A COMPENDIUM OF READING MATERIALS

Summer School in Climate Change Adaptation

July 2012

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Acknowledgements

The Third Summer School in Climate Change Adaptation (CCA) is an academic immersion course for development professionals, researchers and promising candidates for future professionals in the field of climate change. This course is designed to enhance understanding on climate science, vulnerabilities and socio-economic impact of climate change and possibilities for adaptation with empowerment of people.

This was one week long program including field study. The program outlined in this reading material book incorporates the articles and presentation of experts on climate change belongs to government, academic, civil society and international areas.

Developing this program with our partners, we hope that the participants who are and will be working on climate change issues read these pages will experience the same enthusiasm that we did in developing it. We believe this collection will help all who use it to discover innovative and new ideas or approaches in climate change adaptation.

We appreciate the contribution of all collaborative agencies for their significant support and cooperation in summer school. In addition to this we would like to express our heartfelt gratitude to USAID funded Hariyo Ban Program for their financial and technical cooperation extended for the summer school.

Summer School Secretariat, 2012

Summer School in Climate Change Adaptation

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2.	Climate Change Science; Impact and adaptation strategies in the Nepalese context,	Prof/ Dr Dinesh Bhuju, Academician and Consultant
3.	Climate Change issues in Water Resource with focus on Nepalese context	Er Adarsha Pokhrel Experts/Consultant
4.	Climate change mitigation Initiatives (Project case stories),	Mr Resham Dangi, REDD Forestry and Climate Change Cell
5.	Environmental and socio - economic vulnerability from Climate Change prospective	Prof Narendra Raj Khanal, Academic Consultant
6.	Climate change impact from Agriculture, food security and livelihood prospective	Prof Khem Raj Dahal Expert/Researcher
7.	Understanding the linkage between climate change and public health	Dr Bishwo Raj Joshi Public Health Consultant
8.	Climate Change adaptation from gender and social inclusion prospective	Ms Meena Kunwar Gender Expert
9.	Integrated Climate Change Adaptation: Ecosystem based adaptation (EbA) and community based adaptation (CbA)	Dr Judy Oglethorpe, Chief of Party - Hariyo Ban

10.	Integration of local adaptation plan in development process and community needs	Dr Sunil Kumar Regmi Coordinator, Hariyo Ban Program
11.	Climate induced disasters: Understanding the issues and Way forward	Dr Narayan Prasad Chaulagain
12.	EU guidelines/prospective on mainstreaming climate change in development cooperation projects,	Ms Flavia Fabiano, Project Officer, ArsProgetti, Bruxelles
13.	Policies and program in climate change: National initiatives, challenges and opportunities (NAPA and LAPA)	Mr Batu Krishana Upreti, Consultant
14.	Climate change issues in Forest and Biodiversity Sectors: global to local context	Dr. Swoyambhu Man Amatya, Expert
15.	Food Security situation and its interlink with climate change adaptation: program policies in Nepal	Dr. Devendra Gauchan Scientist and Expert

Introduction to Climate Change Scenarios: in Development Prospective

- Mr Suresh Pradhan, Academic Director, ISAS

Climate Change is the global phenomena. What is Climate Change? Why and how it is happening? What different approaches are practiced around the world to deal with challenges brought by the climate change? These are the discussion subjects of the Summer School and will be elaborated intensively in the learning sessions over next five days.

I will leave in-depth discussions on Climate Change to the specialists who will share their knowledge on the Climate Change. This paper consists of a discussion on impacts of the Climate Change in development efforts in general and with specific reference to Nepal in Particular.

Climate Change and Global Warming:

From the layman's level of understanding, let's understand Climate Change as changes in temperature and weather conditions on the Earth. While such changes are caused by the natural phenomenon related to the Earth and Sun, human induced changes – large emission of the Carbon Dioxide and other Green House Gases (GHG)[1] and their deposit in the atmosphere is attributed as the major cause of such change in temperature and weather patterns around the world. It is estimated that presence of the Carbon Dioxide, one of the major GHG has increased from 280 parts per million (ppm) before the industrial revolution to 397 ppm now.

I will go straight to this fact of the climate change – the Global Warming. Scientists have traced cycles of such global warming in the history of the Earth and how nature has taken

[1] Mainly Water vapour, Methane, Nitrous Oxide, Chlorofluorocarbon, Ozone. Green House Gases are important for the Earth to maintain balance in its surface temperature. Lack of these gases in the atmosphere will result in the loss of surface temperature of the Earth by 33°C (59°F).

care of such global warming. Often, we can see devastating effects of the Global Warming in their research findings. We know the temperature around the world is rising again. It is estimated that the average surface temperature of the Earth has increased by 0.8°C (1.4°F) since the 1900 and most of this increase happened after 1980[2]. It is estimated that this may increase at least by another 1.1 to 2.9°C (2 to 5.2°F) over the 21st century[3]. If nature can take care of Global Warming, why should we be worried about it then? Yes, nature can and will eventually take care of such changes but that is a very slow process. The natural system of absorbing GHG is disturbed by the rising population and their activities such as extensive burning of fossil fuel, coal and wood for industrial, transport and domestic purposes; extensive industrial processes; rapid urbanization and resulting use of non-renewable energies; and deforestation of forests. Global Warming is therefore taken seriously for the irreversible and irreparable loss it could cause to the environment and life in the Earth.

It is the threat of rising sea level as a result of increase in the Earth's surface temperature that Maldives' fear wiping out its entire islands from the world map. It is the change in precipitation that is disturbing cultivation patterns throughout the South Asia. It is the threat of receding glaciers and snow lines in Nepal's Himalayas that is depleting water resources for drinking water and for irrigation that could decrease quality of life and agriculture yield. These are only a few examples.

There is therefore call for action to minimize such large scale emission and deposit of the green house gases in the atmosphere so as to prevent irreparable losses the global warming could cause in the Earth. The first major event was establishment of the Inter-governmental Panel on Climate Change (IPCC) in 1988 by the UN which is a scientific body of experts that provide authoritative assessment on the risks of climate change and advice on

United Nations Framework Convention on Climate Change

[2] The National Academics Press, Washington DC (2011): *America's Climate Choices*.
[3] Inter-governmental Panel on Climate Change (2007): *The Fourth Assessment Report*.

mitigation or adaptation issues. Another major event is endorsement of the United Nations Framework Convention on Climate Change (UNFCCC), which is an international treaty endorsed in the World Environment Summit (known as the Earth Summit) held in Rio De Janerio, Brazil in 1992. It has now been ratified by 194 parties. Due to objection of some countries, UNFCCC however could not include mandatory requirements for cutting GHG emissions. This was done after adopting the Kyoto Protocol in 1997 which was enforced in 2005 by ratification of the protocol by majority of the countries (191 to date). This put legally binding limits for emission of GHGs for developed countries. Four countries including the United States of America are yet to ratify this protocol. Every year, the conference of parties (COP#) is held to assess progress towards goals set for reducing adverse effects of climate change. COP15 held in 2009 in Denmark was full of action for getting a politically binding agreement for all countries but it could not get endorsement. Similarly, COP16 held in Cancun, Mexico also brought forward the idea of Climate Change loan financing, which is still under debate. COP18 is being held in Doha, Qatar this year.

Impact of Climate Change:

Impact of the Global Warming can be analysed in three broad categories:

Impacts on natural resources and environment:

Impact of Global Warming is widely predicted on the natural resources. There are many scientific predictions of melting of ice in the arctic region and high altitude areas with arctic like climate resulting in shrinking glaciers, shrinking marshlands, rising sea levels. Rise in average surface temperature are also attributed to the changes in rainfall duration and precipitation as in Monsoon of the South Asia region. Global warming is also predicted to cause loss of flora and fauna diversity. These will be dealt intensively by the subject experts over the next few days. Therefore these are not elaborated so much here. Rather we will focus more on impact of Climate Change more on development interventions and achievements.

Impacts on development interventions and achievements:

World development efforts took a new dimension after the Millennium Summit held in the United Nations, New York endorsed the Millennium development Goals in 2000. Departing from the meta-narratives of development theories and practices of 6 decades past, the MDGs, endorsed by 193 UN member countries to date, has eight clearly-focused medium term development goals to be achieved by 2015 to bring about positive impacts for the present and future generations of people. Impacts of Global Warming pose threat to the development interventions and achievements.

Millennium development Goals:

1. Eradicate Extreme poverty and Hunger
2. Achieve universal primary education
3. Promote gender equality and empower women
4. Reduce child mortality rates
5. Improve maternal health

MDG 1 - eradicating extreme poverty and hunger has three main targets – to halve the proportion of people living on less than US$1 a day; to achieve decent employment for women, men and young people and to halve the proportion of people who suffer from hunger. Income of Nepalese households was on increasing trend, thanks to the large number of migrant youth workers whose remittances keep the country going. Nepal is one of those countries where remittances income constitutes almost one fourth (23%) of its GDP. But it places Nepal in a volatile situation as it is vulnerable to the shocks of global financial crisis. Nepal is on track to achieve this target – to reduce proportion of people living in absolute poverty (on less than $1.25 a day) to 21 % by 2015 from 42% in 1996. Agricultural yield and increased income should support food security and keep people free from hunger. The government target is to increase availability, accessibility and utilization of food is becoming a growing challenge in Nepal due to impact of climate change.

Agriculture contributes to one third (35.7%) of the GDP and more than two-third of population are engaged in it in Nepal[4]. Yet it is still mostly subsistence agriculture. Cropping patters and diversity are highly dependent on the Monsoon, which has already seen changes in precipitation and duration, causing disturbance on agricultural yield. Although minor growth in agricultural yield is reported in Nepal (e.g. 5 % growth this year[5]), this is not sufficient to feed the growing number of population. Meanwhile prices of food commodities had escalated over the years (8% according to the government this year alone), which poses real hardship to lower and middle class households to afford and consume quality food. Agriculture and food security are therefore under tremendous threat from adverse impacts of climate change and this could adversely affect the achievements made so far in Nepal.

MDG3 – of gender equality and women's empowerment targets are also under threat as it is the women, who face the brunt of hardships caused to the households. Depleting water resources could increase the time women have to spend fetching water for households consumption thus diminishing their productive roles.

MDG4 – Nepal has made impressive progress in reducing child mortality rates to 41 deaths per 1,000 live births. There is a need to focus more on neo-natal survival where high child mortality is observed. Water borne diseases are still a prime factor for child mortality. Depleting water resources, especially fresh water for drinking water could pose a serious threat to this achievement as well.

MDG5 – of improving maternal health was also an impressive achievement in Nepal. Nepal may very well achieve this goal of reducing maternal mortality to 192 from current level of 281 maternal deaths per 100,000 live births. However, increased drudgery caused by extra time spent to fetch water due to depleting drinking water resources; drinking unsafe water could disturb achievement of this Goal.

[4] Ministry of Finance 2012), Kathmandu: The Economic Survey 2011-12.
[5] Ministry of Finance 2012), Kathmandu: The Economic Survey 2011-12.

MDG6 – Nepal had successfully contained spread of HIV/AIDS pandemic and controlled many vector borne diseases. However rise in thermometer and prolonged warn seasons have already seen reemergence of some of the vector borne diseases like Malaria.

MDG7 – the environmental sustainability goal is perhaps the most affected MDG in Nepal. The fourth assessment of the IPCC predicts possibility of sharp rise in surface temperature in the South Asia Region. Nepal is highly vulnerable to such change in temperature. It has already faced melting of snow and receding of glaciers. With the Monsoon, water recharge system also changing precipitation, Nepal has been witnessing intense rainfall and flash floods but less of water retention by forests and recharging of ground water. And after the monsoon, the rivers quickly go dry. This situation is already causing tremendous difficulties in Nepal in meeting energy (hydro-electricity) needs of households; in supplying adequate drinking water; in maintaining environmental hygiene. Similarly, less retention of water resources by forests means shrinking marshlands, an integral part of ecosystems. Biodiversity and forest resources which cover 24% of land area of Nepal are also under tremendous threat due to human induced changes such as deforestation for agriculture and settlements. Poor governance and infrastructure are only compounding the situation. Ensuring environmental sustainability therefore calls for renewed actions to revert negative impacts of climate change.

And finally MDG8 – Nepal definitely has been receiving development partners' cooperation in financial and technical support from bilateral donors such as USAID and DFID for climate change adaptation plans. These are however less than adequate to meet its challenges and to build resilience capacities of affected communities.

Dealing with impacts of climate change:

We are concerned about adverse impacts of the Climate Change which are not only affecting adversely the lives of people, but also are posing threats to the achievements of development efforts so far. There are two approaches to deal with the impacts of global warming:

Mitigation:

As Professor Nicolas Stern suggests, investment is required for energy efficiency, low carbon technologies and a halt to deforestation. These will in the long run cut back dependence of countries on imported expensive non-renewable fossil fuels; reduce GHGs

emissions and preservation of water resources and bio-diversity. Of course these are long term investments and mitigation efforts take time to produce results.

Adaptation:

As professor Stern therefore argues, adaptation is the need of the hour[6]. There are also arguments that rich and developed countries should make such additional resources available to countries like Nepal as the developed countries are responsible for current high level of GHGs emission and deposit in the atmosphere. Meanwhile, resource poor countries like ours have a choice to make – that is to start early. Yet it is about providing resources for mitigation to reduce GHGs emission and adaptation to the climate change, which are additional resource requirements on top of the country's existing priorities of development.

In Conclusion

It has become urgent as the poor, rural, marginalized communities are facing the brunt impact of climate change which is already threatening their livelihood. It is therefore necessary that Nepal takes following firm steps –

- Communities which are poor and most vulnerable are consulted and supported to develop their adaptation plans to build the climate change resilience;
- Vulnerable rural communities are supported for protection of ecosystems and biodiversity to protect their livelihoods;
- Such communities are trained and supported to protect freshwater resources and to manage rain-fed and ground water.

In order to strengthen national level initiatives to revert the adverse impacts of climate change, it is also necessary to:

[6] Nicolas Stern (2009), The World Bank website: Low Carbon Growth: The only sustainable way to overcome the world poverty.

- Mainstream climate change adaptation measures in national policy and development interventions;
- Correlate adaptation plans with Disaster Risk Reduction and Disaster Risk Management plans to protect loss of lives and to build resilience capacity of vulnerable communities;
- Link adaptation plans with poverty reduction strategies and food security strategies with particular focus on children and women in vulnerable communities.

It is also imperative for the Government to allocate adequate resources and be accountable for proper use of such resources.

And finally, Climate change impacts everybody. Findings objective facts and evidences of impacts of climate change in the lives of rural vulnerable populations should be the business of media as well. Of course impartiality is their mantra but objective coverage of climate change issues will give farmers, women, children in vulnerable communities the most up to date information about the impact of climate change in their lives which should enable them to claim their rights and entitlements and prompt their action to mitigate and adapt to climate change.

Climate Change Science: Impact and Adaptation Strategies in the Nepalese Context
- Prof Dinesh Raj Bhuju, PhD

ABSTRACT

The science of human induced climate change and debate on its possible impacts began over a hundred years ago, which have been realized at public policy level only recently. Climate change, in specific the global warming, is now an unequivocal issue, yet the Himalaya is depicted as "white spot" in the lack of scientific database. Nepal has formulated policy frameworks including program planning for the grassroots. While general people are independently trying to adapt with the impending climatic impacts with hardships, scientific communities are bound to bring new knowledge on the issue. A combination of scientific endeavors in understanding the impacts of climate change and people's experiences of adaptation measures with indigenous knowledge system could emancipate strategies at the best.

SCIENCE AND PUBLIC POLICY

Climate change emerged in the 1980s as a public policy issue posing apparently intractable challenges to science and policies (Gore 1992). In his classic best-selling book *Earth in the balance: ecology and human spirit*, Albert Gore, a strong proponent of climate change issue and US Vice President (1993-2001) described how the engines of human civilization have brought us to the brink of catastrophe, threatening the destruction of nature and ultimately ourselves. Its groundbreaking analysis placed the environment on the national agenda, prompting politicians, the media, and the public to reckon with a looming disaster. However, the scientific debate of climate change, in particular the global warming, had begun nearly a hundred years ago. In 1896, Swedish scientist Svante Arrhenius (1859-1927), a founder of the science of physical chemistry and Nobel laureate (1903), predicted that emissions of carbon dioxide from the burning of fossil fuels and other combustion processes were large enough to cause global warming.

Svante Arrhenius
(1859 – 1927)

Simplified expression of Arrhenius' Greenhouse Law

$\Delta F = \alpha \ln(C/C_{0})$

Arrhenius was the first scientist to envision the impacts of global warming. His pursuit on nature's energy balance and global warming stemmed from a demonstration of the geochemical cycle of carbon dioxide by a contemporary geologist Arvid Högbom in Stockholms. He went on so details that the Arrhenius'

Greenhouse Law was formulated, which reads as *if the quantity of carbonic acid increases in geometric progression, the augmentation of the temperature will increase nearly in arithmetic progression.* He estimated that a doubling of CO_2 would cause a temperature rise of 5–6 °C. Since then, industrial carbon dioxide levels have risen at a much faster rate: Arrhenius expected CO_2 doubling to take about 3000 years; it is now estimated in most scenarios to take about a century. It is remarkable that Arrhenius' laborious analysis gave thermal results close to those later obtained by hundreds of hours of calculations carried out with powerful digital computers (Gustaf Arrhenius et al. 2008).

How the scientists could know the global warming a century ahead? The prediction was never a Nostradamus prophecy, nor a wizard's enchantment. The scientific postulation that global warming will occur due to carbon dioxide from the burning of fossil fuels and other combustion processes through green-house effect was but a plausible reasoning endowed in the discourse of science. Science is now seen as a process, a process of seeking truth, rather than a definition as a subject of systematic study of natural universe. In its recent definition, Science Council of UK (2009) maintained that *Science is the pursuit of knowledge and understanding of the natural and social world following a systematic methodology based on evidence*.

Arrhenius ideas remained in circulation, but until about 1960 most scientists doubted that global warming would occur as they continued to believe that the oceans would absorb carbon dioxide faster than human activities emitted the gas. Also, most scientists dismissed the greenhouse effect as implausible for the cause of ice ages, as Milutin Milankovitch (1879 – 1958) had presented a mechanism using orbital changes of the earth. Nowadays, the accepted explanation is that orbital forcing sets the timing for ice ages with CO_2 acting as an essential amplifying feedback. To 'question' and to 'doubt' is but a part of scientific discourse, which in fact is basis of discovering new knowledge. Scientific methodology has a built-in mechanism to check and revise itself: *falsification*, and science is manner of thinking and working towards more complete knowledge (of the world). This applies to climate change as well.

IMPACT STUDIES

As the climate change became evidently an unequivocal establishment (IPCC 2007), activists and as well as policy making bodies emphasized on its harmful impacts such as aggravation of flood like disasters, food insecurity due to impending drought and pest infestation, extinction of species and ecosystems, epidemic of tropical diseases etc. This has helped development agencies garner support of the political decisions and accumulate the fund on headings like climate change adaptation and mitigation, recently the climate resilience. However, when Arrhenius first calculated the rate of global warming, he pointed to the benign effects of climatic optima in recent geological and cultural history. It should be pointed out here that it was in the perspective of the inclement Nordic

weather that Arrhenius as a "cultural optimist" considered the global warming as an attractive prospect as it would increase abundance of the plant nutrient carbon dioxide promising improved harvests (Gustaf Arrhenius et al. 2008). The recent scientific papers as well do not discard the contribution of global warming and CO_2 fertilization in the increment of agriculture production especially in the mountain highlands at least in its initial phase (Parry et al. 2007).

Nepal is considered to be one of the most vulnerable countries to climate change impacts due to various factors such as its rugged mountain topography, acute poverty, especially in rural areas, and weak national and local institutional capacity. Most often, citing the 2011 report of risk-analysis company Mapplecroft, Nepal is mentioned as the world's fourth most vulnerable country to climate change. A modeling exercise conducted by Nepal Climate Vulnerability Study Team (NCVST) in 2009, using the emissions scenarios in the IPCC's special report (2007) found that the temperature will increase in the mid-hills and that this region is likely to grow more arid in the non-monsoon seasons. It also suggested that precipitation is likely to be more uncertain and that storm intensity will increase. The report included following key insights (NCVST, 2009):

- Global circulation model (GCM) projections indicate that the temperature over Nepal will increase between 0.5ºC and 2.0ºC with a multi-model mean of 1.4^0C, by the 2030s and between 3.0^0C and 6.3^0C, with a multi-model mean of 4.7^0C, 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.

Local perceptions of farmers suggest that days are becoming hotter and precipitation is growing more erratic, while the impacts are noticeable in daily life such as early flowering, drying of water-holes etc. (Baral et al. 2012). Nepal's National Adaptation Plan of Action (NAPA) prepared in 2010 and National Climate Change Policy (2011) also recognize that climate will be uncertain and vulnerability will increase. In scientific communities, the effect of rising temperatures in Nepal has seen through decreased in areas covered by permafrost (Fukui et al. 2007), retreating glaciers (Bajracharya et al. 2007) and advancement of tree-line (Suwal 2008). The impact of the climate change in biological sector in Nepal including phenological shift, range shift of species are also reported, but limited to media reports and with little justification from scientific research and field data. It is to be noted here that the IPCC's 2007 Fourth Assessment Report has

designated Hind Kush Karakorum Himalaya (HKKH) region as a "white spot" because of the limited number of scientific studies conducted on climate related agenda in this region, including Nepal.

A general expectation is that plant species distribution will shift upward due to climate warming, on which scientific information are piling up. A meta-analysis of a global data set, including 166 sites for which treeline dynamics had been recorded since 1900 AD, showed either tree line advances (52% of sites) or stable position, and only few treelines have shown recession (1%) which were anthropogenically disturbed (Harsch et al. 2009). Recently, based on a study covering 66 mountain summits distributed across 17 study regions, Pauli et al. (2012) confirmed that species have moved upslope on average in the European mountain summits although the magnitude and rate of advancement, population growth and stand densification vary on local environmental conditions. Similarly, reports are there that several other faunal creatures have shifted breeding and/or migration dates. According to an analysis of 1700-some species published in *Nature* (2 January 2003, p. 37) mobile creatures such as butterflies and birds have moved ranges poleward an average of 6.1 kilometers per decade since the 1960s.

In Nepal, scientific studies to understand the impact of climate change and reconstruct the environmental history by using dendro-climatological tools have been initiated (Bhuju et al. 2011). In a study carried out in Samagaon of Manaslu Conservation Area in Gorkha, the species limit of *Abies spectabilis* was found to advance from 3673m asl in 1958 to 3841m asl in 2007 with a total of 168 m upslope shift at the average rate of 34.3 m per decade (Suwal 2009). In the same conservation area, a study in another site called Kalchhuman Tal, an upward shifting rate of upper distribution limit of *Abies* at treeline ecotone was calculated approximately 26.1 m per decade (Gaire et al. 2012). The local climatic data documented climatic warming in recent decades, and the regeneration of the species was found positively related with the May to August rainfall and January to April temperature of current year. Similarly, in the study of Langtang National Park, some seedlings and saplings of tree species, indicating upward migration with temperature increase in recent past. Studies are continued in the site, which will bring new knowledge on the subject.

ADAPTATION PLANNING AND PRACTICES

Adaptation is seen as a key element in creating a resilient society. Two approaches have made their headway in the search of adaptation to the anomalies of climate change, one is community based adaptation (CbA) and the other is ecosystem based adaptation (EbA). Community-based adaptation to climate change is a community-led process, based on communities' priorities, needs, knowledge, and capacities, which should empower people to plan for and cope with the impacts of climate change (Reid 2009). CbA identifies the poor as the most vulnerable to climate change, and advocates for greater support and involving them in the process of adaptation planning. On the other hand, EbA promotes

community resilience through ensuring the maintenance of ecosystem services, support adaptation of different sectors, reduce disaster risks, among others (Coll et al. 2009). Through considering the ecosystem services on which people depend to adapt to climate change, EbA integrates sustainable use of biodiversity and ecosystem services in a comprehensive adaptation strategy (CBD 2009). The concept of EbA complements and supports the concept of CbA and unifies approaches to ecosystem management in terms of adaptation.

One of the challenges to adaptation planning in the context of Nepal is to understand the complexity and uncertainty arising from the inherent dynamic nature of the climatic, ecological, socio-economic and political systems (Thapa et al. 2010). Continuous efforts have been made to tackle this challenge at national and international scales. For example, National Climate Change Policy (2011), National Adaptation Program of Action (2010a) and Local Adaptation Program of Action (2011) have set a framework that might eventually facilitate ground level intervention. NAPA draws nine 'combined profiles' built around six 'thematic areas,' namely, Agriculture and food; Water Resource and Energy; Climate-Induced Disaster; Forests and Biodiversity; Public Health; and Urban Settlements and Infrastructure. On the other hand, LAPA provides a framework to take nationally conceived NAPA activities to the grassroots and is geared towards community ownership of planning, implementation and monitoring processes.

The LAPA Framework ensures that the process of integrating climate adaptation and resilience into local and national planning is bottom-up, inclusive, responsive and flexible as the four guiding principles (GoN-MoE 2011b). Recently, the Government of Nepal launched DFID/EU supported climate adaptation project in the 14 hill districts of mid- and far- western Nepal. Involving much enthusiastic young genre of science graduates, the project is preparing vulnerability maps and adaptation planning for five VDC (village development committee) of those districts. As defined in the LAPA Framework the adaptation planning and implementation follows seven-step formulation process, namely: i) sensitization, ii) vulnerability and adaptation assessment, iii) prioritization of adaptation options, iv) formulation of adaptation plan, v) integration into planning processes, vi) implementation and vii) progress assessment.

At local level, people are responding to the hardships to environmental degradation (including those supposedly aggravated by climate change). An example presented here is from Ramechhap, which ranks as the second most vulnerable district (vulnerability score 0.995 out of 1.000) in Nepal (GoN-MoE 2010b). The district is known for being drought prone, with 19 VDCs in its southern belt facing severe drought. A pilot study was undertaken as a part of Adaptation Knowledge Platform in 2012, which revealed that while the problems in some communities are worse than in the others, several problems are common. Each of the areas, at the least, is characterized by 1) erratic rainfall 2) ever depleting water sources 3) crop failure and 4) loss of biodiversity. The local people were found struggling to adapt to the new situation by applying their own traditional

knowledge and experiences, such as maize cultivation instead of the paddy; rearing small ruminants like goats instead of big ones like cattle, water provisioning from poly-pipes from nearby creeks; and rationing of drinking water are some of the examples of local adaptation (Table 1). However, it may be noted that most of the hardships revolve around water scarcity both for drinking and irrigation.

Table 1 Issues and adaptation practices in Pakharbas VDC, Ramechhap, Nepal

Issues	Adaptation Practices
• Erratic rainfall pattern. Monsoon failure since 2004. Increased temperature • Huge scarcity of drinking water • Drying of spring/waterholes (out of 20 waterholes just 5/6 remain now with very limited water) • Paddy cultivation almost abandoned • Depletion in grass/fodder • Heavy infestation of Invasive species • Low agriculture production • Change in livestock holding and rearing • Bee keeping almost wiped out • Early flowering and unseasonal fruiting	• Padlocking waterholes for regulated use of water • Rainwater harvesting wherever supports are available through NGOs • Paddy cultivation replaced by maize • Initiation of cash crops like coffee/Avocado (by a few individuals to a very limited extent) • Forest conservation

Towards the adaptation measures to save Nepal's biodiversity, an example of how an international collaboration has been conceived is given here. Nepal's flora, specifically those in the high mountains are facing threat from impending global warming and also from human activities. As a collaborative project of Nepal Academy of Science and Technology and Ev-K2-CNR (Italy), the Himalayan Seed Bank Project (HSBP) has been initiated in 2010 (Orsenigo et al. 2012). The HSBP aims to collect, preserve and make scientific studies of the high mountain plants, specifically the threatened and rare, in the beginning. To begin with, *ex situ* conservation activities will be carried out at the Sagarmatha National Park; however, in the future the HSB is planning to conserve seeds from all over Nepal. To expedite its objectives a Memorandum of Understanding has been signed between the two organizations and Seed Laboratory has been developed in the premises of NAST. It is hoped that the project will extend its collaboration with Millennium Seed Bank, an international scheme of conserving seeds for the future. Currently, NAST is trying to get support of the Government of Nepal and include its concerned departments in the endeavor.

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Climate Change issues in Water Resource with focus on Nepalese context - Er Adarsha Prasad Pokhrel, ADAPT Nepal

Climate Maker the Sun, and the Earth

The ancient Hindu POORANAS declare **"AAdityad Jayate Vrishti",** the Sun is the creator of precipitation. True indeed, the modern science has proven that the climate of the earth is driven by a continuous flow of energy from the sun which arrives to the earth in the form of visible light. We live on Earth, which is the third planet in distance outward from the Sun. It is at a distance of some 149,600,000 km from the Sun and is believed to be about 4.56 billion years old. This age is determined by dating radioactive isotopes in meteorites.

The earth makes one revolution, or one complete orbit of the Sun, in about 365.25 days at a mean distance of approximately 149 million kilometers, an axial rotation period of 23 hours 56.07 minutes. Its total surface area is roughly 509,600,000 sq km of which about 71% is water.

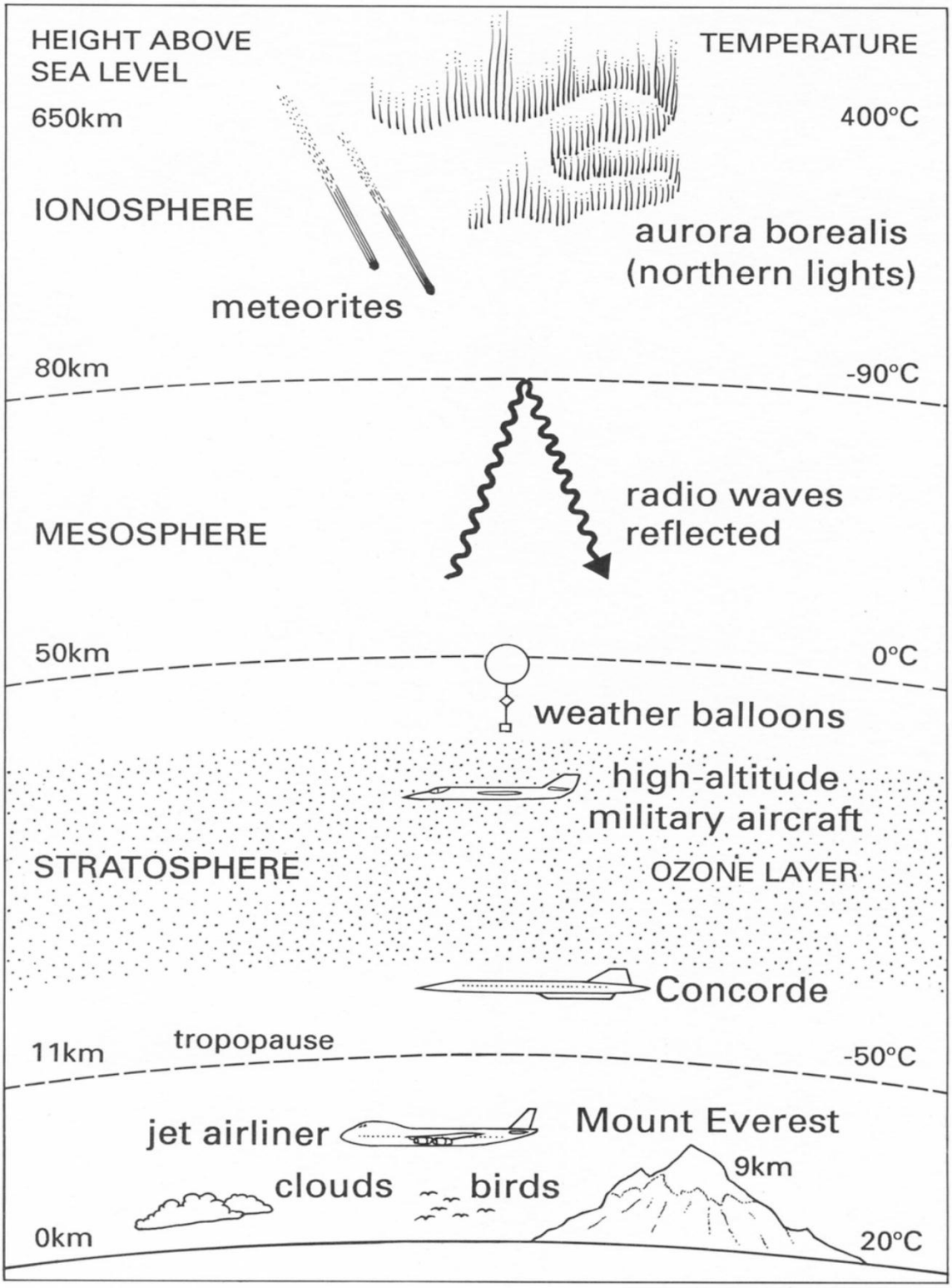
The atmosphere of Earth is a layer of gases surrounding the planet Earth that is retained by Earth's gravity. The atmosphere is a protective cover of air blanketing our Earth. The atmosphere protects life on earth by absorbing ultraviolet solar radiation warming the surface through heat retention (greenhouse gas effect), and reducing temperature extremes between day and night. Dry air contains roughly (by volume) 78% nitrogen 21% oxygen, 0.93% argon, 0.038% carbon dioxide, and small amounts of other gases.

The atmosphere of the Earth has five principal atmospheric layers starting from the one nearest the surface of the Earth upwards, the Troposphere, Stratosphere, Mesosphere, Thermosphere, and Exosphere.

The heights of each layer can vary to some extent due to changing weather and climate conditions, but it can be approximated their values to the following: the Troposphere

extends up to 20 km above sea level, the Stratosphere up to 50 km, the Mesosphere up to 85 km, the Thermosphere up to 690 km, and the Exosphere up to 10,000

The atmosphere



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Climate

Climate in a narrow sense is usually defined as the 'average weather', or more rigorously, as 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. These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. The classical period of time is 30 years, as defined by the World Meteorological Organization (WMO).

The climate of a location is affected by its latitude, terrain, altitude, ice or snow cover, as well as nearby water bodies and their currents. Climates can be classified according to the average and typical ranges of different variables, most commonly temperature and rainfall.

Climate Change

United Nations framework Convention on Climate Change (UNFCCC) defines: "Climate change" means 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.

Climate change in Intergovernmental Panel on Climate Change (IPCC) usage refers to any change in climate over time, whether due to natural variability or as a result of human activity.

Climate change is a change in the statistical distribution of weather over periods of time that range from decades to millions of years. It can be a change in the average weather or a change in the distribution of weather events around an average (for example, greater or fewer extreme weather events). Climate change may be limited to a specific region, or may occur across the whole Earth. It can be caused by recurring, often cyclical climate patterns such as El Niño-Southern Oscillation, or come in the form of more singular events such as the Dust Bowl.

WATER RESOURCES

Overview of Water Resources

The spatial and temporal distributions of fresh water are highly sensitive to climate change resulting in more unfavorable situation. These impacts are more prominent in mountainous country like Nepal. The dense orographic barriers and substantial snow and glacier cover areas are mainly accountable for such responses affecting the planning, development and management of water resources of the country.

Nepal is endowed with abundant water resources from the availability point of view. Water is regarded as the key strategic natural resources having the potential to be the catalyst for all round development and economic growth of the country. There are about 6000 rivers in Nepal. There are 33 rivers having their drainage areas exceeding 1000 sq km. Drainage density expressing the closeness of spacing of channels is about 0.3 km per sq km. The development of Nepal's water resources could generate hydroelectric power, furnish water for irrigation, and supply water for domestic and industrial uses.

Rivers in Nepal can be typically classified into three types depending on their source and discharge. The first type of rivers is large rivers that originate in the Himalayas and carries snow-fed flows with significant discharge even in the dry season. Mahakali, Karnali, Gandaki and Kosi rivers are of this type. These rivers are perennial and offer promising water sources for irrigation and hydropower development. The second type of rivers are Babai, West Rapti, Bagmati, Kamala, Kankai and Mechi rivers, which are the medium type that originate in the Midlands or the Mahabharat range. Rivers of this type are fed by precipitation as well as groundwater regeneration including springs. These rivers are also perennial but are commonly characterized by a wide seasonal fluctuation in discharge. The third type of rivers originates from Siwalik range. These rivers are seasonal with little or no flow during the dry season, and cannot be used for year-round irrigation or hydropower generation without surface storage. Figure 3.3 represents the major basins of Nepal.

Nepalese rivers are characterized by a wide, seasonal fluctuation of flow with the monthly flows generally reaching their maximum in July-August and declining to their minimum in February-March. It can be generalized that the smaller the size of the river catchment area, the wider is the range of flow fluctuation.

Assessment of Climate Change Impacts

Water Resources system is very sensitive to climate change. Although climate change is a global phenomenon, its impact on local hydrology is considerable. Hydrological seasons in Nepal can be categorized in three different groups: (a) dry pre-monsoon season (March–May) with almost no rain; (b) rainy monsoon season (June–September); and (c) post-monsoon season (October–February) with little rain. Specific discharges of Nepalese river are not uniform for all the rivers and vary randomly. Climate change will significantly increase the intra-annual variability of stream flow (Agrawala et al., 2003). An assessment of 30 river systems spatially distributed over the country of different sizes for quantifying the likely impact of climate change on the water availability of Nepalese rivers (out of which seventeen are completely rainfed basins and thirteen are combined snow-glacier-rainfed basins) for the period of 1963-2010 has shown that the changes vary widely from river to river. The rainfed rivers have shown a decreasing trend during lean seasons and an increasing trend during rainy season and magnitude of the change is relatively higher than the snow-glacier fed rivers.

Trend of the annual discharge of three major River basins Koshi, Gandaki and Karnali indicates that the discharges in these major basins are decreasing annually but contrary to this fact, the annual discharges in southern basins were in increasing. Bagmati river which originates in middle mountain region also has the decreasing annual discharge. Time series data of observed monthly flows shows that flow in monsoon season (June – September) is decreasing meanwhile it is increasing in other months. The trend analysis has shown that the aerial averages of flow in eastern and far western mountains have a decreasing trend, however in central and western mountains there is no significant impact of climate changes in annual discharge. Similarly, the increasing trend in annual

response of Babai and Rapti Basins is therefore mainly due to increasing trend in monsoonal rainfall amount over mid western hills of Nepal.

Although, there are apparent trends in stream flow volumes, overall change in mean stream flow is not very noticeable in most of the basins but their impacts on the month-wise distribution are clear. It would obviously affect the water availability in the river temporally. Early shift of the hydrographs seems to be clear in river basins which are snow-fed as Kali Gandaki as well as in midland originated rivers as Bagmati. Shifting of hydrograph also has impact on the normal water withdrawal pattern of the river.

These trends in stream flow have direct impact on electricity generation expansion plan. The projection using climate model for dependable flow shows a significant reduction in river flows. This would therefore reduce the electricity generation of existing plants considerably. This runoff decrease will affect Nepal's economically feasible hydropower potential; however, with only 1-2% of that potential currently developed, it will be quite some time before the opportunities to expand the hydropower are constrained by climate change. Likewise, there might be significant declines in the dependability of dry season flows in certain rivers, which is quite critical for both water supply required for municipal, industrial and agriculture purposes as well as and energy supply. On the other hand, the intra-annual variability of stream flow is also projected to increase significantly – posing considerably more complexity for hydropower planners and engineers in maintaining electricity generation throughout the year. Moreover, the hydropower generation and potential might be seriously affected by a combination of variable flows, flooding risks, as well as sediment load in river due to intense rainfall and GLOF events.

As the models suggest that there will be an increase in flood magnitude and frequencies which may result in damage of irrigation infrastructure during monsoon season. The existing water resources infrastructures, which have been designed and constructed earlier, based on past flow data and regime, might be less appropriate or even inappropriate in the new flow regime under climate change. The models also reveal decreasing lean flows during non-monsoon seasons, when there is more irrigation water

requirement. Increasing temperature would increase the water requirement on one hand and decrease the water availability during dry season on the other. This would result in a growing gap between demand and supply of water for irrigation.

The installed capacity of most of the hydro power plants are designed based on 65% dependable flow using past records of few years. From the above evidences of Bagmati River, estimation of such dependable flow using projected flow from climate model would be much less as compared to that estimated using classical method. This would, therefore, reduce the electricity generation of existing plants considerably in future. This runoff decrease will also affect Nepal's economically feasible hydropower potential.

Efforts for Reducing Vulnerability of Water Resources

Various efforts have been initiated in mainstreaming climate change and climate risks into national and sectoral development plans and policies in recent years. However, some measures such as introduction of non conventional irrigation (e.g. sprinkler/drip irrigation), rainwater harvesting, solar water pumps, and river training works are already in practice.

Activities like the establishment of a national disaster preparedness and management agency, the creation of village-level early warning systems for floods, landslides, building decentralized emergency response capacity, enforcing design standards for buildings and infrastructure that take into account site-specific risks, investing in better weather prediction systems are few coping measures adopted by Nepal Government in the context of climate change. Besides, reorientation of supply driven approach, institutional strengthening, and capacity building of Water Users Associations (WUA) are some other government initiatives.

The development of micro- and small hydro is already in line with Nepal's development priorities, and is being encouraged by both the government and donors. Introduction of multiple units in power plant, alternate sources of energy supply, and better demand side management are some noted approach adopted by Nepal in coping the adverse effect of climate change in hydro power sector. In addition to that the

initiation of Optimum Sediment Exclusion (OSE) research in Jhimruk and Khimti hydro power plants is a step forward in adaptation measure in the context of climate change. Working on OSE research will improve the performance of the existing as well as the planned hydropower projects. Increasing performance means maximizing the benefit from existing hydropower plants. This will lead to minimization of the construction costs and overall environmental effects caused by the construction of new projects to meet an equivalent energy demand.

Time series studies on glacier and snow shows that majority of glaciers in Nepal Himalayas have retreated in the range of 30 to 60 m in the past and while some smaller glaciers have begun to disappear. The most studied glaciers of Nepal; Glacier AX010 in Shorong Himal, Yala Glacier in Langtang Valley, Rikha Samba Glacier in Hidden Valley and Khumbu Glacier in Khumbu region, all are retreating and thinning. Such retreats are helping to expand the existing glacial lakes such as the most studied glacial lakes of Nepal, Imja, Tsho Rolpa and Thulagi Glacial Lakes. The ongoing climatic changes and changes those are projected to occur in the near future are likely to have severe impact on water resources. It also increases the risk of the sudden flooding following glacial lake outbursts. Therefore, climate induced disasters are increasing in number at present and will increase in future too.

Climate Change Mitigation: Reflection of REDD+ Piloting in Nepal:

Mr Resham Dangi, REDD Forestry and Climate Change Cell, MoFSC

1. Back ground:

Climate change has emerged as a global cross cutting issue impacting all sectors. The trend of global temperature rise in 20th century is estimated around 0.7 degrees Celsius and predicted to rise even more in future. Various studies have predicted that the global mean surface temperature has increased by 0.8* C in last century. It has also been predicted that the global temperature may rise up to 1.4 – 5.8* C by year 2100. This indicates that there is high probability of relatively more hot days in future and may severely affect the natural systems and human welfare in future.

IPCC reports predicts that average annual mean temperature over the Asian land mass, including the Himalayas, will increase by about 3*C by the 2050 s and about 5 *C by the 2080 s (quoted by Shresths etc, 2012). Various localized studies on temperature and rainfall patterns show that Himalayas are getting almost three times warmer, at an average rate of 0.06*C yr-1 , than the global average. These studies have also indicated that the average annual precipitation in Himalayan Region has increased in last 25 years and expected to increase by 10-30 % by 2080.

Temperature records between 1976 to 2005 for Nepal indicate that the average annual temperature has increased by 0.04 degree Celsius which is more than global average. Similarly the average rainfall has increased by 163 mm or 6.52 $mmYr^{-1}$. There has been widespread belief among the local people that the flowering season in certain forest trees and cropping cycle for few agriculture crops have changed. These kind of changes have impacted local livelihoods and biodiversity conservation.

It is evident that all countries will be affected from the Climate change, but the coastal countries-like Bangladesh, Srilanka Maldives etc- would suffer most. The trend of temperature rise in the Himalayan region also indicate that the mountain countries like Nepal would be most vulnerable nations due to lack of capacity to cope climate change

and high threat to biodiversity which is life support system for the mountain communities. The increasing temperature and prolonged drought may affect the natural water budget systems and severely affect the structure and function of mountain ecosystem.

All ecosystems do have certain resilient capacity to cope the external shocks within a certain threshold limits. When the external shocks - like biotic intervention, climate-led hazard, Climate change drivers etc- are within the threshold limit then ecosystem can adjust to external distress. If an ecosystem is exposed to beyond its resilient capacity then ecosystem may temporarily or permanently fails to adjust changes. This may ultimately result to system collapse and may cause species extinction and loss of human welfare in local communities. It has been predicted that forest ecosystems would be no longer capable to maintain their current potentiality to provide provisioning, regulating, supporting and cultural services to human society in future.

Though Nepal contributes only 0.025% of the total global Green House Gas (GHG) emissions (MoE, 2011), but this nation is forced to face the adverse effects of climate change. It has been predicted that around 20 glacial lakes are under the high risk of out-burst. Local farmers have been complaining that their work calendar for seed sowing, ripening and harvesting time for paddy, maize and wheat have changed over time. Local media have covered, time and again, that there has been early flowering and fruiting in certain tree species. It has also been observed that certain wildlife habitats have shifted up-wards and over lapped with other habitats, particularly noticed in carnivores. Incidence of new wild life sighting in local forests has been reported by local communities from various parts of the country.

2.0. REDD+ and Climate Change Mitigation:

After Rio convention on 1992, the UNFCCC has been very instrumental platform to negotiate in climate change issues at international level. High rate of deforestation and degradation of forests has not only threatened the loss of biodiversity and ecosystem functions but it has also accelerated the global warming due to green house gas emission. Dual role of Forests, as a source and sink of carbon-dioxide, have had attracted environmentalist to worry about the ongoing global loss of forests in general and tropics in particular.

It is obvious that the cumulative accumulation of GHGs in the atmosphere, due to various anthropogenic activities, is the major drivers of climate change. The IPCC report (2007) states that it is specifically the carbon dioxide gas that plays the most vital role in global warming. Various study indicate that the concentration of carbon dioxide has increased from 315 ppm to 370 ppm in between 1958 to 2000.

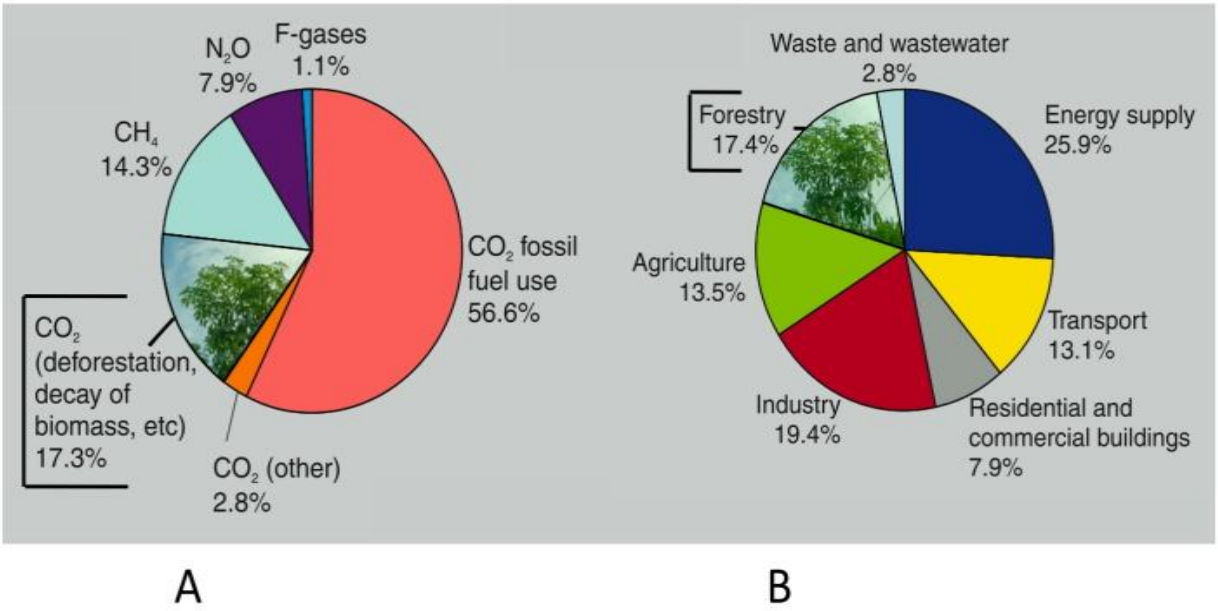

Figure 1: sources of Global GHG Emission

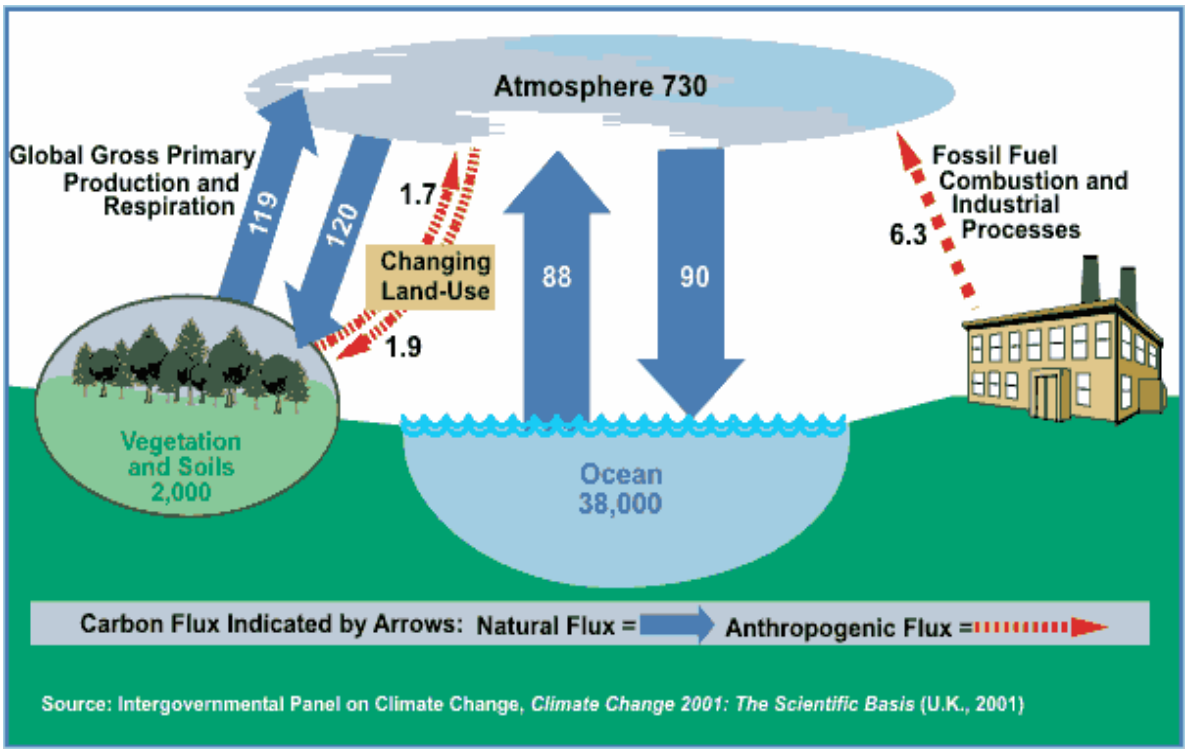

Figure 2: Global Carbon Cycle

It is obvious from above figure-1 (A and B) that the CO_2 is the major contributors of GHGs. The share of different sources in global CO_2 emission is very interesting. The forestry sector alone is responsible to contribute almost 18 percent of the global Emission, which is more than the transport sector. This clearly indicates that the deforestation and degradation of forests is one of the major sources of GHG emissions that can release very high level of CO_2 emission in a very short time period. Though, it is a global problem but it has been a serious issue especially in the tropical region of Latin America, Asia and Africa.

It is obvious from figure-2 that Forest has huge potentiality to capture and store the CO_2 from the atmosphere but it is also important to realize the fact that it is also one of the major source of CO_2 emission in the atmosphere due to deforestation and forest degradation. It is also obvious that the vegetation and soils constitute second largest reservoir of carbon after ocean. The most important point is that the carbon flux indicated by the anthropogenic flux and natural flux reveals the importance of forest

conservation and management to maintain global carbon cycle. If there is disturbance between removal and release of carbon to the atmosphere then the atmosphere fails to maintain carbon balance.

Carbon concentration can increase in atmosphere either due to direct release from human activities or declining sink capacity. The deforestation activities directly contribute to carbon release where as degradation activities may contribute both ways. The combined effect of deforestation and degradation has significant contribution in increasing carbon concentration in the atmosphere and has accelerated global warming.

The aforementioned logic provides sufficient ground to realize the fact that if current rate of emissions from deforestation and degradation are not halted then it may further accelerate the global warming process causing multiple stresses on the natural resources. If this trend continues then it may disrupt the life support system temporarily or permanently in the long-run. Recognizing this fact, global community has sought for international political commitment to conserve the remaining natural forests. This demonstrates the urgency of curtailing current rate of deforestation and degradation of forests to keep earth a safe home for now and future.

There are two basic pathways to respond the climate change impacts. First, to make efforts to moderate harms or improve resilient capacity of the forest ecosystems which is referred as adaptation. Second, to adapt sustainable forest management intervention to reduce carbon emissions or enhance carbon capture and storage capacity of the forests; which is referred as mitigation. The Mitigation options follow two broad policy options with respect to Land Use Change and Forestry- Clean Development Mechanism (CDM) and Reduced Emissions from Deforestation and Degradation (REDD). REDD is a new but an innovative incentive based reward system for implementation of effective regulation and sustainable management interventions in the developing countries.

Many empirical studies support the argument that the costs of reducing carbon emissions from REDD, in many circumstances, are lower compared to other alternatives (Chomoitz 2007; Stern 2007). Most of the tropical forests, which are supposed to be a huge terrestrial GHG sink and important biodiversity hotspots, have been under high threats of agriculture expansion and over exploitation for wood products. These forests are gradually loosing functional potentiality of producing valuable ecosystem services and heading towards the permanent conversion of forests to non-forests. However, complete halt in deforestation and degradation in developing countries is not simple due to poverty, food security and economic development agenda are set at highest priority. Therefore, effective implementation of REDD instrument in these countries needs a high level political commitment.

3.0. REDD+ in Global context:

REDD has emerged as market based instrument to halt current loss of forests and contribute in maintaining environmental integrity at global scale. This concept was first time formally discussed in Montreal Climate Change negotiation (2005), which was later picked-up by CoP-13 (2007) held in Bali. Bali action plan (BAP) clearly express global commitment on forest conservation, sustainable management of forests and enhancement of carbon stocks to reduce the share of GHG emission from deforestation and degradation of forests in developing countries. The BAP also indicated need of mobilizing financial resources from developed countries to developing countries to provide positive incentive for conservation of forests.

The CoP-15 (2009) held in Copenhagen concluded with Copenhagen accord that further clarified the crucial role of REDD beyond deforestation and degradation and included three additional components- sustainable forest management, carbon stock enhancement, conservation of carbon stocks- and since then REDD-plus regime got formal entry to international negotiation.

The CoP- 16 (2010) held in Cancun further pushed REDD+ as a key component of the post -2012 climate change regime through clarifying unclear issues including safe guards for forest dependent communities. The Cancun Agreement concluded without a very clear decision on safeguard and finance issue but agreed to discuss further in CoP 17 at Darban.

Negotiation at CoP 17 (2011) held in Darban was basically focused on four key themes of REDD+ issues- finance, safeguards, reference levels, and MRV of carbon emissions from forest activities. The CoP-17 out-come document clearly indicates that there has been good progress in science related issues; but progress on finance and safeguard issue was still not clear. These issues are expected to be further discussed in CoP -18 to be held in Doha (2012).

Though REDD-plus has emerged as a market based incentive to maintain forests intact and enhance the carbon sequestration potentiality of forests through appropriate forest management interventions. The sustainable forest management (SFM) intervention also offer other co-benefits- included but not limited to biodiversity conservation, resilience of ecosystem, watershed services, livelihoods improvement, good governance etc. which are non-carbon benefits. Therefore, the improved forest management under REDD+ will not only increases the potentiality of forests to offer sustainable supply of ecosystem goods and services (including carbon) but it will also contribute to reduces the vulnerability of forests itself to climate change.

4.0. REDD+ in National Context:

Nepal is a low carbon foot print nation compared to global average. However, if GHG emission from per unit land use change and forestry is considered then Nepal falls under the category of high emission nations. This observation is crucial because of high dependency of local community in forests for sustaining livelihoods and food security.

Since, all plant communities do have potentiality to sequester the carbon; so all types of forests in Nepal do have certain sink capacity. But the sink capacity largely vary with

site quality, forest structure, forest composition, forest tenure arrangement, age-class distribution, geographical feature, extent of anthropogenic intervention and other underlying drivers of forest change. Therefore, management intervention like silvicultural treatment, forest fire control, forest restoration and regulatory intervention like control illegal harvesting, law enforcement, corruption control etc are very important to manipulate carbon capture and storage capacity of the forests.

Like many other developing countries, Nepal is also suffering from lack of adequate public finance to invest in forest management activities. Therefore, weak financial and human resource capacity has constrained public forest institutions to limit themselves in to day-to-day forest administration activities and have largely failed to offer technical input in forest management. Despite high demand, public forest institutions are unable to produce time series data to detect changes in forest cover, carbon stocks, carbon emissions and carbon removals. Due to such limitations, there is difficulty to meet global expectation to maintain scientifically robust methodological framework to establish reference emission level (REL) and establish high standard Monitoring Reporting and Verification (MRV) systems. In this context, Nepal's REDD+ participation has created additional investment demand to public finances.

It is very evident from various CoP decisions that market based REDD+ will require a credible REL and a very robust MRV systems for successful carbon trade in future. If Nepal is committed to adopt tier- 3 (as per earlier submission to SABSTA) , then substantial amount of investment will be required to establish REL and periodic measurements in future. Considering the existing level of technical capacity, available public finances; and the nature and dynamics of drivers of deforestation and degradation in the field, a step-wise approach starting from tier-2 with moving target of tier -3 should be the right approach to move further.

In addition to limited financial and technical capacity, there are other pertinent issues in REDD+ participation. One of the bottleneck for REDD+ participation is fragmented

forests, mosaic forest management regimes, difficult terrain and inaccessibility. These factors could substantially increase transaction and implementation costs in producing certified emission reduction certificates from the individual forest regimes. For example, almost one-third forests are under community forests (CF) management regimes. However, almost 60 % of them are below 50 ha in size. This self explains that there is scope for local community engagement in REDD+ process but it is not clear whether individual CF would be capable enough to effectively participate in the global carbon markets.

This problem is also pertinent for other participatory forest management regimes as well. Therefore, it is crucial for all forest owners to consider the potential costs associated with the REDD+ carbon transaction before planning to develop REDD+ Project Idea Note (R-PIN) for emission reduction.

5.0. REDD+ Readiness activities in Nepal

The REDD+ readiness process started with the preparation and submission of the Readiness Plan Idea Note (R-PIN) in 2008. After approval of R-PIN, Nepal took initiation to prepare Readiness Preparation Proposal (RPP) with financial support from forest carbon partnership facility (FCPF) under the World bank. The R-PP was submitted in April, 2010 and endorsed by FCPF 6th participant committee (PC) meeting to fund implementation of this R-PP. Nepal signed grant agreement with the World bank on 31st March 2011 to receive grant of $ 3.4 million for R-PP implementation. Out of total projected cost FCPF will cover only 45 % and rest will be shared by bilateral donors (including DfID, US-AID, Government of Finland, Switzerland and Japan) and Government of Nepal.

To implement R-PP a three layer organizational setup is in place - apex body, REDD Working group, and REDD Cell. Apex is the highest body formed under the chair of Hon Minister of Forests and Soil Conservation (MoFSC) and consists of members from the National Planning Commission, Ministry of Environment (MoE), Ministry of

Agriculture Cooperatives (MoAC), Ministry of Energy (MoEn), Ministry of Irrigation, Ministry of Finance, Ministry of Land Reform and Management, Ministry of Tourism and Civil Aviation, Ministry of Industries, Ministry of Local Development (MoLD) and Ministry of Physical Planning and Works. The main role of this body is to provide inter-ministerial coordination and cooperation for the implementation of REDD activities.

The second tier is REDD Working Group (RWG) chaired by the Secretary of the MoFSC and comprised of members representing Department of Forests, Department of National Parks, Department of Forest Resources and Survey, MoAC, MoLD, MoEn, Civil society, and donors. The main role of this entity is to guide over all REDD+ readiness process in the Center. Below this entity there is a third layer- REDD Forestry and Climate Change Cell.

The REDD-Cell under the MoFSC is a kind of secretariat to deliver the decisions made by Apex and RWG. Major responsibilities includes to carry out day-to-day administrative business, participate in international REDD dialogue as national delegate and coordinate all national level REDD related activities. The REDD Cell has three sections- Policy and Program Development Section, MRV Section and outreach Section. Two separate loose forum- REDD stakeholder forum and expert committee- are also envisaged to make REDD process more inclusive, transparent and effective.

Table 1: Status of REDD+ Piloting in Nepal

Theme	**Institutions**	**Lessons Learned**	**Remarks**
1. PES- Reward for Forest Conservation	ICIMOD, FECOFUN, ANSAB	Establishment of a Forest Carbon Fund, Designing MRV System	Watershed based

2. Poverty alleviation	WWF, Nepal	standard methods of forest carbon measurement Forest Carbon inventory Data	Landscape level
3. Capacity building	RECOFTC	Awareness in grass root level	Local community
4. Adaptation through forest management	SDC	synergy of adaptation & mitigation activities	Community forest users
5. Adaptation through forest management	DfID	Adaptation plan to address impacts of CC	CFUGs
6. Capacity building	NEFIN	Awareness raising especially in IPs	Local IPs
7. Capacity building	SNV, Nepal	Awareness creation to Tarai people about CC & REDD	Mahottari district

This table demonstrates that the pilot activities have focused on three important aspects of the REDD readiness process- local capacity building, preparation of forest carbon baseline, benefit sharing mechanisms.

6.0. Key Issues, Challenges and Opportunities:

- **Weak capacity at various levels**- There is need of capacity building at institutional and personal levels. Many of the REDD piloting institutions do not have technical capacity for analysis of remote sensing data. Similarly, DFRS which is central hub for MRV

does not have the up-dated knowledge and skill for establishing REL and MRV systems.

- **Unplanned Deforestation**: Large scale deforestation occurs due to unplanned infrastructure development and forest encroachment guided by political party;
- **Policy inconsistency and poor coordination**: Forest Act and Bi-laws are contradicting with other sectoral Acts and Regulations. This often creates confusion and develops power ego between the sectoral agencies. Weak coordination among sectoral agencies has been one of the strong driver of forest loss;.
- **Poor technology transfer**-The development of the REDD process has brought up new techniques and technologies in the field of forest carbon trade and forest carbon inventories, which are costly. Nepal is investing huge amount of financial resources in developing REL and MRV through international experts;
- **Data Gaps**- the detail information on forest types would have contributed much in developing reference base line, trade-off analysis, and strategy options for removal enhancement, unfortunately such data are not available.
- **Data inconsistency:** National forest inventories are carried out in long space of time and have produced data set with different methodologies. The sample plots established in the past do not overlap with the recent permanent sample plots.
- **Difficult Topography and remoteness**-The difficult topography and steep mountain slopes has increased costs of developing robust MRV system, forest restoration and law enforcement.
- **High transaction cost**- The transaction cost of operating the MRV system will be higher due to a higher number of fragmented and mosaic forest regimes;
- **Benefit sharing**- Effective, efficient, and equitable benefit sharing among different regimes and within the individual regimes is quite challenging and complex;

- **Non-Carbon benefits**: Due to methodological complexity it is difficult to suggest premium values for non-carbon benefits like biodiversity conservation, watersheds, livelihoods, good governance etc

- **High Uncertainty***:* Demand size of REDD+ CER is still not very clear. The demand size in voluntary market is small and compliance market is unclear;

- **Data integration:** There is huge challenge to integrate local data generated by different forest regimes to national MRV system;

- **REDD Project Boundary:** It is not very clear whether ER-PIN will be developed with ecological or political boundary;

- **Opportunities:** Despite various challenges, Nepal has good success in community based forest management. Forests are important for food security, livelihoods improvement, biodiversity conservation, fresh water supply, energy security and so forth. So in that context, REDD+ is an opportunity to bring forestry back to business. To participate in REDD+ Nepal needs to institutionalize the governance reform, which would be a great opportunity to improve and institutionalize the forest law enforcement and good governance practice in forestry sector.

7.0. Conclusion:

The REDD readiness process in general consists of three phases- development of national strategy, demonstration of national strategy implementation and result based actions (fully MRV-ed emission reduction). The first phase involves the formulation of national REDD strategy, implementation framework, capacity building, and establishment of REL/MRV. The second phase involves the demonstrative activities to experience the learning of national REDD strategy implementation. Though they are two separate phases but can go together side by side to gain mutual benefits from each process. The third phase is real transaction phase which is far away

The REDD Forestry and Climate Change Cell is now working side by side to prepare a national REDD strategy and consulting for developing emission reduction project idea note (ER-PIN) which will be a part of national R-package in second phase. If Nepal successfully submits a standard proposal, there is opportunity to access additional finance from carbon fund for phase two.

The R-package is a voluntary arrangement for REDD readiness process under FCPF. The R-Package incorporates key sub-components of the R-PP template. Prior to submit R-package submission of mid-term progress report of R-PP is compulsory. In that sense, R-Package will be developed after the key activities of R-PP will be implemented in the field. This will help REDD Cell to track down the implementation status of R-PP activities and establish performance based payment with respect to established reference baseline. Since, this work demands a high level of critical and rigorous exercise, REDD Cell expects moral and intellectual support from all knowledge holders at individual and institution level.

Disclaimer: The views expressed in this paper are personal and does not necessarily represents the author's organization. Author takes full responsibility to clarify any issues raised in this paper at personal capacity.

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Environmental and Socio-economic Vulnerability from Climate Change Perspective - Prof Narendra Raj Khanal, PhD

Climate Change Trend in Nepal

Except for small isolated pockets, most of Nepal has an increasing trend upto 0.55° C per decade. The trends in diurnal temperature range (monthly mean difference between daily maximum and minimum temperatures) are positive over most of the stations and negative over southern plain. In addition, decreasing trends in occurrences of frost days (annual count when daily minimum temperature is less than 0 ºC) are evident over the mountainous region. Further, increasing trends in summer days as well as summer nights and decreasing trends in winter days as well as winter nights over most of the stations, except increasing trends of winter days over southern Terai region which could be due to persistent winter fog over Terai region, are evident.

According to the annual precipitation trend analysis, in general, most of the country have positive trend with maximum increase of about 15 percent of the annual amount per decade over few isolated pockets. While some places of west Nepal show negative trend. It is likely that the climate change in Nepal will increase the frequency and magnitude of extreme weather events.

Indices like monthly maximum one day precipitation amount, annual count of days when precipitation of 50 mm or more falls, extremely wet days (annual total precipitation when rainfall exceeds 99th percentile) all exhibit increasing trends in many stations particularly in the west and decreasing trends in some mountainous locations. However, the annual total precipitation in wet-days (days with 1 mm or more precipitation) does not exhibit increasing trends similar to other indices. In addition, increasing trends in consecutive dry days (maximum number of consecutive days with rainfall less than 1 mm) and decreasing trends in consecutive wet days (maximum number of consecutive days with rainfall equal or more than 1 mm) over most of the station are good indicators of increasing extreme precipitation events in Nepal.

Table 2: Temperature scenario

Season	OBS (˚C)	Baseline (˚C)	Bias (˚C)	2020s (˚C)	2050s (˚C)	2080s (˚C)
Maximum Temperature						
DJF	17.8	9.5	8.3	1.5	2.8	4.4
MAM	26.0	21.7	4.3	1.1	2.6	4.5
JJAS	27.3	21.6	5.7	1.0	2.1	3.3
ON	23.3	14.7	8.6	1.2	2.7	3.8
ANNUAL	23.6	16.9	6.7	1.2	2.6	4.0
Minimum Temperature						
DJF	4.7	-5.6	10.2	2.3	3.9	5.4
MAM	12.5	7.0	5.4	1.2	2.9	4.2
JJAS	18.5	15.3	3.3	1.2	2.4	3.4
ON	10.8	2.9	7.8	2.5	3.8	5.0
ANNUAL	11.6	4.9	6.7	1.8	3.3	4.5

Table 3: Precipitation scenario

Season	OBS (mm)	Baseline (mm)	Bias (%)	2020s (%)	2050s (%)	2080s (%)
Precipitation						
DJF	71	163	-130	-15	3	-12
MAM	211	319	-51	4	10	-3
JJAS	1330	1190	11	-1	8	20
ON	72	220	-206	-4	-5	3
ANNUAL	1683	1892	-12	-2	6	12

Observed all-Nepal seasonal and annual change and their PRECIS projected values during baseline period (1981-2010) including changes during 2020s (2011-2040), 2050s (2041-2070) & 2080s (2071-2098).

Climate Change Impacts

Several sectors – agriculture, water resources including the development of hydropower, irrigation, and drinking water, forest and biodiversity, human health, infrastructure including human settlement and overall livelihood of the people are likely to be impacted from climate change.

Agriculture

Climate change decreases rice and wheat production. Projection has shown that the net decrease in rice production will be 51 thousand metric tons in 2020; 216 thousand metric tons in 2050 and 412 thousand metric tons in 2080. The decrease in 2020 is

1.6% of the present production, that in 2050 is 6.7% of the present production and in 2080 12.9% of the present production.

The projected changes in production is equivalent to a 15.5% decrease in 2020, 5.6% increase in 2050 and 9.7% decrease in 2080 in terms of present level of production. Everything else remaining the same, the national loss in food production is expected to be 5.3% in 2020, 3.5% in 2050 and 12.1% in 2080.

Livestock production is highly sensitive to climate change. Increased temperature increases lignifications of plant tissues and reduce the digestibility reducing meat and milk production in range-based livestock production system. The increased heat alters heat exchange between animal and environment affecting the feed intake and metabolism. Such stresses will affect growth and productivity of the animals. But, effects vary from species to species and management practices. Nepalese livestock farmers who cannot control the production conditions of the livestock are bound to suffer from the reduced production and inadequate rise of the price. Climate change also increases mortality and morbidity of animals particularly from the climate sensitive infectious diseases. Increases in zoonotic diseases among the animals also increase the risks of transmission of such diseases in the human being.

Water resources

The availability and quality of water resources is likely to be affected the most from climate change. Retreating of glaciers, expansion of glacial lakes, change in the volume of discharge in the rivers and shifting in hydrographs are some of the observed changes in this sector. Time series studies on glacier and snow shows that majority of glaciers in Nepal Himalayas have retreated in the range of 30 to 60 m in the past and while some smaller glaciers have begun to disappear. Such retreats are helping to expand the existing glacial lakes. So, the risk of the sudden flooding following glacial lake outbursts is increasing.

Trend of the annual discharge of three major river basins Koshi, Gandaki and Karnali indicates that the discharges in these major basins are decreasing annually but contrary to this fact, the annual discharges in southern basins were in increasing trend.

Early shift of the hydrographs has been observed in snow-fed river basins such as Kalidgandaki as well as in midland originated rivers such as Bagmati. The shifting of hydrograph has also affected the normal water withdrawal pattern of the river. These trends in stream flow have direct impact on hydropower generation, irrigation and water supply. There might be significant decline in dry season flows in certain rivers, which is quite critical for both water and energy supply.

The intra-annual variability of stream flow is also projected to increase significantly. There will be an increase in flood magnitude and frequencies which may result in damage of irrigation infrastructure during monsoon season. The existing water resources infrastructures, which have been designed and constructed earlier, based on past flow data and regime, might be less appropriate or even inappropriate in the new flow regime under climate change. It is also revealed a decreasing trend in lean flows during non-monsoon seasons, when there is more irrigation water requirement. Increasing temperature would increase the water requirement on one hand and decrease the water availability during dry season on the other. This would result in a growing gap between demand and supply of water for irrigation.

Forest and biodiversity

Climate change has increased vulnerability on forests and biodiversity of Nepal. Rise in temperature, decrease in snowfall, increased variability and timing of precipitation, these all are impacting flowering and fruiting season and also ultimately resulting in difficult situation for survival of plant species in forests and change in wildlife habitat also. Some identified impacts on forest ecosystems are due to increased dryness and fire; physical disturbance from erratic rain, landslides and erosion; altered natural life cycles; encroachment by alien species; disease and pests; degradation of species

diversity. Similarly, the rangelands might be impacted through more grass due to rise in temperature; less grass due to drought; reduced availability of NTFP; damage by fire. In the same way, the wetland ecosystem will also be adversely affected e.g. degradation of species; encroachment by alien species; and degradation of livelihood resources. Loss of local crop diversity is another impact of climate change on agriculture ecosystems. Some of other potential climate change impacts on biodiversity are: ecological shift of some life zones; shift in tree line or snow line; ecological shifts of species (endemic species); changes in species assemblages in ecotones; changes in phenology of plants; loss of some cold tolerant genetic diversity; enhanced invasion of alien species; loss of chemical diversity in some medicinally important plants. Likewise, physiological biochemical response and behavior change may occur in large animals; insect population may increase; and frequency of fires will increase due to climate change and deplete biodiversity. Species mortality may increase and seed viability of some tree species may be affected.

Human Health

The climate change has differential impacts on human health due to different levels of vulnerability of the people. There are huge spatial and temporal variations of climatic elements in Nepal. The impacts of climate change on health have been observed through the changes in average temperature, precipitation and extreme weather events. These changes have brought direct and indirect impacts on human health.

Based on existing database and observation, the health impacts due to climate change are summarized into three groups: (a) Extreme weather related health impacts such as heat wave causing heat stress in Terai region of Nepal where average summer temperature remain above 30°C. The consequences are hyperthermia, heat stroke, heat exhaustion, heat syncope, heat cramps, and heat rash. Similarly cold wave in different parts of the country including Tarai region in winter causes respiratory problems such as cough, throat infection, chronic obstructive pulmonary disease (COPD), bronchitis,

asthma, pneumonia, chronic bronchitis and others like rotavirus diarrhoea, skin diseases etc. (b) Vector borne diseases including Japanese Encephalitis (JE), malaria and Kala-azar (Visceral leishmaniasis) seem to have occurred in the warmer districts of Nepal. The cases of Dengue have also been observed in the selected districts of Nepal. (c) Diarrhoeal disease shows a definite monthly pattern in a year i.e. with distinct seasonal pattern. The trend of diarrhea morbidity has been in increasing despite several government intervention programs. Some weather conditions are conducive for spreading of water borne and vector borne diseases. There are serious concerns that increased climate variability in combination with increased population density and inadequate sanitation could augment the occurrence of these diseases in Nepal.

Conceptual Framework

Vulnerability in general is the function of probability of occurrence of event (hazard), probability of damage (element's exposed*sensitivity) and adaptive capacity. International Strategy for Disaster Reduction (ISDR, 2009) defines a **hazard** as a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption or environmental damage. Snow and blizzard, drought, floods, fog, frost, windstorm, hailstorm, thunderbolt and fire, heat and cold waves (loo, sireto etc) are different form of hydrometeorological hazards. Though landslide is a geologic/geomorphic hazard, it is induced by precipitation and considered as water induced disasters. Climate variability and change may also cause biological hazards such as pests and diseases and also determines growing season of crops and thus affects the livelihoods. Recent trend of increasing temperature and frequency of high intensity precipitation has increased the occurrence probability of hazards such as drought, landslides, floods including glacial lake outburst floods and landslide dam outburst floods in the mountain areas like Nepal. **Risk** is defined as the combination of the probability of an event and its negative consequences. Risk is the product of hazard probability and damage probability. ISDR (2009) defines **vulnerability** as the

characteristics and circumstances of a community, system or assets that make it susceptible to the damaging effects of a hazard. Some people treat vulnerability simply as exposure to hazards or being in the wrong place at the wrong time.

There are four fundamental dimensions of Hazard, Vulnerability and Risk assessment (HVR). Those are i) system of analysis (population group, an economic sector, a geographical region or a natural system), ii) attribute of concern (the value attribute of the vulnerable system that is or are threatened by its exposure to hazards), iii) hazard (a potentially damaging influence on the system of analysis), and iv) temporal reference (the point in time or time period of interest) (Fusel, 2007).Not all the exposed people (individual, household, community) or socio-economic sectors (agriculture, health, infrastructure) or a natural systems (forest, biodiversity, water, land cover) or geographical regions are equally affected from a hazard. It is determined by the vulnerability factors which is the function of sensitivity and adaptive or resilience capacity. The vulnerability factors are generally grouped into four categories – i) internal/endogenous or in a place, ii) external/exogenous or beyond place, iii) socio-economic, and iv) biophysical.

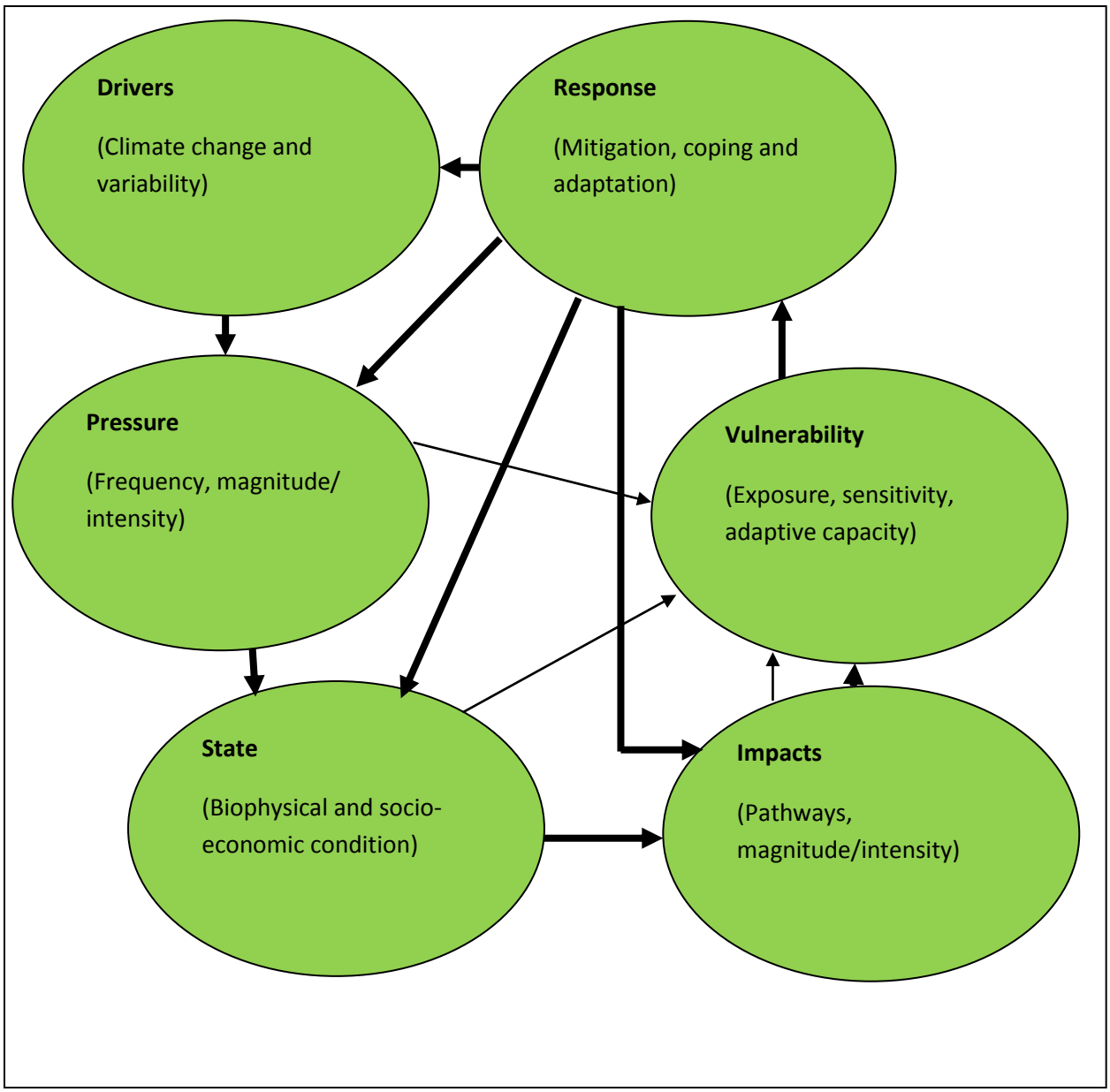
For example household income, social networks, access to information is socio-economic internal vulnerability factors whereas topography, environmental conditions and land cover are biophysical internal factors. Similarly, national policies, international aid, economic globalization are external socio-economic vulnerability factors whereas severe storms, earthquakes are external biophysical vulnerability factors. Internal vulnerability factors are taken as vulnerability and adaptive capacity (human coping and adjustment or resilience or human influence) whereas internal biophysical factors as sensitivity or intervening condition to danger. The external vulnerability factors are taken as hazard or environmental influence (Fusel, 2007).

Table 1: Example for each of the four categories of vulnerability factors classified according to the dimensions sphere and knowledge domain (Fussel, 2007)

Sphere	Domain			
	Socio-economic		Biophysical	
Internal (in place)	Household income, social networks, access to information	Resilience (vulnerability and adaptation- coping and adjustments	Topography, environmental condition and land cover	Sensitivity (intervening conditions of
External (beyond place)	National policies, international aid, economic globalization	Human influences	Severe storms, earthquakes, sea-level change	Environmental influences (hazard)

Fussel (2007) has reviewed different approaches of hazard, vulnerability and risk assessment. The commonly used approaches include i) risk-hazard approach, ii) political economy approach, iii) pressure-and release model, iv) integrated approach, and v) resilience approach. Risk and hazard approach is useful for assessing the risk to exposure units that arise from their exposure of hazards of a particular type and magnitude. According to the political economy approach, the vulnerability is determined by the availability of resources and crucially by the entitlement of individual and groups to call on these resources. The pressure-and-release model conceives the risk as the product of hazard and vulnerability. The risk-hazard and the political economy approach is combined and extended into in various integrated approaches, most notably the hazard-of-place. It is the interaction of the hazards of place with the social profile of communities. The resilience approach is used to examine the propensity of social and ecological systems to suffer harm from exposure

to external stresses and shocks. Another commonly used approach is livelihood. According to this approach the vulnerability due to low adaptive capacity is determined by the access to physical, natural, social and financial capital or assets. An integrated approach by combining risk-hazard through assessing the exposure of a system or elements (life and properties) to potential hydrometeorological hazard in a particular place and livelihood approach by assessing sensitivity and adaptive capacity of the people through examining different livelihood strategies and outcomes is commonly adopted in HVR assessment.



The process of risk assessment starts from the i) identification of hazard, its magnitude and probability of occurrence based on frequency and likely changes in such hazards as a result of climate change to the ii) identification and quantification of elements exposed to hazards; iii) estimation of sensitivity of the exposed elements (probability of loss or damaged) based on past experience; iv) assessment of coping and adaptive capacity of people and institutions (individual, household, community, VDC, District levels) based on the analysis of livelihood strategies and outcomes; and vi) estimation of risk as the function of hazard probability and damage probability.

An analytical framework of climate change impact and vulnerability is given in (Figure 1). Many sectors- agriculture, livestock, forest, water resources, landscape and biodiversity, health and environment are highly affected due to climate change. Similarly, the livelihood options are also affected. However, the types and intensity of impacts are determined by the level of exposure of life, properties and infrastructure on one hand and the capacity of people to cope with the adverse impacts on other hand. The capacity of people depends on the access to resources, information, technology, skills, service infrastructure, institution and decision making. People living in areas with high exposure and low capacity are more vulnerable and susceptible to different types of hazards, conflicts and violence. In this context, it is necessary to enhance the capability and limit the exposure through equity and empowerment to reduce the

vulnerability and conflicts (Figure 2).

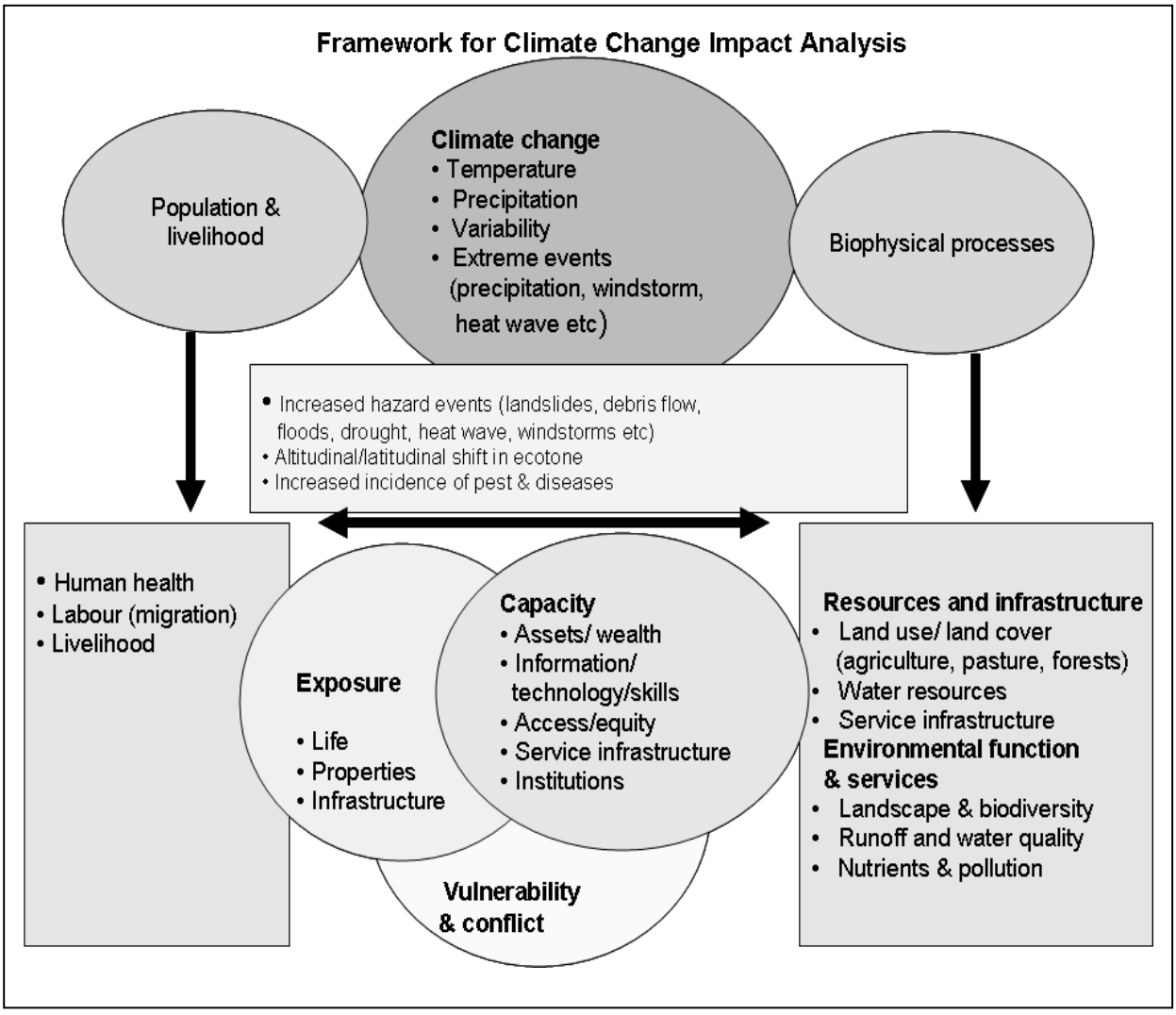


Figure 1: Framework for climate change impact analysis

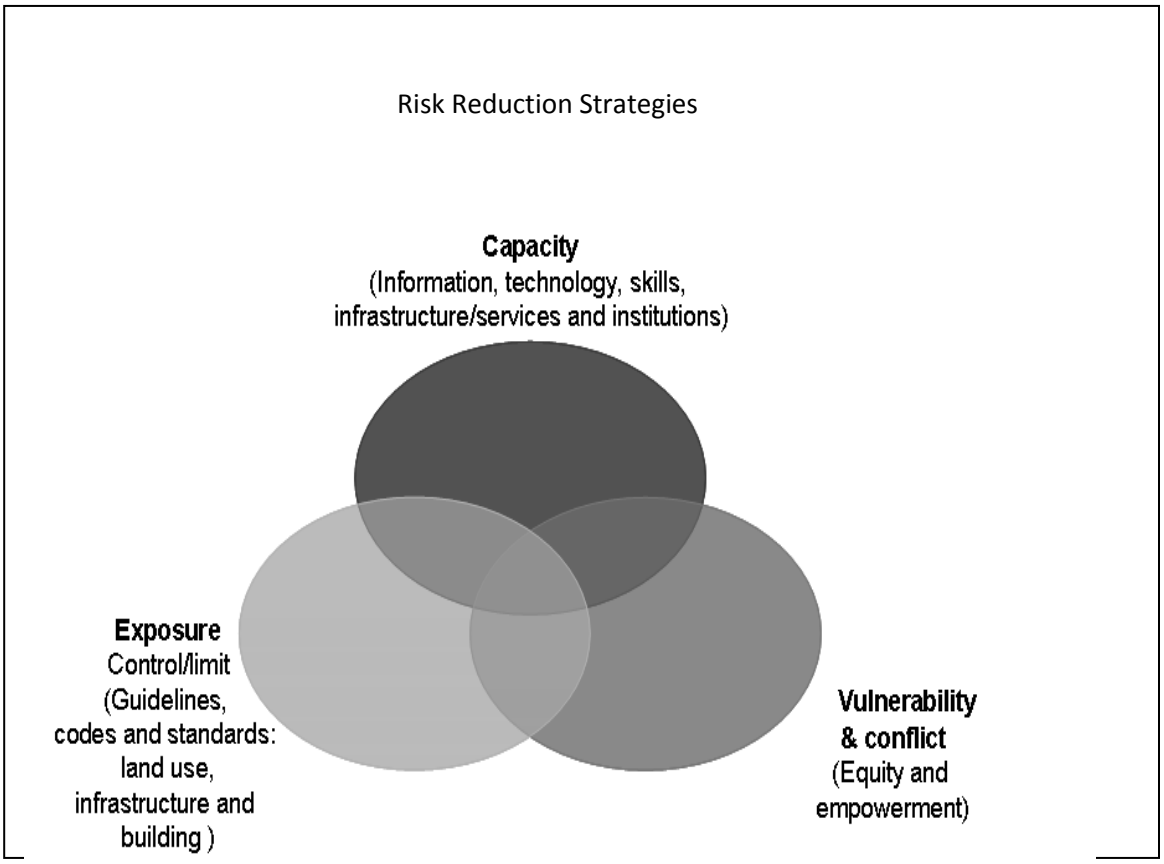


Figure 2: Adaptation/mitigation strategies for risk reduction

Vulnerability Assessment Methodology and Steps

According to IPCC, the word vulnerability is defined as "the degree to which a system is susceptible to, or unable to cope with, the adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity" (IPCC 2001, p.995). Vulnerability is thus defined as a function of exposure, sensitivity, and adaptive capacity as:

Vulnerability = f (exposure, sensitivity, adaptive capacity) ……. *(Eq. 1)*

IPCC has defined exposure as “the nature and degree to which a system is exposed to significant climatic variations”; sensitivity is defined as “the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli”; and adaptive capacity is defined as “the ability of a system to adjust to climate change (including climate variability and extremes), to moderate the potential damage from it, to take advantage of its opportunities, or to cope with its consequences”. Vulnerability assessment and mapping is generally carried out using 7 steps.

1. Deriving climate change scenario (observed change, GCM projections)
2. Selection of parameters related to environment, population, socioeconomic condition, service infrastructure, technology and institutions and collection of data (formulation of base line scenario and projected scenario with and without climate change
3. Selection of parameters for vulnerability mapping and assessment
4. Normalization or standardization of the data for preparation of index value
5. Calculation of the index value
6. Mapping of indices
7. Interpretation of the patterns with conclusions

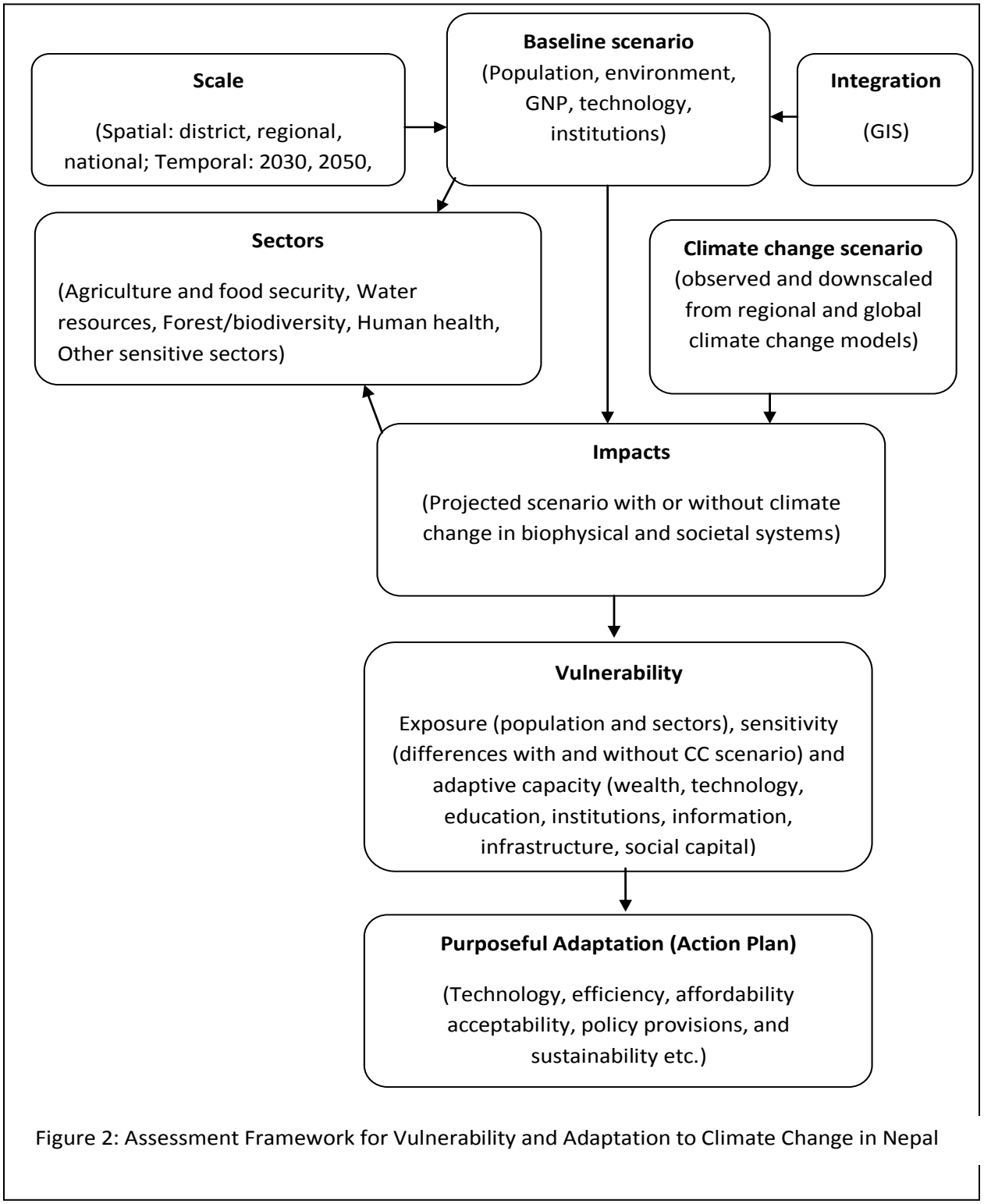


Figure 2: Assessment Framework for Vulnerability and Adaptation to Climate Change in Nepal

Number of parameters to be selected for vulnerability assessment depends on the availability of data and its temporal (year) and spatial coverage (spatial units).

Hahn, Riederer and Foster (2009) have developed the following livelihood vulnerability index. This study has also incorporated environmental factors in order to develop overall vulnerability index.

Livelihood Vulnerability Index (LVI_d) = $(e_d\text{-}a_d)*s_d$

where, e_d = Exposure index of the district

a_d = Adaptive capacity of the district

s_d = Sensitivity index of the district

The value of a district were aggregated and normalized to a scale of 0 to 1 range using the following formula. For the purpose of aggregation, the indicators were grouped into two groups: Group A and Group B. Group A consists of those indicators whose values increase with the decrease (from better to worse) in the level of performance among districts. Group B consists of those indicators whose values increase with the increase (from worse to better) in the level of performance among the districts.

Group A: $Z_{i,j}= (X_i^{max} – X_{ij})/(Xj^{max}\text{-}Xj^{min})$

Group B: $Z_{i,j}= (X_{i,j} – X_j^{min})/(Xj^{max}\text{-}Xj^{min})$

where, $Z_{i,j}$= standardized indicator index of type i of district j,

$X_{i,j}$ = unstandardized indicator index of type i of district j,

Xj^{max}= maximum value of the indicator index over district j, and

Xj^{min} = minimum value of the indicator index over district j.

Index values are calculated simply by averaging the scores or by using the weighted values.

Vulnerability Mapping and Assessment in Nepal

The Ministry of Environment has prepared and published climate change vulnerability map for Nepal for the first time in 2010 at district level (MoE, 2010b). It used 5 proxy indicators/indices of sensitivity, 15 direct indicators/indices of exposure/risk and 10 direct indicators/indices of adaptive capacity to prepare a composite climate change vulnerability map of Nepal (Table 4).

Table 4: List of indicators/indices selected for vulnerability assessment and mapping by districts

Particulars	Direct Indicators/Indices	Proxy indicators/Indices
Sensitivity		
Human		Population
		Area
Ecology		Forest area coverage
		Protected area coverage
		Area
Exposure/Risk		
Temperature and Rainfall	Mean annual temperature trend	
	Annual rainfall trend	
Landslide and Flood (Hill and Mountain Ecological	Occurrences	
	Death	
	Injured	
	Property losses	

Zone	Positive rainfall trend	
Flood (Terai Ecological Zone)	Occurrence	
	Death	
	Injured	
	Property losses	
	Positive annual trend	
Drought	Negative annual rainfall trend	Food production
		Food requirement
	Mean annual temperature trend	Population at risk due to food shortages
GLOF	Location of potential GLOF	Distance from GLOF potential lake
Ecology		Population pressure on forest land
		Human poverty index
		Motorable access
Adaptation		
Socio-economic	Human Development Index	
	Human Poverty Index	
	Gender Development Index	
	Human Empowerment	

	Index	
Infrastructure	Road length	
	Area	
	Landline phone numbers	
	Population	
Technology	Irrigation coverage	
	Area	

Source: MoE, 2010b

While preparing Second National Communication Report for Ministry of Environment, Science and Technology, ADAPT-Nepal has also attempted for vulnerability mapping and assessment with slight modification in the methodology (selection of parameters and scoring technique). The parameters used are listed in Table 5.

Table 5: Lists of Indicators selected for Vulnerability Assessment

Particulars	**Indicator**	**Data Sources**
Exposure		
Climate	Mean Annual Temperature Trend	Calculated based on time series data obtained fromDHM
	Mean Annual Precipitation Trend	Calculated based on time series data obtained from DHM
Disaster	Property Loss Due to Disaster	DNCDM, MOHA, 2011
	GLOF Risk	Climate Change Vulnerability Mapping

		for Nepal, MOE, 2010
Sensitivity		
Socio-Economic	Population Density	CBS, 2011
	Health Facilities (Health Institutions)	Annual Report 2066/67, DOHS, 2011
	Food Balance	Department of Agriculture and Cooperatives, 2009/10
	Drinking Water Facility	Nepal WASH Sector Status Report 2011
	Irrigation Facility	Department of Agriculture and Cooperatives, 2002/3
	Road Facility	Statistics of Strategic Road Network SSRN2009/10
Environment	Steep Slope (> 30 Degree)	LRMP, 1986
	Sloping Terraces	LRMP, 1986
	Forest Coverage	JAFTA, 2001
Adaptive capacity		
Development	Human Development Index	Nepal Human Development Report 2004, UNDP, Nepal, 2004
Livelihood Strategies	Economically active people engaged in non-	National Census Report 2001, CBS

	farm activities	
Social Network	Number of working NGOs	Social Welfare council(1978-2009)

Comparison and conclusion

ADAPT-Nepal (2012) has identified nine districts namely Bhojpur, Khotang, Udaypur, Dolakha, Sindhuli, Chitwan, Gorkha, Lamjung and Baglung are highly vulnerable, 27 districts are in medium level of vulnerability and 39 districts are in low level of vulnerability. Districts like Udayapur, Lamjung, Dolakha, Gorkha and Chitwan were also identified as high to very high vulnerable districts and Baglung, Sindhuli and Bhojpur in moderate categories while making vulnerability assessment in 2010 (MoE, 2010). Some districts like Kathmandu, Ramechhap, Mugu, Bhaktapur and Jajarkot which were identified as districts of very high vulnerable in the earlier study (MoE, 2010b) did not appear in high category by ADAPT-Nepal. Kathmandu, Mugu and Bhaktapur appeared as low vulnerable in this report whereas Ramechhap, Saptari and Jajarkot as medium vulnerable category. Such differences in ranking of the districts in terms of vulnerability are partly due to selection, categorization and use of the different indicators and partly due to incorporation of updated climate and socio-economic data. In the context of upcoming population data (Census 2011), forest survey data, downscaling of climate projections data and other relevant data, it seems necessary to re-assess the vulnerability to climate change in the future.

Reference:

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Climate Change Impact from Agriculture and Livelihood Prospective -Prof Prof Prof Khem Raj Dahal, Expert/Researcher

1. Climate Change

Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 2007a). It may be natural or accelerated and in recent decades, the earth is facing accelerated climate change. The human activity is very likely the cause for this (IPCC, 2007b) - the rapid increase in global average temperatures as a result of increased green house gases (GHGs) in the atmosphere. According to the World Meteorological Organization, the decade from 2001 to 2010 had a global temperature that was 0.46^{0}C above the 1961–1990 average; the highest value ever recorded for a 10-year period.

Sectors affected by climate change may vary from country to country, although agriculture, forestry, infrastructures, transport, energy, nature, tourism, water resources, and health and well-being are the most common (Taalas, 2009). Mode and severity of the effect, and responsive strategies accordingly, vary depending upon the way the country or region earns its livelihood and economic prosperity. However, the impact on agriculture is of a great concern on local, national and global levels as food production is the basis of all human activities (Dahal, et al, 2009).

2. Livelihood

Livelihood basically refers to the means of securing the necessities of life. In broader sense, it is the command an individual, family, or other social group has over on income and/or bundles of resources that can be used or exchanged to satisfy its needs. This is the way people live encompassing and their engagement and earning. In developing countries it depends largely upon the endowment of natural resource and its domination which shape the life style of the people. Farming is the source of livelihood for agrarian countries; fishing is for the countries lying in coastal areas; tourism in others; and so on.

Determined by the geographical characteristics and past course of development, agriculture remains the source of livelihood of majority of Nepalese people. At present, about 65 % of the population depends on agriculture for their livelihood and agriculture contributes about 34% of the national Gross Domestic Products, GDP (ABPSD, 2010). Although dependence of country and its population on agriculture has been reduced drastically in recent decades; it provided livelihood for about 90% of the population, accounted for nearly two-thirds of GNP and 80% of the export earnings in 1990s (MoF, 1992), it still remains one of the crucial life supporting systems in the rural areas, and an important economic sector of the country.

3. A glimpse of Nepalese agriculture

Nepalese farming as a source of livelihood is an inseparable integration of five **J** (**Hf**): *Jamin* (Land), *Jangal* (Forest), Jal (Water), *Janawar* (Animal), *Jaibik bibidhata* (varieties of macro & micro flora including the crops/varieties) managed by another J, *Janata* (People or Farmer). These are the resources as well as the builders (components), of our agriculture, if perceived it as a system or a whole functional entity. Degradation or malfunctioning of one of them may make our system unsustainable.

Jamin (Land) is the very basis of food production. There is 21% cultivated land with average land holding of 0.8ha. Under as well as over-utilization; expansion of urban/basic infrastructure and housing onto fertile lands; no proper land use planning; imbalanced and ruthless use of agro-chemicals; mining mentality and associated nutrient drain; soil erosion, landslide and siltation; land fragmentation and tenure; etc are degrading the land making it, less fertile, low productive and useless.

Jangal (Forest) is an integral part of farming as farmers depend on them for fodder, animal bedding, fuel wood, medicine, and timber for building and agricultural implements. 84% of the total energy and about 42% of the fodder requirement, and 9.45% from direct products and 27.55 percent indirect services to the GDP, come from forest. There is mere 29% of the forest cover in the country and deforestation is going on

with 100,000 ha of forest is under encroachment in *Tarai* by illegal squatters and overstocking of livestock and tree cutting in mountains.

Jal (Water) is vital for agriculture as lack of water impairs the proper functioning of all living components of the system. Although Nepal is the second largest country in the world in water resource but only 38% of land is irrigated. Traditional small irrigation schemes are almost defunct due to urbanization and construction works; sources are dying due to increasing deforestation and land slide; big schemes are expensive even to maintain; and frequent untimely drought is jeopardizing the system making livelihood hard.

Janawar (Animal) is an indivisible part of the system contributing to the livelihoods through manure, nutritious food and income generation. Loss of traditional hardy breeds, large stock of unproductive herds, declining transhumance systems in high hills, shrinking grazing lands and manpower, difficulty in maintaining exotic breeds due to high feed requirements, diseases and infertility are the problems. Yet, many success stories with goat, pig, and poultry are seen in this sector contributing to sustain livelihoods of farming family and supporting even the industrial sector.

Jaibik bibidhata (macro and micro floral diversity including crops and varieties) is important for productivity, stability and resilience. People have been using 3,000 or more plant species for food and sustaining livelihood, cultivating and trading some 150 of these. Traditional crops and associated knowledge base are being lost and landraces of major crops are being displaced by modern varieties. Exotic varieties are vulnerable to pests and diseases making farmers to use more and more chemicals rendering the system both ecologically and economically unsustainable. Production and productivity of major crops are either declining or are stagnant.

Janata (People) manage these components based on biophysical and socioeconomic conditions and according to their goal and aspirations. Lack of trained manpower is a bottleneck for research and development on sustainable livelihood through agriculture.

There is no attraction of people to agriculture, especially of young generation, and about 400000 youth out-migrate every year in search of job leaving old parents at home and putting the land fallow.

With this situation, agriculture is not being able to serve the purpose of, at least, feeding the population and maintaining their livelihoods. The country is becoming severely food deficit with two of three Nepalese suffering food insecurity at some point during the year. Although food production fluctuates with marginal surplus in some years, 55 of the 75 districts are categorized as food deficient. Two fifths of 3.4 million land holdings in Nepal produce enough food only for less than six months.

4. Climate change and agriculture

Climate change affects agriculture either directly or indirectly, through changes in ecosystem and support services. Directly, it controls the soil moisture level; the amount of solar radiation plants receive; and the conditions plants are subjected to on a daily basis. Changes in these variables can alter crop yields, affecting food supplies and farmers' livelihoods (WMO, 2009b). Indirectly, climate change may bring changes in land vegetation, ocean circulation, sea surface temperature and global atmosphere composition, which, in turn, affect rainfall patterns (Salinger, et al., 2005) that have impacts on agricultural systems. It holds the potential to radically alter agro-ecosystems and devastating crop failures, which are already evident in several countries of the world (Borron, 2006). In addition, temperature increases may influence crop-pest interactions by speeding up insect and pathogen growth rates, which increase reproductive generations per crop cycle, by decreasing pathogen mortality due to cold winter temperatures, and by effects on the crop itself that leave the crop more vulnerable (FAO, 2005). Climate change is significantly impacting biodiversity, ecosystem and the services they provide (food security, climate regulation, fresh water supply, disaster risk reduction), which are the fundamental units of life support on Earth.

5. Nepalese Scenario

Long term meteorological data show that mean daily temperature in Nepal has increased at the rate of 0.043^0C per annum (1.3^0C in 30 years) between 1976-2005 and annual precipitation has increased at the rate of 14.2 mm/year in the same period (DHM, 2007 as cited by Bhandari, 2009). Monsoon rain has become more intensive resulting in increased frequency of flash floods and landslides (Gurung, 2009). SAGUN (2009) has reported the increasing trend of weather-related extreme events such as excessive rainfall, longer drought periods, landslides and floods in term of both magnitude, as well as frequency in Nepal. Through their dependence on agriculture for their livelihood, people in Nepal are greatly affected by climate change. Changing climate have put their livelihood at risk threatening sustainability of agriculture and livelihood systems, and jeopardizing the economic development endeavors. Studies have shown that farming communities already perceive unusual changes in weather parameters such as warmer temperatures, temperature extremes, alterations in monsoon patterns and erratic rainfalls (Dahal, et al, 2009; Manandhar, et al, 2010). These changes constitute additional threats to the farmers and rural population, who are habituated and dependent on certain rainfall and temperature patterns for their agricultural production (TDF, 2008)

6. Impact of agriculture on climate change

Not only agriculture is affected by climate change but it also has significant effect on the process of climate change mainly through the emission of green house gases (GHGs). Food and Agriculture Organization (FAO) estimates that agriculture is responsible for 25% of carbon dioxide, 50% of methane and more than 75% of nitrous oxide emitted annually (WMO, 2009). Fossil fuel use and land use change are the primary cause for increase in carbon dioxide concentration, while rice farming, livestock farming and use of nitrogenous fertilizers are primarily blamed for methane and nitrous oxide. Agriculture is also a major contributor of reduced carbon sequestration (storage) through land use change (e.g. the loss of soil organic matter in cropland and pastures, and forest

conversion to agriculture), although quantitative estimates are uncertain (WB, 2008). The conversion of ecosystems to farmland is a major source of CO_2; not only due to losses of plant biomass but also through increased decomposition of soil organic matter caused by its disturbance, and the energy costs of various agricultural practices such as fertilization and irrigation. Similarly, another source of greenhouse gases in agriculture is the fertilizers as the production of fertilizer is an energy intensive process, and when it is applied to the land it emits nitrous oxide. The combined impacts of the production and use of chemical fertilizer is estimated to contribute as much as 3-5 percent to the long term greenhouse effect (OE, 2009). However, no matter what the environmental or climate cost of food production is, we can not stop cultivating the land and producing the foods. It is therefore, mitigating climate change through the reduction of GHGs emission and getting adapted to the changing climate are of a paramount importance for sustainable development and safe livelihoods.

7. Mitigation and Adaptation

Mitigation as an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases whereas and adaptation is adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate harm or exploits beneficial opportunities. While mitigation tackles the causes of climate change, adaptation tackles the effects of the phenomenon. In agriculture, forestry and fisheries sectors, many mutually re-enforcing synergies and benefits exist among mitigation and adaptation actions and overall development goals. Although, agriculture and forestry sectors are the largest sources of methane and nitrous oxide emissions, however, at the same time, these sectors of economy and livelihood have a very high potential for reducing emissions and enhancing carbon sinks. Sustainable agriculture that boost the capacity of agricultural production to adapt to more unpredictable and extreme weather conditions, reduce greenhouse gas emissions and halt or reverse carbon losses in soils are, thus, more critically needed than ever before.

7. Sustainable Agriculture

TAC, CGIAR defines sustainable agriculture as the successful management of resources for agriculture to satisfy the changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources. Invention of DDT (1874), reinvention of its insecticidal property by Paul Muller (1934), massive production and use of DDT in agriculture (1943), Nobel Prize to Paul Muller (1948), The Silent Spring by Rachel Carson (1962), Ban of DDT in USA and formation of IFOAM in France (1972), IFOAM International Conference Towards Sustainable Agriculture (1977) and Our Common Future by Brundtland Commission (1987) were instrumental to pioneer the present day movement on sustainable agriculture. There are three pillars of sustainable system in general and of sustainable agriculture in particular: environmentally sound, economically viable & socially acceptable.

Overall notion of sustainable agriculture is attached with the welfare (conservation) of soil and plant as vital components of ecosystem. Managing agriculture in a sustainable way is one of the important and effective strategies to face the climatic adversities.

Sustainable livelihood approach (SLA): is a way to improve understanding of the livelihoods of poor people. It draws on the main factors that affect poor people's livelihoods and the typical relationships between these factors. It can be used in planning new development activities and in assessing the contribution that existing activities have made to sustaining livelihoods. Natural resources, and dependent on them, agriculture is at the at the centre of SLA Guiding principles are: be people centered, be holistic, be dynamic, build on strength, promote micro-macro links, encourage board partnership and aim for sustainability

8. Way forward

No matter how much efforts have been made to reduce the emission of green house gases, the climate will keep changing for many years to come, and so, adaptation is an urgent strategy to live with. Our aim, so, should be to make agriculture to transcend from

being a problem to an essential part of the solution to climate change provided there is a more holistic vision. Farming practices such as organic farming, agro-forestry, conservation farming that include minimum tillage/zero tillage, bed planting, direct seeding (rice), mulching, system of rice intensification (SRI) are proven to be climate resilient. Improvements in existing agricultural practices such as improved compost, urine management, recycling of farm wastes, use of urban waste through composting, rain water harvesting, biodiversity management, conservation of indigenous knowledge, reducing the food mileage, etc are easy and helpful to cope with climate change.

Adoption of organic farming has major potential for reducing agricultural greenhouse gas emissions because of carbon sequestration in soil, and no use of energy intensive and N_2O releasing nitrogenous inorganic fertilizers. An eighteen year study comparing fields fertilized organically versus with eight mineral fertilizers in Europe found that the organic fields sequester three to eight more tons of carbon per hectare. Adaptation potential of organic farming is also high because it utilizes the synergistic effect among the components. Similarly, agro-forestry system can sequester between 9 and 63 tons of carbon per hectare depending on the composition, cover and practice. SRI is a system that produces high grain yield with minimum water. Adoption to low water demanding crops/varieties also help farmers to adapt to the situation. Keeping the agricultural land engaged with suitable crops, and waste lands planted with trees, are very important and easiest means to cope with climatic adversities at farm level. In addition, for climate smart livelihood not only agriculture but lifestyle itself should be changed and made sustainable following the path of green economy and low carbon foot print**.**

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Climate-induced Disasters: Understanding the Risks and Way Forward

Dr. Narayan Prasad Chaulagain, Renewable Energy Expert

General

The disasters related to and caused by climatic elements are called climate induced disasters. A disaster is a natural or man-made hazard resulting in an event of substantial extent causing significant physical damage or destruction, loss of life, or drastic change to the environment. A disaster can also be defined as any tragic events such as floods, earthquakes, catastrophic accidents, fires or explosions. It is a phenomenon that disasters can cause damage to life, property and destroy the economic, social and cultural life of people. Academically, disasters are defined as the consequence of inappropriately managed risks. These risks are the product of a combination of both hazards and vulnerability. Hazards that strike in areas with low vulnerability will never become disasters, as is the case in uninhabited regions.

The Water Cycle

The water cycle, also known as the hydrological cycle or H_2O cycle, describes the continuous movement of water on, above and below the surface of the Earth. Water can change states among liquid, gas and ice at various places in the water cycle. Although the balance of water on Earth remains fairly constant over time, individual water molecules can come and go, in and out of the atmosphere. The water moves from one reservoir to another, such as from river to ocean, or from the ocean to the atmosphere, by the physical processes of evaporation, condensation, precipitation, infiltration, runoff, and subsurface flow. In so doing, the water goes through different phases: liquid, solid, and gas. During the circulation of water in the cycle, different types of climate disasters occur due to ‘too much’ or ‘too little’ of water in its different locations.

Climate Induced Disasters

Drought

A drought is an extended period of months or years with a deficiency in its water supply whether surface or underground water. Generally, this occurs when a region receives consistently below average precipitation. It can have a substantial impact on the ecosystem and agriculture of the affected region. Although droughts can persist for several years, even a short, intense drought can cause significant damage and harm the local economy. The term drought may refer to a meteorological drought (i.e. precipitation well below average), hydrological drought (i.e. low river flows and low water levels in rivers, lakes and groundwater), agricultural drought (i.e. low soil moisture), and environmental drought (i.e. a combination all of the above). The socio-economic impacts of droughts may arise from the interaction between natural conditions and human factors such as changes in land use, land cover, and the demand for and use of water. Excessive water withdrawals can exacerbate the impact of drought.

In regions that are already suffering from drought, climate change is expected to have an exacerbating effect: it may cause a decrease in precipitation combined with an increase in evapotranspiration. Climate change would make marginal areas into drought areas. Increases in agricultural intensity and population density on top of climate change contribute further to drought situations. The consequences of hydrological droughts depend on regional / local circumstances (soil type, crop type, availability and depth of groundwater, water storage etc.).

Droughts affect rain-fed agricultural production as well as water supply for domestic, industrial and agricultural purposes. Particularly, subsistence farmers suffer the most from droughts, which may lead to forced migration or famine

Floods

A flood is an overflow of water that submerges land. It can be as a covering by water of land which not normally covered by water. Flooding may result from the volume of water within a body of water, such as a river or a lake, which overflows or breaks levees, with the result that some of the water escapes its usual boundaries, or may be due to accumulation of rainwater on saturated ground.

Floods can also occur in rivers, when flow exceeds the capacity of the river channel, particularly at bends or meanders. Floods often cause damage to homes and businesses if they are placed in natural flood plains of rivers. While flood damage can be virtually eliminated by moving away from rivers and other bodies of water, people have always lived and worked by the water to seek sustenance and capitalize on the gains of cheap and easy travel and commerce by being near water. That human being continues to inhabit areas threatened by flood damage is evidence that the perceived value of living near the water exceeds the cost of repeated periodic flooding.

Several factors contribute to the increase of river floods. In almost all mountainous regions, glacier retreat is causing a decrease in snow melt, leading to a lower base flow in rivers. With higher temperatures winter snow melts quicker, leading to an increase in peak flows. Furthermore, almost all models predict more dynamics in rainfall patterns, i.e. with higher intensity of precipitation leading to even more pronounced peak flows in rivers. In combination with climate drivers, changing land use will still remain to be one of the main culprits behind increased flood risks in the future.

Five types of floods resulting loss of life and properties have been reported from Nepal. Those are flash floods associated with i) extreme local scale precipitation (cloud burst) like in Lele area in 1981, Kulekhani area in 1993 and Syangja in 1998; ii) heavy monsoon precipitation at regional scale like in 1954 and 1955 in many parts of the country; iii) Glacial Lake Outburst Floods (GLOFs) like in Bhotekoshi/Sunkoshi in

1981 and Dudhkoshi in 1985; and Landslide Dam Outburst Floods (LDOFs) like in Budhi Gandaki in 1967 and 1968, Balephi in 1982, Myagdi in 1988 and Larcha khola in 1996 and flood triggered due to failure of infrastructure such as dam and embankments like Koshi flood in 2008 due to failure of embankment and Bagmati flood in 1993. Nine events of disastrous flood triggered by the failure of infrastructures have been reported from Nepal. In addition to these riverine floods, sheet flooding or inundation after heavy precipitation is common problem in lowland area in Inner Terai and Terai regions.

A glacial lake outburst flood (GLOF) is a type of outburst flood that occurs when the dam containing a glacial lake fails. The dam can consist of glacier ice or a moraine. Failure can happen due to erosion, a buildup of hydrostatic, an avalanche of rock or heavy snow, an earthquake or volcanic eruption under the ice, or if a large enough portion of a glacier breaks off and massively displaces the waters in a glacial lake at its base. A glacial lake outburst flood is a type of outburst flood occurring when water dammed by a glacier or a moraine is released.

A landslide dam is a natural damming of a river by landslide. The water impounded by a landslide dam may create a dam reservoir. Because of their rather loose nature and absence of controlled spillway, landslide dams frequently fail catastrophically and lead to downstream flooding often with high casualties. A common failure scenario is overflowing with subsequent dam breach and erosion by the overflow stream.

Landslides

A landslide is a geological phenomenon which includes a wide range of ground movement, such as rock falls, slope failures and debris flows. Although the action of gravity is the primary driving force for a landslide to occur, there are other contributing factors affecting the original slope stability. Typically, pre-conditional factors build up specific sub-surface conditions that make the area/slope prone to failure, whereas the actual landslide often requires a trigger before being released.

A mudslide is the most rapid (up to 80 km/h) and fluid type of downhill mass wasting. It is a rapid movement of a large mass of mud formed from loose soil and water. Similar terms are mudflow, mud stream, debris flow (e.g. in high mountains).

Debris flows are fast moving, liquefied landslides of mixed and unconsolidated water and debris that look like flowing concrete. They are differentiated from mudflows by their coarser and more poorly sorted sediment load. Flows can carry materials ranging in size from clay to boulders, and may contain a large amount of woody debris such as logs and tree stumps. Flows can be triggered by intense rainfall, glacial melt, or a combination of the two. Speed of debris flows can vary from 5 km/h to up to 80 km/h in extreme cases. Volumes of material delivered by single events vary from less than 100 to more than 100,000 cubic metres. Variables considered important in debris flow initiation include slope angle, available loose sediment, and degree of land disturbance by activities such as forest harvesting. Debris flows are often more frequent following forest and brush fires. Debris flows are extremely destructive to life and property, and claim thousands of lives world-wide in any given year. They are a particular problem in steep mountainous areas subjected to intense rainstorms.

Avalanche

An avalanche is a sudden, drastic flow of snow down a slope, occurring due to the triggers, such as loading from new snow or rain, explosives or overload of the snowpack. The influence of gravity on the accumulated weight of newly fallen loose snow or on thawing older snow leads to avalanches which may be triggered by earthquakes and the movements of animals. Avalanches are most common during winter or spring but glacier movements may cause ice avalanches during summer. Avalanches cause loss of life and can destroy settlements, roads, railways and forests. Typically occurring in mountainous terrain, an avalanche can mix air and water with the descending snow. Powerful avalanches have the capability to entrain ice, rocks, trees, and other material on the slope. Avalanches are primarily composed of flowing snow, and are distinct from mudslides, rockslides and sudden collapses on an icefall.

Avalanches are not rare or random events and are endemic to any mountain range that accumulates a standing snowpack. In mountainous terrain avalanches are among the most serious hazards to life and property, with their destructive capability resulting from their potential to carry an enormous mass of snow rapidly over large distances.

Avalanches are classified by their morphological characteristics and are rated by either their destructive potential, or the mass of the downward flowing snow. Some of the morphological characteristics used to classify avalanches include the type of snow involved; the nature of the failure; the sliding surface; the mechanism of the failure; the trigger of the avalanche; the slope angle; slope aspect; and elevation.

Heat and Cold Wave

A heat wave is a prolonged period of excessively hot weather, which may be accompanied by high humidity. The heat wave is relative to the usual weather in the area and relative to normal temperatures for the season. Temperatures that people from a hotter climate consider normal can be termed a heat wave in a cooler area if they are outside the normal climate pattern for that area. The term is applied both to routine weather variations and to extraordinary spells of heat which may occur only once a century. Severe heat waves have caused catastrophic crop failures, thousands of deaths from hyperthermia, and widespread power outages due to increased use of air conditioning.

A cold wave is a weather phenomenon that is distinguished by a cooling of the air. A cold wave is a rapid fall in temperature within a 24 hour period requiring substantially increased protection to agriculture, industry, commerce, and social activities. The precise criterion for a cold wave is determined by the rate at which the temperature falls, and the minimum to which it falls. A cold wave can cause death and injury to livestock and wildlife. Exposure to cold mandates greater caloric intake for all animals, including humans, and if a cold wave is accompanied by heavy and persistent snow, grazing animals may be unable to reach needed food and die of hypothermia or

starvation. They often necessitate the purchase of foodstuffs at considerable cost to farmers to feed livestock

Hailstorm and Thunderstorm

Hail is a form of solid precipitation. It consists of balls or irregular lumps of ice, each of which is referred to as a hail stone. Hail formation requires environments of strong, upward motion of air with the parent thunderstorm and lowered heights of the freezing level. Hail stones generally fall at higher speeds as they grow in size. Hail can cause serious damage, notably to automobiles, aircraft, glass-roofed structures, livestock, and most commonly, farmers' crops.

A thunderstorm is a form of weather characterized by the presence of lightning and its acoustic effect on the Earth's atmosphere known as thunder. Thunderstorms are usually accompanied by strong winds, heavy rains and sometimes snow, hail or no precipitation at all. Thunderstorms result from the rapid upward movement of warm, moist air. As the warm, moist air moves upward, it cools, condenses, and forms clouds that can reach heights of over 20 km. As the rising air reaches its dew points, water droplets and ice form and begin falling the long distance through the clouds towards the Earth's surface. As the droplets fall, they collide with other droplets and become larger. The falling droplets create a downdraft of air that spreads out at the Earth's surface and causes strong winds associated commonly with thunderstorms. Thunderstorms cause physical destruction as well damage to life of the people and livestock due to the very high voltage electricity shock.

The Way Forward

The best to reduce the risks of **the** climate disasters to better prepare for these disasters in order to adapt with them. There are different ways how to deal with them, such as i) developing and operationalizing early warning system, ii) increasing adaptive capacity of

the people through training, information access, income diversification, building social networks, developing drought and flood tolerant crops, iii) disaster mapping, iv) relocation/resettlement from the disaster prone areas.

Integration of Environment and Climate Change in Development Cooperation, European Commission (EC) - Ms Flavia Fabiano

This session aims to introduce to the class the Guidelines on the Integration of Environment and Climate Change in Development Cooperation. These guidelines define a comprehensive reference framework for integrating the environment and climate change into the different stages of the cycle of operations for EC development cooperation covering the programming phase and the three aid delivery approaches: sector support, general budget support and project approach.

In the EC context, **mainstreaming** is defined as 'the process of systematically integrating a selected value/ theme/idea into all domains of development cooperation…' and requires changes both in ideas and practices. The integration of the environment and climate change serves four main objectives:

- Identifying and avoiding harmful direct and indirect environmental impacts of programs and projects in the different co-operation sectors, which can undermine sustainability.
- Recognizing and realizing opportunities for enhancing environmental conditions, thereby bringing additional benefits to development and economic activities.
- Promoting improved environmental dialogue with partner countries.

- Identifying potential risks of a project or programme by assessing its exposure and sensitivity as well as response capacities in place to deal with existing or anticipated climate variability and change.

The rationale for mainstreaming the environment including climate variability and change is based on a number of arguments. These include the concept of environmental services and the increasing realization of external environmental costs. The concept of sustainable development based on approaches that not only address economic objectives but also social and environmental ones is established and emphasized in EU development cooperation objectives, however achieving sustainable development remains both a local and global challenge. The main area of interaction between environment and development priorities are: poverty eradication, gender, security, human rights and governance.

Environment and climate in programming.

Integration in multi-annual programming is considered particularly critical as it sets the parameters for subsequent phases in the cycle of operations. During programming, key steps are taken to identify and avoid any harmful impacts of cooperation; to realize opportunities for enhancing environmental conditions; and to address risks, constraints and opportunities including those resulting from climate variability and change.
The main environmental integration tool during programming is the **Country**

Environmental Profile (CEP). The CEP provides the necessary information to integrate environmental concerns into the country analysis and response strategy and, if required, inform policy dialogue on environment and natural resource management. In the definition of a response strategy and multi-annual programming, the environment should be considered as a **cross-cutting issue** influencing the specific interventions for different focal and non-focal sectors, and may also be considered as a possible sector of intervention.

Environment, including climate, in sector policy support programs

Sector policy support is a major aid delivery approach of the EC and refers to the individuation and support of certain sectors- e.g. in Nepal: education, trade and peace building and security. Although the impact of sector programs on the environment and also the influence of the environment on sectors may not be as immediate and apparent as for some projects, they can be very significant.

The main phase when environment and climate can be mainstreamed is **identification phase**, when sector policies or programs are screened for environmental and climate implications. **Screening** supports the identification of those policies and programmes that have the potential to cause significant environmental impacts and/or are significantly dependent upon environmental and climatic constraints. Screening can identify opportunities for the sector policy or program to make positive contributions to environmental sustainability. One outcome of screening could be a decision to proceed with a **Strategic Environmental Assessment (SEA).** An SEA is a systematic process for evaluating the environmental consequences of proposed policies, plans or programmes in order to ensure they are fully included and appropriately addressed at the earliest stage of decision making. Understanding the links between environmental, social, economic and cultural factors is essential. The engagement of stakeholders and the inclusion of their concerns into the process in order to identify appropriate responses is another key element. Lastly, it should be stressed that SEA approaches are particularly appropriate for assessing the influence of climate change on policies and programmes, as well as possible mitigation and adaptation measures.

Environment, including climate, in General Budget Support

General Budget Support refers to the aid delivery method for which the European Commission supports directly government spending in policy areas connected to development priorities, e.g. poverty eradication strategy, infrastructural reforms, trade reforms. For GBS, much of the environmental integration effort is during the initial

phases, focusing on assessments and analysis of linkages between policies and environment and institutional capacities to effectively carry out the environmental tasks. During **formulation phase,** a comprehensive evaluation of the 'seven assessment areas' is under-taken, and guidance is provided on where environmental considerations may be particularly relevant, including: performance monitoring indicators; donor coordination on the environment; and the institutional setting and capacity analysis in relation to environment and climate change.

Environment, including climate, in Projects

This final chapter gives guidance on opportunities to integrate climate change and environmental issues during the identification, formulation, implementation and evaluation of projects. Projects may differ from the other aid delivery methods in that there are typically a larger number of environmental integration entry points in (donor supported) project procedures.

The first opportunity for integration at the **identification stage** is in the logical framework approach, in particular to ensure that environmental problems are included in the **problem tree analysis**. When the critical parameters of a project have been identified, the project should be screened from an environmental perspective to identify both possible impacts and climate risks. In order to minimize impact in a climate change perspective, only **no regrets or low regrets measures** should be adopted. If necessary, in the **formulation phase** an **EIA** Environmental Impact Assessment of the project should be conducted.

In project implementation, if an environmental management plan had been prepared, this should be implemented, as should any other recommendations on environmental sustainability developed during formulation. Environmental indicators included in the project design should be monitored, triggering adjustments in project management in case of need. Lastly, in evaluation phase, Projects can be evaluated from an environ-mental

perspective by applying an environ-mental and climate change 'lenses' to the five standard evaluation criteria: relevance, effectiveness, efficiency, impact and sustainability.

Policies and Programmes on Climate Change: National Initiatives, Challenges and Opportunities- Mr Batu Krishna Uprety, Climate Change Expert

The climate change – evergreen concerns of the international community - has significantly affected the people, their livelihood and ecosystems. The climate has always changed and will continue to change naturally, but anthropogenic emissions of greenhouse gases (GHGs) having high global warming potentials has changed the climate system rapidly. People having low or no resources, knowledge and skills, have not been able to cope with the emerging threats of climate change.

Nepal has formulated and is implementing policies, programmes and projects to address the adverse impacts of climate change along with the implementation of the UN Framework Convention on Climate Change (UNFCCC), 1992 and the Kyoto Protocol (KP), 1997. There are opportunities to address climate change challenges if we *act now, act together and act differently*. This requires enhanced political will, new and additional financial resources, technology development and transfer, and capacity building measures.

The Climate Change Risk Atlas 2010 ranked Nepal as the 4th most vulnerable country worldwide (out of 170 countries). In order to adapt to climate change, Nepal has initiated several activities ranging from policy development to coordination.

As a Party to UNFCCC and KP, Nepal has initiated activities that directly or indirectly contribute to address the adverse common threat and impacts of climate change in the mountains. Nepal's participation in the UNFCCC process from early 1990s to mid-2000s enhanced understanding on climate change and its impact. During the period of 1994 -

2006, the remarkable work Nepal preformed was the preparation of the initial national communication which was shared with the Parties to the UNFCCC in 2004. In 2007, Nepal prepared the proposal for the preparation of the National Adaptation Programme of Action (NAPA) to access funding from LDC Fund. The NAPA is a programme that addresses the most urgent and immediate adaptation needs of the Least Developed Countries (LDCs), and a programme that should be prepared by the LDCs to be eligible for support from the LDC Fund. Some of the activities that are initiated since 2007 are grouped as follows:

1. **Climate Change Policy:** Policy is a verbal or written or implied basic guide to actions. It provides guidance for future actions and policy is determined by demand, support and public choice, and willingness to pay and/or willingness to accept. In general, policy follows the SMART rule (S = specific, M = measurable, A = achievable, R = realistic, and T = time-frame).

   The Government of Nepal has issued the Climate Change Policy, 2011 to mainstream climate change activities in the development programmes and projects. The policy focuses, *inter alia*, on climate adaptation, resilience and low carbon development path and climate-friendly resource management to minimise impacts of climate change in the country. The Policy also urges to spend over 80% of the total fund received for climate change in the field level programmes. It provides provision to establish Climate Change Centre, Climate Change Fund, and Climate Award. It includes policies on climate adaptation. The Policy was drafted through consultative process and was sufficiently discussed in MCCICC and CCC before approval by the Cabinet.

2. **NAPA and LAPA Preparation:** Nepal's NAPA was prepared through extensive consultation process within the functional time of 16 months and was funded from LDC Fund, DFID and Danish Embassy in Kathmandu. The NAPA, which contains 9 priority programmes, was approved by the Government of Nepal on 28 September 2010. In order to translate the NAPA into actions, the MoE, in collaboration with MoFALD and support from DFID drafted the National Framework on Local

Adaptation Plan for Action (LAPA), and Government of Nepal has approved it on 22 November 2011. For NAPA implementation, GoN has secured funding from DFID-EU and LDC Fund. USAID has also allocated funds for climate adaptation in its Hariyo Ban Programme. As of now, integrated programmes, community-based flood management, GLOF, and ecosystem-based adaptations have been focused for implementation. In September 2009, 14 donors and development partners have entered into a MoU with MoE clearly indicating their strong willingness to support Nepal on climate change activities in Nepal.

3. **PPPCR and Other Projects:** The Strategic Programme for Climate Resilience has allocated funding for the implementation of the Pilot Programme for Climate Resilience (PPCR). The MoE is preparing projects under this PPCR and its component 3 is now under implementation. The funding for PPCR activities is both grant and concessional resources. The MoE is also speeding up the preparation of the Second National Communication and Technology Needs Assessment Projects through GEF funding where UNEP functions as the GEF Implementing Agency. Nepal is also conducting economic assessment of loss and benefits from climate change in key sectors.

4. **Coordination and Institutional Strengthening**: The GoN has constituted a Climate Change Council (CCC) in 2009 under the chairmanship of the Rt. Hon'ble Prime Minister for policy coordination and guidance. The Council is also represented by 8 independent experts. A high-level coordination committee has also been recently constituted under the chairmanship of Hon'ble Minister for Environment to ensure better coordination on PPCR and other climate change activities. Similarly, a Multi-stakeholder Climate Change Initiatives Coordination Committee (MCCICC) was formed in 2010 under the chairmanship of the Secretary of the Ministry of Environment (MoE) to promote functional level coordination amongst the stakeholders and streamline climate change activities.

The GoN in 2010 established the Climate Change Management Division in the Ministry of Environment (MoE) with three sections - Climate Change Section, Climate Change Council Secretariat Section, and CDM Section with a total of 9 permanent staff. There are additional steering committees or the technical committees established on project-type basis.

5. **CDM Promotion**: As the Designated National Authority (DNA) for Nepal to promote Clean Development Mechanism (CDM) projects, MoE has issued procedures for the approval of the CDM projects to benefit from KP provisions. As of 12 May 2012, it has approved Project Design Document (PDD) of 15 CDM Projects for carbon trade. However, the CDM-Executive Board has issued CER (certified emission reduction) of 31,874 for "Biogas Support Program - Nepal (BSP-Nepal) Activity-2. The CER from second biogas project was issued on 23 September 2011. Additional 4 projects are in different stages to get CER from CDM-EB.
6. **Conferences and Meetings**: Nepal organised South Asian Regional Climate Change Conference (from Kathmandu to Copenhagen), a Cabinet Meeting at Kalapathar at the base camp of the Mt. Everest on the eve of COP15 (15^{th} Session of the Conference of the Parties to the UNFCCC), summiteers summit to save the Himalayas in Copenhagen in 2009, and International Conference of Mountain Countries on Climate Change in April 2012. In 2010, Nepal organized 18^{th} meeting of the LDC Expert Group (LEG) in collaboration with the UNFCCC Secretariat, and an International Expert Consultation Meeting on Climate Change in collaboration with ICIMOD in Kathmandu. In 201, it organized international and regional workshops and meetings on CDM. In order to inform mountain countries about the Mountain Initiatives, Nepal organized two side-events in Bonn, Germany and one each in Cancun, Mexico in 2010 and Durban, South Africa in 2011.
7. **Negotiations**: The MoE prepared status paper for COP15 for negotiation purposes, and continued it for COP16 as well. The MoE, as the focal point for UNFCCC, submitted its views and ideas on NAPA and extension of LEG mandate in 2010 and

National Adaptation Programmes (NAPs) in 2011. Nepal will function as the Chair of the LDC Coordination Group for UNFCCC for 2013 and 2014 (two years), meaning the leader of 48 LDCs on climate negotiation.

8. **Securing Funding**: During the last 4 years, major effort was given in securing funding for climate change activities from sources available within and outside the UNFCCC. Besides PPCR, GoN has also secured funding up to USD 40 million for scaling up renewable energy programmes (SREP) from the Climate Investment Fund, and LDC Fund for climate adaptation and CDKN for climate negotiation, and economic assessment. Climate finance is secured from LDC Fund, bilateral sources, Climate Investment Fund (CIF) and international NGOs.

   There are several challenges to promote climate adaptation in Nepal. Inadequate knowledge, skill, scientific data and information related to the science of climate change and its impact on different geographical and socio-economic development sectors including enabling environment are the overriding challenges. However, this could be converted to opportunities. As a Party to the UNFCCC and its KP, effective implementation of the Convention provisions and Climate Change Policy along with NAPA and LAPA would promote institutional development, enhance capacity, develop and utilise technologies, ensure fund flow, and update data and information and enhance our capacity to promote climate adaptation, mitigation and carbon sequestration.

   Ice has been broken to implement climate change regime in Nepal as climate change is the national development agenda. In order to benefit from climate regime, and reduce adverse impacts of climate change, NAPA should be implemented through LAPA and new and additional financing. It seems that options and opportunities exist to have the fresh fruits before being rotten.

   In Nepal, strong 'political will' exists on climate change. Several institutions involved in climate change should double or quadruple their activities to address the adverse impacts of climate change. Opportunities exist to benefit from climate change regime if we act together through common understanding on major issues.

Gender and Social Inclusion in Climate change from adaptation

Ms Meena Kunwar, Gender expert

Increases in the concentration of carbon dioxide and other greenhouse gases in the atmosphere are leading to increases in global average air and sea temperatures, with different consequences at regional and local levels including melting of snow and ice, sea-level rise, increases in ocean salinity, changing wind and rainfall patterns, as well as an increase in the frequency and intensity of extreme weather events (IPCC 2007). Scientist have already confirmed that mitigation is critical for slowing the climate change but even the emission rate of GHG is reduced there is going to be some amount of climate change due to already existing GHG in the atmosphere. Therefore, adapting to the possible climate impacts is critical.

With an increasing understanding of climate change as a development issue not only requiring scientific but also social, political, economic and behavioral solutions, the need to ensure these solutions are gender-responsive should be self-evident. The impacts and perceptions of climate change vary at the local level, and they also vary between women and men, girls and boys.

The climate change will have differentiated impacts on men and women. Therefore, the responses to climate change are also not gender neutral. There are important gender differences in the implications of climate change for the lives of females and males of all ages (UNDP 2009), as the multiple environmental, physical, social and economic processes associated with climate change have differentiated impacts on them. There are many evidences related to research on disaster management that shows that women are more vulnerable than men.

Women and men do have different experiences with the environment and therefore have distinct knowledge and skills to contribute in the management of disasters. Similarly, in developing country like Nepal large population out-migrate for the job and women are the one who take control over management of house, family as well as the Natural resources management.

Including both men and women in decision-making on climate change adaptation and mitigation, and understanding the reasons for and implications of their different roles, responsibilities and capabilities is, therefore, gender consideration is essential for poverty reduction and climate adaptation.

What is Gender and Social Inclusion?

The term "gender" refers to socially ascribed roles, responsibilities and opportunities associated with women and men, as well as the hidden power structures that govern relationships between them. Gender is "... in essence, a term used to emphasize that sex inequality is not caused by the anatomic and physiological differences that characterize men and women, but rather by the unequal and inequitable treatment socially accorded to them. (Riquer, 1993 in IUCN, 2009).

"Gender" is the behavior that lets people know "he is a man" or "she is a woman"
"Gender" is socially learned behavior and creates or challenges social expectations
Gender roles may be different in different countries. Gender identities can change this is why the political project of gender equality is possible

Various terminologies related to gender and development is given in Annex – 1.

In Nepal, the Ministry of Local Development (MoLD) has developed the Gender and Social Inclusion Strategy Operational strategy (GESIOS) and it acknowledges that women's rights can be achieved only with change in discriminatory gender relations (GESIOS - LGCDP, GoN 2009). In Nepal, socially constructed power relations between women and men establish the roles, responsibilities, opportunities and decision-making authority of women and men, usually positioning women as subordinate to men. These gender relations are a cross-cutting dimension of discrimination, with varying degrees, across all social groups in Nepal. All women experience discrimination but women of

Box 1. Progression of women inclusion in periodic development - Nepal

- 6th periodic plan (1980-85) - conceptualization of women inclusion in development programs
- 7th periodic plan (1985-90) - active participation of women and quota for women, ensuring at least 10 percent of women participation
- The forest sector's Master plan 1988 recognized the role of women in forest management
- 8th periodic plan (1992-97) - women specific sub-sector program such as group formation, training
- 9th periodic plan (1997-02) - women in decision making, post harvesting programs
- 10th periodic plan (2002-07) - gender mainstreaming through capacity building and entrepreneurship
- Three years interim plan (2007-011) - inclusive development and targeted programs

excluded communities experience multiple exclusions (GESIOS-LGCDP, GoN, 2009).

Social exclusion describes the experience of groups who are systematically and historically disadvantaged because they are discriminated against on the basis of their caste, gender, ethnicity, disability or religion or an overlapping combination of these. Exclusion happens in public (formal) institutions like the legal system or health system, as well as social (informal) institutions like caste or gender systems or networks of political patronage (GESI Strategy, LGCDP/MLD, 2009).

Social Inclusion is the removal of institutional barriers and the enhancement of incentives to increase the access of diverse individuals and groups to development opportunities. This means changes in policies, rules, social practices and shifts in people's perspectives and behavior towards the excluded groups. Both **gender** and **social inclusion** issues must be addressed simultaneously if sustained change in the lives of the excluded women and men is to be achieved.

The progress ion of gender and development is given in Annex 2. And the progression of gender and development is given in the box 1.

Why gender matters in the context of vulnerability to climate change and adaptation

"Gender inequalities intersect with climate risks and vulnerabilities. Women's historic disadvantages - their limited access to resources, restricted rights, and a muted voice in shaping decisions - make them highly vulnerable to climate change." Human Development Report 2007/08, Fighting climate change: Human solidarity in a divided world.

Women and girls often experience the most severe impacts of climate change and have less decision-making power and less access to and control over resources to face them. Women – particularly in poor countries will be affected differently than men. They are the most vulnerable to the climate

Box 2 Weather Extremes and Women: Number Reveal Risks

- Women and children are 14 times more likely to dies than men during natural disasters.
- The 1991 cyclone in Bangladesh killed 140,000 people – the mortality rate of women over 40 was 31%.
- More than 70% of the dead from the 2004 Asian tsunami were women.
- Hurricane Katrina, predominantly affected African American women.
- In a sample of 141 countries over the period 1981–2002, it was found those natural disasters (and their

change. Women work largely on the agriculture land; they do not have access to the resources, and do not have income. Similarly, they are running house and responsible for feeding their families, which often increase their mobility and work load and increase the vulnerability. Draught and erratic rainfall force women to walk long hours to fetch water and it will be also harder to secure food. Girls drop out from the school due to extra time they have to spend on the household work.

Box 3 Gender inequalities

- Approximately 70% of those who live on less than a dollar each day are women
- Women work two-thirds of the world's working hours yet receive only 10% of the world's income.
- Women own only 1% of the world's property.
- Women members of parliament globally average 17%
- Women make up 64% of the world's illiterate.'
- 75% of the world's 876 million illiterate adults are women.
- Worldwide women received 78% of the wages received by men for the same work,
- In some parts of the world, the wage gap between women and men is close to 40%.
- Of the 550 million low-paid workers in the world, 330 million or 60% are women.

(Sources: Christian Aid Website, Gender and Climate Change, IUCN; Global employment trend for women, 2004; The World's Women 2010, UN)

How gender inequality shapes the vulnerability context

The gender equality and women's empowerment has been defined in the MDG 3. Social inequalities have serious implications on women's lives, limiting their access to land ownership, housing, education, health care and participation in decision making process at household as well as society, formal and informal institutions and policy level.

In developing countries the gender inequality persists at different level and that has been one of the challenges to attain the sustainable development. In the context of climate change the gender inequalities exacerbates and women are more exposed to vulnerable context See Box 3 and 4.

The IPCC report highlights that the climate change impacts will hit hardest the poorest regions and the poorest people who have the least resources for facing the changes brought by increasing droughts, floods or storms; seventy percent of these poor are women.

Historic disadvantages, including restricted access to resources, information, and decision-making, result in heavier burdens for women during and after natural disasters. Women in developing countries are largely responsible for securing food, water, and energy for cooking and heating. Drought, desertification, and erratic rainfall result in

women having to work even harder to secure these resources, leaving them with less time to earn income, get an education, or provide care to their families.

Climate change exacerbates the health outbreak of epidemics and disasters. Women get more stressed because of increased work load to care for sick and elderly people. Climate change challenges food security. Women are highly dependent on NRM and agriculture, they have to feed family and this will directly make them vulnerable as they have to work hard to secure food and tend to eat less. In the case of water women are more vulnerable due to their specific responsibility. In the case of disasters, women are 14 times more vulnerable than men (Neumayer and Pluemper, 2007). As far as human security is concerned women are affected more on all aspects. Climate migration has also put women more burden as it affects production patterns, work division, labor availability.

To understand and address the differential impacts of climate change and disasters, it is, therefore, important to understand how gender inequality shapes vulnerability. In many societies, the gender inequality is largely due to social and culture, where women often have limited choices and less access to land, information, social networks, technology and other assets that would help them off-set or avoid these impacts. For example, women may have lower literacy or reduced access to information, meaning, they cannot read or do not receive early warning messages channeled through public spaces. Similarly, in some places, culturally girls do not learn skills to swim climb trees and bargain with outsiders, which deprive them of key skills for during difficult time.

Box 4 Result of socio-cultural barriers

In some communities in Bangladesh, women are deprived of the capacity to cope with disasters by being kept in dependent positions in terms of accessing information from the world outside their home. In this respect, *purdah2 as an institution,* which prevents women from engaging in socioeconomic roles outside the household directly prescribes women's vulnerability to disaster. *Source: Ikeda, 1995.*

Gender and climate change adaptation in Nepal

Nepal falls under within 10 highly vulnerable countries due to climate change. The most vulnerable within Nepal as outlined by NAPAs are the poor and excluded communities.

In Nepal the gender inequalities is persistent across various sector, geography, communities and institutions. Education the most important driver for bringing gender gap and low educational attainment impacts the capability thus hindering better options

for livelihoods and meaningful participation. Largely women population is illiterate and the trend of literacy rate is also significantly less compared to men (See Annex 3).

Why gender matters in Nepal

- Gender and social exclusion is widespread across various caste, class and geography.
- Floods and landslides are seasonal disasters in Nepal. Climate change is expected to further exacerbate the frequency and intensity of flooding.
- More and more women are being house head in rural Nepal due to outmigration of the men.
- The agriculture sector is becoming more and more feminism.
- Women do have knowledge, skills and solutions to the problem
- Country is largely relying on women for natural resources management, agriculture sector and health

As given in box 1 gender and development discourse is slowly getting into gender mainstreaming approach. Presently, various programme and policy documents mentions gender in its key policy documents, strategies, frameworks and also budgetary allocations. However, the existing challenges for gender mainstreaming are very difficult to address without strong commitment from all including political, beaurocratic, civil society and individual citizen. In some cases despite the policy development there are no strong initiatives to practice it.

Government of Nepal has recently developed the **NAPA** (National Adaptation Plan of Action) in 2010. However, until the last moment gender was not considered in design, no disaggregated information was assessed during the vulnerability mapping and it was gender blind. At the National level once the all documents were drafted effort was given to make a gender sensitivity analysis of the NAPA by doing a consultation.

The outcome of that consultation is attached in the NAPA and given below. This analysis even though not done robustly gives quite alarming messages about how women and girl will be impacted by the climate change impact in Nepal.

Gender sensitivity analysis of climate change impacts (NAPA 2010, Nepal)

Water & Energy	**Agriculture & Food Security**	**Forestry & Biodiversity**	**Urban Settlements**	**Public Health**	**Climate Induced Disasters**
Decreased women's access to water resources increases work load, impacting on reproductive health (e.g. prolapsed uterus) and personal hygiene. Climate induced resource conflicts increases social violence, anxiety and depression in women. Women are often the household members who look after water firewood and energy management. Any risk	Male out-migration imposes additional work load on women. Women consume less food during shortages causing under-nourishment and weakness-especially during pregnancy and lactation. Women are custodians of local knowledge, agricultural skills and practice (e.g. seed preservation) and other livelihood related activities.	Reduced availability of income generating forest products affects women and marginal communities directly because of their high level of reliance on such products for revenue generation and as safety nets. Women and marginalized groups have limited access o new information and communications to support adaptation. Climate induced resource use conflict amplifies existing gender inequalities. Women become more vulnerable when conflict	Water scarcity would mean that women have to spend more time collecting water. Migration and frequent movements due to temporary displacement related to flash floods pose risks of insecurity and sexual violence against women. Inadequate incorporation of gender concerns in urban planning and policies undermines adaptation. Under representation	Due to socially constructed multiple roles, more women than men die or get injured from climate change related health hazards Climate change exacerbated gender differentiation and poor health of women. Women bear the brunt of providing increased care of vulnerable children, sick, disabled and old age people. Climate change induced diseased, such	Women have less access to early warning and climate information and generally, lack the skill to survive extreme events. Women face the risk of increased sexual violence in shelters. Cultural and social restrictions curtail mobility of women and their ability to avoid disasters. Women and marginalized people are poorly represented

involving them should be addressed in climate adaptation strategies.	Loss of these resources due to climate change would Mage women more vulnerable. Adaptation strategies need to improve women's access to these resources. Due to limited access to credit, market, land and agricultural extension services, women are more vulnerable to adverse climate change impacts.	leads to social violence, anxiety and depression	of women and marginal communities in urban projects and infrastructure development. Women are to be important actors in the development of urban adaptation.	as respiratory disorders, allergy, asthma and other respiratory diseases appear more among women, marginal people including children. This leads to women's illness, physical and mental stress.	in formulating disaster related policies and programme. In case of food scarcity, women often eat less and also become less careful about their health which also makes them to become more prone to malnutrition and diseases

NAPA principally focuses on country driven approach and ensure effective representation of people whose lives are at risk due to climate change but followed process undermines this philosophy. False assumption that women will benefit if community institutions are involved in adaptation dominates and NAPA contributes

gender inequality as none of the six projects envisioned to have a clear set of operational strategies in order to address the gender issues that it identified (Khadka, 2010).

As the NAPAs were developed as a policy guiding document at the National level, efforts were made to operationalise NAPAs through Local Adaptation Plan of Actions (LAPA) and community based adaptation planning (CAP) that directly works with communities and district level stakeholders to assess the vulnerability and identify adaptation options to mitigate those. Based on the learning GoN has already developed a LAPA framework and now National Climate Change Support Programme is going to support in preparing LAPAs.

LAPA framework also does not have clear guideline on addressing gender issues. It assumes that inclusion and community participation in general covers it. No gender analysis tools integrated in the vulnerable household identification and other tools. It also does not much refer to the widely acknowledged the GESI strategy of MoLD.

Responding to the issue of gender and climate change

Possible ways to address challenges engendering climate change

- Climate change is not gender neutral and therefore climate information and services cannot be gender neutral. Therefore, gender specific research and data is required.
- Ensure women have equal access to knowledge, resources and technology, which are necessary in influencing climate change.
- Gender analysis tools are necessary to be used to understand men's and women's different roles and responsibilities and their access to resources and decision making.
- Mainstreaming gender perspective into climate change adaptation is must at policy design process, implementation, monitoring and evaluation of policies and programmes.
- Building on existing knowledge, capacities and best practices such that it will be easily adapted. For example use of participatory tools and approaches to involve all in planning and implementation at community.
- Creating enabling environment for women to participate more actively in policy and decision making processes

- Recognizing Women leadership is critical as they are the powerful agents of change
- Strong Monitoring Mechanisms are in place to understand the gender differentiated impact and solutions

Gender inequality and gender discrimination influence adaptation strategies and therefore a response to climate change, it is crucial to ensure gender sensitive responses for such issues. Gender inequalities and gender roles play a key role in determining the choice of adaptation strategies. The gender inequalities are not only due to climate change but it is in many cased affected by gender blind policy and programming. Often the priorities of men and women to adaptation options could be very different but being excluded from the decision making process will always affects women and children. Women's knowledge and skills on Natural resource management as well as managing stress could be ignored if they are not given enough opportunity to empower them to speak and influence the other community members specially men.

It is urgent that the climate change related gender strategy is developed at National and local level to ensure the gender equality is promoted and women's risk and vulnerability due to climate change reduced. A good hope is there are Ministry of Environment (MoE) is already started to facilitate such process of developing gender strategy for MoE.

Building on existing best practices such as GESI strategies of MoFSC, MoLD and also various projects that are strong in addressing gender and social inclusion is important. Based on such practices developing climate and gender sensitive processes, relevant tools and methodologies and capacity building packages that are practically acceptable, adaptable at local level is necessary.

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Annex 1 Gender-related concepts and definitions

Gender refers to roles, responsibilities, rights, relationships and identities of men and women that are defined or ascribed to them within a given society and context – and how these roles, responsibilities and rights and identities of men and women affect and influence each other. These roles, etc., are changeable over time, between places and within places.

Gender division of labour concerns the allocation of the tasks and responsibilities of men and women at home, at work and in society according to patterns of work that are felt to be acceptable in a particular place and time.

Gender equality refers to equal rights, voice, responsibilities and opportunities for men and women in society, at work and in the home.

Gender equity refers to fairness between men and women in access to society's resources, including socially valued goods, rewards and opportunities.

Gender gaps refer to societal differences between men and women that are felt to be undesirable.

Gender mainstreaming refers to the consideration of gender equality concerns in all policy, programme, administrative and financial activities, and in organizational procedures, thereby contributing to organizational transformation.

Gender roles refer to how men and women should act, think and feel according to norms and traditions in a particular place and time.

Gender valuation of work refers to the social and economic values attached to different tasks and responsibilities of men and women.

Gendered access to resources, facilities, services, funds, benefits and decision making refers to the differences between men's and women's rights and opportunities to make use of these resources and to take part in decision making, due to norms and values existing in a particular place and time.

Gendered control over resources and decision-making processes refers to differences between women's and men's rights and power to decide on the use of resources, gain benefits, and take part in decision-making processes, due to norms and values existing in society.

Gender perspective means that:
• A differentiation is made between the needs and priorities of men and women;
• The views and ideas of both men and women are taken seriously;
• The implications of decisions on the situation of women relative to men are considered: who will gain and who will lose; and
• Action is taken to address inequalities or imbalance between men and women.

Sex refers to the biological nature of being male or female. The biological characteristics of men and women are universal and obvious.

Sex roles are those that are bound to one particular sex due to biological factors, for example, giving birth.

Women's empowerment refers to the process in which women reflect upon their reality and question the reasons for their situation in society. It includes developing alternative options and taking opportunities to address existing inequalities. It enables them to live their lives in the fullness of their capabilities and their own choices in respect of their rights as human beings. In the Beijing Declaration, it was agreed that "women's empowerment and their full participation on the basis of equality in all spheres of society, including participation in the decision-making process and access to power, are fundamental for the achievement of equality, development and peace."

Source: UNDP. (2007). *Gender Mainstreaming: a Key Driver of Development in Environment and Energy.*

Annex 2: Progression of Gender and development International context

- 1946-Formation of Commission on Status of Women Under UN
- 1945-UN Charter to provide equality on the basis of race, sex, language or relition
- 1954-UN calls to abolish discrimination against women
- 1960-women's movement/feminist movement in the west (reproductive rights)
- 1970-extensive research to show women as agents of development (the term Women in Development started
- 1975-International year of Women
- 1976-1985-Decade for women
- 1970-1980's- Women and Development-equity approach
- 1979 - CEDAW (Convention of all forms of Discrimination against Women) adapted in 1979, Nepal ratified in June 22, 1992.
- 1992 - The Rio-conference (or the earth summit), 1992 recognizes the importance of roles women and indigenous peoples play in the bio-diversity conservation and forest restoration
- Beijing declaration 1995

Millennium DG: 3 of 8 goals are directly linked to gender equality

Gender mainstreaming into climate change regimes and policies - in particular UNFCCC and NAPAs – is not an issue of voluntary action, but a legal obligation.

- Sustainable development and environment agreements that contribute to the global policy framework on climate change and gender equality include:
- Johannesburg Plan of Action (2002)
- Millennium Declaration (2000)
- World Summit for Social Development (1995)
- International Conference on Population and Development (1994)
- Convention to Combat Desertification (1994)
- Convention on Biodiversity (1992)
- Agenda 21 (UN Conference on Environment and Development 1992)

Human rights agreements that contribute to the global policy framework on climate change and gender equality include:

- UN Declaration on the Rights of Indigenous Peoples (2007)

- World Conference on Human Rights (1993)
- International Covenant on Economic, Social and Cultural Rights (1966)
- International Covenant on Civil and Political Rights (1966)
- Universal Declaration of Human Rights (1948)

Gender equality agreements and resolutions that contribute to the global policy framework on climate change and gender equality include:

- Review and Appraisal of the Beijing Declaration and Platform for Action (Commission on the Status of Women 2005)
- ECOSOC Resolution 2005/31
- Beijing Platform for Action (4th World Conference on Women 1995)
- Convention on the Elimination of All Forms of Discrimination against Women (1979)
- Disaster risk reduction agreements and meetings that contribute to the global policy framework on climate change and gender equality include:
- Hyogo Framework for Action (World Conference on Disaster Reduction 2005)
- Expert Group Meeting on "Environmental Management and the Mitigation of Natural Disasters: A Gender Perspective" (ISDR/DAW, Ankara, 2001)

Climate Change issues in Forest and Biodiversity Sectors: global to local context; understanding the gap and issues[7].

- Dr Swoyambhu Man Amatya, PhD

1. What do we understand by climate change?

Climate change is an alteration in the statistical properties of the climatic system considered over long periods of time, regardless of cause. Climate change affects more than just a change in the weather; it refers to seasonal changes over a span of time. However, fluctuations that occur shorter than a few decades, such as El Nino does not correspond to climate change. Climate ascribes to patterns of temperature, precipitation, humidity, wind and seasons. Sometimes, climate change specifically refers to the change caused by human activities, as opposed to changes in climate that may have resulted as part of Earth's natural processes.

Many systems are tied with climate and one of the major determinants is the deleterious rate of deforestation. It has been estimated that globally, forest covers a total of 3952 025 thousand hectares (about 30.3 % of the total land area of the earth), just under40 million km^2. This corresponds to an average of 0.62 ha (6200 m^2) per capita. This area is unevenly distributed (Table 1). This estimate was based on data on forest area reported by 228 countries and territories.

Table 1: Forest cover by sub region and distribution (2005)

Region/ sub-region	Forest Area (1000 ha)	% of land area	% of global forest area

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Jointly organized by International School of Advanced Studies (ISAS), Himalayan College of Agricultural Sciences and Technology (HICAST) and Midwestern University in collaboration with the USAID funded Hariyo Ban Program

Eastern and Southern Africa	226 534	27.8	5.73
Northern Africa	131 048	8.6	3.32
Western and Central Africa	277 829	44.1	7.03
Total Africa	**635 412**	**21.4**	**16.08**
East Asia	244 862	21.3	6.20
South and Southeast Asia	283 127	33.4	7.16
Western and Central Asia	43 588	4.0	1.10
Total Asia	**571 577**	**18.5**	**14.46**
Total Europe	**1 001 394**	**44.3**	**25.34**
Caribbean	5 974	26.1	0.15
Central America	22 411	43.9	0.57
North America	677 464	32.7	17.14
Total North and Central America	**705 849**	**32.9**	**17.86**
Total Oceania	**206 254**	**24.3**	**5.22**
Total South America	**831 540**	**47.7**	**21.04**
WORLD	**3 952 025**	**30.3**	**100.00**

Source: Global Forest Resources Assessment, 2005.

Forests have **four major roles in climate change**: they currently contribute about **one-sixth of global carbon emissions** when clear cut, overused or degraded; they react sensitively to a changing climate; when managed sustainably, they **produce wood fuels as an alternative to fossil fuels**; and finally, they have the potential to **absorb about one-tenth of global carbon emissions** into their biomass, soils and products and store them in perpetuity.

The table above shows that Europe covers more than one-quarter of total forest area, subsequently followed by South America and then North and Central America. South America covers almost half of the total land area whereas Asia has the lowest percentage of forest cover (less than 20% of land area).

Globally, deforestation – mainly the conversion of tropical forests to agricultural land is high. Deforestation has been taking place at a pace of about 130 000 km^2 (13 million hectares, an area the size of Greece) per year during the period 1990–2005 with few signs of a significant decrease over time.

2. Role of forests in Climate Change issues in global context

Industrial and energy generation activities are producing various green house gases and their compositions have been increasing in the Earth's stratosphere. This is resulting in changes in net solar radiation received by the Earth, atmospheric circulation and hydrological cycle resulting in global warming and erratic rainfall patterns. These effects are instigating changes in the land surface, water bodies, forests and ice sheets. Temperature increase and variability in rainfall, snowfall, heat, drought, etc. are resulting changes in forests and biodiversity. These climatic deviations are related to climate change and increasing the vulnerability in the perpetuation of trees, herbs, small and big animals and insects.

Climate change is emerging as perhaps the greatest environmental challenge of the twenty-first century. It has been reported that in Washington State, climate change is already disrupting the environment, economy and communities. A change in climate can affect many aspects such as living of plants and animals, food production, and availability and use of water among others. For example, forest fires in Australia which occurred in February 2009, has killed more than 200 lives and made a myriad of people homeless (Box 1).

Box1:

In February 2009, for two weeks the temperature was more than 40OC. Maximum temperature recorded during these days was 46 OC. Wind was blowing with high speeds of up to 110 kilo meter per hour. The wind was dry. No humidity. It came from the desert but felt like it came straight from a furnace. There was a weeklong forest fire in Victoria State, Australia in early February, 2009. The fire took more than 200 lives. It made several people homeless; in fact, this fire was recorded as the most damaging forest fire in the history of Australia. Hot conditions by raising temperatures up to 46 degree Centigrade and high speed wind, which facilitated the transfer of fire, contributed in spreading fire.

Similarly, the numbers of polar bears are continuously decreasing in the Hudson Bay of Canada (Box2).

Box 2:

Polar bears (Ursus maritimus) are estimated to be 20,000 to 25,000 worldwide. They are heavily depended on seals for their survival. Seals in sea ice are their main food; it is easy for them to hunt in sea ice than in water due to seals being less mobile in icy waters. Continuous access to sea ice allow bears to hunt throughout the year. Due to the global warming, break-up of the sea ice on the Hudson Bay of Canada, has already occurred about 3 weeks earlier than in 1970.

As a result, polar bears in the area are coming ashore earlier with reduced body fat (15% decline in body condition). As the result, the bear population in Hudson Bay has decreased from 1200 in 1987 to fewer than 950 in 2004. (Faschlin et al, 2007, p. 231)

Another example of climate change impact can be seen in the decline of calcification of coral reefs in Asia (Box 3)

Box 3:

Impact on Coral Reefs

Coral reefs are habitat for about a quarter of marine species and are the most diverse amongst marine ecosystems. Those will be affected by rise in atmospheric carbon dioxide concentration resulting in a decline in calcification and coral Skelton weakening (Faschlin et al, 2007, Pp. 235). Recent risk analysis of coral reef in Asia suggest that between 24% - 30% of the reefs in Asia are likely to be lost during the next 10 years and 30 years, respectively (Cruz et al, 2007). Currently Corals at the triangle (Indonesia, Malaysia, Papua New Genia, Philippines, Solomon Island and East Timor) are mostly suffering from weak calcification problems (Nagarik daily 12 July, 2012).

3. Use of forests and forest products in Nepal

Forests are an integral part of the farming system in Nepal and form a vital resource for livelihood especially in rural areas.

According to the recent data, forest and shrub cover 29.0% and 10.6% respectively of the total land area of the country. The Far Western Development Region of the country has the highest percentage of forest land area followed by the Central development Region (Table 2).

Table 2: Forest and Shrub Area by Development Region (ha.)

Region	Total land area	Forest Area	Forest % of total land area	Shrub Area,	Shrub % of total land area	Forest and shrub total, %
WDR	1,953,900	687,400	35.2	263,900	13.5	48.7
MWDR	4,237,800	1,192,400	28.2	442,000	10.4	38.6
WDR	2,939,800	734,300	25.0	256,900	8.7	33.7
CDR	2,741,000	918,600	33.5	233,800	8.5	42.0
EDR	2,845,600	736,100	25.9	362,600	12.7	38.6
Total	14,718,100	4,268,800	29.0	1,559,200	10.6	39.6

There are 35 major forest types and 118 ecosystems found in Nepal. Nepal, although very small in size (0.03 percent of the total landmass of the world), is very rich in species diversity. It has been reported that the country provides habitat for 2.33 percent of the World's flowering plants. Scientists estimate that a total of 7000 species of flowering plants are located in Nepal's Himalayas.

Unfortunately, the forest coverage is being depleted due to various reasons. High population growth, unmanaged settlement, unemployment, encroachment, grazing and forest fire are some of the underlying causes for the depletion. As a result, the forest area decreased at an annual rate of 1.7%, whereas forest and shrub together decreased at an annual rate of 0.5% during the period of 1978/79 to 1994. The recent studies in 20 Terai districts of the country revealed that forest cover has decreased at an annual rate of 0.06% from the period of 1990/91 to 2000/2001. Of the various causes, one is population

growth. The trend of forest cover lost is inversely related with the increase in the nation's population (Table 3).

Year	Forest cover (ha)	Total Population
1952	**63,43,500**	**82,56,625**
1978-79	**63,06,700**	**1,60,50,631**
1994	**58,28,000**	**20,067,307**

4. Biodiversity in Nepal

The climate in Nepal varies from the sub-tropical to the Alpine within about 150 km span from south to north. The biodiversity in Nepal is supported by forest, rangeland, wetland and mountain ecosystems and is a reflection of its unique geographical position and climatic variations. There are over 6500 species of flowering plants, over 1500 fungi species, and over 350 lichen species. Out of those, about 370 species of flowering plants are considered endemic to Nepal. Faunal diversity in Nepal is also vast; the country harbors 175 mammal species, 836 bird species, 147 reptile and 77 species of amphibian species, 180 species of fish, 640 species of butterfly and more than 2000 species of moth. Of these, 26 species of mammals, nine birds and three reptiles are either endangered or vulnerable or threatened. Those species include Tiger, Rhinoceros, Elephant, Musk deer, Snow leopard, Swamp deer, Wild buffalo, Bengal florican, Lesser florican, Red panda, Clouded Leopard, Gangatic dolphin, Gharial.

The country receives winter and summer monsoon. Average rainfall is 1,500 mm, with rainfall increasing from west to east. Recently it has been experiencing that annual rainfall is not adequate and its distribution is uneven. Flooding is frequent in the monsoon season, while droughts are also increasingly becoming common phenomenon.

Temperature observations in Nepal show a general warming trend. The temperature differences are most explicitly seen during the dry winter season. Significant glacier retreat as well as significant areal expansion of several glacial lakes has also been documented in recent decades, with an extremely high likelihood that such impacts are linked to rising temperatures.

5. Effect of Climate change in Nepal

Climate change is increasingly becoming important in the Nepalese context and is being viewed as one of the challenges in the overall development scenario. Over the last few years, it has been experiencing the occurrence of frequent and intense floods, droughts and extremes in local temperature in the country. Due to the effects of climate change, there has been an annual increase in temperature of 0.06 degree centigrade in Nepal. The major consequence of climate change can be seen in the Himalayan regions. According to the Department of Hydrology and Metrology, there has been a decrease in the winter period in Kathmandu.

The maximum temperature at Kathmandu in the year 2004 was 18.3 Degree Centigrade and the minimum was -1 Degree Centigrade, whereas in the year 2009 there has been a rise in temperature: the maximum was 24 Degree Centigrade and the minimum was 7 Degree Centigrade. The temperature did not drop from 1.2 degree centigrade in the year 2009 whereas it dropped to minus 3.5 Degree Centigrade during the year 1978. The Table 3 below compares the maximum temperature of Nepal in degree centigrade over the period of five years (2004 and 2009).

Table 4: Trend of change in Temperature in some of the major cities of Nepal

Place	January 2004	January 2009	Change in temperature (Degree Centigrade)
Kathmandu	18.0	24.0	6.0

Nepalganj	17.0	24.0	7.0
Silgadhi	15.9	24.0	8.1
Simara	12.0	22.7	10.7
Bhairahawa	17.9	21.7	3.8

Source: Department of Hydrology, Quoted in Kantipur Daily, 22 January, 2009.

Of particular concern the effect of climate change is that the loss or damage to housing, roads and other transportation means, water supply, forest products, crop yields and other natural resources. While damages affect all levels of society, the impact and time to recover are most pronounced and devastating to the poor communities, particularly those that lack solid institutional frameworks of governance and access to timely knowledge and information sources. The implications of climate change for the poor are profound. Poor communities are generally the most directly dependent for their livelihoods on a relatively stable and favorable climate.

However, Nepal's contribution to global greenhouse gas (GHG) emissions is very low (1971.1 kg per capita) compared to the global average of 3.5 tones (Nepal Millennium Development Goals, 2010). Nonetheless, more than 9700 average annual per million people are suffering from natural disasters And 2.3 percent of the total population are living on degraded land (Human Development report, 2011).

6. General Vulnerability for Nepal

It has been reported that as many as six Red Panda have been killed in the peripheries of Makau-Barun National Park. In the past Pangolins have been caught at Makwanpur district and ultimately killed. The possible purpose for the animals coming to the Makwanpur district could have been due to their search of food.

Animals, like human beings, can communicate albeit by different manners of communication and speech. Similarly, they also feel the repercussions of climate change and due to habitat loss resulting from climate change, countless animals are becoming extinct.

Likewise, the incidence of forest fire is increasingly becoming a serious problem in Nepal. Recent forest fire incidences (in the year BS 2065) has killed 43 people. A notorious forest fire was in the Ramechhap district which killed 33 firefighters.

Unforeseen flooding is an example of climate change. According to the Ministry of Home Affairs in the year 2010, 226 persons were killed from flood and landslides Recently (April 2012), the unexpected flooding of the Seti River (Central Development Region) has taken the lives of more than 50 people and washed away thousands of hectares of fertile land.

Additionally, all climate change related impact in rural Nepal is also facilitating the out-migration of indigenous peoples and rural communities making the rural ecosystem more vulnerable due to reduced availability of human resources.

Similarly, due to erratic rainfall and less surface water, wetlands, and water sources are decreasing in and around high altitude forests. This decrease in water is also affecting trees, shrubs, herbs, water plants in ponds and lakes, and fishes. All of these are an important part of food and habitat for the local and migratory birds like the Danphe pheasant (*Lophophorus impijanus*). As the result, communities have said that migratory birds like domicile crane (*Anthropodis virgo*) and other birds like pheasants are seen less. So, vulnerability to high altitude birds and migratory birds are also increasing.

Physiographic zones	***Impact on ecosystem***	***Impact on wildlife***	***Impact on plants***
Terai	Siltation from forest materials Flooding Increased dryness in forest Reduction in water bodies, less quantity of water	Reduced local bird Reduced migratory bird Reduced wild animals Change in habitat of wildlife Change in food availability	Diseases and insects in trees and plants Reduction of tree species Reduction of herbs and NTFP Early flowering and fruiting Increase in invasive species
Mid-hills	Increased dryness in forest Reduction in water bodies, less quantity of water Increased landslides	Reduced local bird Reduced migratory bird Reduced wild animals Change in habitat of wildlife Change in food availability	Diseases and insects in trees and plants Reduction of tree species Reduction of herbs and NTFP Early flowering and fruiting Increase in invasive species
High Altitude	Landslides Less snow but more water in precipitation	Overlapping range of low altitude animals like leopard.	Biodiversity loss Habitat change Upward shifting of tree line Disease in plants

Furthermore, the vulnerability of animals has also been observed in high altitude regions. There has also been a shifting of high altitude animals like the Pika (*Ochotona* spp.). Expert's claim that the species which has been residing mostly in 2800 meters above sea level, is now found to be shifted up to 3200 meter high. Similarly, the common leopard is now observed at a higher altitude.

Due to less availability of herbs in forests, forest dependent indigenous communities and poor women are being more vulnerable. Less availability of herbs also impact local indigenous communities, poor people and women who regularly collect herbs and non-timber forest products in high altitude areas.

6.1 Vulnerability of Water Source and Wetlands

Due to less rainfall, water has been decreased in water sources in forests. Similarly, small ponds and lake are being increasingly more dry.

6.2 Vulnerability of Local Ecosystem

Invasive species such as *Lantana camera*, *Eupatorium* spp., *Mikania micrantha*, are increasing. An extreme example is found in Chitwan National Park where *Mikania macrantha* are spreading extensively affecting original vegetation of shrubs and trees, which are important food for many wild animals.

7 The issues and the gaps

The issue of forest and biodiversity conservation is not because of the dearth of policies and Regulations. Nepal has adequate policies and regulations towards conserving forests and overall biodiversity. For example, although old, the following development plans were instrumental in conserving the biodiversity.

- Periodic plans (Development plans)

- National Forestry Plan, 1976
- National Conservation Strategy, 1988
- Master Plan for Forestry Sector, 1989
- Nepal Environment Policy and Action Plan, 1993
- Agricultural Perspective Plan, 1995

Similarly, some of the major legislation on Biodiversity Conservation is as follows:

- Aquatic life Protection Act, 1961
- Plant Protection Act, 1972
- National Parks and Wildlife Conservation Act, 1973
- Soil and Water Conservation Act, 1982
- Nepal Trust for Nature Conservation Act, 1982
- Forest Act, 1993
- Environment Protection Act, 1996
- Shivapuri Watershed and Wildlife Reserve Development (Formation) order, 1984
- Central Zoo Development Board (Formation) Order, 1989

Even the present Constitution of Nepal (2007) has shown its commitment in protecting the biodiversity of the country. For example, article 35 (10) stresses the vital need for protecting forest and plant and biodiversity conservation in a sustainable way and sharing their benefits on an equitable manner. Similarly, various working policies in conserving biodiversity have been categorically spelled out in the Three Year Plan (2067/68-2069/70). One of the targets is to register biodiversity (institutional framework and implementation) in all the 75 districts of the country.

Attention has also been paid at global climate conventions such as Rio Conventions: the Framework Convention on Climate Change the Convention to Combat Desertification (UNCCD), and the Convention on Biodiversity.

Protocols such as Kyoto aimed to combat global warming have also been signed. And the concerned Conference of the Parties (COP 17) held in Durban, South Africa, agreed to establish a second commitment period of the Kyoto Protocol from 2013 until either 2017 or 2020.

7.1 Then where is the gap?

Nepal should focus its programme to combat climate related risks, including flooding and siltation, as threats to biodiversity conservation. Nepal's National Assessment Report for the World Summit on Sustainable Development (2002) has already recognized the links between climatic circumstances and land degradation, erosion and landslides: *'too much water' and 'too little water' is responsible for land degradation in different land uses in Nepal.*

I think as climate change is one of the by-products of forest and habitat loss due to degradation and deforestation. The degradation of forest could be reduced to some extent through good governance in the Forestry sector. Governance in forestry sector is expected to have:

- competitive administration,
- participatory,
- Transparent, service oriented, result oriented, accountable, inclusive and gender equity.

The important performance measurer could be

- effectiveness of coordination,
- inclusive of representation,

- legitimacy of procedures,
- accountability of authorities and
- fairness of allocation of benefits

Additionally, the climate change policy of the Government of Nepal, January 2011 should be translated in the field with new positive mindset. Similarly, financing climate change development is a challenge for implementing effective climate adaptation and mitigation therefore visioning for climate finance in Nepal could be another step in combating the future impact of climate change

8. Conclusions:

Natural habitats are vital for assuring sustainable development. They provide services that enrich and sustain human life with both tangible and intangible economic and social value and life-sustaining environmental services, such as breathable and usable water. Amartya Sen in his Idea of justice -2009 talks about three fundamental aspects: they are :

1) Conceptual clarity needed on environmental challenge.

2) Demands of sustainable development.

3) Context and relevance of what constitute environmental issue:

-State of nature a) Extent of forest cover

b) Depth of ground water level

c) Number of living Species.

We need to be very clear about the term development as Brundt Land (1987) report that Development that meets the needs of the present and without compromising the ability of future generation to meet their own needs is the real development.

Environmental sustainability has been defined in terms of the preservations and enhancement of the quality of human life. The environment is not only a matter of passive preservation but also one of active pursuit. Even though many human activities that accompany the process of development may have destructive consequences, it is also within human power to enhance and improve the environment in which we live. In thinking about the steps that may be taken to halt environmental destruction, we have to include **constructive human intervention**. Our power to intervene with effectiveness and reasoning can be substantially enhanced by the process of development itself .e.g greater women education and women employment can help to reduce fertility rates, which in the long run can reduce the pressure on global warming and the increasing destruction of natural habitats.

Similarly, the spread of school education and improvements in its quality can make us more environmental conscious; better communication and a more active and better informed media can make us more aware of the need for environment oriented thinking.

In general looking at/seeing development in terms of increasing the effective freedom of human beings brings the constructive agency of people engaged in environment friendly activities directly within the domains of developmental achievements.

Development fundamentally is an empowering process and this power can be used to preserve and enrich the environment and not only to decimate it. Purification of water, elimination of epidemics contributes both to development and to environment enhancement.

Finally, climate change issue, I reckon, has been already dealt with in Gautam Buddha's sutta nipata. Since we are enormously more powerful than other species, we have some responsibility towards them that links with their asymmetry of power. We can have many reasons for over conservational efforts not all of which are parasitic on our own living standard or need fulfillment some of which turn precisely on own sense of values and on our acknowledge and of our judiciary responsibility.

Food Security Situation, Program Policies and Its interlink with Climate Change Adaptation in Nepal[1] – Dr Devendra Gauchan, PhD

Food Security Situation

Food insecurity is a major problem for many Nepali people. About 60% of the households in Nepal have only six months food sufficiency from their own production. About 30 out of 75 districts of the country particularly those located in the mountains and hills regions are food deficit in 2011/12 (MoAC, 2011). More than half of the farms are small, marginal and fragmented with farm size of less than half hectare (CBS, 2011). Over two third of the cultivated lands are rainfed and risk prone, hence production depends on the mercy of monsoon.

According to the Economic Intelligence Unit (2012), Nepal ranked 79th among 105 countries in food security status using Global Food Security Index (GFSI), 2012. Nepal scored 35.2 (highest score 89.5 – USA) out of 100. The country has annual food requirement (edible) of 5.15 million tonnes based on the consumption rate of 190 kg per person. Food production in Nepal was impressive in the last 2 years (2010/11 and 2011/12) as a result of favorable weather conditions (MoAC, 2011). However, extreme weather increasingly threatens harvests, and agricultural productivity gains are waning as investment falters globally and locally. Limited investment in agriculture and agricultural research also results in development of new technologies to increase food production adapted to changing climatic context. High prices for fuel, fertilizers and other agricultural inputs are making production more expensive, less profitable and unattractive to young generation resulting severe off-farm migration of youth from rural agricultural areas.

Concepts of Food Security

A globally accepted definition of food security is the one adopted by the World Food Summit (WFS) held in Rome in November 1996, i.e. 'Food security exists when all people at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life' (FAO, 2010). Food security has three key dimensions viz; spatial, temporal and social. In addition, there are other three key dimensions of food security viz; availability, accessibility and utilization. Food availability means a situation in which the food required to maintain a safe and healthy life is available for all people in the country and therefore, is determined by net domestic production and the balance of imports and exports. Accessibility to food implies that the people in a given location have both physical and economic access to obtain food.

1. A paper presented in "Summer School in Climate Change Adaptation (CCA)" 17-22, July, 2012 Yak Palace, Pulchowk, Kathmandu, Nepal

Access to available food is also determined by the consumption pattern within the household units and by intra-household food distribution systems. Food distribution, employment and income levels and non-market entitlements reflect access to food. Utilization of food refers to the capacity to translate food efficiently into energy. It is determined by nutritional knowledge, standards of health, people's access to safe drinking water, access to health care facilities, food quality etc. – all of which help determine their ability to metabolize food efficiently.

Role of Agriculture in Food Security

Agriculture is the main source of income, employment and livelihood of Nepalese people. It is a key driver of food consumption patterns and food security in both rural and urban area. Agriculture has broad linkage with overall economy. Agriculture is likely to improve food security and nutrition mainly through the food production including other pathways such as through increased income and women's empowerment. Improved agriculture leading to better household food security has been identified as a fundamental determinant of processes that lead to food security, adequate dietary intake and nutritional status, and health. Strategies and approaches for increasing domestic food availability through agricultural production have basically emphasized: (i) the need for technological change to increase labour, land and input productivity in agriculture, (ii) improved connectivity to increase market access and thus reduce the transaction costs of getting inputs and services from market to farm, and produce from farm to the market, and (iii) price guarantees to serve as an incentive to farmers to produce for the market, incentives that have sometimes been backed up by more forceful measures, including export bans.

Food Security Policies and Programs

Maintaining food security is a major problem for Nepal especially since population growth outstrips agricultural growth. Major food policy goals of Nepal include increased food production, equity in regional distribution of food, improvement in nutritional status of the poor, and food security through reduction in the variability in food production. The government of Nepal has accorded high priority to agriculture sector and food security issues in recent plans and policies, despite there are many short comings in resource allocations and implementation of the programs. The strategic framework for agriculture and food security is provided by the longer-term Agriculture Perspective Plan (APP, 1995-2015). The objectives of the agriculture sector are addressed by the National Agriculture Policy (NAP, 2004). The Interim Constitution of Nepal 2007 recognizes food sovereignty as the fundamental right of citizens. The importance of agricultural growth

and food security has been underscored in a sequence of the recent official documents and plans: the second Three Year Plan (2010/11-12/13), the National Agriculture Sector Development Priority plan (NASDP 2011-2015), and the associated Country Investment Plan (CIP). Also, most recently (2012) a Multi-Sectoral Nutrition Plan of Action, led by the National Planning Commission, aims to integrate, *inter alia*, contributions from the agriculture sector (Ministry of Agriculture Development) to lay the foundation of a national "nutritional architecture".

Since the beginning of first periodic plans in early 1950s, the country has launched agricultural production programs in different ecological regions and locations to increase food production and enhance food security of the people in Nepal. Various agricultural research stations and farms were established to develop new technologies in the country. Agricultural extension programs were established in all the 75 districts to promote new technologies for increase food production. Outreach research programs were established in the specific agro ecological domains by the NARC research programs to link technology development with dissemination with the participation of farmers and other stakeholders (Gauchan, 2008).

In addition, since early 1970s, direct and subsidized food distribution programs were initiated by National Food Corporation (NFC) and World Food Programs (WFP) in remote hills and mountainous districts. Government and some donor funded projects and programs also initiated some safety net programs to poor and food insecure groups. Similarly, infrastructure support (rural roads, irrigation, god owns, seed stores, processing plants) and institutional support (farmers' groups, cooperatives, collection centers) were initiated for food production, marketing and distribution by different projects/programs. Despite all of these, the country still suffers from acute food shortage in many remote mountainous and poverty stricken rainfed districts of Nepal.

Effects of Climate Change in Food Production and Food Security

In recent years, food production is increasing affected by changing climatic conditions in the country. Changes in weather pattern with increasing incidence and intensity of droughts, flooding and cold waves are frequent phenomenon. Rainfall patterns are erratic, uncertain and untimely resulting in low and uncertain food production. In the last one decade (2001-10), the country faced droughts in five out of 10 years resulting in food deficit, which caused food insecurity both at the national and household levels (Gauchan and Gumma, 2011).

There has been an increasing tendency of warming in summer with increasing temperature (e.g. higher altitudes) and declining temperature in the Terai in the winter as a result of cold waves. As a result, there are increasing incidence of disease, pests and weed infestations in agricultural crops resulting in unstable food production in the country. These adverse effects of climate changes have made vulnerable and at risks of

food insecurity for poor farmers, indigenous and marginalized people, migrant labor including poor women and children.

Climate Change Adaptation

Farmers in various parts of Nepal have resorted to new agricultural practices and adaptation measures to cope with changing climatic situations. In recent years, similarly, agricultural research and development programs have initiated R & D measures to address and mitigate the effects of adverse effects of climate changes. Some of these measures include shift to new crops and cropping patterns that are more adapted to adverse climate change (e.g. wheat to maize) and shift to climate resilient varieties (short duration drought tolerant, drought escaping and flood tolerant, heat tolerant, disease resistant crop varieties). Agricultural research program in Nepal particularly, Nepal Agricultural Research Council (NARC) has recently developed and released some climate resilient crop varieties to address climate change effect (NARC, 2011). These include drought tolerant rice varieties Radha -32, Sukhadhan 1, 2, 3 and submergence tolerant rice varieties Swarna Sub-1, Samba Masuli sub1 and Ug99 resistant wheat variety like Vijaya (BL 3063). NARC has also developed and promoted some crop management technologies to address climate change effects, which include resource conservation technologies (minimum and zero tillage e.g. direct seeding), Aerobic rice technologies and Alternate wet and drying (AWD) technologies etc.

Strategy for Enhancing Food Security

In order to increase food security situations both at the national and household level and adapt agricultural production in the changed climatic contexts, there is a need to increase investment in new agricultural technologies, key inputs (seeds, fertilizer, irrigation, credits), infrastructure and create enabling policy environment to increase agricultural production and improving food security situation of the country. Some of these strategies and options suggested are as follows:

- Accelerate investment in Science and Technology especially in Knowledge Triangle – research, education, and extension for sustainable food production
- Increase investment in the availability of key inputs (seeds, fertilizer, irrigation, credits) for increasing food production
- Promote investment in physical (irrigation, rural roads) and social infrastructure for increasing production and improving marketing and distribution systems
- Create enabling policy environment for the trade of food products and development and growth of agro enterprises

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