

Mountainous Country Nepal: From The Perspectives of Climate Change

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Abstract: Nepal is a mountainous country located in South Asia. Climate change is one of the challenging phenomena and various symptoms of climate change are already seen in Nepal. This paper is made by analyzing the impacts of climate change in different sectors of Nepal like on water, health, forestry, agriculture, biodiversity, temperature and so on. It has also highlighted the impacts from global to country level. This paper has discussed adaptation strategies applied in the ward side that is Mustang district of Nepal. This study suggested that Nepal should promote eco-friendly as well as traditional practices in order to enhance climate change mitigation and adaptation strategies. The study further recommended to heighten developmental activities by considering sustainability of the available resources and betterment of mountainous peoples' lives in Nepal.

Keywords: Climate change, water, eco-friendly, mountainous peoples

I. Background

Climate is one of the key parameters in the earth's environment. Climate is usually defined as the average weather and in broad sense, it is the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years [1]. The Intergovernmental Panel on Climate Change (IPCC) clearly mentioned that climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer.

Human activities that could possibly change the climate include as a result of emission of gases in the atmosphere, industrial activities, development of extensive cities, pollution of waterways and cities, creation of thousands of dams and lakes, conversion of grassland or forest to cropland, agricultural activities [2]. Previously it is assumed that climate change is caused due to natural causes. Some of the more prominent natural causes affecting in climate change are continental drift, volcanoes, the earth's tilt and ocean currents. These changes are being studied through evidence obtained from tree-rings, pollen samples, ice-cores and sea sediments [3].

Among many concepts about the cause of climate change, a group of scientists are not fully agreed to clearly mention that greenhouse gas (GHG) is the main factor to be climate change. Their concept is "land-use change impacts regional and global climate through the surface-energy budget, as well as through the carbon-cycle effects. The surface-energy budget effects may be more important than the carbon-cycle effects" [4].

Global warming is a major factor to be climate change. Even a conservative estimate of 1°C increase could have dramatic effects for all aspects of human life. For example, during the Medieval warming period (1200-1500AD)

and during the little Ice Age (1600-1700AD) temperatures were 0.5 °C higher and 0.5 °C lower respectively (on average) than they are today [5].

The following Figures of IPCC, 2013 shows recent status of temperature pattern in the globe.

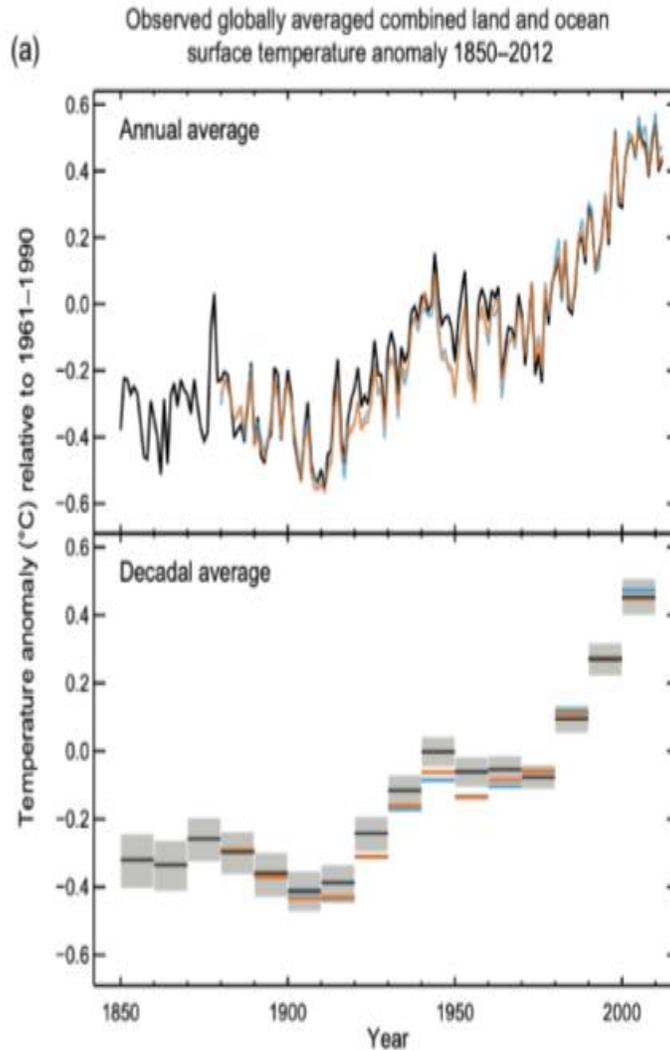


Figure No. 1: Globally averaged combined land and ocean surface temperature anomaly [6]

Continuous greenhouse gas emissions at or above current rates will cause further warming and induce many changes in the global climate system during the twenty first century that would very likely be larger than those observed during the twentieth century [7]. These changes have the potential to greatly impact regional hydrological processes, and affect long-term water availability [8], the occurrence of droughts or floods [9] and water resources management practices [10], particularly at regional scales [11]. Understanding the potential effects of climate change on hydrological regimes has thus become a priority area, both for process research and for water and catchment management strategies [12].

The below given Figure of IPCC, 2013 shows recent status of global carbon dioxide emission in the earth.

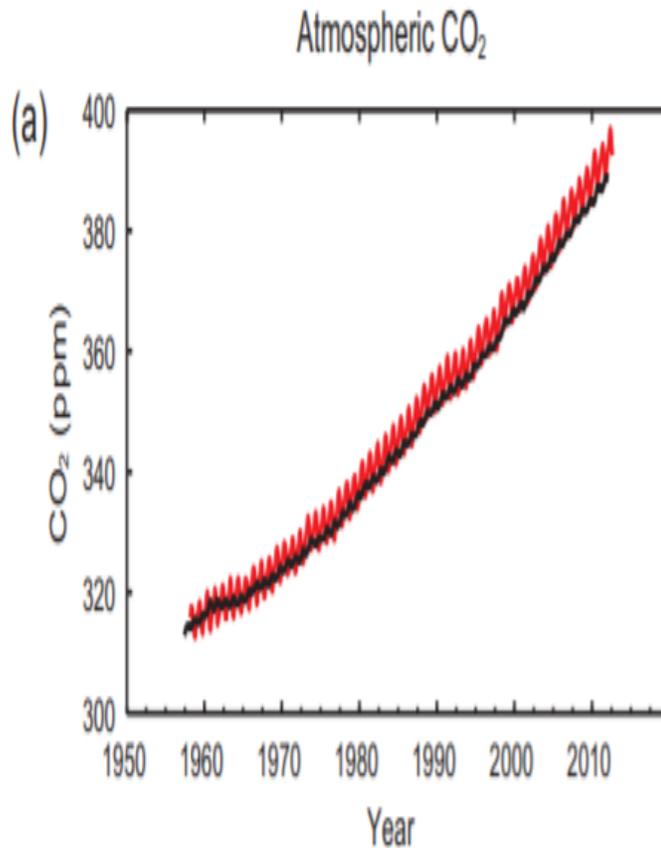


Figure No. 2: Emission of carbon dioxide in the earth [6]

II. Impacts of Climate Change In Global context

Impacts of climate change can be categorized through positive and negative aspects. Less chilly winters and greenery in high altitudinal areas can be considered as some positive impacts due to global temperature rise. However, the adverse (negative) impacts are highly seen in compared to the positive impacts.

Table No. 1: Observed effects of climate change and its observed/possible impacts on water services in global perspectives [1]

Observed effect	Observed/possible mpacts
Increase in atmospheric temperature	<ul style="list-style-type: none"> Reduction in water availability in basins fed by glaciers that are shrinking, as observed in some cities along the Andes in South America
Increase in surface water Temperature	<ul style="list-style-type: none"> Reductions in dissolved oxygen content, mixing patterns and self-purification capacity Increase in algal blooms

Sea-level rise	<ul style="list-style-type: none"> • Salinization of coastal aquifers
Shifts in precipitation patterns	<ul style="list-style-type: none"> • Changes in water availability due to changes in precipitation and other related phenomena (e.g. groundwater recharge, evapotranspiration)
Increase in inter-annual precipitation variability	<ul style="list-style-type: none"> • Increase the difficulty of flood control and reservoir utilization during the flooding season
Increased evapotranspiration	<ul style="list-style-type: none"> • Water availability reduction • Salinization of water resources • Lower groundwater levels
More frequent and intense extreme events	<ul style="list-style-type: none"> • Floods affect water quality and water infrastructure integrity, and increase fluvial erosion, which introduces different kinds of pollutants to water resources • Droughts affect water availability and water quality

III. Impacts of Climate Change In Nepalese Context

Nepal is a mountainous and landlocked country having an area of 147, 181 square kilometers. The country is located between 26°22' to 30°27' north latitudes and 80°04' to 88°12' east longitudes. It occupies about 0.03 percent of the total land of the earth and about two-thirds of its land is hills and mountains. It extends approximately 885 km east to west and about 193 km north to south. Elevation of the country starts from 61m to 8848 m within a span of less than 200 km [13].

Nepal is located in central part of the Hindu Kush-Himalayan (HKH) region. It is found that the rate of warming in the HKH region is higher than global average that is 0.74°C over the last hundred years [14]. While categorizing the HKH region, as western Himalayas, central Himalayas and Tibetan Plateau, the central Himalayas (Nepal) and the Tibetan Plateau appear to be considerably higher rates of temperature rise (that is, 0.04 to 0.09°C per year and 0.03 to 0.07°C per year respectively).

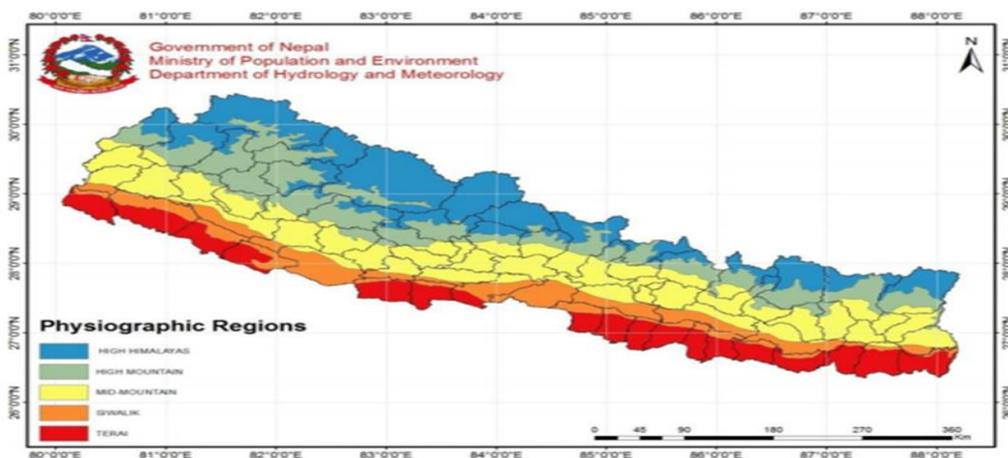


Figure No. 3:Physiographic features of Nepal [15]

Nepal is divided into five characteristic climatic zones in a span of less than 200 km (south to north), which are categorized as follows [16].

- Hot monsoon climate in the Terai, inner Terai, and Siwalik regions with a hot and wet summer, and mild and dry winter.
- Warm temperate monsoon climate in the Middle Mountains up to a height of about 2,100 meter above mean sea level (amsl).
- Cool temperate monsoon climate in the Middle Mountains and the High Mountains between 2,100 and 3,300 amsl.
- Alpine climate in the High Mountain region up to a height of about 4,800 amsl.
- Tundra type of climate above the snow line, that is, 5000 m[17] where there is perpetual frost and cold desert condition exists.

We can divide the impacts of climate change in Nepal among various sectors: water resources, health, forestry, agriculture, biodiversity, economy, tourism and so on.

Water resources: People consider monsoon as ‘life giving rain’ in Nepal. More than 80% of the population depends on agriculture, which is predominantly fed by monsoon rain. Any change in the monsoon system directly affects the production of food. In recent years, concern for monsoon rains has been legitimated by increasing rainfall intensity and droughts throughout the country.

It is a fact that Nepal is one of the Himalayan countries in world. The adverse impacts of climate change has already shown in different glaciated regions of Nepal including glacier lakes. The below given figure shows one of the realities of glacier lake expansion in Nepal.

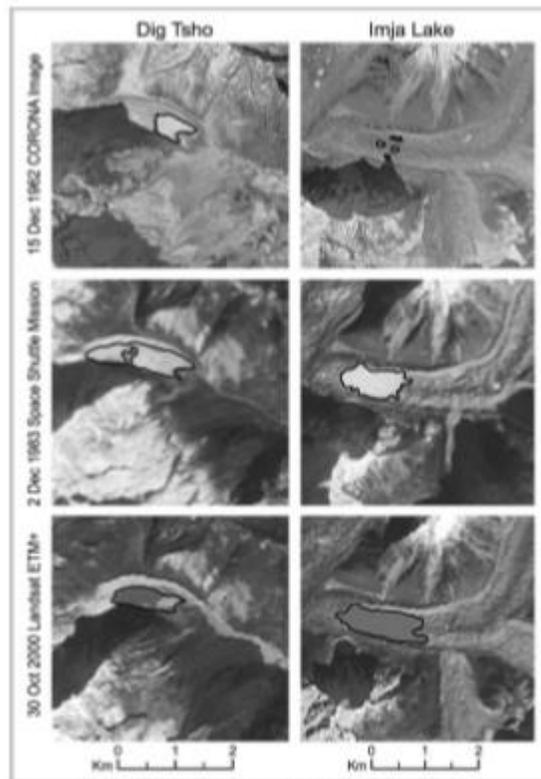


Figure No. 4: Growth of Dig Tsho and Imja lakes, Nepal [18]

Health: Climate change may be intensifying the spread of mosquito related diseases such as malaria, dengue fever, Ross River virus, and West Nile virus [19]. Gautam (2005) has shown that a mosquito problem has emerged in the high Jomsom valley of Nepal (2,700m) [20]. Aryal et al. (2013) found that the average annual temperature has increased by 0.13°C in the upper Mustang region, a rate faster than temperature increases in the central Himalayas of Nepal and the Tibetan Plateau [21].

Forestry: Gaire et al (2011) studied dynamics of *Abies pectabilis* relation to climate change at the treeline ecotone in Langtang National Park [22]. They collected tree core sampling and found that upward advancement of treeline should be expected in the coming decades. They further concluded that the general increase of winter minimum temperatures might be responsible for the upward advancement of the tree line and early melting of snow.

Biodiversity: Chaudhary and Bawa (2011) conducted field surveys in Darjeeling and West Bengal of India and in the Ilam district of Nepal to analyze local perceptions of climate change [23]. Respondents reported changes in biodiversity such as early budburst and flowering, new agricultural pests and weeds, and the appearance of mosquitoes. They also reported that temperature increases appeared to be more rapid at higher altitudes.

Agriculture output: Nepal Agricultural Research Council (NARC) has warned that the effect of a rise in temperature due to global warming will be greater on winter crops like wheat and millet. The vegetative state of those crops would be shorter with higher temperatures, thus lowering productivity [24]. All these scenarios are showing that cropping systems could change with climate change.

Temperature: The average number of ‘hot’ nights per year in Nepal increased by 9 and the average number of ‘cold’ days per year has decreased by 19 of days between 1960 and 2003 [25]. A general circulation model (GCM) projection has shown that mean annual temperatures are projected to increase by 1.3 to 3.8°C by the 2060s and 1.8 to 5.8°C by the 2090s [25].

One of the studies carried out by this author has also shown significant increase of future temperature compared to current situation. Its diagrammatic representation is given in Figure 5.

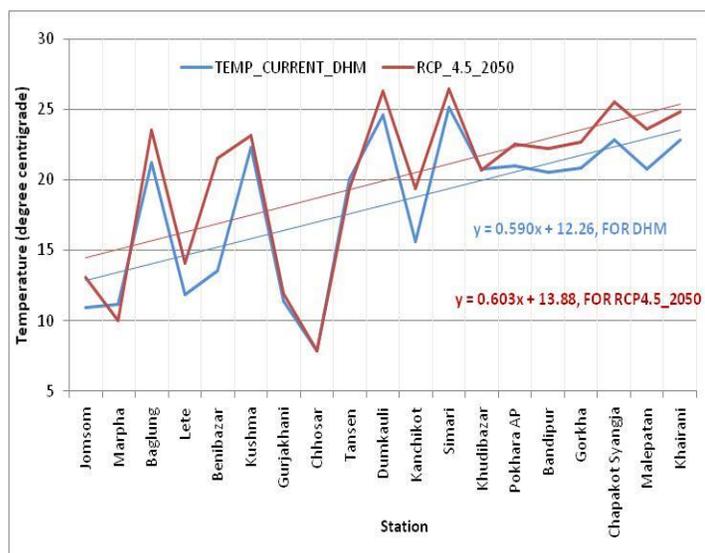


Figure No. 5: Status of current and future temperature in few stations of Nepal

IV. Climate Change Adaptation-A Reality of Mustang

Mustang is located in North Western part of Nepal and is also known as trans-Himalayan region. The district generally gets very less amount of annual rainfall being a leeward side in Nepal [26]. The author had experienced a real example of climate change adaptation from the field study of Dhakarjun and Phalak regions of Mustang.



Figure No. 6: Some of the houses and surrounding environment in Phalak, Mustang [26]

The author carried out field study in order to investigate status of climate change especially in water resources at Mustang district of Nepal. I had performed deep interaction with the people of Dhakarjun and Phalak communities and Hydro-Meteorological data were analyzed for Jomsom station. Dhakarjun and Phalak communities are located in north eastern side about nine kilometres away from the Jomsom. It is found that the local communities had agreed to use water and agricultural practices as recommended by community leader, 'Mukhiya'. They had allocated water using time frame as per number of households and had promoted agricultural practices including apple farming, house construction/repair in consideration to changing climatic conditions. The community leaders mentioned that due to such proper consideration of climate change including less availability of water, they are able to properly manage water for nearly hundred households. They were happy to inform that nobody was migrated due to the reason of climate change and/or scarcity of water in their communities.

V. Conclusion

It is a fact that Nepal has negligible contribution in global greenhouse gases (GHGs). However, the country has already seen various adverse impacts of climate change in many sectors. Those sectors may be water, health, agriculture, forestry, biodiversity, economy and so on.

Nepal Himalayas are main source for major rivers of the country and it is also known by 'water tower' in the region. It is in the sense Glacier works as 'water storage reservoirs' and Nepalese rivers significantly contributes in the lean flows of downstream regions including India.

Nepal should promote eco-friendly works to reduce emission of GHGs. Such kind of activities can be considered as mitigation measures against climate change. Forest conservation, use of renewable energy including micro-hydro plants, scientific ways for urbanization along with agricultural activities, waste management and so on can be taken as some of the examples of the eco-friendly works which should be enhanced for the better environmental condition in the nation. Nepal should lead the issues of least developed as well as mountainous countries in the world especially considering the climate change. The nation should properly utilize the external

and/or internal economic resources with due consideration of development and environmental aspects along with the sustainability of the programs and/or projects for the betterment of Nepalese communities.

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