

Trends of climate change and its Impact on Biodiversity and Ecosystem of Nepal

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Abstract: Climate change is one of the most challenging problems in biodiversity and the ecosystem. The purpose of this study is to analyze trends of climate change and its impacts on Biodiversity and ecosystems in Nepal. There is a general agreement that Climate Change impacting Nepal rather disproportionately compared to its size and its meager contribution to greenhouse gases. However, given its location between the two rapidly growing economies of India and China, Nepal cannot escape the rapidly increasing influence of climate and global changes. The research-based on secondary data and document review. The national documents were collected from the concerned, office, projects as well as official websites. The research shows the trend of maximum and minimum temperature during 1975-2006. Due to the climate change, its effects rapidly retreating glaciers (average retreat of more than 30 m/year), the rapid temperature rise ($>0.06^{\circ}$), erratic rainfalls, and an increase in the frequency of extreme events such as landslide, floods, and drought-like situation are some of the effects in Nepal is facing during the last few years. Anthropogenic activity is a key factor for climate change. Climate change also affects biodiversity and the ecosystem. Biodiversity is affected by climate change at different levels from low land to high mountains as well as small rivers to deep seas. Some species have become extinct while others are endangered. Nepal is rich in biodiversity. Biodiversity is another important resource of Nepal that is also being affected as invasive species will spread fast and useful medicinal, food, and nutrition-related plants may threaten and disappear. Climate Extinctions can disrupt fundamental ecological processes. The Government and non-government agencies implemented different programs such as national parks, wildlife reserves, conservation areas, hunting reserves, and simsar sites are being created in Nepal to manage the good biodiversity and ecosystems. The different strategies or plans implemented by the government mitigate climate change in developed and developing countries. Nepal is currently preparing National Action Plan on Adaptation (NAPA) which should be made as comprehensive and topical as possible. As people became more aware of the effects of climate change, a variety of programs have been implemented to protect it.

Keywords: Climate change, Bio-diversity, Eco-system, threats, NAPA, and soil conservation.

I. Introduction

Climate change is the global phenomenon of climate transformation characterized by the changes in the usual climate of the planet (regarding temperature, precipitation, and wind) that are caused by natural and artificial activities. As a result of unbalancing the weather of Earth, the sustainability of the planet's ecosystems are under threat, as well as the future of humankind and the stability of the global economy. Geographers have been involved in scientific studies on the effects of climate change on human life since the early 19th century. Critchfield (1966) integrates the issues of climate change and their interrelationships with the global distribution and physical properties of climatic elements between the earth and atmosphere over a long period. According to Geographers weather, climate, and climate change in this way: the weather is the condition of the atmosphere at a particular place over a short period, and climate includes the weather pattern, using statistical data over a long

enough period (at least 32 years) to yield meaningful averages. Climate change includes an increase in temperature, erratic and extreme rainfall patterns, and the increased frequency of floods, landslides, and droughts that annually result in the massive loss of lives and properties (Critchfield, 1966; Wilson, 1967; UNDP, 2009; FAO,2014; Carbone, 2016; Rohli, 2018).

According to the definition of National Aeronautics and Space Administration (NASA) of says climate change is "a broad range of global phenomena created predominantly by burning fossil fuels, which add heat-trapping gases to Earth's atmosphere. These phenomena include the increased temperature trends described by global warming, but also encompass changes such as sea-level rise; ice mass loss in Greenland, Antarctica, the Arctic and mountain glaciers worldwide; shifts in flower/plant blooming; and extreme weather events."

A change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.

The Fourth Assessment Report of the United Nations Intergovernmental Panel on Climate Change (IPCC, AR4) projected warming in South Asia of 2–4 °C by the end of the 21st century relative to the end of the 20th century, under the different forcing scenarios explored (Christensen et. al,2007).

The term biodiversity was introduced in 1985. Biodiversity is important in natural and artificial ecosystems. Its emphasis is on nature's variety, the biosphere. It refers to variability among plants, animals, and micro-organism species.

Biodiversity describes the richness and variety of life on earth. It is the most complex and important feature of our planet. Without biodiversity, life would not sustain.

Biodiversity holds ecological and economic significance. It provides us with nourishment, housing, fuel, clothing, and several other resources.

Biodiversity is affected by climate change at different levels from low land to high mountains and from small rivers to deep seas. Some species have become extinct while others are endangered. Extinctions can disrupt fundamental ecological processes (Sodhi, 2008).

The different strategies or plans implemented by the government to mitigate climate change in developed, developing countries, and least developing countries. Nepal has implemented National Action Plan on Adaptation (NAPA) for adaptation to climate change. It focuses on the 80% budget share at the local level for the use in climate change. The paper focuses on the trend of climate change and its impact on biodiversity and the ecosystem in Nepal.

II. Method and Materials

The research paper is based on the review of different national and international papers related to biodiversity and ecosystem and it, being affected by climate change. Secondary/ library data regarding climate change and its effect on the various biodiversity and ecosystem were collected. The national documents, policies, plans, strategies, booklets, reports, programs, projects related to agriculture and climate change were collected from the concerned, office, projects as well as official websites. But, Nepalese data, policies, strategies, and programs are also done in brief.

III. Discussions and Results

Agriculture plays an important role in the livelihood of the communities living in Nepal. The share of agriculture in GDP increased to 19.9 percent in 2020-21 from 17.8 percent in 2019-20. The last time the contribution of the agriculture sector in GDP at 20 percent was in 2003-04 (ADS,2015-2035)

i. Trends of climate change in Nepal

Climate change is one of the most challenging problems in the world and it has been affected by many developing countries like Nepal. So it seems that individuals, scholars, and institutional authorities have been involved in studying this issue in the world. Effects of climate change are taking place both academically and governmentally in Nepal. For example, the Agriculture Development Strategy of Nepal has also envisioned accelerating agricultural growth through governance, productivity, commercialization, and competitiveness of profitable crops. Similarly, the Prime Minister Agriculture Modernization Program has been implemented by the government of Nepal. It is an effort that emphasizes increasing yields of crops in the project area through different pockets, blocks, zones, and super zones. The project has initially proposed 2,100 pockets, 150 blocks, 30 zones, and seven super zones across the country. The project also seems to have determined the size of the land for the pocket, block, zone, and super zone, respectively 10 ha. 100 ha.500ha.and 1,000 ha. The project has provided 50 percent subsidies in the purchasing of agricultural equipment and tools in the block and it was 85 percent for the construction of agriculture production and collection centers to pocket areas. The project has also provided technical support services through JT, JTA (junior technical assistant), and agricultural experts free of cost for specialized products (ADS, 2015-2035). For this project, the government of Nepal has also allocated the budget (3.22 Arab) to improve commercial crops in this Fiscal Year (2077/78 BS). To inform the impact of climate change in the world, the Government of Nepal had also organized a Cabinet meeting in Sagarmatha Base Camp to endorse the issue of the impact of climate change on the mountains in 2009. The Everest Declaration of the Cabinet had increased the areas of the protected area from 20 percent to 25 percent, enhancing the capacities of local communities to cope with climate change and collaboration with other countries to mitigate the impact of global warming (Shrestha, 2009).

National Adaptation Plans (NAPs) have also prepared an implementation framework to envisage the operation costs that will be kept to a minimum and at least 80% of the available financial resources will reach the local level to fund activities on the ground. Stakeholders in Nepal have also started discussing which are medium and long-term adaptation plans for the country (UNFCCS, 2007).

The different warming trend in Nepal after 1997 has ranged from 0.06° to 0.12° C per year in most of the middle mountains and Himalayan regions. But, the Siwalik and Tarai regions warming trend has been less than 0.03°C per year (Shrestha, 1999).

Nepal is a mountainous country. There is a different type of industries. Especially the large scale industries establish in the Tarai region and produce the maximum carbon dioxide which is an effect on human health, agriculture production, biodiversity, ecosystem, etc. Again, there is a different rate of affecting health factors and others.

As presented in Table 1 the average temperature trend in Nepal from 1971 to 2014 is 0.027o C per decade. The global average trend for a similar period is 0.017o C (IPCC, 2007). The findings indicate that the average temperature in Nepal is increasing by more than 50 percent compared to the global average. The trend of increases in maximum temperature and minimum temperature are given below in a table:

Table 1. Presented the Trends of temperature (o C/yr)

		Elevation Range			
Average Trend	Overall	72-200m	200-1000m	1000-2000m	>2000m
		Average temperature			
	0.027	0.014	0.031	0.031	0.034
Maximum Value	0.062	0.028	0.028	0.057	0.062
Minimum Value	-0.029	-0.008	-0.008	-0.029	0.015
	Average Minimum Temperature				
Average Trend	0.018	0.022	0.034	0.014	0.028
Maximum Value	0.107	0.050	0.090	0.090	0.107
Minimum Value	0.101	0.031	0.006	-0.101	-0.031
	Extreme Minimum Temperature				
Average Trend	0.017	0.009	0.019	0.006	0.064
Maximum Value	0.222	0.057	0.076	0.052	0.222
Minimum Value	-0.102	-0.079	-0.083	-0.102	-0.057
	Average Maximum Temperature				
Average Trend	0.041	0.005	0.032	0.065	0.047
Maximum Value	0.152	0.024	0.066	0.152	0.101
Minimum Value	-0.049	0.012	-0.008	-0.049	-0.030
	Extreme Maximum Temperature				
Average Trend	0.019	-0.006	-0.002	0.041	0.031
Maximum Value	0.171	0.040	0.065	0.171	0.092
Minimum Value	0.160	0.036	-0.160	-0.083	-0.036

DHM, (1971-.2014).

Table 1 Shows that the per decade 1971-2014, a summary of average temperature,

average minimum temperature, average maximum temperature, extreme maximum temperature, and extreme minimum temperature of Nepal.

ii. Impact of climate change on biodiversity and ecosystem

The current Nepalese population is also dependent on agriculture and the impact of climate change in agriculture on the region. Nepal is rich in agro-biodiversity due to variation in cultivars grown at different elevations. Diversity in agro-ecosystems continuously supplies food, nutrition, fiber, fuel, and services that contribute to livelihoods (Sthapit, Upadhyay, Baniya, Subedi, & Joshi, 2001). Functional and genetic diversity between plant and animal populations that deliver ecosystem services will help humanity adapt to change (Paudel, Bhattarai, & Kindlmann,2012). Nearly one-quarter (23.2%) of Nepal's land area is protected within 12 national parks, 1 wildlife reserve, and 6 conservation areas (Bhattarai, Wright, Poudel, Aryal, Yadav&Wagle, 2017). The Patterns of Species Richness Nepal's ecological and climatic diversity supports high species diversity for its relatively small size, it comprises less than 0.1% of Earth's total land cover, and yet current estimates for this small country indicate disproportionately high levels of biodiversity. This is given below in table 2.

Table 2: Group, relative species and biodiversity of the world.

Group	Group Number of Observed Species	% Relative to Known Species Worldwide
Angiosperms	6973	3.2
Gymnosperms	26	5.1
Pteridophyte	534	5.1
Bryophytes	1150	8.2
Lichens	465	2.3
Fungi	1822	2.6
Algae	1001	2.5
Flora total	11,971	-
Mammals	208	5.2
Birds	8673	9.5
Reptiles	123	1.9
Amphibians	117	2.5
Fish	230	1.9
Butterflies	651	3.7
Moths	3958	3.6
Spiders	175	0.4

MFSC, (2014)

Table 2: shows the Forest and Soil Conservation of Nepal. It indicates that the Studies of biodiversity in the Himalayas have documented similar patterns across plant and animal groups, but point to conflicting underlying processes in the study area. It indicates that Flora total 11,971 which expressed the largest number of species and lowest species is Gymnosperms 26. The highest diversity is typically found in the Mid-Hills across plant and animal groups, which is where nearly one-third of Nepal's forests are found. Although fish diversity in Nepal decreases with altitude, endemic species show a unimodal peak at mid-elevations (Bhatt, Manish, & Pandit, 2012). That the Himalayas are populated primarily by biota dispersed from elsewhere seems further plausible given its relatively low level of the locality. Nepal is rich and unique biodiversity is threatened by anthropogenic and natural factors operating at different spatial scales. Deforestation, biological destruction, pollution, overexploitation, fire, and mining in fragile regions degrade natural ecosystems; while poaching is responsible for the decline of some keystone species (MFSC, 2014). However, in recent decades, continued efforts of government agencies, NGOs, INGOs, and communities have improved the continued forest conditions. Based on aerial photographs taken during 1992-1996, the forest cover of Nepal was estimated to be 29%. Also, 10.6% of the area was found to be degraded shrub land; thus 39.6 % of the country's land is under forests, Department of Forest Research and Survey (DFRS 1999). Biodiversity impacts human health in several ways, both positively and negatively. The following human activities can be enumerated as the principal threats to the conservation of biodiversity in the country:

. **Deforestation:** Deforestation is still a major problem in the Siwalik and Terai regions. Wood is the main source of energy in rural areas. About 87 percent of the nation's energy requirement is met by forest products and each person consumes one cubic meter of wood per year for this purpose (Upreti & Sarma, 1985). Population pressure and the so-called developmental activities are causing a rapid depletion of forests in every part of the country. As a result, countless plant species are facing the considerable danger of extinction.

. **Forest fires:** A wildfire, bushfire, wildland fire or rural fire is an unplanned, unwanted, uncontrolled fire in an area of combustible vegetation starting in rural areas and urban areas. Due to the forest fire to kill trees, obtain fuelwood and construction materials, as well as to extend the area of the adjoining agricultural lands. Consequently, many valuable herbs flourishing in those habitats are heavily affected and the organic matter in

the upper layer of the soil is usually destroyed resulting in the disappearance of many valuable biological species from the area.

. **Shifting cultivation:** Shifting cultivation is an agricultural system in which plots of land are cultivated temporarily, then abandoned while post-disturbance fallow vegetation is allowed to freely grow while the cultivator moves on to another plot. This practice destroys a large number of biological species.

. **Overgrazing:** Overgrazing can be defined as the practice of grazing too many livestock for too long a period on land unable to recover its vegetation, or of grazing ruminants on land not suitable for grazing as a result of certain physical parameters such as its slope. Fodder for the estimated 15 million cattle in the country, which includes important non-timber forest products used by the villagers, is estimated at 5.6 million tons of fodder per year (Upreti, 1985).

. **Over-exploitation:** Overexploitation, also called overharvesting, refers to harvesting a renewable resource to the point of diminishing returns. Continued overexploitation can lead to the destruction of the resource. The term applies to natural resources such as wild medicinal plants, grazing pastures, game animals, fish stocks, forests, and water aquifers. The raw materials are overharvested by the removal, for example, of immature plants, roots, tubers, and rhizomes, or by over-pruning. As outside interest dictates the price and quantity of raw materials extracted, a major part of the local ecosystem has suffered irreversible harm.

. **Medicinal plants in trade and industry**

Every year, thousands of tons of medicinal herbs are collected from the forests and pastures and traded to foreign countries. The trade-in medicinal herbs are an important source of revenue for the government and a major source of income for the rural people. About 100 species of medicinal herbs are currently exploited for commercial and industrial purposes (Mallet, 1995). The uncontrolled commercial extraction has significantly eroded the country's medicinal plant resources, and particular species have gradually become more difficult to find in a given locality where they once flourished. Collection and trade of medicinal herbs and other non-wood forest products provide up to 50 percent of a family's income in certain areas of the country.

. **Wild plant resources in the livelihood of the rural people**

Apart from commercial and industrial uses, the majority of the lay population uses wild plants in a variety of ways, the additional uses being for food, folk medicine, fodder, fuel, and a variety of domestic articles. They are also used as sources of dyes, tannins, fibers, gums, and resins, for producing agricultural and hunting tools and weapons, and in witchcraft and magic. Some species are also used in worship and religious rituals.

. **Reasons for the excessive extraction of wild plant resources**

The improper and excessive exploitation of biological resources leading to habitat destruction and placing a threat on biodiversity is largely due to illiteracy, poverty, and the shortage of off-farm employment opportunities for the rural population. Illiteracy and poverty have forced the rural Nepalese people to continue activities that help them survive in the present but which will cause more severe problems in the future.

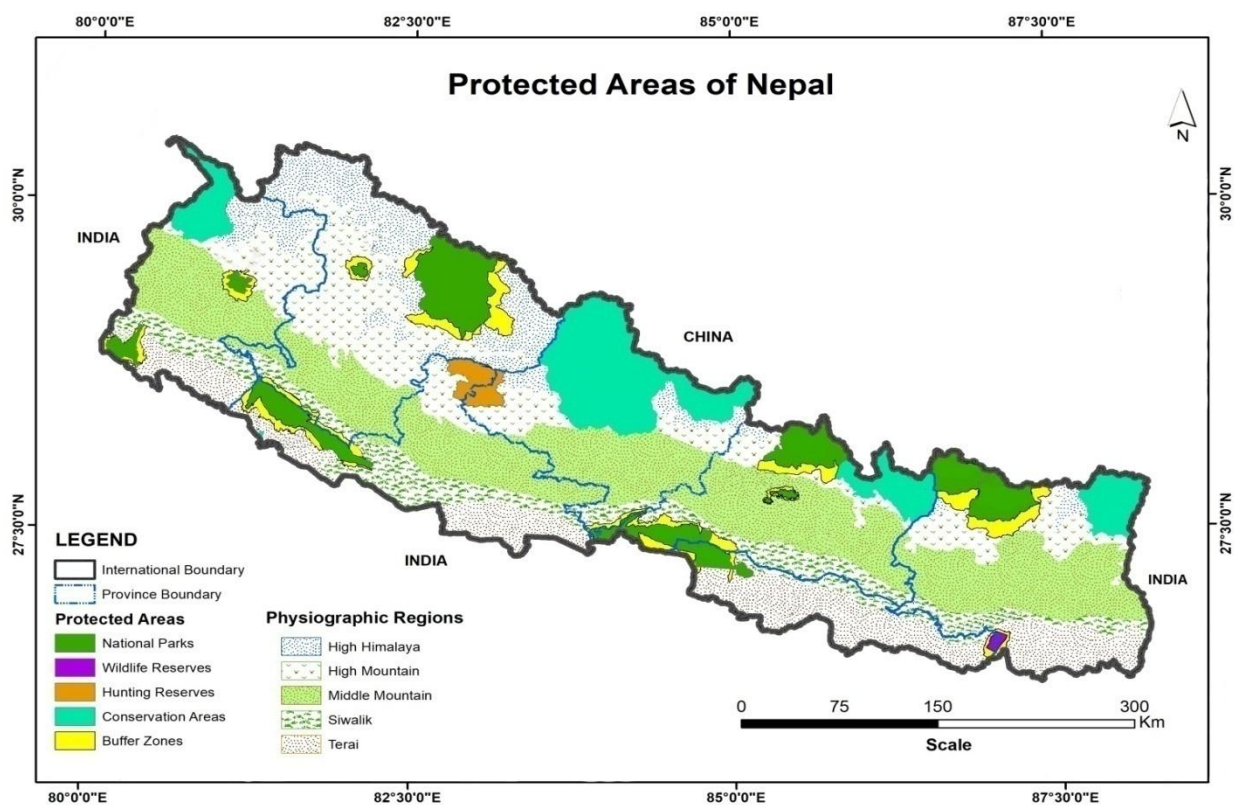
Many valuable genetic resources are conserved in the protected areas for their potential use in the future. Department of National Parks and Wildlife Conservation (DNPWC) was established in 2037 BS (1980 AD) to conserve and manage the wildlife and biodiversity of the country. Nepal has established a very good network of Protected Areas system with 12 National Parks, 1 Wildlife Reserve, 1 Hunting Reserve, 6 Conservation Areas, and 13 Buffer Zones extending from lowland Terai to high mountains, covering 23.39 % of the total country's land, which contribute to in-situ conservation of ecosystems and biodiversity across the country. Conservation efforts made by the government of Nepal are worldwide popular and highly recognized by international.

Climate change is also affecting ecosystem services by affecting vegetation and area, primary productivity, species populations and migration, the occurrence of pests and disease, and vegetation regeneration.

The increase in greenhouse gases is already affecting species composition and changing the ecosystem structure, which in turn affects ecosystem function. Climate change will have a profound effect on the future distribution, productivity, and ecological health of vegetation. There could be a significant reduction in alpine and cryospheric ecosystems and their services.

It is a major expansion of the mountains, hilly, and Terai region, whereby the quality and quantity of ecosystem services are likely to change dramatically for the worse

National Parks and Wildlife Conservation



Source: Department of a survey, DNPWC , MoFE, Government of Nepal,(2077)

IV. Conclusion

Climate change is a burning issue and its effect on all sectors of the people. Especially, the causes of climate change are human activities and natural factors. The paper shows the per decade 1975-2006, a summary of average temperature, average minimum temperature average maximum temperature, extreme maximum temperature, and extreme minimum temperature of Nepal. Climate change also affects biodiversity. Due to climate change, the bio-diversity going to lose or decrease Nepal is rich in Biodiversity. There are different types of threats to the biodiversity and ecosystem such as deforestation, forest fire, overgrazing, shifting cultivation, overexploitation, etc. We get the different types of species in Nepal. The government, NGOs, INGOs, and communities are implemented different types of programs for the conservation of the biodiversity and ecosystem. Therefore, the Government of Nepal has formulated policies regarding biodiversity with the hope of conserving the ecosystem and biodiversity.

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