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CLIMATE CHANGE AND ITS IMPACTS IN NEPAL



A term paper report

Submitted to

CENTRAL DEPARTMENT OF ENVIRONMENTAL SCIENCE

Institute of Science and Technology

Tribhuvan University

Kirtipur, Kathmandu, Nepal

In partial fulfillment of the requirements for the award of Degree of M.Sc. in
Environmental Science

Submitted by

Regan Sapkota

Roll No.: 3

T.U. Registration No. : 5-2-37-719-2010

Date: 9/18/2016



TRIBHUVAN UNIVERSITY

Tel No: 4332147

Central Department of Environmental Science

Kiritipur, Kathmandu, Nepal

Date: 9/18/2016

LETTER OF RECOMMENDATION

I, hereby, certify that the term paper report entitled “**CLIMATE CHANGE AND ITS IMPACTS IN NEPAL**” submitted by Mr. Regan Sapkota submitted to the Central Department of Environmental Science is based on scientific investigations carried out by the student under my supervision.

(Supervisor)

Prof. Kedar Rijal, PhD

Central Department of Environmental Science

Tribhuvan University

Kiritipur, Kathmandu, Nepal



TRIBHUVAN UNIVERSITY

Tel No: 4332147

Central Department of Environmental Science

Kirtipur, Kathmandu, Nepal

Date: 9/18/2016

LETTER OF APPROVAL

We hereby certify that the term paper report “**CLIMATE CHANGE AND ITS IMPACTS IN NEPAL**” submitted by Mr. Regan Sapkota to the Central Department of Environmental Science has been accepted as the requirement for the partial fulfillment of Masters in Environmental Science. The report is based on the work of the student under the supervision of Prof. Dr. Kedar Rijal.

Prof. Kedar Rijal, PhD

Supervisor and Head of Department

CDES, Tribhuvan University

Kirtipur, Kathmandu, Nepal

External Examiner

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Regan Sapkota

regan.sapkota2@gmail.com

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ABSTRACT

Climate change may be caused by both natural and anthropogenic forcing, but at present time unsustainable anthropogenic activities and enormous greenhouse gases (GHGs) emissions are causing erratic climate change. The Earth's average temperature has risen by 1.5°F over the past century, and is projected to rise another 0.5°F to 8.6°F over the next hundred years. Nepal is one of the least developed country in the world and was ranked as the 4th most vulnerable country due to the impacts of climate change by Maplecroft in 2010, but, in contrary, it is one of the least contributor to global GHGs emissions, emitting 0.027% of global total. Lack of adequate fund for adaptation makes Nepal and its people very vulnerable to climate change. This study is intended to study the impacts of climate change that Nepal might face in future. The study was generally based on the secondary data like journal papers, reports and others. Nepal lies in Hindukush Himalaya region and IPCC 4th Assessment report suggests region as a “white spot” due to the lack of adequate research. Even though compressing limited number of research, climate change is supposed to cause enormous negative impacts in this region and Nepal. It was found that the temperature of Nepal is warming at the rate faster than that of the global average. Review of many papers shows that vulnerability of Nepal may be alleviated by the fact of country’s fragile ecosystem, uneven topography, high dependency on agriculture, hydroelectricity and low GPD. It was seen that climate impacts many key sectors of Nepal like agriculture, hydroelectricity, food security, tourism and many others. Climate change is expected to cause many other climate induced hazard like flood, drought, landslides. Thus, these impact will directly impacts the economy of the country and hence the livelihood of the people.

Keywords: Climate change, climate induced disasters, Green House Gases, impacts, IPCC, vulnerable

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ABBREVIATIONS AND ACRONYMS

AR5	Assessment Report 5
CBS	Central Bureau of Statistics
CDES	Central Department of Environmental Science
CO ₂	Carbon Dioxide
Ex.	Example
GDP	Gross Domestic Products
GHGs	Green House Gases
IDS	Integrated Development Society
INGO	International Non-governmental Organization
IPCC	Intergovernmental Panel on Climate Change
LAPA	Local Adaptation Plan of Action
MoPE	Ministry of Population and Environment
M.Sc.	Masters in Science
NAPA	National Adaptation Programmes of Action
NGO	Non-governmental Organization
NPC	National Planning Commission
REDD	Reducing Emissions from Deforestation and Forest Degradation
TU	Tribhuvan University
UNCBD	United Nations Convention on Biodiversity
UNCCD	United Nations Convention to Combat Desertification

UNFCCC

United Nations Framework Convention on Climate Change

US\$

United States Dollar

CHAPTER I

INTRODUCTION

1.1 Background

Intergovernmental Panel on Climate Change fourth assessment report defines climate change as 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. Climate change may be due to natural internal processes or external forcing such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes. United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as: “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

Greenhouse gases is considered as the major force in causing the accelerated climate change. Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by unsustainable anthropocentric activities, and are now higher than ever. Their effects, together with those of other anthropogenic drivers are extremely likely to have been the dominant cause of the observed warming since the mid-20th century. Earth's average temperature has risen by 1.5°F over the past century, and is projected to rise another 0.5 to 8.6°F over the next hundred years. Small changes in the average temperature of the planet can translate to large and potentially dangerous shifts in climate and weather (US EPA, n.d.).

Rising global temperatures cause significant impacts on weather and climate. Many places have seen changes in rainfall, resulting in more floods, droughts, or intense rain, as well as some place has witnessed more frequent and severe heat waves. The planet's oceans and glaciers have also experienced the impacts of changing climate; oceans are warming and becoming more acidic, ice caps are melting, and sea levels are rising. As these and other changes become more pronounced in the coming decades, they will likely present challenges to our society and our environment (US EPA, n.d.).

Nexus between climate change and its impacts on Nepal

Nepal is a land-locked country located in South Asia between India and China, at 28° North latitude and 84° east longitude. It has an extremely varied and complex climate, driven by the uneven terrain and regional weather systems. Within a few hundred kilometers, the country's elevation changes from the lowland of 70m in the Terai to the top of the world, Mount Everest (8,848m). Nepal is considered as one of the top ten countries most likely to be impacted by global climate change (WFP, 2009) but is one of the least contributors to the emissions of greenhouse gases (GHGs), emits only 0.027% of global share (INDC, 2016). Nepal is one of the least developed countries of the world having GDP of mere US \$562 (CBS, 2012) with around 25% of the total population living under poverty line as of US\$ 1.25 a day (NPC, 2010). Nepal economy is highly dependent upon agricultural sector (contributes about 38% of the country GDP), and supports more than 70% of the country population (CBS, 2012). In addition, Nepal ranks 145 on the Human Development Index. All these facts makes Nepal very vulnerable to climate change (INDC, 2016).

Data on trends of Nepal from 1975 to 2005 showed that temperature rise by 0.06°C annually whereas mean rainfall has significantly decreased on an average of 3.7 mm (-3.2%) per month per decade. Under various climate change scenarios, mean annual temperatures are projected to increase between 1.3-3.8°C by the 2060s and 1.8-5.8°C by the 2090s. Whereas, annual precipitation is projected to reduce in a range of 10 to 20% across the country (INDC, 2016). The temperature in the Himalayas, however, is increasing at a faster rate, and this has serious impacts on the country's glacial lakes (Raut, 2004). According to Nepal's second communication report, 2014; overall seasonal maximum temperature in the country is found to have the largest increase of 4.5°C in spring and smallest increase of 3.3°C in summer, whereas minimum temperature in the country is found to have the largest increase of 5.4°C in winter and smallest increase of 3.4°C in summer by the end of the 21st century. PRECIS projection found that annual precipitation will decrease by 2% of the baseline amount by 2020s. However, it will increase by 6% and 12% of the baseline by 2050s and 2080s (MoSTE, 2014).

Legal framework

United Nations Framework Convention on Climate Change (UNFCCC) is the focal body of UN for climate change. Nepal signed the UNFCCC on 12 June 1992; it was ratified on 2 May, 1994 and entered into force on 31 July, 1994. Nepal's Ministry of Population and Environment (MOPE) is the focal point for the UNFCCC whereby it coordinates climate related activities in the country.

Key Policy Interventions/Submission by Nepal

- Climate Change Council, 2009, chaired by the Prime Minister
- Climate Change Management Division, 2010, MoEnv
- National Adaptation Programme of Action, 2010
- Climate Change Policy, 2011
- Climate Resilient Planning Tool , 2011: NPC
- Local Adaptation Plan of Action (LAPA), November 2011
- Intended Nationally Determined Contributions, 2016
- National Adaptation Plans is ongoing

The Government constituted the Climate Change Council under the chairpersonship of the Prime Minister in 2009, endorsed the Climate Change Policy in 2011, adopted the National Adaptation Programme of Action (NAPA) in 2010 and framework for Local Adaptation Plan of Actions in 2011. In 2010 a Climate Change Management Division under the Ministry of Environment (currently Ministry of Population and Environment) was established and two years later the Climate Change Budget Code was approved. Adding to this, the National Planning Commission prepared a tool for climate resilient planning which mainstreams adaptation to climate change into the planning process.

1.2 Statement of the Problem

Climate is changing at an unprecedented rate and this is highly impacting people of Nepal as well as the economy of the country. Nepal's low resilient capacity, lack of adequate fund for adaptation makes Nepal and its people very vulnerable to climate change. Adding to this, it is observed that climate change impacts largely on agriculture, tourism, hydroelectricity, economy, livelihood and might cause many climate induced disaster like GLOFs, landslide,

flood, drought, epidemic. Thus, this study is intended to study the impacts that Nepal might face as an effect of climate change in future. This paper might be helpful to develop certain remedial plan to adapt or mitigate those situations.

1.3 Objectives

General Objective:

To study the impacts of climate change in Nepal.

Specific objective:

- To study the impacts of climate change by sectoral basis in Nepal

CHAPTER II

MATERIALS AND METHODS

This study was generally based on the secondary data. Many journal articles published on the international journal, few reports and some authorized web page were critically reviewed. Syntheses have been drawn after reviewing those papers in order to document nexus and the impacts of climate change in Nepal.

CHAPTER III

RESULTS AND DISCUSSIONS

Impacts of climate change is uncertain. Nepal lies in the central part of Hindukush-Himalaya region. IPCC's AR4 designated this region a "white spot" because of the limited scientific studies. Meanwhile, the number of researchers we have till now suggests that few positive impacts of changing climate might be seen in some places, but, in the long run in most of the places, the negative impacts is projected to be dominant. Some of the impacts of climate change that Nepal is facing and might be facing in future are discussed below.

3.1 Temperature and Precipitation Projections of Nepal

According to the study done Nepal Climate Vulnerability Study Team (NCVST) 2009, the projection of climate change in Nepal is given below:

- Global circulation model (GCM) projections indicate that the temperature over Nepal will increase between 0.5°C and 2.0°C with a multi-model mean of 1.4°C, by the 2030s and between 3.0°C and 6.3°C, with a multi-model mean of 4.7°C, by the 2090s. GCM outputs suggest that extremely hot days (the hottest 5% of days in the period from 1970 to 1999) are projected to increase by up to 55% by the 2060s and up to 70% by the 2090s.
- GCM outputs suggest that extremely hot nights (the hottest 5% of nights in the period from 1970 to 1999) are projected to increase by up to 77% by the 2060s and 93% by the 2090s.

- GCMs project a wide range of precipitation changes, especially during the monsoon: from a decrease of 14% to an increase of 40% by the 2030s and from a decrease of 52% to an increase of 135% by the 2090s.

3.2 Impacts on Agriculture

The agricultural sector accounts for around three quarters of employment and around one-third of Gross Domestic Product (GDP) in Nepal. The sector is predominantly made up of small-scale farming and much of this is dependent upon monsoon natural rainfall. Agriculture is considered extremely sensitive to climate change. Climate change might reduce the amount of the desirable crops while on the other hand encourages pest and weed proliferation. Agriculture in Nepal is highly vulnerable to climate change due to its rugged terrain with steep topography, tectonically active geology and related risks of the natural disasters. Large proportion of marginal farmers with small landholding, limited irrigation availability, low income level, limited institutional capacity, and greater dependency on natural resources increase the degree of vulnerability (Regmi and Adhikari, 2007; World Bank, 2008).

Farmers are likely to face three types of costs from climate change, namely, direct impact costs, indirect impact costs, and adaptation costs (Pant, 2011).

- Direct impacts costs includes the cost of effects of climate change on crop production, livestock production, and risks of natural hazards.
- Indirect impacts costs includes the cost of effect of climate change on socioeconomic conditions and lost opportunities.
- Adaptation costs includes the cost incurred to keep themselves away from or minimize the negative effects of climate change.

A number of additional potential effects from climate change are highlighted, including higher flood risks, enhanced soil erosion and changes in the range/prevalence of pests and diseases – these would all be likely to increase impacts to the agricultural sector (IDS-Nepal et al., 2014). Study shows that increase in temperature has positive impacts on the production of rice. According to MoPE, 2004; rice production may increase by 0.09% to 7% in the case when temperature is increased up to 4°C and precipitation is increased by 20%. The analysis

found potentially high impacts in the Terai region, especially for rice and wheat production, but a varied pattern in the hills and mountains. Assuming that the projected loss of rice and wheat yields in Terai region, the climate change is likely to reduce food production in Nepal. Everything else remaining the same, the national loss in food production is expected to be 5.3% in 2020s, 3.5% in 2050s and 12.1% in 2080s. The loss of food grain thus accounts to 435 thousand metric tons in 2020s, 302 thousand metric tons in 2050s and 1040 thousand metric tons in 2080s. By the 2070s, net agricultural losses in Nepal are estimated to be the equivalent per year of around 0.8% of current GDP, or US\$140 million/year in current prices. The impacts will be much more severe in years of extreme rainfall variability. However, it is to be noted that increase in maximum temperature different effect in mountainous region than that of Terai (IDS Nepal et al, 2014).

On the other hand climate change is making the situation of the food security even worse. Climate change have affected production, processing, consumption and distribution of food either directly or indirectly. Thus, plays a significant role in the alteration of the personal hygiene and human health by increased activities of the pathogens (Pant, 2012).

3.3 Impacts on Livestock Production

There is a growing concern on the effects of climate change on livestock production. Climate change can have positive as well as negative impacts on livestock production. On positive aspect, rise in temperature may result into more greenery and pasture land, benefiting livestock production in high mountains. However, opinions are divided. Several studies (e.g. Kabubo-Mariara, 2009, Hertel and Rosch, 2010) show that climate change adversely affects livestock and poultry production. Kabubo-Mariara (2009) argues that livestock production is highly sensitive to climate change.

Climate change also increases mortality and morbidity of animals particularly from the climate sensitive infectious diseases (Patz et al., 2005b). Increases in zoonotic diseases among the animals also increase the risks of transmission of such diseases in human beings. Increased temperature and relative humidity is said to increase the risks of aflatoxin development in feedstuffs whereby increasing the risks of poisoning among animals (Pant, 2011). Moreover, it is said that climate change increases the costs of veterinary medicines

in livestock and poultry production. In summary, as a result of climate change, Nepalese farmers have to bear loss from the livestock production.

3.4 Impacts on Hydroelectricity

Water is critical for Nepal's power production as hydroelectric plants provide around 90% of total electricity (IDS-Nepal, 2014). Rainfall has a major influence on electricity generation. During the dry season, river flows are insufficient to operate all plants, which results in high levels of planned interruptions. An analysis of the impact of climate variability on electricity production (and the impact of planned interruptions) indicates that economic costs could be equivalent to 0.1% of GDP per year on average, and 0.3% in very dry years. On the other hands, hydroelectric plants are also subject to the risks of floods including, GLOFs in some locations. For example a multi-million dollar hydropower facility was lost in 1985 due to a GLOF event and there have been more recent losses of micro hydro plants from floods (IDS Nepal et al., 2014).

Thus, for the country like Nepal which is highly dependent on the hydroelectricity for power generation, climate change is considered as curse in the long run. Many reports says that, due to glacier melting the discharge in the river will increase for certain period of time and that particular time might be fruitful for the electricity generation. But, if we consider long run, water discharge level is supposed to decrease after 2050, thus it will be hard for Nepal to extract high amount of electricity from running water. Many other climate induced disaster like GLOF, flood, drought, landslides, erosions are also supposed to cause negative impacts on hydroelectricity generation (IDS Nepal et al., 2014).

3.5 Impacts on Livelihood

Climate change impacts will affect Nepal through a number of pathways, including disasters, hydropower, irrigation, and domestic water usage. This might lead to the change in livelihood of people. Some people migrate to other place for better livelihood. While some others might change their habits to adapt to the changing climate, some people have changed their cropping systems or patterns. Few case studies done by IDS Nepal shows that, there is increase in the frequency of occurrence of hailstorm in Kaski district while on the other hand, west Rapti river side have witness high number of floods in last decade. Meanwhile, in Mustang a decline in the productivity of buckwheat over the last decade was seen. The above

three case studies from different part of Nepal can be an example on how climate change is affecting different communities of the country. Nepal has suffered from the impacts of increased frequency of extreme weather events, such as landslides, floods and droughts resulting in the loss of human lives as well as high economic costs and social disputes. The way of living has been changed by the impacts of climate change.

About 1/3rd of working force of Nepal is dependent upon agriculture as their major occupation to sustain their livelihood. But as discussed above agriculture is very sensitive to climate change. The negative impacts of climate change on agriculture might largely affect the economy and hence the livelihood of the people. Many people are also dependent upon tourism sector to sustain their livelihood, but for mountainous country like Nepal, climate change might cause many adverse impacts in tourism sector which might ultimately affect the livelihood of the people who are dependent upon the tourism sector to sustain their livelihood.

3.6 Impacts on Economy

Current climate variability and extreme events lead to major economic costs in Nepal. These are dominated by floods, soil erosion, droughts but also include rainfall variability on agriculture. Low seasonal river flows reduces hydroelectricity generation which impacts greatly on country's economy. The 2013 study on Economic Impact Assessment of Climate Change in Key Sectors (agriculture, hydropower and water-induced disasters) has estimated direct cost of current climate variability and extreme events equivalent to 1.5 to 2% of current GDP per year (approximately USD 270-360 million per year in 2013 prices) and much higher in extreme years, rising to 5% or more. This is high by international levels (IDS-Nepal et al., 2014). An indicative analysis of the impacts of climate change on water-induced disasters at the national level estimates that the additional average expected annual direct cost could be equivalent to 1.1% per year of current GDP by mid-century, with an upper estimate of almost 3% per year.

3.7 Climate Induced Disasters

Climate change not only affects agriculture, livestock, tourism, hydroelectricity, livelihood and economy. It is supposed to affect almost every sector and people from every walk of the life, either directly or indirectly. Besides direct impacts of direct of climate change there is

many other indirect impacts of climate change that might affect Nepal and its people severely. Climate induced disaster and their further consequences can be as the indirect effect of climate. Some of the disaster that can be triggered by climate change is discussed below.

Flood:

Floods in Nepal are particularly associated with summer monsoon rains, and are a feature of current climate variability. The country's more than 6,000 rivers and rivulets, with a total of 45,000 km in length, support irrigated agriculture and other livelihoods, but also wreak havoc in valleys and in the Terai when they overflow. For example the Koshi embankment breach flood caused by institutional dysfunction affected 3.5 million people in Nepal and India (Dixit, 2009; Shrestha et al., 2010). At the same time, the return period of a flood of a certain magnitude is found to reduce significantly, such that the flow associated with a 1-in-10 year event could happen every few years under climate change, and a 1-in-100 year event could occur every few decades (IDS-Nepal et al., 2014). In most cases, climate change is projected to increase the intensity and frequency of high flows, and increase flood risks in Nepal. Flood inundation is the major climate-related hazard in the country, affecting property, agriculture, infrastructure (roads, bridges, communications and transmission networks), business and commerce and, at worst, causing loss of life. Each major flood costs the average household the equivalent of US\$9,000. In a desperately poor country such as Nepal, where average household annual income in 2011 was US\$2,700 (using 2011 exchange rates), these floods are a huge financial burden. The floods also bring water-borne diseases such as cholera and typhoid, putting lives at risk. This story is replicated across Nepal. Between 1983 and 2010, floods have every year on average resulted in 283 deaths, 8000 homes destroyed and 29,000 families affected (CDKN, 2014). There are also additional risks from Glacial Lake Outburst Floods (GLOFs) which can impact on communities and infrastructure for considerable distances downstream. Geo-scientist have predicted that 4 degree Celsius increase in temperature could wipe out 70% of snow and glaciers and this eventually resulting in GLOF. INDC of Nepal, 2016 stated that, in Nepal's Himalaya, total estimated ice reserve between 1977 and 2010 decreased by 29% (129 km³). The number of glacier lakes increased by 11% and glaciers recede on an average by 38 km² per year during

the same period. Hence, climate change has visible and pronounced impacts on snows and glaciers that are likely to increase the possibilities of Glacier Lake Outburst Floods.

Landslides:

It is another climate induced hazard which are often related to extreme rainfall or flood events. Landslides also have significant impacts on communities and infrastructure. Nepal is a country of uneven terrain and people of hills and mountainous region are consider to be vulnerable to landslides. Occurrence of landslides can be triggered by high precipitation hence climate change can be significant role in increase the frequency of the precipitation and hence the landslide.

Drought:

Due to climate change some part of the country might get excessive amount of rain while other part might suffer from drought. Increasing temperature might trigger drought event. Climate dynamics suggest that agriculture in Nepal will face immense challenges as seasonal drought increases. The impact of the 2008-2009 winter droughts on farming and on local food security was severe. In that period, most monitoring stations received less than 50% of normal rainfall, 30% recorded no precipitation at all and temperatures were 1-2°C above average. At the national level, wheat and barley production decreased by 14.5% and 17.3% respectively and the 2009 maize production was also seriously affected. At present, 40 districts, mostly in the West, face major food deficits. The increase in the frequency in the occurrence of the drought event will effect severely in agricultural sector. Thus, Nepal, a country with its 1/3rd of working force dependent upon agriculture to sustain their livelihood will be severely impacted.

Forest fire:

An increase in the frequency and intensity of droughts, if coupled with extended forest cover, will greatly increase the risk of forest fires. These fires not only had a negative impact locally but have other indirect long-term impacts, too. The loss of forest implies loss of local livelihoods. It may also affect integrity of local water sources. Biodiversity also will be severely impacted by forest fire and changing climate.

Besides these there are many other climate induced hazards whose frequency might be enhanced if the climate continues to change abruptly. National Adaptation Programme of Action (NAPA) 2010, ranked 29 districts as highly vulnerable to landslides, 22 districts to drought, 12 districts to GLOFs, and 9 districts to flooding.

CHAPTER IV

CONCLUSION

Overall, it can be concluded that climate change and Nepal have a nexus between each other. It was found that the temperature of Nepal is warming at the faster than that of the global average. Review of many papers shows that Nepal is very vulnerable to climate change and this problem may be alleviate low resilient capacity. It was seen that climate impacts many sectors. Few sectors in which GDP of the country is highly dependent is also impacted by climate change. For example agriculture, hydroelectricity. Climate change is expected to cause many other climate induced hazard like flood, drought, landslides, forest fire etc. with it. Climate change thus directly impacts the economy of the country and hence the livelihood of the people.

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