economic unpredictability, and inflict annual losses amounting to billions globally [1]. Yunnan, with its complex geological history and specialized geography, and rich vegetation and animal populations, is inevitably affected by these global trends as a biodiversity hotspot in China [2]. Of particular concern are large mammals such as elephants. In Yunnan, these organisms are not only important components of the ecosystem, but also closely related to the local culture and economy. However, their survival and habitats are being threatened as never before. Land development, agricultural expansion and other anthropogenic factors have directly weakened and fragmented their habitats. This habitat fragmentation has led to a reduction in food and water sources and increased contact and conflict with humans. In addition, the close interaction between elephants and humans further compounds the complexity of the problem.

China's Yunnan Province, known for its ecological diversity, is currently facing significant changes in vegetation structure and distribution [3]. First, with the gradual increase in temperature, certain endemic plant populations may migrate towards higher latitudes and altitudes [4]. Furthermore, changes in drought and rainfall patterns have had significant impacts on both water resources and agriculture in Yunnan, a mountainous region [5]. In addition, changes in wetlands and river systems may further affect local ecosystems [5].

In recent years, there has been a significant increase in human-elephant conflicts in Yunnan, and this issue has attracted widespread attention. According to Bai in 2022, human-elephant conflict

incidents have increased [6]. Among them, climate change was identified as a key factor. As the global climate continues to change, the vegetation structure in Yunnan has also changed significantly and specific food and water supplies have become scarcer. As a result of this ecological change, elephants are under increased pressure and are forced to enter human communities more frequently in search of food and water. This not only affects the survival of the elephants, but also causes great distress to local farmers and villagers. Shaffer further emphasized in their 2019 study that this altered ecological landscape has led directly to a direct collision between wild elephants and human agricultural systems [7]. The direct economic losses of damaged farmland and nibbled crops further exacerbate the conflict between humans and elephants.

Although global trends in climate change and the basics of elephant ecology have been heavily researched, specialized studies on how changes in vegetation structure due to climate change in Yunnan affect elephant-human conflict remain scarce [8]. This gap limits our understanding of the issue.

Climate change has already had a profound impact on Yunnan's ecosystem, leading to an increase in elephant-human conflict. In order to cope with this problem, comprehensive research is needed to find long-term and effective solutions from a variety of ecological, social and economic perspectives. The aim of this paper is to synthesize the current literature to reveal the interrelationships between climate change, changes in vegetation structure, elephant habitats and human-elephant conflict, and to suggest possible directions for future research. We hope that this review will provide a more comprehensive and in-depth understanding for policy makers, researchers and the public to better protect Yunnan's ecosystems and biodiversity.

## 2. Impacts of climate change on vegetation structure

### 2.1. Climate Change and Vegetation Relationships in a Global Perspective

Global climate change has become one of the greatest challenges of the 21st century. Along with the continuous global warming, different ecosystems are undergoing profound changes. Several studies have revealed that the increase in temperature has led to changes in precipitation patterns as well as seasonal shifts in most regions. These shifts in climatic factors have had a dramatic impact on vegetation distribution, growing seasons, biodiversity, and ecosystem functioning [9, 10].

As temperatures rise, precipitation patterns and seasonality change in most regions. First, for vegetation distribution, the vegetation line in the Arctic and subarctic regions is migrating in a northerly direction, which not only changes the habitats of native organisms, but also may lead to the risk of extinction for some species [10]. In contrast, at the global scale, the effects of climate change on vegetation are manifested in longer growing seasons, reduced ecosystem resilience, and northward or elevated distributions [11]. For example, in the Pyrenees region of Europe, forest lines are steadily pushing northward and upward as temperatures rise, causing some low-elevation plant populations to lose their ecological niches and face survival risks [12]. On the other hand, tropical and subtropical regions are also being significantly affected. Changes in precipitation patterns have resulted in the blurring of previously well-defined ecological boundaries, such as the junction of grasslands and forests. This blurring may lead to increased competition between populations of organisms, and certain species may be threatened while some may benefit [13].

### 2.2. Specific situation in China and Yunnan region

China, as the world's largest developing country, has a huge geographic range and diverse ecosystems that make it particularly vulnerable to climate change. Among them, Yunnan Province is undoubtedly a focal point for climate change research in China and East Asia due to its unique geographical location and rich biodiversity. In the last 18 years, vegetation shifts in Yunnan have been prominent both spatially and temporally, influenced by both climate change and human activities. Various types of vegetation in Yunnan, including grasslands, forests, and farmlands, have increased growth trends in the growing season, spring, and fall [14]. This could be attributed to the

rising levels of rainfall and temperature in Yunnan over recent years, which created favorable conditions for the growth of vegetation. However, this phenomenon is not limited to Yunnan. Vegetation trends similar to those in Yunnan have also been observed in other regions, such as the Tibetan Plateau, the Heilongjiang Basin, and Nanshu Lake [15]. Since the 1980s, in response to the national policy of ecological and environmental protection and to meet the challenges of climate change, Yunnan Province has adopted a series of ecological restoration and protection measures. For example, large-scale closure of mountainous areas for afforestation, implementation of returning farmland to forests and promotion of artificial afforestation. These measures have resulted in a staggering 6,754 square kilometers of fallow forest in Yunnan Province between 2001 and 2017 [14]. In terms of climate, both precipitation and temperature have increased in Yunnan over the past 18 years, providing favorable conditions for vegetation growth [14]. Overall, climate change has had a profound impact on vegetation in Yunnan and beyond.

## 3. Impacts of changes in vegetation structure on elephant habitats

Ecological changes due to global climate change and anthropogenic activities pose a serious threat to biodiversity. In this, the adjustment of vegetation structure is closely related to wildlife habitat. Yunnan, known for its rich biodiversity and unique ecological environment, has not been immune to such global ecological pressures in recent years. Changes in vegetation structure, especially the loss of primary forests and the degradation of grasslands, mean that large herbivores such as elephants will be affected in their traditional habits and migration paths. Elephants in Yunnan, especially Asian elephants, have long depended on specific plants on the land for food. However, due to factors such as forest fragmentation, agricultural expansion and urbanization, these key food sources are being gradually reduced or relocated elsewhere. This poses a challenge to the daily diet of elephants [6]. At the same time, the area of land available for migration is also decreasing due to agricultural expansion and human activities. These changes are especially critical for elephants, a large herbivore with strict habitat requirements.

Elephants, as the largest land mammals on Earth, have specific needs for their habitat. These ecological needs make them particularly vulnerable in the face of habitat change. Elephants consume large amounts of food and water on a daily basis: a typical elephant needs to consume 150 kg of food and 190 liters of water per day, which determines their need for a vast and abundant range of vegetation [16]. Therefore, any reduction or change in these resources could have a significant impact on elephants. Studies have already found that changes in vegetation structure, especially forest fragmentation due to anthropogenic activities, may lead to the reduction and segregation of elephant habitats, thus affecting their ability to migrate and find food and water [7]. In a vegetation-rich environment, elephants can meet their nutritional needs more efficiently, which is essential for their health, reproductive capacity and long-term survival. In addition to this, abundant vegetation provides elephants with the necessary cover to hide from natural predators or other potential threats. At the same time, healthy vegetation slows down soil erosion and raises the water table, thus providing a constant and reliable source of fresh water for elephants. Simultaneously, elephants' feeding behaviors can impact their surrounding ecosystems by damaging tree canopies, pulling out young trees and bushes, and dispersing seeds [17]. In summary, changes in vegetation structure have direct and indirect effects on elephant survival, reproduction, migration and ecological functioning, which emphasizes the importance of taking measures to maintain and restore a healthy vegetation structure in order to protect elephants and their habitats.

## 4. Conflict relations between elephants and humans in Yunnan Province

Human-elephant conflict is a growing ecological and social problem globally, especially in the native areas of elephants. With population growth, land use change and climate change, this problem

has become more and more prominent, leading to economic losses, human casualties and even intensifying illegal hunting and killing activities of elephants.

Firstly, habitat loss and fragmentation rank among the primary reasons for human-elephant conflicts. With land use changes caused by human activities, such as farmland expansion, infrastructure construction, urbanization and mineral extraction, elephant habitats are being drastically reduced and fragmented. This habitat shrinkage is forcing elephants to operate in smaller territories, or forcing them into human settlements, agricultural lands and other economic areas [6]. As a result, elephants are likely to destroy crops, buildings, and other property, while also increasing the probability of direct conflict between humans and elephants. Secondly, competition and scarcity of resources are also key factors that induce human-elephant conflict. With climate change, food and water resources are becoming scarcer in some areas. Elephants, as large herbivores, require large amounts of food and water on a daily basis [16]. Under natural conditions, their food and water sources are restricted or unstable, which forces elephants to enter human farmlands and settlements to access these resources, leading to conflict. Socio-economic factors are also important causes of human-elephant conflict. In some areas, especially in developing countries, people are highly dependent on land for their livelihoods, such as agriculture, livestock and forestry. Therefore, damage to crops and other resources by elephants can have a serious impact on the economic situation of local people. In addition, perceptions and experiences of human-elephant conflict in the community, as well as attitudes towards wildlife conservation, may also influence the severity of human-elephant conflict [18]. Notably, anthropogenic disturbances such as poaching, hunting and trapping may lead elephants to display aggressive behavior towards humans. Thus, even in the absence of obvious competition for resources, elephants may show hostility towards humans, thereby increasing the risk of conflict.

In Yunnan Province, a major elephant range in China, habitat interactions between elephants and humans have increased significantly with the rapid economic development, population growth and agricultural land expansion in Yunnan in recent times. Especially in recent decades, frequent incidents of elephants entering villages and farmlands have led to increased human-elephant conflict. Yunnan, an ecologically critical region in China, has vegetation and climatic characteristics that significantly affect elephant populations. Recent studies have shown that Yunnan has experienced an upward trend in vegetation over the past 18 years, especially during the growing season, spring and fall, providing a richer food source for elephants. Meanwhile, due to the ecological measures of returning farmland to forests, the forest cover in the region has also increased and the number of elephants has risen, which means that elephants need to explore more living space, which indirectly increases the conflict between elephants and humans [19]. In addition, with the increase in precipitation and temperature, it also provides ample water and more vigorous vegetation for elephants. Forest fragmentation leads to habitat fragmentation, which limits the space available to elephants and increases their interactions and conflicts with human communities. When elephants attempt to traverse these fragmented habitats, they may face increased risks such as collisions with motorized vehicles, illegal hunting, or conflicts with farmers. Forest fragmentation may also affect elephant migration patterns. Migration is not only a way for elephants to find food and water, but it is also an important part of their socialization and reproduction. Loss of traditional migration paths may lead to population segregation, reduced gene flow and declining population health [18].

The problem of elephant-human conflict in Yunnan has become an important issue for ecological conservation and social development in the region. In the face of this problem, it is first necessary to restore and protect elephant habitats, such as increasing forest vegetation to provide more natural food sources for elephants. In addition, strengthening the education and training of local villagers is key. They need to understand the ecological value of elephants and learn ways to coexist peacefully with them, such as setting up fences and using non-lethal lethal-repellent tools. Meanwhile, the Yunnan provincial government could consider providing compensation to farmers affected by the conflict to mitigate their economic losses. In terms of long-term strategies, land planning should be

promoted to set up certain buffer zones for elephant migration and activities to reduce the possibility of conflict with human settlements.

## 5. Conclusion

The effects of climate change on global ecosystems and biodiversity are becoming more and more pronounced. Yunnan, a treasure trove of biodiversity, has not been spared. In recent years, due to the global greenhouse effect and anthropogenic factors, Yunnan's climate has shown a clear trend of warming and drying. This climate change has triggered a series of ecological responses, the most obvious of which is the change in vegetation structure.

Changes in vegetation structure, especially the degradation of forests and grasslands, have directly affected elephant habitats in Yunnan. As vegetation provides food and living space for elephants, this change means that elephants are under pressure from both food shortages and habitat loss. As a result, the migration routes and ranges of elephants have also changed, which not only threatens their survival and reproduction, but also increases their conflicts with local residents. As a matter of fact, human-elephant conflicts in Yunnan have increased significantly in recent years, and many villages and farmlands have been infested by elephants, causing great disturbance to the lives of local residents.

From a more macroscopic perspective, this human-elephant conflict is not isolated, but is a product of the complex relationship between global ecological changes and local socio-economic development. With globalization and economic development, mankind's increasing demand for land and resources has led to massive forest destruction and land conversion. And climate change has further exacerbated this ecological destruction, making the elephant's habitat narrower and narrower. This not only threatens the survival of elephants, but also makes them more prone to conflict with humans. Therefore, the solution to this problem needs to be considered at both the global and local levels, both in terms of strengthening global climate governance to reduce greenhouse gas emissions, and in terms of strengthening local ecological protection and community participation to reduce human-wildlife conflicts.

In addition, scientific research and technological innovation also need to be strengthened in order to effectively respond to such human-elephant conflicts. Through in-depth research on elephant behavior and habitats, it is possible to better understand their habits and needs and provide a scientific basis for conservation and management. At the same time, through technical means, such as drones, infrared cameras and GPS tracking, elephant activities can be monitored in real real-time for timely warning and intervention to reduce conflicts. In addition, ecological corridors, artificial breeding and population management can be used to provide better living environments for elephants so that they can coexist harmoniously with humans.

Overall, changes in vegetation structure caused by climate change pose a serious threat to the habitat of Yunnan's elephants and exacerbate their conflicts with humans. An effective response to this challenge requires global and local efforts to strengthen scientific research and technological innovations to achieve harmonious coexistence between humans and elephants. At the same time, it is also a warning of the global ecological crisis, reminding us that we need to cherish and protect this fragile home of the earth even more and create a sustainable living environment for all creatures.

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