MELTING ICE: "WARNING SIGNS"

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Abstract

Melting ice is one of the concerns of world climate scientists and planners. It is the gradual change of ice in the liquid form caused by increase in atmospheric temperature. Global Warming is the increase in atmospheric temperature caused by greenhouse effects (CO_2, CH_4, N_2O and CFCs). Increase in temperature of atmosphere by 1°C that has been occurred since 1860 AD (IPCC, 1996). Scientists predicted that the Earth would warm by 1.4 to 5.8°C by 2100. In case of Nepal, increase of temperature was recorded 0.06°C per year (DHM). Sea level rise causes by melting ice is recent warning sign. The Times Center, 2007 estimated sea level rise would be 51 -140 cm by 2100 AD. It affects wide variety of ecosystem, water resources, agriculture, life and livelihoods of people in the world. However, its impact is largely unpredictable and uncertainty. There were series of glacial outburst in Nepal since 1964, destroying ecosystem of surrounding region caused by global warming. Therefore, IPCC member's countries with United State of America (USA) must act quickly to reduce greenhouse gasses to overcome threat of melting ice.

***Key words**: Ice melting, Global Warming, Greenhouse Gas, Sea Level Rise and Greenhouse Effect*

Introduction

Impact of ice melting is not some one else is concern but it is very real threat to the lives and livelihoods of world. It largely affects coastal regions throughout the world, causing flooding, erosion, and saltwater intrusion into aquifers and freshwater habitats. It is the major consequences of "Global Warming" and it has already killed 150,000 people a year worldwide (Lean, 2003). Green house effect is the effect of heat trapped in the lower atmosphere due to presence of greenhouse gases that causes increase in air temperature of globe. This is due to Carbon dioxide, Methane, and Nitrous oxide emission. These three major gases contribute about 88 per cent of the increase radiative forcing of the atmosphere. World Data Centre of Greenhouse gases reported recent global abundance of gases is 377.1 ppm, 1.783 ppm and 318.6 ppb respectively (World Climate News 2006). Rise of the gasses in pre-industrial period and postindustrial period is given in Fig, 1, 2, 3. Those gases were increased by 35,155 and 18 percent after industrialization respectively. Records shows that during ice ages the carbon dioxide in the atmosphere was around 200 ppm, during warm period it reached around 270 ppm. Because of the anthropogenic reason in the atmosphere, has reached 360 ppm in the 1990s and now has reached 377.1 ppm, Fig 1 (Brown, 2004). Average increase of the gas is at the rate of 3 ppm a year (WCN, 2006).

"Melting Ice "in Green land, Antarctica and mountains with rise of sea level and depth of adjacent seas are becoming a hot topic of debate for the Climate Specialists. A team of scientist believed that the ice melt is temporary and would not play such dramatic role of disaster. According to John Christy, professor of Alabama University, Greenland did not melt much within the past thousand years when it was warmer than now and said that global warming is real and manmade, but he believes it is not as worrisome as advertised. But University of earth science professor Lonnie Thomption, a polar ice specialist said there will be unpleasant surprises as we move in to the 21st century and said the world's coastlines have

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swamped much earlier than most predicted (The Times Center, 2007). Intergovernmental Panel of climate change (IPCC) scientists have been working on climate change and its impact on sea level rise. Some previous prediction for sea level rise caused by different source are given below in Table 1 and 2. If sea levels reached up to 51 to140 cm by 2100, some great cities like London, New York and New Orleans would get flooded (The Times Center, 2007).

Table 1 Estimated contribution of sea level Rise (cm) over last 100 years

S.N	Title	Low	Best estimate	high
	Thermal Expansion	2	4	6
2	Mountain glacier	1.5	4	7
3	Green land ice sheet	1	2.5	4
4	Antarctic ice sheet	.5	0	5
5	Total	-0.5	10.5	22

Source: Santra, 2001.

Table 2 Estimated contributions to sea level Rise (cm) from 1990-2030

S. N	Title	Low	Best estimate	high
1	Thermal Expansion	6.8	10.1	14.9
2	Mountain glacier	2.3	7.0	10.3
3	Green land ice sheet	.5	1.8	3.7
4	Antarctic ice sheet	-0.8	-0.6	0
5	Total	8.8	18.3	28.9

Table 1 shows three different types of estimations on the sea level rise over the last 100 years. According to this table, there might be about 10.5 cm rise in the sea level. This rise in the level of the sea didn't seem too worrying and it might not have been the threat to the coastal environment. Table 2 shows us the estimations done on the sea level rise to the end of 2030.The table tells us that an average of 18.3 cm sea level rise will occur during the period. There are speculations about the sea level that to rise even further up to 55-140cm which might be worse than it seems for the environment of the world.

Objectives of this paper: The main objective of the paper is to give some accounts on melting ice, global warming, greenhouse gasses and greenhouse effects. The Specific objectives are:

- To explore the major cause of sea level rise, past and recent status of sea level of the world and their role on lives and livelihood of the world.
- To highlight the status of ice melting in Nepal and future consequences caused by ice melting and the role of government to overcome its impacts.
- To understand the soil, plant and greenhouse gas emission mechanism and to reduce the uncertainties in the greenhouse gas emission estimates and mitigates the emission level.

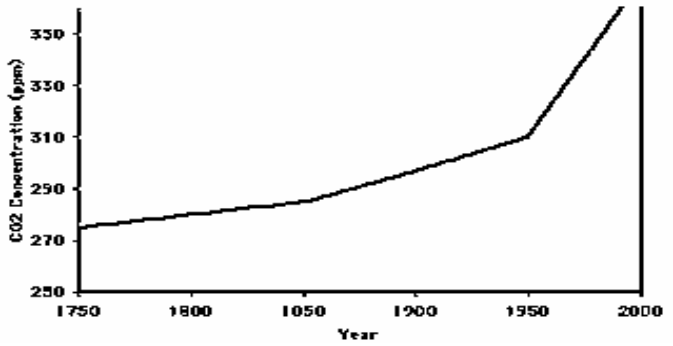


Fig.1. Rise in concentration of Carbon dioxide

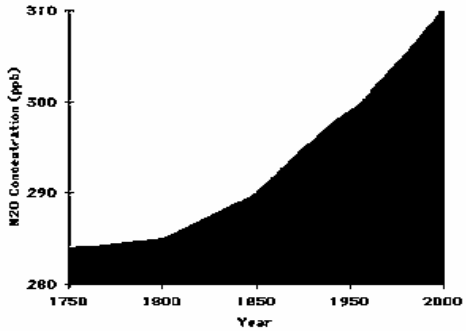


Fig.2. Rise in concentration of Nitrous oxide

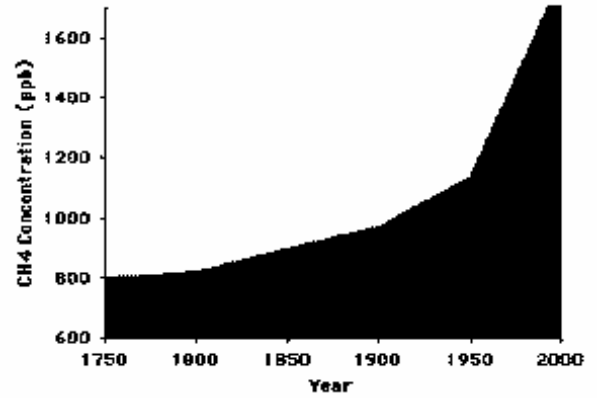


Fig.3 Rise in concentration of Methane

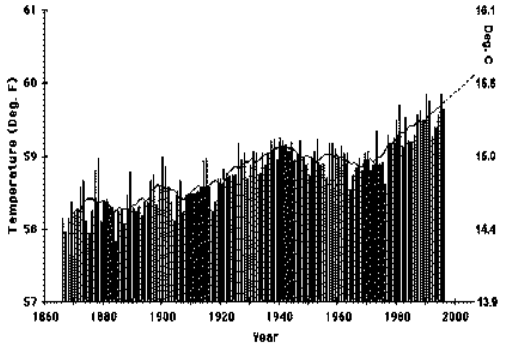


Fig.4 Rise of temperature with time (1860-2000)

Sources: (IPCC 1996)

Fig. 1, 2 and 3 are the representations of the concentration of greenhouse gases during the last 250 years. The figures show that the increase in concentration of these gases has been alarming for the last 50 years in case of methane and carbon dioxide but not so sharp in case of nitrous oxide. Tables depicted warming signs have came only after industrial revolution. Fig. 4 shows the rise of temperature with time from 1860 to 2000. It shows that the increase in the average temperature is 1°C with the curve going down slightly in the 1970s and then rising sharply. This proves that the earth is getting warmer.

Nepal is mountainous, landlocked and agro-based country. It consist of a range of wonderful climatic variation e.g. 11 different bioclimatic zones, 118 diversified ecosystems, 75 vegetation types and 35 forest types (Dobermez 1972). The country is rich in water resources and biodiversity. The annual mean flow of the snow fed major rivers is estimated to be 4930m3/sec (State of environment 2001). It has no access of sea, having no threat of sea level rise no warning signs of sea level rise but there is still alarming threat of ice melting in Hills, Mountains and Terai areas would get flooded. The Himalayas of the country are quite vulnerable to melting ice and land degradation. The country has five potentially dangerous lakes e.g. Dig Tsho, Imja, Lower Barun, Tsho Rolpa and Thulagi all lying above 4100 meters and 6000 rivers and streams. Mt. Sagarmatha–the highest peak in the world, consist of central

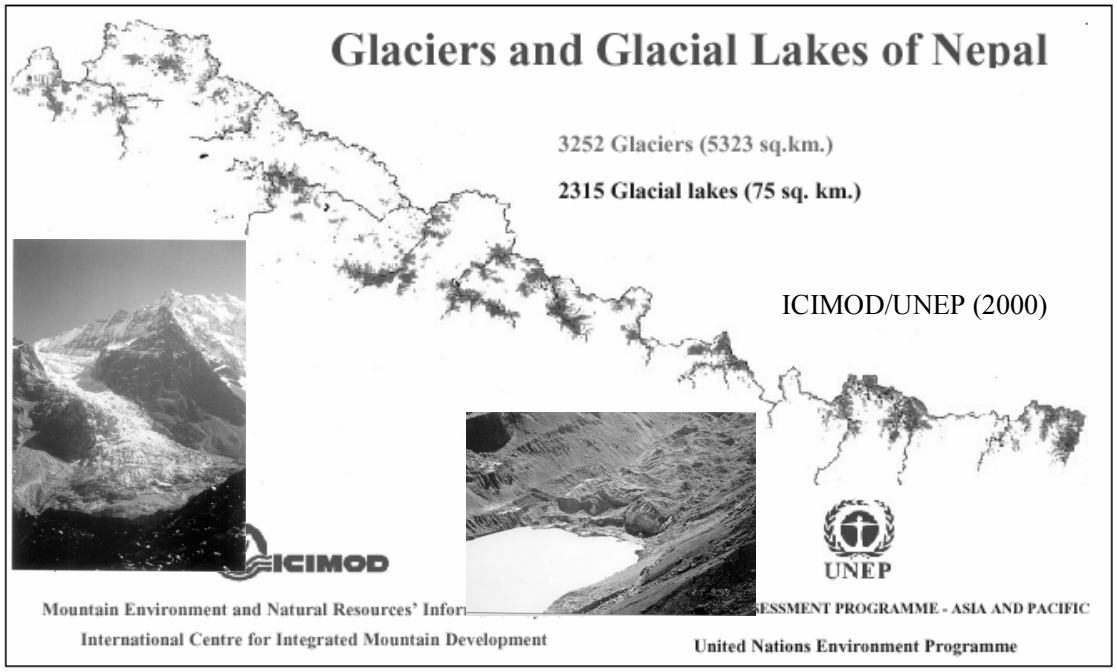
one-third part (885 km) of the entire length of the Himalayas (2500 km). According to Department of Hydrology and Meteorology (DHM) Noguzumpa, Khumbu, Bhote Koshi and Hongu are the four largest glaciers in the Sagarmatha with areas 82.61, 45.39, 39.63 and 22.91 Km^2 respectively.

Mountains are fragile ecosystems, globally important as water sources of the earth and the high altitude areas of above 5000 msl are generally covered with snow. These high mountains are very unique, beautiful and important for tourism and economic development of the country. The growing impact of tourism is also taxing the world's highest mountain. In this region, there is big and small isolated valley system and there are different ecosystem and biodiversity. The kingdom has different climate (altitude varies from 90 to 8848 meters) and different ethnic group distributed throughout the country. The main food of Nepalese is rice and those of mountains are potato, maize and millet. The people of the mountain mostly cultivate potato and livestock as an agricultural practice

Glacier Melting: Nepalese Perspectives

The high mountains of Nepal are more susceptible to thinning ice or retreating glacier mass cause by global warming. The events of glacial lake outburst floods (GLOF) have been experiencing for many decades. This event came as an issue only after 1985 when the Dig Tsho glacier outburst took place. Since the second half of the twentieth century, the glacial environment of the high mountain has been experiencing rapid melting of its large glaciers, instigating the formation of a large number of glacier lakes. It is pointed out that those events were the reason of global warming (State of environment Nepal, 2001). A team sponsored by the United Nations Environment Programme (UNEP) has found signs that the landscape of Mount Everest has changed significantly since Sir Edmund Hillary and Tenzing Norgay first conquered the peak in 1953. A primary cause is ice melting (Danielson, 2002). According to Tashi Janghu Sherpa, president of the Nepal Mountain Association told us that he had seen quite rapid and significant changes over the past 20 years in the ice fields and that these changes appeared to be accelerating. DHM reported AX 010: is small clean glacier mountain. It is shrinking at an alarming rate. If it continues to shrink at the same rate it will disappear by 2060, Rika Samba: The terminus of this glacier is retreating by 10 m per year and Lirung: About 4 m of surface lowering in one year. In 2000 UNEP scientists have pointed out 44 glacial lakes in Nepal and Bhutan that are now so swollen; they could burst their banks in as soon as five years time.

Fig.5 Glaciers and glacial Lakes of Nepal



Source: ICIMOD/UNEP (2000)

Above figure 5, shows clear images of glaciers and glacial lakes of Nepal. It mainly lies in northern part of the country. If anthropogenic greenhouse gasses are not mitigated, warming of climate will continue and cause mountain lakes to burst. It may cause serious damage in infrastructure, bridges, houses, pasturelands, livestock, agriculture and ecosystem of the area. Regular monitoring on greenhouse gasses is required to prevent negative consequences of ice melting in those probable areas. The detail of the glacier lake outbursts in Nepal in the past is given in the Table 3 below.

Impact of "Global Warming "on Agriculture

Global warming can lead to regional and global changes in climate and climate-related parameters such as temperature, rainfall, soil moisture, and sea level. Human health, terrestrial and aquatic ecological systems, agriculture, forestry, fisheries, and water resources are sensitive to changes in climate. Agriculture is sensitive to land degradation: floods, erosion, and landslide and glacier lakes outburst flow. Some important events of glacier melting are given in table 3. The table shows details history in the last 450 year. All these changes caused by melting ice would have tremendous impact on agricultural production. Potential difference between impact of melting ice on agriculture and global warming are given below.

Impact of Melting Ice on Agriculture

May increase photosynthesis because of higher temperature, but all plants will not be benefited.
May increase the total amount of global rainfall. However, there will be regions that may receive less rainfall than before.
Affect on demand for irrigation is likely to increase in all regions that may lead to higher competition for existing water resources.
Affect on evapo-transpiration is a likely result, which may lead to increased frequency of droughts and thus demand for irrigation.
May change the population of agricultural pests, increase diseases and heat stress.
Affect the crop calendar in low latitude regions, particularly where more than one crop is harvested in a year.

Impact of Global Warming on Agriculture

Alteration of the energy balance and circulation system in the World Ocean will directly affect the productivity of the marine ecosystem.
Affect in the food supply and access through their direct and indirect effects on crops, soil, livestock, fisheries, pests, and agricultural land-use.
Availability of irrigation due to ice melting may increase crop productivity in some regions and may reduce in some region.
May lead to the transformation soil organic matter, soil erosion, decline in arable areas and decline productivity of crops.
Frequent GLOF events affect in the deterioration of mountain ecosystem and infrastructures.

Melting ice in Nepalese Environment

As mentioned above, Nepal is mountainous, landlocked and agro-based country with no access to sea. So, there is no threat of sea level rise as in Bangladesh and Maldives. Sea-level rise will only affect coastal regions throughout the world, causing floods, erosion and saltwater intrusion into aquifers and freshwater habitats. However, melting ice is a threat to any country. According to Arun B. Shrestha DHM, following events of GLOF serious caused damages in mountain region: **1. Zhangzangbo -cho** burst twice in 1964 and 1981 and caused enormous damage such as destruction of Friendship Bridge, roads and diversion weir of Sun Koshi hydropower project. **2. Dig Tsho GLOF** occurred in 1985. It damaged Namche

hydropower project, cultivated lands and others infrastructures.**3. Chubung GLOF** in 1991 caused the chain outburst of several ponds, damaged several houses and killed one person.**4. Tam Pokhari GLOF** in 1998 took the life of two persons, damaged six bridges and agricultural lands.

The table 3 is the record of the glacial outbursts occurred in Nepal in the past. Machhapuchhre lake was the first glacier lake that outburst 450 years ago. In the 1960s as many as five outbursts occurred in the country. Affect was observed in Seti Khola, Sun Koshi, Arun and Trisuli river basin. The last outburst was observed when Lake Tam Pokhari burst in the year 1998 and affected river basin was Dudh Koshi.

Policy issues

Although the policies like "Environment Protection Act 1996" and "Environment Protection Rules 1997" ,with the objective of maintaining clean and healthy environment by minimizing negative impacts, has been formulated, there have not been any significant step taken towards its implementation. The governing bodies for the climate change issues, Ministry of Population and Environment (MoPE) and Department of Hydrology and Meteorology (DHM), have not been working properly towards minimizing

Table 3 Past Glacier Lake Outburst Flow (GLOF) in Nepal

No	Date	River Basin	Name of Lake
1	450 years ago	Seti Khola	Machhapuchhare
2	August 1935	Sun Koshi	Taraco, Tibet
3	September 21, 1964	Arun	Gelaipco, Tibet
4	1964	Sun Koshi	Zhangzangbo, Tibet
5	1964	Trishuli	Longda, Tibet
6	1968	Arun	Ayaco, Tibet
7	1969	Arun	Ayaco, Tibet
8	1970	Arun	Ayaco, Tibet
9	Sep. 3 1977	Dudh Koshi	Nare Tibet
10	June 23, 1980	Tamur	Nagma Pokhari,
11	July 11, 1981	Sun Koshi	Zhangzangbo, Tibet
12	August 27, 1982	Arun	Jinco, Tibet
13	August 4, 1985	Dudh Koshi	Dig Tsho
14	July 12, 1991	Tama Koshi	Chubung
15	Sep. 3, 1998	Dudh Koshi	Tam Pokhari

Source: Yamada, 1998; DHM, ICIMOD

the emission of greenhouse gases which is the main cause for the global warming. The steps should be taken to mitigate the threats of the greenhouse gases by the concerned bodies. The number of researches done should be increased to know the exact situation of GHG of the country and actions should be taken accordingly. The chances to minimize the emission of greenhouse gases is very much possible in Nepal as there is more hydropower potential that is capable of replacing the fossil fuels. The sincere adoption of remedies to institutionalize the assessment system as defined by the act and rules is a must. Necessary steps taken should implement the commitments of several conventions carried out earlier.

Conclusion and Recommendations

Nepal is a small country. Nepalese agriculture is not blamed to be a major contributor of atmospheric greenhouse gases like methane and nitrous oxide However, Nepal Agricultural Research Council, has been engaged in research on greenhouse gas emissions from agriculture since 2001 with the collaboration of Japan to understand the soil, plant and greenhouse gas emission mechanism in detail and to reduce the uncertainties in the greenhouse gas emission estimation and mitigate the emissions. The institute has standardized the techniques of gas emission measurement, conducted several field experiments to measure the emissions of methane and nitrous oxide from agricultural soils. Lastly, it is very important that Nepal's ice policy be developed and Environment Protection Act 1996 be revisited and implemented in a proper manner. Therefore, the formulation and implementation of such Acts should be encouraged. The use of alternative energy sources like biogas; micro-hydro power and solar energy for clean development mechanism should be promoted and included in the policies. The paper might be helpful to the policy makers for the enhancement of the knowledge to plan ice and mountain policy. Lastly, it may be helpful in the conservation of mountain environment and reduce the negative impacts of GLOF. Thus it can be concluded that the possibility of overwhelming deglaciation in the Himalayas in near future can be minimized. Lastly, A monitoring system for greenhouse emission must be developed to reduce warning signs of global warming.

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