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Climate Change and Its Impact on Biodiversity of Nepal

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Abstract

Climate change and biodiversity are interdependent on each other. Increased average global temperatures, due to anthropogenic greenhouse gas emissions, along with extreme and unpredictable weather patterns, are key manifestations of climate change, significantly affecting the planet's biodiversity and further threatening the delicate balance of the ecosystem. Biodiversity, the cornerstone of ecosystem stability and resilience, is severely threatened by habitat loss, altered migration patterns, and increased frequency of extreme weather events. Nepal, with its variety of ecosystems, vegetation types, diverse forest cover, and a wide range of plant and animal species, is exceptionally rich in biodiversity; however, it is also not spared. Located in the lap of the Hindu Kush-Himalayan region with a unique topography, Nepal is one of the most susceptible countries to confront the harmful impacts of climate change and requires appropriate urgent proactive actions. This paper examines the multifaceted relationship between climate change and biodiversity in Nepal, highlighting the threats posed by rising temperatures, altered precipitation patterns, and increased frequency of extreme weather events. Through qualitative content analysis of existing literature and empirical data, this study aims to identify effective strategies for mitigating climate change's adverse effects on Nepal's biodiversity. The finding has emphasised the Community Forest program as a 'Go Green Campaign,' increasing the role of local governments and the Nepali Army in nature conservation, stringent law enforcement, funding increase towards climate change, promoting national and international collaboration to enhance the resilience of climate change and biodiversity conservation in Nepal.

Keywords*: Climate change, biodiversity, extinction, greenhouse gases, threat, diversity, habitat*

Introduction

From the very genesis of our Mother Earth to the present, over 4.5 billion years (Dalrymple, 1991), she has undergone gradual, dramatic transformations. Albeit, there had been no such unprecedented pace and scale of these changes in the entire timeline than now, primarily driven

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by the actions of a single species–us, the Homo sapiens. As climate change accelerates, the dynamics of our planet are being altered at an unparalleled rate, which is likely to reshape the 'lives' of the Earth forever. This climate change refers to the long-term alterations in the Earth's climate system, including temperature, precipitation, and atmospheric conditions, primarily driven by human activities such as fossil fuel combustion and deforestation. The Intergovernmental Panel on Climate Change (IPCC) has recognized climate change as a critical threat to global biodiversity, leading to habitat loss, species extinction, and ecosystem degradation (IPCC, 2022). In Nepal, the impacts are particularly severe due to its geographical diversity, which ranges from lowland plains to high Himalayan peaks. Climate change is receiving worldwide attention due to its anticipated impact on the Earth's physical and biological systems. It is not merely an environmental issue but also a threat that goes beyond the national borders. Several global initiatives have been taken by the World Forum for the Sustainable Conservation of Biodiversity like the Convention on Biological Diversity (CBD) which has been in force since 1993; a celebration of International Day for Biological Diversity (IDB) on 22 May of every year since 2000 with different themes; and the Global Biodiversity Framework (GBF) adopted in 2022 (Gotame, 2022). Climate change and its impact on biodiversity constitute a set of complex and serious consequences to be tackled by an individual country like Nepal, as several studies have investigated the detrimental effects of climate change on biological invasions.

Climate change poses a persisting threat with serious consequences for the quality of life, posing significant challenges to individuals, communities, and nations (Scheffran and Battaglini, 2011). Despite being widely discussed as a burning issue in academic discourse with extensive literature on climate change and biodiversity, there are few studies examining the relationship between these two. In this context, Nepal must analyze this issue from an ecological perspective.

Nepal has a great diversity of flora and fauna due to its unique geographical location of deciduous and coniferous forests of subtropical and temperate regions to the subalpine and alpine, pastures, and snowcapped Himalayan peaks with their cold streams, glaciers, and lakes. It consists of more than 5,000 species of flowering plants, 181 species of mammals, 844 species of birds, 185 species of fishes, about 635 species of butterflies, and more than 2,252 moths (Thapa, 2010). The projected rise in temperatures in Nepal is expected to surpass the global average. Between 1900-1917 and 2000-2017, temperature changes in Nepal ranged from 1.0°C to 1.3°C (WBG & ADB, 2021). Specific studies on the Himalayas indicate even higher warming rates, with an average temperature increase of 1.5°C between 1982 and 2006 (WBG & ADB, 2021). Given Nepal's challenging terrain, rising temperatures and adverse weather patterns have intensified disaster frequency. Moreover, it faces challenges such as glacial retreat, shifting monsoon patterns, and extreme weather events like floods and landslides (ICIMOD, 2020), threatening biodiversity, added with reliance on subsistence farming, fragile infrastructure, and socio-economic challenges, along with limited financial and technical capacity, further complicating efforts to develop effective climate change mitigation and adaptation strategies (Shrestha, Mool, & Bajracharya, 2007). Therefore, the Government of Nepal (GoN) must prioritize establishing an effective framework to address future climate

threats to its biodiversity.

This study delves into the potential relationship between climate change and its consequences for biodiversity, with a specific emphasis on Nepal. It examines key environmental trends that jeopardize species and ecosystems and offers a series of recommendations for geographically diverse nations such as Nepal to lessen the adverse effects of climate change.

Research Methodology

This qualitative research utilizes content analysis within an exploratory research design to investigate the present situation of climate change and its effects on biodiversity in Nepal. The study is predominantly based on the secondary source of data. However, few efforts to acquire primary data were made through informal conversations with climate experts, professionals, geographers, nature preservationists, and Ministry of Forests and Environment officials. Literatures were identified for review through a comprehensive search using electronic and non-electronic databases. Related published literature and documents have been searched in a systematic way using a range of keywords relating to climate change and its impacts on biodiversity.

This study explores the linkage between climate change and biodiversity, offering a range of potential mitigation and adaptation measures in addressing the challenges posed by climate change. A review of relevant literature and reference materials was conducted, and full-text studies were gathered. A pragmatic epistemological approach was adopted to interpret the available data. To establish a relationship between climate change and its anticipated impact on biodiversity, a six-step thematic content analysis method was used. Throughout the thematic analysis, triangulation was applied to validate findings by comparing multiple data sources. This involved a rigorous examination of scientific and empirical data from both primary and secondary sources. Findings were validated by examining the evidence and conversing with different sources of data. Additionally, key findings were verbally shared with subject-matter experts for further authentication.

Conceptual Framework

In recent years, climate change has become a buzzword in the field of academic discourse. The temperature rise, changing patterns of rainfall, a high volume of CO2 concentration in the atmosphere, and extreme events are the major climate change components. The most important pieces of evidence of climate change are the long-term data available on CO2 levels, global temperature, and weather patterns (Shivanna, 2022). Climate change is a fact that has wide-ranging impacts in many areas, including biodiversity. The snow-capped mountains of Nepal are slowly but gradually losing their cover. Temperature increases, irregular patterns of precipitation, and adverse weather events are altering the country's fragile ecosystems and threatening biodiversity. This research is grounded in a conceptual framework that explores the contemporary effects of climate change on Nepal's biodiversity. It examines the current state of climate change and its impact on various species and ecosystems within Nepal, as shown in the schematic diagram below.

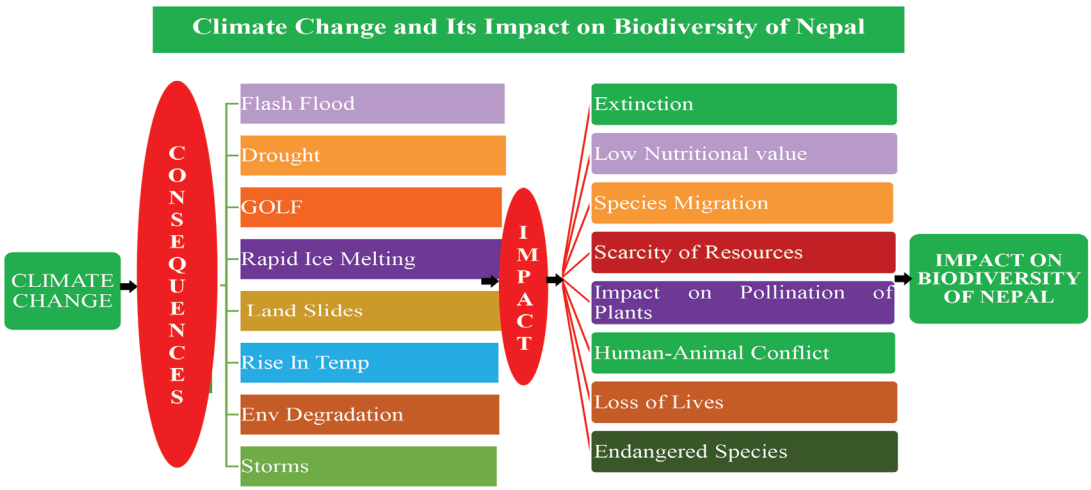

Figure 1. Conceptual Framework of the Research

Nepal's Vulnerability to Climate Change

An increased number of disastrous events with higher intensity and frequency, adverse weather patterns, and rapid temperature change have shown that Nepal is one of the most susceptible countries to climate change. Its distinctive geographic features play a significant role in it. The country encompasses a wide range of altitudes, from the low-lying Terai plains at around 60 meters above sea level to the towering peaks of Mount Everest at 8,848.86 meters. This variation creates diverse climatic zones that support a rich array of flora and fauna (MoFE, 2021). However, this diversity also complicates the impacts of climate change, as ecosystems at different elevations are affected differently by changing climatic conditions. This diverse topography, while fostering rich biodiversity, also magnifies Nepal's vulnerability to climate change due to the varying and unpredictable impacts across various communities.

Socioeconomic conditions further amplify Nepal's exposure to climate change. A significant portion of the population, approximately 66%, depends on farming as their main source of income (NPC, 2022). Given that agriculture is highly sensitive to climatic fluctuations, such as shifts in rainfall patterns or extreme temperature changes, food security becomes a critical issue as climate change progresses. Moreover, rural communities often lack the necessary resources to adapt their farming practices or recover from climatic shocks, making them particularly vulnerable. Nepal's susceptibility to climate change is also evident through its history of environmental problems. The devastating earthquake in April 2015 underscored the country's exposure to natural disasters, revealing not only geological vulnerabilities but also weaknesses in infrastructure resilience. Climate change is exacerbating these vulnerabilities, leading to an increased frequency and intensity of such disasters (Subedi, 2022).

During the High-Level Meeting of the 29th Conference of the Parties (COP-29) to the United Nations Framework Convention on Climate Change, held in Baku, Azerbaijan, dialogues were conducted regarding the effect of climate change in the Himalayas. President of Nepal Ramchandra Paudel addressed the world summit, highlighting several extreme weather events that the country has suffered recently, including the glacial lake outburst in Thame village of Solukhumbu district, monsoon-triggered floods, landslides, and inundation (The Kathmandu

Post, 2024). Numerous studies have documented the adverse effects of climate change on ecosystems globally. In Nepal, the interplay between climate change and biodiversity loss is pronounced due to factors such as glacier retreat, habitat destruction, and increased frequency of natural disasters (Bhargava, 2023). The World Bank Group (WBG) and Asian Development Bank (ADB) report that the average temperature in Nepal has risen significantly over the past century, with projections indicating further increases in the coming decades (WBG & ADB, 2021).

Significance of Biodiversity Protection to Nepal

Protection of biodiversity is extremely significant to Nepal due to its rich natural resources, unique ecosystems, and the critical role it plays in supporting the country's economy, culture, and climate resilience. Here are some key reasons why biodiversity protection is vital for Nepal.

Ecological Balance and Ecosystem Services

Nepal is home to a wide variety of ecosystems, from the lowland Terai plains to the towering Himalayas. These ecosystems provide essential services, which are outlined below.

(a) ***Water Regulation***: Forests and wetlands help regulate water flow, preventing floods and soil erosion, especially in the mountainous regions.

(b) ***Soil Fertility***: The diversity of plant and animal species contributes to soil health and fertility, supporting agriculture.

(c) ***Pollination****:* Biodiversity supports pollinators (such as bees and butterflies), which are crucial for crop production. The migration of pollinators due to unpleasant weather and unfavourable temperatures adversely impacts the pollination process. According to the UN Food and Agriculture Organization, three-quarters of all crops around the world depend on pollinating insects and other animals (Cheng, 2024).

Economic Importance

Nepal's economy is closely tied to natural resources. Agriculture, forestry, and tourism are key sectors that depend on biodiversity.

(a) ***Tourism***: Tourism is a vital component of Nepal's economy, contributing significantly to national income and employment. The country's diverse ecosystems, including national parks, wildlife, and trekking routes in the Himalayas, and its rich cultural heritage make it a world-famous tourist destination. Biodiversity plays a pivotal role in attracting tourists; unique species such as the Bengal Tiger and the one-horned Rhinoceros (Rhinoceros unicornis) are major attractions in Chitwan National Park. The protection of threatened species like the Bengal Tiger, one-horned Rhinoceros, and Snow Leopard is crucial for maintaining tourism revenue. Additionally, the diverse flora found in various ecosystems enhances the overall tourist experience by providing opportunities for eco-tourism and nature-based activities (Nepal Tourism Board, 2021). Protecting biodiversity is essential not only for sustaining tourism but also for preserving the cultural identity tied to these natural resources.

(b) ***Medicinal Plants***: Many traditional medicines in Nepal are derived from local plants and herbs. Protecting them ensures the continued availability of these natural resources for both local use and international markets.

(c) ***Agriculture***: Biodiversity is vital for maintaining soil health, improving crop yields, and sustaining livestock (Cheng, 2024). It also helps in the development of drought-resistant crops, which are important for food security.

Global Conservation Efforts

Nepal is part of various international conservation agreements, which include the Convention on Biological Diversity (CBD), among many others, and it has committed to protecting its ecosystems. Nepal's biodiversity is also part of the broader conservation network in the Himalayas, which is a biodiversity hotspot. The protection of biodiversity in Nepal contributes to global efforts to combat its loss, as many species are endemic or have global conservation importance. So far, approximately 23.25 percent of the landmass of Nepal has been covered in the protected area network with significant achievement in the species and ecosystem conservation sector. The remarkable increase in the tiger population in Bardia National Park was a piece of welcome news, and as a result, Bardia won the TX2 Award in 2021 for doubling the tiger population among tiger range countries globally (Gotame, 2022). Within the purview of climate finance, international finance for biodiversity in Nepal between 2012 and 2021 totalled just under US$119 million, primarily consisting of grants from bilateral and multilateral sources (Chhetri & Rai, 2024). COP29, held in Azerbaijan, the UN climate conference agrees to triple finance to developing countries, protecting lives and livelihoods.

Endemic Species and Unique Ecosystems

Nepal is home to a high number of endemic species, meaning they are found nowhere else on Earth. The preservation of these species is critical not only for Nepal's identity, but also for global biodiversity conservation. Apart from the mountains, deep gorges, river valleys, and flatlands, Nepal provides a unique assemblage of very different habitats and unique biodiversity within a small geographical area (Paudel et al, 2011). The country's unique ecosystems, such as the Himalayan mountain ranges, subtropical forests, and alpine meadows, are irreplaceable and must be safeguarded.

Disaster Risk Reduction

Natural ecosystems like forests, wetlands, and mangroves play a key role in reducing the impacts of natural disasters such as landslides, floods, and droughts, to which Nepal is highly susceptible due to its topography. Protection of the ecosystem is one of the few approaches that can impact all elements of the disaster risk equation, mitigating hazards, reducing exposure, reducing vulnerabilities, and increasing the resilience of exposed communities (Renaud, 2013). Healthy ecosystems act as buffers against these disasters, protecting communities and infrastructure.

Maintain Natural Beauty

Nepal is home to eight of the fourteen highest peaks in the world, including the highest peak, Mount Everest, which attracts climbers and trekkers from around the globe. This stunning landscape not only serves as a source of national pride but also plays a vital role in sustaining ecological equilibrium. Biodiversity contributes to the aesthetic value of natural landscapes, enhancing tourism experiences and promoting conservation efforts. The rich variety of flora and

fauna found in Nepal's national parks and protected areas, such as Chitwan National Park and Sagarmatha National Park, makes it one of the richest nations in terms of biodiversity globally (Bhatta, 2018). Protecting biodiversity ensures that these natural wonders remain intact for future generations to enjoy, fostering a sense of stewardship among locals and visitors alike.

Geographical Diversity

Geographically, Nepal is situated in the range of the Hindu Kush Himalayas, with unique topography spanning from the lowland Terai plains to the towering peaks of the Himalayas. Nepal encompasses a wide range of climatic zones and habitats within a relatively short geographical span (WBG & ADB, 2021). This remarkable variation supports an incredible array of biodiversity within its borders (MoFE, 2021). The country's varied terrain includes tropical forests, subtropical valleys, temperate forests, alpine meadows, and glacial landscapes. Each habitat harbours unique species adapted to specific environmental conditions. The protection of biodiversity in this context is vital for maintaining ecosystem services that are essential for human survival. As climate change continues to threaten these ecosystems through habitat loss and altered weather patterns, safeguarding biodiversity becomes increasingly important for ensuring ecological resilience.

Climate Change Adaptation

Nepal is among the most susceptible countries to climate change, facing the impacts of melting glaciers, changing rainfall patterns, and an increased frequency of natural disasters. Healthy biodiversity helps Nepal in the following ways.

(a) ***Mitigate Climate Change Impacts****:* Forests and wetlands act as carbon sinks, helping to absorb CO_2 and reduce the effects of climate change (UNDP, 2023).

(b) ***Adapt to Changing Climates****:* Biodiversity increases resilience to climate change by supporting a diverse range of species that can survive in different conditions, thus stabilizing ecosystems and local communities.

Cultural and Religious Significance

Many of Nepal's indigenous communities have deep spiritual connections to the natural environment. Forests, rivers, mountains, and animals often hold cultural and religious significance. For example, sacred groves and forests are part of traditional religious practices. Such sacred groves play a significant role in biodiversity conservation (Joshi, 2020). The conservation of species like the cow, tiger, and elephant is linked to Hindu and Buddhist beliefs.

Climate Change Impacts on Biodiversity of Nepal

The impacts of climate change on biodiversity are very complex compared to other sectors. Both gradual events like drought and glacier melt and sudden events like floods, fires, and landslides are becoming more frequent, intense, and severe, which directly affects biodiversity (MoFE, 2021). While climate change poses significant risks to the Himalayan region, natural adaptation alone is insufficient. Coordinated adaptation interventions that incorporate local knowledge, tools, and practices are essential. Climate change has had a substantial impact on Nepal's biodiversity, leading to various consequences. Major impacts on biodiversity due to climate change in Nepal are:

Global Warming

The warming trend of the globe has significant implications for snowmelt patterns, which are crucial for water supply, particularly during dry seasons. Glaciers across the Himalayas are retreating at an alarming rate, with studies estimating that over 70% could vanish by the end of the century if current warming trends persist (Khanal et al., 2019). The retreat of glaciers poses a direct threat to freshwater availability for millions who depend on glacial melt water downstream. Additionally, the migration of species due to unfavorable temperatures also impacts the pollination process of plants, which in turn hampers the production of crops, as most of the plants and animals are living in a symbiotic relationship with each other.

Altered Precipitation Patterns and Extreme Events

Climate change has also led to significant shifts in precipitation patterns, resulting in increased variability. Prolonged dry spells and droughts have become more common, severely impacting agricultural productivity and exacerbating food insecurity. Additionally, intensified monsoon rains have triggered severe flooding events, leading to soil erosion and further degradation of agricultural land (MoFE, 2021). Nepal has experienced approximately 500 disasters, including earthquakes, landslides, and floods, every year, which cause the loss of a huge number of animal and plant species.

Altered Life Cycle

Climate change can alter the life cycles of species in many ways. It increases the invasive species, wildlife diseases, and faster juvenile stages of animals. Changes in the timing of seasonal life cycles can influence many species, affecting their migration, blooming, and reproduction, which can in turn reduce their growth and survival (Bhatta, 2021).Several species endemic to Nepal are currently at considerable risk due to the combined impacts of climate change and anthropogenic activities. These threats are exacerbated by changing climatic conditions, which alter the suitability of its natural habitat, further endangering the population of animals like the Red Panda and Leopard. The Snow Leopard (Panthera uncia), a keystone species of the high-altitude Himalayan ecosystem, is similarly imperilled. The Snow Leopard's survival is increasingly jeopardized by shifts in prey availability. Rising temperatures and subsequent changes in vegetation patterns have caused herbivores, the primary prey of Snow Leopards, to migrate to new areas (Jackson et al., 2018). This shift disrupts the predator-prey dynamic, reducing the availability of food and threatening the sustainability of Snow Leopard populations in their traditional habitats.

Threat to Habitat of Species

Climate change can significantly alter or eliminate species' habitats in various ways. Rising temperatures can cause the habitat ranges of both terrestrial and aquatic species to shift to higher elevations. A particular example of this phenomenon is the change observed in the Himalayas, where the southern edge of the range is shrinking due to a shifting tree line, potentially leading to habitat loss for the snow leopard. The rising temperatures and altered precipitation patterns associated with climate change have resulted in significant transformations of ecosystems, leading to the degradation of habitats for numerous species. Many species are unable to adapt swiftly to these rapid environmental changes, resulting in population declines and, in some

cases, an elevated risk of extinction. As species migrate in search of suitable habitats, they encounter fragmented ecosystems, limiting their ability to adapt and thrive. Most recently, wildlife experts and conservationists were shocked to spot the rare snow leopard in Urlabari of the hot Terai region (Baizu, 2024). The snow leopard is normally found at an altitude of 2,000 to 6,000 meters, while Urlabari of Morang is 146 meters above sea level. Warmer temperatures and reduced snowfall in Nepal's Langtang Valley are disrupting the pika's natural habitat, forcing them to migrate to cooler climes at higher altitudes for survival (Rai, 2016). Additionally, warmer temperatures may promote the proliferation of invasive species, which often outcompete native flora and fauna, disrupting local ecosystems and threatening biodiversity.

A study by scientists from Tribhuvan University and the Kunming Institute of Zoology in China investigated the population abundance and distribution of Pika in Langtang National Park. The study warned of the potential for Pika populations to completely disappear from lower elevations. Pikas play a crucial role in maintaining the mountain ecosystem. They not only serve as a food source for larger carnivores but also act as ecosystem engineers. Pikas are considered as guardians of biodiversity in the Himalayan region because the prevent harm to other animals by consuming poisonous plants.

Food Availability and its Quality

Disappearing certain plants and animals creates a scarcity of food and shelter for other certain animals. Elevated levels of atmospheric CO_2 have been shown to enhance plant growth; however, this increase often comes at the cost of reduced nutritional quality (EPA, 2023). A related concern is the nutritional decline in food sources. The decline in nutrient content poses a dual threat, impacting not only animal health but also the well-being of herbivorous species that depend on these plants for their diet. The reduced nutritional value of vegetation weakens herbivore populations, making them more susceptible to diseases and less resilient to environmental stressors.

Phenology of Plants & Animals

The physiology, phenology and distribution of plants and animals are affected by climate change and also increase the risk of mortality and injury from windstorms, flash floods, drought, and expected numbers of vector-borne diseases (Bhatta, 2021). Rainfall data from the last 30 years (1991-2020) indicates an average June-July rainfall of 768.7 mm. However, since the start of the 2023 monsoon, only 555.5 mm of rainfall has been recorded across the country (Paudel, 2023). This extreme and unpredictable rainfall pattern disrupts the ecological balance, impacting the phenology of plants and animals.

Human-Wildlife Conflict

As climate change reduces the resource availability in nature and hinders the flow of ecosystem services upon which both humans and animals depend, the intensity of human-wildlife conflict is likely to increase. As natural habitats diminish and food resources become scarcer, wildlife is increasingly forced to encroach upon human settlements in search of sustenance (Thapa, 2019). This encroachment often results in conflicts that can lead to crop destruction, livestock losses, and, in severe instances, injuries or fatalities. Based on the annual report for the fiscal

year 2021/2022 prepared by the Department of National Parks and Wildlife Conservation (DNPWC), there were a total of 12,682 reported human-wildlife casualty incidents nationwide, including 58 cases of human fatalities, 116 cases of severe human injuries, and 72 cases of minor human injuries, and the rate is accelerating each year (Bhusal & et al. 2024).The annual report of DNPWC shows that the number of reported wildlife attacks grew on average by 33% per year (Dhakal &Udaya, 2024). Such incidents underscore the urgent need for comprehensive mitigation strategies to protect both human livelihoods and wildlife populations.

Recommendations

The findings of this research highlight the crucial need for immediate and comprehensive climate change adaptation and mitigation strategies that are tailored to the specific circumstances of Nepal. To effectively address the intricate relationship between climate change and biodiversity loss, the government, along with other relevant authorities and stakeholders at all levels, must work together and should implement the following key points, which can serve as a guide for future actions:

The Community Forest program in Nepal is an example to the world. Community forests are making a significant contribution to sustainable forest management, community development, capacity building, empowerment, and protection of the ecosystem. Hence, it is high time to foster a 'Go Green Campaign' by involving all the stakeholders with serious concern for the future of biodiversity. Each individual should be self-conscious about the significant reduction of CO2 emissions and the use of green energy by cutting down on consumption of fossil fuels. The adoption of electric vehicles (EVs) in private and public transportation significantly reduces greenhouse gas emissions, with battery electric SUVs achieving up to 60% lifecycle emission savings compared to internal combustion engine vehicles (International Energy Agency, 2024). Common consensus and understanding of the effects of global climate change on biodiversity are still insufficiently well-developed. Environmental protection campaigns should incorporate all the stakeholders at all levels, including students. The government should encourage relevant authorities to include climate change, environmental protection, and mitigation/adaptation strategies in school and college curricula to educate young minds. Additionally, students can be motivated to plant trees upon joining educational institutions and care for them until graduation. Local governments, empowered by the Constitution of Nepal, can effectively implement and monitor these initiatives. All levels of government should work together to protect the environment, promote sustainable development, and build a more resilient society capable of adapting to climate change challenges. GoN must cultivate relationships with indigenous groups, civil society organizations, and local communities to support effective and long-lasting grassroots conservation and climate change programs.

Protecting vital habitats and species in Nepal requires the expansion of protected areas and wildlife reserves, especially in light of the mounting effects of climate change. The effectiveness and sustainability of conservation efforts can be improved by supporting community-based conservation projects that involve local communities in biodiversity monitoring, management and decision-making processes. To stop the widespread exploitation of Nepal's priceless biodiversity, law enforcement must be strengthened in the best possible way. The involvement of the Nepali Army in nature conservation duty against the illegal

wildlife trade and poaching has proved to be successful, and this effort by the Government of Nepal has been commendable in the sustainable protection of the ecosystem. This effort should be continued, further integrating it with sophisticated equipment and the latest technology. Additionally, funding research and monitoring initiatives to evaluate the effects of climate change on biodiversity and pinpoint priority regions for conservation action is essential. As, the COP29 UN climate conference agrees to triple finance to developing countries, protecting lives and livelihoods, the GoN should come up with a workable and convincible plan prioritizing the investment sector to claim climate finance.

Fostering collaboration and partnerships with national, regional, and international agencies is crucial for aligning local strategies with broader climate action initiatives to effectively tackle transboundary environmental challenges that have extensive effects on biodiversity and ecosystems. United Nations agencies and regional organizations are best positioned to address the long-lasting effects of climate change. By acknowledging shared environmental challenges, collaborative efforts can substantially strengthen Nepal's resilience and foster sustainable development. It is imperative to take practical and timely steps to proactively identify threats and implement risk reduction measures. Strengthening institutional capacity, promoting stakeholder engagement, enhancing data and knowledge systems, fostering innovation, and mobilizing financial resources are key areas for improving Nepal's response to the risks of climate change. The GoN can address the challenges posed by climate change to biodiversity in Nepal through diversified approaches, such as, public awareness, enhancing preparedness for natural disasters, and incorporation of climatic consideration into National Policy.

Conclusion

The multifaceted implications of climate change on biodiversity necessitate urgent action tailored specifically for Nepal’s unique context. Harnessing local knowledge alongside scientific research while fostering community engagement through educational initiatives will be a crucial step towards building resilience against future climatic threats. The subject of climate change is exceedingly complex and precarious. It has the potential to severely disrupt the country’s biodiversity and ecological balance through natural catastrophes. The resulting impacts include mass migration of species, depletion of critical natural resources, and increased pressure on conservation efforts due to limited resources. The interconnected nature of climate change distinguishes it from other localized environmental issues, as its effects are pervasive and influence ecosystems across the globe. Climate change has led to alterations in temperature, precipitation patterns, and the frequency of extreme weather events, directly impacting species distribution, habitat availability, and ecosystem functions. Rising temperatures, for instance, force species to migrate to cooler areas, disrupting local ecosystems and leading to habitat fragmentation. Additionally, shifts in precipitation patterns and increased climate variability can alter the phenology of plants and animals, affecting breeding cycles, food availability, and ecosystem stability.

Given these widespread impacts, there is an urgent necessity for integrated adaptation strategies that encompass both scientific research and traditional ecological knowledge. Utilizing local insights, particularly from indigenous communities who have coexisted with diverse ecosystems for centuries, can offer valuable context-specific solutions. Moreover, international

cooperation is vital for sharing research findings, pooling resources, and implementing conservation initiatives that address the transboundary nature of climate change impacts. In the context of several global initiatives taken by the world forum, like operationalising the Biodiversity Convention, celebrating the International Day for Biological Diversity with different themes every year, and providing climate finance, specially focusing on developing nations, Nepal should be able to take maximum benefit, aiming to encourage affirmative actions. By combining local expertise with global efforts, it is possible to develop comprehensive measures aimed at building resilience in vulnerable ecosystems, thereby mitigating the adverse effects of climate change on biodiversity. This approach will be instrumental in safeguarding the delicate balance of ecosystems and ensuring the continued survival of species in the face of accelerating climate change. For Himalayan countries like Nepal, climate change mitigation, acclimatization, and disaster risk reduction, as well as mitigation, must be a top priority due to their profound impacts on biodiversity. Climate change should be approached from the perspective of biodiversity conservation, yet the government has thus far given insufficient attention to these concerns, treating them as isolated projects managed by specific ministries. The nation must adopt a broader, integrated strategy to address these critical issues before it's too late, as the future appears increasingly uncertain and challenging for Nepal's diverse ecosystems.

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