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Fragile Balance: Interplay of Deforestation and Climate Change on Honeybee Population in Khyber Pakhtunkhwa, Pakistan

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Abstract: *The study investigates the connection between climate change, deforestation, and diminishing honeybee populations in Pakistan's Khyber Pakhtunkhwa province. The study emphasizes how deforestation contributes to climate change by releasing carbon dioxide into the atmosphere, causing global warming. This affects honeybees and their capacity to pollinate crops by disrupting weather patterns and habitats. The study focuses on the socio-economic impact on communities that rely on honey production and agricultural pollination. To solve these issues, the article suggests sustainable forest management, afforestation, and advanced beekeeping practices. It also emphasizes the significance of creating knowledge about the function of honeybees and maintaining forests for Biodiversity and sustainable lifestyles.*

Key Words: Climate Change, Deforestation, Honeybee Population, Social Impact

Introduction

The term "climate" refers to a state of the environment on the entire planet that can be defined as variations in temperature, precipitation, pressure, and atmospheric humidity. Moreover, it is the mean and variability of metrological variables over a time span. The Earth's climate has undergone natural variations throughout its history, but in recent years, it has become more concerning because of human activities and other anthropogenic reasons. Therefore, "climate change" refers to a shift in this environmental situation brought on by either natural occurrences or human activities. Climate change is a global phenomenon that contributes to global warming, unpredictable weather, melting of ice glaciers, rising sea levels, and a variety of other climatic occurrences (Lipczynska-Kochany 2018; NASA 2018). This adds an enormous amount of greenhouse changes to those naturally occurring in the atmosphere, increasing the greenhouse effect and global warming. It is essentially caused by human activities. The variety of animals, plants, fungi, and even microorganisms like bacteria that make up our natural environment are all included in what is known as Biodiversity (Hussain, 2019).

Deforestation is the deliberate destruction or thinning of trees and forests. When forests are cut down, much of the carbon contained in them is released back into the atmosphere as carbon dioxide, contributing to climate change (Charles Palmer, 2023). A reason for the clearance of forests is the expansion of industrialization and residential areas. Forest depletion leads to numerous adverse consequences. One significant loss is the elimination of carbon sinks. Trees use carbon gases to produce oxygen for humans. When this process is disrupted, the amount of carbon dioxide in the atmosphere increases, leading to the greenhouse effect. Consequently, global temperatures rise, which is happening now. Another negative impact is the disruption of the water cycle, which affects rainfall patterns. Sometimes, there are severe droughts and sometimes excessive floods due to this disturbance. Clearing forests for agricultural purposes also contributes to the emission of greenhouse gases (Leonel J.R. Nunes, 2020). As Pakistan's population increases and concomitant urbanization increases, the impact of climate change will be devastating. Moreover, Pakistan is the 6th most populated country in the world, with an annual population increase of

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approximately 2 percent. Climate change is expected to have significant impacts on Biodiversity in Pakistan, leading to changes in species distribution, altered ecosystems, and increased vulnerability of certain species (Areeja Syed, 2022).

The function of deforestation leads to its impact on climate change and has implications for the natural reproduction of honeybees in Pakistan. In Pakistan, beekeeping is primarily concentrated in the Khyber Pakhtunkhwa, central, and northern regions, but it is currently spreading quickly throughout the entire nation. Afforestation is required to mitigate climate change by sequestering carbon, conserving Biodiversity, and reducing soil erosion and water runoff. Sustainable Forest management protects forests while also providing immediate benefits to people and the environment. It supports local livelihoods while also providing environmental benefits like carbon sequestration and the conservation of water, soil, and Biodiversity (Mudassar Hussain, 2020).

In Khyber Pakhtunkhwa (KPK), climate change is closely tied to biodiversity loss, resulting in significant consequences for the environment, wildlife, and local communities. Human activities drive climate change, leading to rising temperatures and disrupting ecosystems. Biodiversity loss affects ecosystem functions and services, contributing to increased flooding, landslides, and altered climate patterns. The decline of certain species impacts ecological interactions and the well-being of local communities. Honeybees, crucial for pollination and honey production, are also affected.

This research aims to explore the consequences of the impact of climate change on the decline of the honey bee population, causing Biodiversity Loss. Also, recommendations and measures to take precautions to overcome the disastrous situation have been suggested. The SDGS and Aichi biodiversity targets have been linked in this research to consider the targets. So, the work is in progress to take the initiative for betterment. Tending to these elements will require a diverse approach that includes knowledge, policy changes, and support programs. This research will explore the impacts of deforestation that contribute to leading towards climate change and affect Biodiversity. The factors include urbanization, road building, infrastructure, wood extraction, and agriculture expansion. By inspecting these elements, the situation can give a better understanding of the interplay complexity between individual behavior and other influences. And develop targeted interventions that can assist with decreasing deforestation to make it less effective on climate change and Biodiversity.

Significance of Study

The significance of this research is that it helps us recognize how deforestation affects climate and wildlife interactions along with the guides' efforts to protect the environment by informing effective conservation strategies. Also, it raises awareness about the importance of preserving forests and Biodiversity for a sustainable future.

Research Objectives

The objectives of this research are as follows:

- To understand the impact of deforestation on Climate change in Khyber Pakhtunkhwa Pakistan.
- To witness how Biodiversity is being affected by Climate change.
- To observe the impact of Climate change on Honeybee reproduction.

Research Questions

- What are the effects of deforestation on climate change?
- How does climate change impact honeybee habitat and their reproduction?
- What are the social effects of loss of Biodiversity?

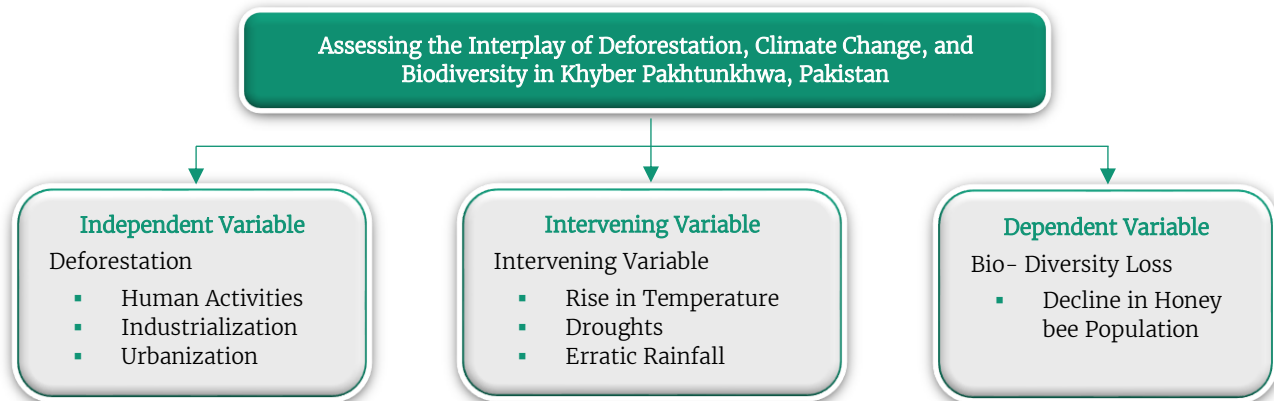
Research hypothesis

Alternative hypothesis: Climate change due to deforestation causes a decline in the honeybee population.

Null hypothesis

Climate change due to deforestation does not cause a decline in the honeybee population.

Conceptual Framework



Literature Review

A forest is a region of the Earth with a lot of trees. Forests are valued because of their relevance to both the economy and the environment. Forests are currently crucial for both human and animal life, but despite this, deforestation persists mindlessly, endangering the environment. Forests store large amounts of carbon. Trees and other plants absorb carbon dioxide from the atmosphere as they grow. This is converted into carbon and stored in the plant's branches, leaves, trunks, roots, and soil. More carbon dioxide is now accumulating in the atmosphere because of burning fossil fuels than can be absorbed by current carbon sinks such as forests, along with a decline of carbon sinks from deforestation and other activities. As more carbon dioxide gathers in the atmosphere, heat is trapped in the lower atmosphere, thereby causing global warming. The current level of carbon dioxide is the greatest in recorded human history. Storing carbon in forests does not effectively "offset" the greenhouse gas emissions caused by the burning of fossil fuels. This is because current trees are unable to absorb the amount of carbon dioxide that fossil fuels release into the sky. Deforestation significantly increases CO₂ emissions as forests naturally absorb carbon dioxide. Urbanization and agriculture disrupt this process, contributing to climate change. In Pakistan, urbanization and industrialization are major factors driving carbon emissions and climate change (Dean, 2019).

At the same time, as climate change grows more intense, carbon reserves in forests and other natural carbon sinks will become more unstable. Due to climate change, droughts, tropical storms, heat waves, and fire conditions are becoming more severe and frequent. As a result, forest losses and temperature will keep rising, increasing the amount of carbon dioxide released into the sky. By keeping the increase in global temperature well below two °C, risks are greatly diminished but not eliminated. In the period of rapid climate change, deforestation is currently an ongoing phenomenon and a major environmental problem. In addition, a link between agriculture and deforestation, as well as between livestock and climate change, was established (Dean, 2019). Significant alterations in the ecological system, variations in the weather, and climatic conditions have been brought about by several known reasons. One of the reasons for this is deforestation.

The habitats of native animals, including jackals, monkeys, foxes, ducks, doves, honeybees, and Bengal tigers, were negatively impacted by the rapid expansion in the human population, which was placing tremendous strain on forests and transforming agricultural fields into housing societies. This leads to pollution and a rise in temperature mainly due to Climate change, and the ensuing loss of Biodiversity is threatening the existence of humans. Biodiversity is crucial to ecosystem function and is difficult to restore when lost due to its importance. The protection of native wildlife is significantly impacted ecologically and economically by country-specific vegetal diversity (Warda Minhas, 2023).

Climate change is causing problems for honeybees in Pakistan, especially in the Khyber Pakhtunkhwa province. The rising temperatures and unusual rains are destroying the honey season, which has led to a huge decrease in the number of honeybees. The impact of climate change has been significant, with honeybee production dropping by 35 percent in recent years across the country. This decline is affecting the lives of local communities who depend on beekeeping for their livelihoods. It's important to understand



that honeybees are crucial for pollinating crops and maintaining the balance of ecosystems. To help honeybees and other pollinators, we need to address climate change and promote sustainable land management practices. By doing so, we can create a better environment for these essential insects and support the communities that rely on them (Khan M. Z., [2015](#)).

Beekeeping is critical for food security, poverty alleviation, health, environmental protection, and plant pollination. In recent years, several biotic and abiotic variables have posed a threat to these critical practices. These factors have an impact on honeybees and their important products, either together or separately. Climate change, relative humidity, water scarcity, deforestation of floral plants, and human causes such as inadequate apicultural practices, synthetic pesticides, illnesses, and arthropod pests all contributed to the reduction of honeybee colonies and their products (Yigezu, [2021](#)). The global honeybee population has been declining at an alarming rate. According to the Food and Agriculture Organization (FAO), the Honeybee population has decreased by

approximately 16–30% annually in recent years. Honeybees play a role in pollinating a wide variety of crops, which are essential for food production and Biodiversity. It is estimated that they contribute to the pollination of about 75% of the world's food crops. The decline in the honeybee population has significant economic implications for agriculture. Reducing pollination services can lead to lower crop yield and increased production costs for farmers (Food and Agriculture Organization, 2019). In Pakistan, 61 major crops that are dependent on honeybee pollination have an output worth 1590 million US dollars. Honeybees play a role in pollinating a wide variety of crops, which are essential for food production and Biodiversity. Honeybees require specific temperature conditions for reproduction, with an optimum temperature range of 30–35°C (Huiyue Zhao, [2021](#)). The most active honey-producing months are usually June, July, and August, but this may vary depending on location and climate. In a tropical climate, bees will work year-round, although their honey output will be affected by seasonal changes in the plants that are available to them. Honeybees are active throughout the year, including the winter season. During the winter, honeybees maintain their hive temperature between 24 and 34 °C (75–93 °F) by forming a thermo-regulating cluster. In the fall, honeybees prepare for winter by storing honey and pollen for the winter season. It is a good idea to harvest honey at the end of summer, sometime before September, to ensure that the honey is not too cold and thick to extract (Nickson, [2023](#)). This enables them to survive long periods of cold temperatures. It is estimated that they contribute to the pollination of about 75% of the world's food crops. Starvation may result if honeybee populations drop below a particular point. In a developing nation like Pakistan, food security is a problem. Khyber Pakhtunkhwa and the center and northern regions of the Punjab provinces of Pakistan are where beekeeping is most common (M Usman, [2022](#)).

Climate change is leading to habitat loss for bees as they struggle to move to cooler areas and create new hives. Rising monthly temperatures are causing flowers to bloom earlier in the spring. This can create a problem because the timing between when flowers produce pollen and when bees need to collect it might not contrast. Even a small difference of three to six days could harm bees' health, reducing their ability to reproduce and making them more vulnerable to predators and parasites. Additionally, certain types of bees, like bumblebees, are particularly sensitive to temperature due to their large, furry bodies. (Duran, [2017](#)).

This study delves into the effects of climate change on honey production in Pakistan, particularly focusing on how extreme weather events are making the country vulnerable and causing a decline in honeybee populations. The agricultural-based economy of Pakistan is particularly sensitive to these changes, underlining the need to grasp the broader impacts on both the industry and local livelihoods. Shamim-ul-Sibtain Shah, the Director General of the National Agriculture Research Center (NARC), highlights how climate change disrupts honeybee habitats, leading to negative effects on honey production. As bee colonies decrease due to unpredictable weather patterns, the honey-making process is interrupted, leading to a gradual reduction in honey production capacity. Sheikh Gul Badshah from the Pakistan Honeybee Keepers Association notes an estimated 40 percent decrease in honey production this year. Flash floods caused by unexpected rains have destroyed many honeybee boxes, exacerbating challenges for beekeepers. The dwindling numbers are compounded by insufficient government support and limited advancements in beekeeping methods. Dr. Muhammad Nafees, a professor of environmental sciences, further breaks down the reasons for declining honey production. He identifies various factors, including unpredictable weather shifts, flash floods, extended droughts, pesticide usage, and

deforestation, all contributing to the degradation of honeybee habitats and subsequently affecting honey production. Saba Rani, a honey trader, illustrates the economic consequences of reduced honey production by highlighting significant increases in honey prices. Shamim-ul-Sibtain Shah emphasizes the need to preserve bee flora by imposing a ban on tree cutting. He also stresses the importance of modern beekeeping equipment to enable beekeepers to adapt to changing climate challenges. (Mehusd, [2021](#))

The decrease in honey production in Khyber Pakhtunkhwa (KP), Pakistan, is largely driven by the impacts of climate change. Bees, essential for pollination, are encountering multiple challenges due to various factors. For instance, Gulab Shah, a beekeeper from the Nowshera district, faced substantial losses when heavy rains and flooding swept away his beehives and his hopes for a fruitful honey harvest. Experts suggest that honey production in Pakistan, especially in KP, has dipped by approximately 35% in recent times. Climate change is a major factor affecting honeybee populations and their well-being. Extreme weather disrupts the bees' ability to control their hive temperature, affecting their health and honey production. These weather shifts also disrupt suitable habitats and pollen sources, reducing bee diversity and overall honey production. The decline in native bee numbers and the loss of trees like Beri and palosa due to both human activity and extreme weather further contribute to the decline in honey output. Changing flowering schedules and limited food availability hamper bees' nectar and pollen collection for honey production. The effects of climate change are exacerbated by increased pesticide use and human expansion into areas where wild bee colonies thrive. Additionally, outdated beekeeping methods hinder the potential for higher honey yields (Khan I., [2021](#)).

The honey industry, which prospered in KP with UNHCR's help in the 1980s, faces challenges in sustaining honey exports due to falling production and quality standards. Although Pakistan's honey exports peaked at around 26,000 metric tons in 2011, recent restrictions and climate-related issues have impacted export possibilities. The decrease in honey production due to climate change raises concerns about the industry's future. This emphasizes the need for innovative techniques and sustainable practices to rejuvenate bee populations, ensuring the well-being of ecosystems and crops that rely on pollination (Khan I., [2021](#)).

Pollinator variety is declining because of climate change and honeybee loss, which disturbs ecosystems and might have a domino impact on other species (Sandra Díaz (Co-Chair, [2019](#))). To preserve food production and protect pollinator populations, farmers, beekeepers, and policymakers must take adaptive measures in response to climate change and honeybee loss (Heinrichs, [2018](#)). The decrease in honeybee numbers has important effects on society, especially when it comes to having enough food and a stable economy. Honeybees are important for helping lots of the foods we eat, like fruits, vegetables, and nuts, to grow well. This study shows how crucial honeybees are for making crops healthy. Insufficient bee populations could precipitate a decline in the yield of crops reliant on pollination, potentially leading to an increase in the cost of such foods. This escalation in cost has the potential to create obstacles in accessing nutritious dietary options for a considerable portion of the population. Furthermore, agrarian communities dependent on the cultivation of these crops may encounter heightened financial challenges, thereby engendering socio-economic complications in regions where agriculture constitutes a pivotal component of livelihood (Klatt, [2020](#)).

Research Approach

The study will employ a mixed-method approach in which qualitative and quantitative data will be collected and analyzed concurrently, providing a more comprehensive picture of the phenomenon.

Data Collection Methods

Secondary data will be gathered from a variety of sources, including academic publications published on the same issue and coastal vulnerability reports from relevant government organizations.

Ethical Consideration

Ethical considerations were maintained during this research by acknowledging and appropriately attributing all sources used. The values of transparency, prohibition of plagiarism, and admission of

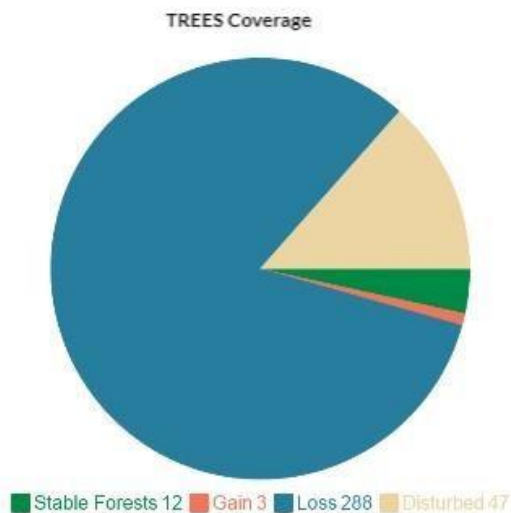


boundaries dictated the ethical framework of this research, resulting in responsible and trustworthy research outputs.

Discussion

The province's growing population drives demand for housing, infrastructure, and agriculture. For these goals, forests are removed, resulting in deforestation. Deforestation occurs when forests are converted into agricultural land to accommodate population-driven food demands.

From 2001 to 2022, Peshawar lost 2ha of tree cover, equivalent to a 0.15% decrease in tree cover since 2000, and 370t of CO₂ emissions. From 2000 to 2020, Peshawar experienced a net change of 2.90kha (24%) in tree cover. (Watch, [2015](#)).



Stable forest: 12.0kha

Gain: 3.19kha

Loss: 288ha

Disturbed: 47ha

Trees help to manage water cycles by transpiring water, which aids in cloud formation and precipitation. Deforestation affects transpiration, which disrupts local rainfall and may result in droughts or excessive runoff. Deforestation in KPK reduces water supply, changes weather patterns, and increases vulnerability to floods and landslides. Whereas carbon emissions from KP's deforestation contribute to global greenhouse gas levels, affecting the global climate. The worldwide impact of deforestation includes biodiversity loss, which reduces ecosystem resilience to climate change. Deforestation releases stored carbon as CO₂, increasing the greenhouse effect and contributing to global warming. Soil disturbance accelerates the breakdown of organic materials, resulting in increased CO₂ emissions. Deforestation increases the frequency of wildfires, releasing considerable carbon and leading to atmospheric CO₂. As temperatures rise owing to climate change, deforestation releases carbon, magnifying the greenhouse impact and potentially prompting additional carbon-releasing wildfires. Tree loss devastates habitats and Biodiversity, with ecosystem health influencing climate consequences and vice versa (Xianyao Chen, [2017](#)).

Deforestation is a major problem in Pakistan's Khyber Pakhtunkhwa (KPK) province, which is the worst affected in the country. Due to persistent deforestation, the woods in KPK have lost around 74% of their strength over the years. Between 1990 and 2010, Pakistan had rapid deforestation in 170,684 ha of forest area, with KPK suffering the most (40%) and Gilgit-Baltistan suffering the least (15.8%). Recent global warming is a direct cause of deforestation and forest degradation in northern Pakistan, as it increases the frequency of intense drought events, which promote deforestation and degradation. By releasing carbon dioxide into the atmosphere, deforestation has the potential to contribute to local and global climate change. Deforestation and degradation are the primary causes of significant carbon emissions in tropical

forests, which have worldwide implications for the Earth's climate system's balance and sustainability. The loss of forest cover in the area might result in teleconnections, which include deforestation-related consequences or secondary effects of deforestation. Deforestation, climate change, and local ecosystems all have feedback loops. Deforestation can cause local ecological changes such as soil erosion, desertification, and land degradation, which can worsen climate change. Climate change can also cause changes in local ecosystems, such as changes in precipitation patterns and an increase in the frequency of extreme weather events (Safi Ullah, [2022](#)).

Shifts in Biodiversity

Biodiversity in Khyber Pakhtunkhwa has most likely shifted because of numerous factors, such as natural habitats being degraded because of urbanization, agricultural development, and deforestation. Changing temperature and precipitation patterns may alter the suitability of habitats for various species, producing shifts in their distribution. Non-native species can destabilize ecosystems by outcompeting native species, resulting in shifts in species composition. Pollution from many sources can disrupt aquatic and terrestrial ecosystems, hurting the animals that rely on them. Unsustainable hunting, fishing, and resource extraction can lead to the extinction of species and shifts in their functions within ecosystems. A major part of ecological studies is the relationship between changing climate and alterations in species distribution and abundance. As climate patterns vary because of global warming, many species are modifying their ranges and population levels. This relationship has far-reaching consequences for ecosystems and Biodiversity. The well-being of honeybees is intimately connected with the presence of trees within their habitat. Unfortunately, the widespread practice of deforestation has emerged as a significant threat, exerting detrimental consequences on honeybee populations and their ecosystem. Species are migrating to new geographic locations as their original habitats become unsuitable due to climate change. This can result in some areas expanding and others contracting. As temperatures rise, certain species' ranges shift to the poles, affecting both terrestrial and aquatic environments. At the same time, Warmer temperatures and longer growing seasons may boost reproductive success and survival rates in some species. Extreme weather events, reduced food availability, and disturbed breeding seasons, on the other hand, can cause population decreases in some species. Climate change has altered temperature and precipitation patterns in Khyber Pakhtunkhwa (KP), Pakistan, with serious consequences for the region's unique habitats and ecosystems. These alterations can have a profound impact on the structure, composition, and operation of local habitats. Climate change can cause more frequent droughts or intense rainfall events, affecting ecosystem stability and species viability. Changes in precipitation can affect plant development, affecting food sources for numerous animals. Changes in environmental circumstances in Khyber Pakhtunkhwa (KPK), Pakistan, caused by climate change and habitat disruption, can allow invasive species to thrive and propagate. These conditions can favor invading species over native species, causing ecological disruptions. Changing temperature and precipitation patterns can make conditions more suitable for certain invasive species, allowing them to spread their ranges. Invasive species can outcompete native species, resulting in decreased Biodiversity and, in extreme cases, extinction. Invasive species can disrupt established food webs and disturb ecosystem processes, compromising overall ecosystem functioning (M.Suleman Bacha, [2021](#)).

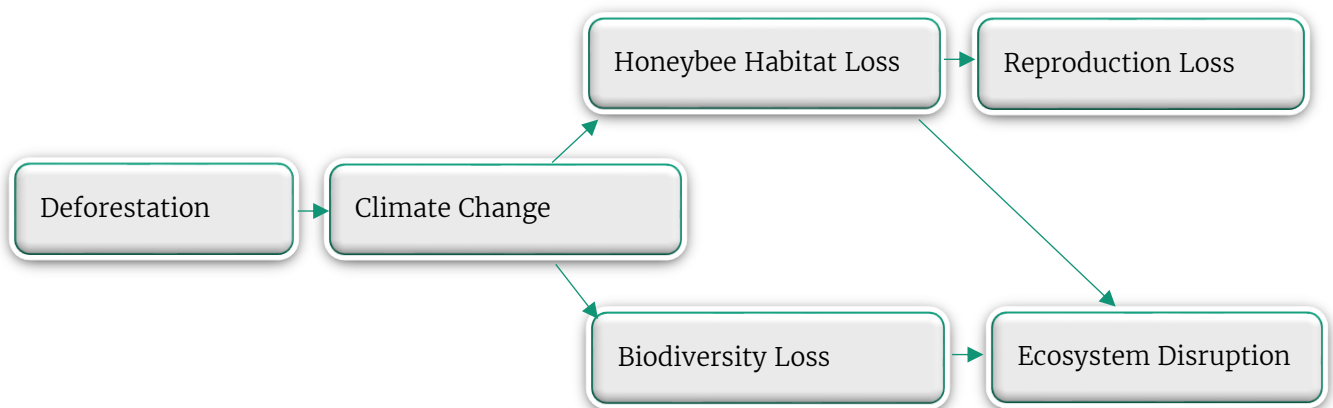
Honeybees can be found in several areas of Khyber Pakhtunkhwa (KPK), including Swat Valley,

Peshawar, the Hazara Division (including Abbottabad and Mansehra), the Malakand Division, Chitral, and Dir. These areas have various landscapes that are ideal for honeybee populations to thrive. Climate change has a substantial impact on honeybee behavior and reproduction. Temperature changes and changed blooming patterns have an impact on honeybee foraging and pollination. Climate change's impact on honeybee populations has implications for local agriculture and ecosystems. Honeybees are important pollinators for many crops, and their reduction can result in lower agricultural output and quality. According to research, climate change has a deleterious influence on bees and the flowers they pollinate. The misalignment of the flowering period and bee visitation results in less pollination and starved bees. Changed temperature regimes have an impact on crucial feeding sites and may lead to the extinction of specific plant species critical to honeybee survival. Stress caused by climate change can diminish the quantity and content of nectar and pollen from bee-pollinated species. The decrease in honeybees has serious implications for food security and Biodiversity. Honeybees pollinate a substantial amount of the



world's food crops, and their reduction can result in decreased agricultural productivity and quality. Because honeybees pollinate wildflowers and other plants, a reduction in honeybee populations can lead to a decline in Biodiversity (Charlotte Descamps, 2021).

Biodiversity loss has far-reaching societal consequences, affecting nutrition, livelihoods, cultural decay, and inequality. These impacts are especially significant in the context of Pakistan and the province of Khyber Pakhtunkhwa (KPK). Biodiversity loss can have a direct influence on food production and availability in Pakistan, where agriculture is an important sector. Reduced Biodiversity makes agricultural systems more susceptible to pests, illnesses, and the effects of climate change. This vulnerability can lead to decreased agricultural yields, decreased food diversity, and increased food insecurity, affecting residents' nutrition and livelihoods. Reduced Biodiversity undermines social links to nature and deepens social gaps, thereby affecting the quality of life and well-being (Roland Ebel, 2021). Biodiversity loss in KPK, Pakistan, can contribute to the degradation of traditional knowledge, customs, and cultural values related to nature and Biodiversity. Indigenous communities and underprivileged groups that rely on Biodiversity for their livelihoods and cultural traditions are especially vulnerable to biodiversity loss, which exacerbates social inequities (Food and Agriculture Organization, 2019).



Key Findings

The research supports the alternative hypothesis that climate change resulting from deforestation contributes to a decline in the honeybee population. The loss of Biodiversity can result in fewer ecological services, affecting human well-being, livelihoods, and socio-economic stability. The objective of this research has implications for the overall ecosystem. Deforestation can contribute to climate change and biodiversity loss, affecting honeybee reproduction. Honeybees perform an important role in pollination, which is necessary for healthy ecosystems and food security. Honeybee extinction can have a domino effect on the ecology, reducing plant reproduction and food production. Deforestation, biodiversity loss, and honeybee decrease all have mutually reinforcing effects. Deforestation can result in the loss of habitat for numerous species, resulting in a fall in Biodiversity. This loss of Biodiversity can subsequently lead to a drop in pollinators, such as honeybees, affecting the environment further. Honeybee extinction can also contribute to a decrease in plant reproduction, exacerbating the loss of Biodiversity. Because these objectives are interrelated, there is the possibility of cascade consequences on the ecosystem. For example, the extinction of honeybees might result in a decrease in plant reproduction, exacerbating the loss of Biodiversity. This loss of Biodiversity can subsequently lead to a drop in pollinators, such as honeybees, affecting the environment further.

Key Recommendations

Policy actions can be critical in resolving these interconnected concerns. More and more countries are adopting national targets for accounting and reporting on ecosystem and biodiversity values. The United Nations has declared a Decade of Ecological Restoration (2021–2030) to prevent, halt, and reverse global ecological degradation. In the aftermath of the COVID-19 pandemic, envisioning a resilient future for biodiversity conservation can also assist in addressing these issues. We can work toward a more sustainable future by incorporating ecosystem and biodiversity values into national and local planning, development

processes, poverty reduction strategies, and accounts, as well as mobilizing and significantly increasing financial resources from all sources to conserve and sustainably use Biodiversity and ecosystems.

Incorporating the SDGs and Aichi Biodiversity Targets into these ideas can help to improve conservation efforts even more. Among the related SDGs and Aichi Biodiversity Targets are:

Aichi Biodiversity Target 1: By 2020, people should understand the importance of Biodiversity and the activities they can take to protect and use it sustainably.

Aichi Biodiversity Target 7: By 2020, agricultural, aquaculture, and forestry lands will be managed sustainably, ensuring biodiversity conservation.

These targets have been focused on working for a sustainable environment to prevent biodiversity loss. And so, these targets are still in progress.

SDG 15: Life on Land – Protect, restore, and promote sustainable use of terrestrial ecosystems; manage forests sustainably; combat desertification; halt and reverse land degradation; and stop biodiversity loss.

SDG 12: Responsible Consumption and Production – Ensure sustainable patterns of consumption and production.

SDG 13: Climate Action – Take immediate action to combat climate change and its consequences.

These are a few suggestions to achieve these targets and prevent biodiversity loss and Climate Change.

Promote Afforestation

Raise awareness about the importance of afforestation and its role in climate change mitigation. Educate the public and policymakers about the benefits of tree planting and forest restoration. Create and put in place strong forest policies that promote afforestation and forest conservation. Measures to maintain and restore existing forests, as well as incentives for individuals and communities to participate in afforestation activities, should be included in these policies. Seek partnerships with international institutions like the Asian Development Bank and the United Nations Framework Convention on Climate Change to obtain funds and technical assistance for afforestation initiatives. Encourage local communities to take an active role in afforestation efforts. This can be accomplished through community-based tree planting projects, providing communities with training and resources, and including them in decision-making processes. Invest in research and development of sustainable environmental practices, as well as the identification of tree species that are well-suited to the local climate and soil conditions. This will contribute to increasing the success and effectiveness of afforestation efforts.

Biodiversity Conservation

Creating and sustaining bee habitats is critical for their survival and the conservation of Biodiversity. Each hive should have two hectares (five acres) of habitat, according to the conservation organization Bug Life. This can be accomplished through projects such as rewilding, native wildflower planting, and the preservation of natural landscapes. While attempts to rescue honeybees are critical, it is also critical to prioritize the conservation of native bee species. Most wild bee species are becoming more sensitive to environmental hazards. Formal safeguards for native bees, such as classifying them as endangered species under the Endangered Species Act, can provide critical tools for their recovery. Bee populations and Biodiversity are under threat from habitat loss and excessive use of agrochemicals such as insecticides. Pollinators and their habitats can be protected by implementing efforts to prevent deforestation, promote sustainable land use practices, and reduce pesticide use. Creating public-private collaborations can help to boost honeybee and other pollinator conservation initiatives. These collaborations can inspire government agencies, conservation organizations, farmers, and other stakeholders to work together to execute effective conservation initiatives. It is critical to engage local communities and raise awareness about the value of Biodiversity and pollinators. Community-led projects, educational programs, and workshops, governments, and non-governmental organizations (NGOs) can serve to instill a sense of responsibility in people and motivate them to take action to safeguard bees and their habitats. It is critical to raise awareness about the importance of pollinators, the risks they face, and their contribution to sustainable development. On May 20th, World Bee Day is observed to promote awareness about the importance of bees and other pollinators. While attempts to rescue honeybees are critical, it is also critical to prioritize the conservation



of native bee species. Efforts to combat biodiversity loss and its social consequences in Pakistan and KPK should prioritize developing sustainable farming methods, conserving natural habitats, and bolstering the resilience and livelihoods of local communities. This can be accomplished by implementing biodiversity-friendly farming techniques, managing protected areas, and recognizing and incorporating indigenous knowledge and practices into biodiversity conservation programs.

By implementing these recommendations, Pakistan can make substantial progress in increasing afforestation, combatting climate change, and preventing biodiversity loss. These initiatives will not only contribute to carbon sequestration and climate mitigation but will also generate multiple co-benefits such as enhanced air and water quality, biodiversity conservation, and sustainable livelihoods for local populations.

Research Limitations

The study encounters several limitations that deserve acknowledgment. First and foremost, a noteworthy constraint is the lack of availability of comprehensive data. This scarcity weighs down the depth of analysis and might lead to gaps in understanding.

The crucial aspect relates to the potential absence of certain influential factors. The study's scope might involuntarily exclude significant variables that could contribute to a more nuanced interpretation of the subject matter.

The reliance on secondary research sources introduces an additional layer of limitation. The study's reliance on previously published materials, while convenient, could potentially compromise the reliability and validity of the data collection process. The absence of direct data collection might undermine the accuracy and authenticity of the findings, potentially introducing biases or inaccuracies.

Considering these limitations, it becomes imperative to interpret the study's results with caution and to acknowledge the inherent constraints that might impact the overall robustness and comprehensiveness of the research outcomes.

Conclusion

The discussion underscores the complex interplay between deforestation, climate change, and biodiversity loss in Khyber Pakhtunkhwa (KPK). As the population expands, deforestation for various purposes worsens climate change effects and disrupts ecosystems, with global implications. This degradation of Biodiversity deepens social inequalities. The decline of honeybees due to changing climates exemplifies the link between climate change, biodiversity loss, and societal well-being. Climate change influences honeybee behavior, intensifying food security concerns and threatening livelihoods. A comprehensive plan integrating sustainable land management, reforestation, climate adaptation, and community involvement is required to overcome these multidimensional concerns. Recognizing the link between environmental deterioration and social vulnerability necessitates actions to promote awareness, support local projects, and enact equitable regulations. The effects of deforestation, climate change, biodiversity loss, and social inequality can be alleviated by addressing these challenges holistically, promoting a more resilient and balanced future for KPK and beyond.

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