

MOUNTAIN ENVIRONMENT AND CLIMATE CHANGE IN NEPAL

Country Report for the International Conference of
Mountain Countries on Climate Change

April 5-6, 2012



ICIMOD



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Ministry of Environment

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Published by:

Government of Nepal

Ministry of Environment

Singha Durbar, Kathmandu

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Citation:

MoEnv (2012) Mountain Environment and Climate Change in Nepal: National Report prepared for the International Conference of Mountain Countries on Climate Change, 5-6 April 2012, Kathmandu, Nepal: Ministry of Environment, Government of Nepal

Layout:

PrintShop Nepal

Newroad, Kathmandu, Nepal

Tel: 4245166

Printed at:

Hill Side Press (P) Ltd.

Kalimati, Kathmandu, Nepal

Tel: 4271755



Minister for Environment
Government of Nepal

Ref:



MESSAGE

Climate change is emerging as the greatest challenge of this century. It has already produced multiple effects across the globe. All life-forms are increasingly affected by climate change. Some plant and animal species are about to extinct and some new are emerging. Some of the snowy mountains are converting to barren rocky cliffs; fertile cultivated lands in the plains are filled-up with sediments accelerated from climate-induced disasters. Heavy localized precipitation and prolonged drought have accelerated hazards. In this way, climate change will likely challenge the human survival and destroy physical assets worth millions of dollars. Number of homeless, landless and jobless people will continue to increase if the state of global warming remains unattended to the required extent.

The adverse impact of climate change will be felt by all - rich or the poor, but the poor, marginalized and disadvantaged people will suffer more. People living in the mountains are being further affected by climate change due to its inherent geographical remoteness, climate variability, lack of infrastructure and coping capacity. Even the developed countries might face difficulty to escape from the adverse impact of climate change although they can minimize its effect to an acceptable extent using appropriate technologies. It is, therefore, an urgent task for all the nations to come forward for a joint effort to address the impacts of climate change by developing and utilizing user-friendly and cost-effective tools.

As an attempt to translate the concept into reality, the Government of Nepal, Ministry of Environment is hosting an International Conference of Mountain Countries on Climate Change on 5-6 April 2012 in Kathmandu. I believe that the conference will provide a common platform for mountain countries to come up with a shared vision and partnership to save the fragile mountain ecosystem against the adverse impacts of climate change.

The Ministry has prepared this national report to share our information and experiences with other mountainous countries. The report precisely reflects the Nepalese context of climate change and associated consequences. It presents national concerns on climate change, and will hopefully provide information to the researchers, academicians, planners and professionals to design and implement climate change related actions in the field.

I would like to acknowledge the technical support of the International Centre for Integrated Mountain Development and Integrated Development Society - Nepal in preparing this report. I would also appreciate the contribution of Messrs Krishna Gyawali, Secretary and Batu Krishna Uprety, Joint Secretary (Tech.) for initiating and completing this report and thank the contributing authors, reviewers and ministry officials for their timely and effective efforts to bring this report into the present form.

30 March 2012


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ACKNOWLEDGEMENT

The Government of Nepal endorsed the Mountain Initiative concept in May 2010 and has designated the Ministry of Environment (MoEnv) as the focal Ministry to carry forward the task of developing and implementing the commensurate programs. The aim of the Mountain Initiative is to provide a framework within which mountainous countries, in collaboration with global and regional agencies specializing on mountain development, can work together to better understand the changes that are taking place and the resulting challenges. Since 2010, Nepal has organized four side-events during the UNFCCC meetings of Subsidiary Bodies and the Conference of Parties to share the information on this Initiative with other mountainous countries. This international conference is the culmination of the past efforts, with the basic objective of sharing knowledge and experiences on the impact of climate change on the mountains and implications on both the upstream and downstream communities. The conference aims to deliberate on common risks and hazards people face, and recommend different adaptation and mitigation measures that we have to undertake to deal with climate change concerns for managing mountain ecosystems and livelihoods.

Nepal plans to use this opportunity to share the issues, challenges and initiatives related to dealing with climate change vulnerability, and the impacts that are already evident. This report has been prepared through collaborative efforts of the MoEnv, the International Centre for Integrated Mountain Development (ICIMOD) and Integrated Development Society, Nepal (IDS). The report has been prepared through a multi-stakeholder consultative process including representatives of all segments of the society – decision makers, scientists, researchers, national and international experts, practitioners, and students. The report would not have been possible without their active support, encouragement and feedback.

A number of individuals and institutions deserve our special thanks for their role in the preparation process. In particular, I would like to thank the group of authors led by Dr. Govind Nepal of Tribhuvan University and members of the writing team Dr. Dinesh Chandra Devkota, former Vice-Chair, National Planning Commission and Dr. Tara Nidhi Bhattarai, Tribhuvan University. Similarly, Prof. Dr. Ram Prasad Chaudhary, Tribhuvan University; Dr. Posh Raj Pandey, Former Member, National Planning Commission; Prof. Dr. Punya Prasad Regmi, Tribhuvan University; Dr. Ganesh Raj Joshi, Secretary, Ministry of Tourism and Civil Aviation; Mr. Batu Krishna Uprety, Joint Secretary (Tech.), Ministry of Environment; Dr. Netra Prasad Timsina, Chairperson, NGO Federation Nepal; and Dr. Madhav B. Karki, Deputy Director General of ICIMOD reviewed and commented on the report. Many of these individuals including Mr. Bhusan Tuladhar, Expert Member, Climate Change Council, worked as the panelists during a National Workshop organized

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to gather feedback on the report. Dr. Arun Rijal, Member, Climate Change Council, and Mr. Sudhir Bhattarai, Under Secretary of the Ministry of Foreign Affairs also deserve special thanks for their valuable inputs.

Mr. Ram Chandra Khanal, CDKN Country Coordinator, and Ms. Prabha Pokhrel, Chairperson, IDS-Nepal assisted in finalizing the report; and Mr. Binod Bhattarai provided editorial support. Mr. Madhukar Upadhyaya and Mr. Govinda Gajurel did the technical editing and proof reading of the final draft. I would also appreciate the contribution of the officials engaged in giving final shape to the report in various capacities, most notably, Mr. Arjun Kumar Thapa, Under Secretary in the Ministry and his whole team working in the Mountain Initiative Secretariat. I thank everyone I have named here and many others that I have not named who have assisted in conceptualizing, designing and producing this report.

The preparation of this report has been made possible through financial support received from the ICIMOD under the World Bank Development Grant Facility (WB/DGF) programme of Strategic Initiative on Mountains and Climate Change (SIMCC). The IDS-Nepal provided technical and logistic support.

Finally, I hope that this report will serve its propose of informing about and sharing the vulnerability status, impacts and adaptation activities and help in better understanding the impacts of climate change in the mountains of Nepal.

30 March 2012

(Krishna Gyawali)
Secretary

ABBREVIATIONS

ADB	Asian Development Bank
AEPC	Alternative Energy Promotion Center
BCM	Billion Cubic Meters
CBS	Central Bureau of Statistics
CDM	Clean Development Mechanism
CFUGs	Community Forestry Users Groups
CIA	Central Intelligence Agency
COP	Conference of The Parties
CO	Carbon Monoxide
CSOs	Civil Society Organizations
DFRS	Department of Forest Research and Survey
DoF	Department of Forest
DPSIR	Driving Forces, Pressures, States, Impacts and Responses
FAO	Food and Agricultural Organization
FCPF	Forest Carbon Partnership Facility
FY	Fiscal Year
GCM	General Circulation Models
GDP	Gross Domestic Product
GEN	Glaciological Expedition in Nepal
GHG	Greenhouse Gases
GLOF	Glacial Lake Outburst Flood
HDR	Human Development Report
HKH	Hindu Kush Himalayas
HMGN	His Majesty's Government of Nepal
ICIMOD	International Centre for Integrated Mountain Development
ICS	Improved Cooking Stoves
ICT	Information, Communication, Technology
IUCN	International Union for Conservation of Nature
KL	Liters
LAPA	Local Adaptation Plan for Action
LDCs	Least Developed Countries
MAPs	Medicinal and Aromatic Plants
MCCICC	Multi-stakeholder Climate Change Initiatives Coordination Committee
MCTCA	Ministry of Culture, Tourism and Civil Aviation
MEAs	Multilateral Environmental Agreements
MOEnv	Ministry of Environment
MoF-	Ministry of Finance
MoFSC	Ministry of Forestry and Soil Conservation
MoPE	Ministry of Population and Environment
MW	Megawatt
NAPA	National Adaptation Programme of Action
NCVST	Nepal Climate Vulnerability Study Team
NGOs	Non-Governmental Organizations

NLSS III	Nepal Living Standards Survey III
NO ₂	Nitrogen Dioxide
NPC	National Planning Commission
NPWCA	National Parks and Wildlife Conservation Act
NRDB	Nepal Red Data Book
NRP	Nepalese Rupee
NTFPs	Non Timber Forest Products
NWP	National Water Plan
OECD	Organization for Economic Co-operation and Development
Pb	Lead
PES	Payment For Ecosystem Services
PREGA	Promotion of Renewable Energy, Energy Efficiency and Greenhouse Gas Abatement
PV	Photo Voltaic
RCM	Regional Circulation Models
REDD	Reducing Emission from Deforestation and Forest Degradation
RONAST	Royal Nepal Academy of Science and Technology
R- PP	Readiness Preparation Proposal
RWG	REDD Working Group
SAARC	South Asian Association for Regional Cooperation
SO ₂	Sulphur Dioxide
SPCR	Strategic Programme for Climate Resilience
TSP	Total Suspended Particles
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VAT	Value Added Tax
WECS	Water and Energy Commission Secretariat
WRI	World Resources Institute
WWF	World Wildlife Fund

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Executive Summary

Background

Mountains cover around 24 percent of the Earth's land surface, host about 13 percent of the world's population and provide essential ecosystem goods and services to billions of people living in the downstream valleys and plains. But mountain issues remain to be adequately addressed in international policy deliberations. To address this gap Nepal has appealed all mountain countries and stakeholders to join a common platform to ensure that mountain concerns receive due attention in the international deliberations. This call for cooperation has evolved into a process popularly known as the Mountain Initiative (MI) and has been translated into a chain of events including this Mountain Conference. This report of the Government of Nepal intends to communicate the impacts of climate change in the country within a broader framework of major driving forces, pressures, current state, impacts and response measures.

Nepal is a least developed, agrarian mountainous country situated in the central Himalayas. The altitude varies from 60m in the lowest point in the south to 8,848m in the north, the highest point on the Earth (Mt. Everest). The climate and topography nurture about 118 ecosystems, 75 vegetation types and 35 types of forests. Four biodiversity hotspots are found within Nepal Himalaya. The average temperatures have increased at a rate of 0.06°C between 1977 and 1994 and the precipitation in the eastern Nepal shows an increasing trend while the western and central parts of Nepal face a negative trend of <700 mm/decade.

Driving Forces

Human activities, particularly those resulting from the use of resources, land use changes, and production processes produce GHG emissions, which in turn affect the climate. Nepal's contribution to the global annual GHG emission is 0.025%. The total GHG emission from Nepal is estimated at 39,265 Gega gram (Gg) and per capita emission is 1,977 kg compared to the global average of 3.9 tons. Nepal's decade-long armed conflict and protracted political instability, the traditional livelihoods and energy use practices; overexploitation of the natural resources resulting in deforestation or forest depletion and land degradation, unsustainable farming practices, haphazard roads construction, high population growth and increased urbanization, poverty, air pollution, and increasing energy-intensive consumption collectively comprise the driving forces for climate change.

State of Environment

Water Resources: Nepal has 3,252 glaciers covering an area of 5,323 km² (about 3.6% of Nepal's total surface area) with an estimated ice reserve of 481 km³ and the surface water available is about 225 billion cubic meters per annum, equivalent to an average flow of 7,125 m³/sec. Nepal has been experiencing water deficit, for four to five months outside the monsoon seasons and further warming may worsen the situation. The decline in natural recharge of aquifers (due to drought, low precipitation, and intense localized precipitation) and over exploitation of groundwater have led to rapid drop in the groundwater table in many regions.

Biodiversity and forests: Nepal's unique biodiversity is a result of its unique geography and climatic variations. Altogether, 342 plant species and 160 animal species have been reported as being endemic to Nepal. Forests occupy about 5.8 million hectares of land, which is 39.6 percent of the total area of the country. Of this, 29 percent is forests and 10.6 percent is shrub-land.

Air Pollution: Air pollution, in terms of Total Suspended Particles (TSP), Carbon monoxide (CO), Hydrocarbons (HC), Nitrogen dioxide (NO₂), and Sulphur dioxide (SO₂), is increasing in urban areas. Updated data on air pollution do not exist but an increase in the trend is apparent.

Land Use Changes: Land use change is noticeable in forest and agricultural land. There is also a tendency to cultivate marginal lands, which is one of various factors that have contributed to land degradation. Several studies have concluded that soil erosion is a major environmental concern for Nepal.

Habitat loss: Cutting of trees and wildfires also cause habitat loss. Several animals like tiger, rhinoceros, snow leopard and red panda are now in the verge of extinction mainly due to deforestation and illegal poaching.

Mountain Tourism: Nepal's tourism is primarily nature-based with mountains, glaciers, lakes, rivers and flora and fauna as major attractions. The tourism industry and particularly the destinations are sensitive to climate variability and change. Climate defines the length and quality of tourism seasons and plays a major role in destination choice and tourist spending.

Impacts

Water: Global warming is often accompanied by changes in the hydrological cycle e.g. changes in rain and snowfall patterns, snow and glacier melt, atmospheric water vapor and evaporation, and changes in soil moisture and runoff. These changes have significant impact on water in glaciers, rivers, wetlands and underground aquifers and affect agriculture, energy, human health, water-related disasters and water supply. Drought has caused drying of springs, groundwater depletion, reduction in river water discharge, and wetland degradation. The “too little water” situation has particularly affected women and children who have to travel long distances to fetch water. They also face diseases caused by poor sanitation resulting from water scarcity. Rapid glacier melting in the Himalayan region has resulted Glacier Lake Outburst Floods (GLOFs) that have caused catastrophic floods downstream. Heavy precipitation in the form of extreme events have resulted in devastating floods and triggered landslides that have caused loss of lives and destroyed infrastructures downstream. The extreme climate events that result in “too much water” degrade drinking water sources. Similarly, prolonged droughts may cause reduction of discharge, which in turn, again makes water unfit for drinking and is therefore a major risk to human health.

Human health: Nepal has been experiencing increased climate change impacts on public health. There is an increase in the prevalence of vector and waterborne diseases. With climate change subtropical and warm temperate regions could become more vulnerable to diseases like malaria and kala-azar. Further, a rise in temperature could make the subtropical regions more vulnerable to Japanese encephalitis.

Change in ecosystems: Forests, rangelands, wetlands, mountains and agro-ecosystems are variously affected by climate change. Forest ecosystems are deteriorating and this affects biodiversity. This is probably related to increase in temperature, upward shifting of vegetation, encroachment of invasive species and colonization, and increased prevalence of disease and pests.

Glaciers: Out of 2,323 glaciers lake inventoried, 330 lakes have expanded to become larger than 0.02 sq. km and are still expanding. About 21 glacial lakes are already reported to have reached sizes large enough to be critical. The rate of retreat of some glaciers is estimated to be as high as 20 m/year.

Agriculture: Increased temperature and rainfall variability have resulted in shifts in agro-ecological zones, prolonged dry spells, and resulted in higher incidence of pests and diseases. Productive agricultural lands in Terai are shrinking owing to drought and precipitation variances while land under agriculture is increasing in the hills.

Food Security: Nepal's vulnerable subsistence farming economy faces risks arising from unreliable stream flow, intense and erratic rains, and floods. Decline in rainfall from November to April adversely affects winter and spring crops. A report said that a million people face severe food shortages because of climate change.

Natural Disasters: Nepal faces many natural hazards such as earthquakes, floods, GLOFs, landslides and debris flows resulting from its steep topography, on-going mountain building process, highly fractured rocks, diverse climate and intense precipitation. Every year floods and landslides kill around 300 people. The economic loss caused by natural disaster averages to around Rs. 1,208 million per year.

Hardships on women: Shortage of grazing land, water and fuel have increased burden on women who have been affected disproportionately by climate change impact. Floods, droughts, and degraded ecosystems directly affect their livelihoods but unlike other groups, the women, children and indigenous people and particularly the poor are also least capable to manage or adapt to the changes.

Response to Climate Change

The government has made efforts to set up appropriate institutional and policy regimes to facilitate the implementation of plans and programs aimed at addressing climate change impact. The important policies and institutions include Climate Change Council 2009, Mountain Initiative 2009, Climate Change Policy 2011, Climate Resilient Planning Framework, NAPA and LAPA, Climate Change Management Division under the Ministry of Environment and Climate Change Initiatives Coordination Committee.

On the program side, the government has given priority to clean energy development and energy efficiency, REDD+, climate adaptation and sustainable agricultural programs. Further, Nepal is aspiring for greening the economy with focus on realizing the value of mountain ecosystem services, expanding markets for niche products, linking livelihoods with environmental services, and introducing market-based incentive mechanisms for mountain ecosystem services. Other important programs include community-based biodiversity conservation, collaborative and leasehold forestry, and creating new jobs in mountain areas with NTFPs and through tourism, and potential green enterprises.

The Way Forward

Following actions are needed for effectively addressing the multiple issues, especially those related to climate change in mountainous regions.

National Efforts

1. Building resilient mountain socio-ecological systems requires adequate information, awareness and support of civil society, NGOs, civil society organizations (CSOs), community-based organization (CBOs), the private sector, universities, and other research institutions.
2. Effective mountain-specific policies and programs require addressing the specific development needs of mountain regions and the disproportionate vulnerability of social-ecological systems in the uplands. High fragility, loss of biodiversity, physical isolation, and political marginalization of mountains can be taken as a basis for formulating policies to address climate change impacts, and conserve the vital ecosystem services.
3. Policies, strategies, programs, and laws that explicitly address mountain issues and are better able to respond to challenges resulting from climate change, particularly those related to assuring food security and sustainable mountain development.
4. Sustainable mountain development strategies, integrated with Green Economy require institutional arrangements to allow mountain communities to benefit from emerging opportunities and reduce the pressure on mountain resources resulting from increasing demand.
5. Efforts to improve the economic situation of mountain communities need to consider innovative financing mechanisms and approaches such as payments for environmental services.
6. Supportive and enabling environment for the promotion of high-quality niche products and services from mountain areas would be critical for improving livelihoods and protecting mountain environments. This would require assuring access of mountain products to national and international markets.
7. The poorest and the marginalized people are usually affected first by changes of climate and extreme weather events such as floods, droughts, and heat waves. Further, existing gender inequalities, combined with social, economic and political factors make women more vulnerable. It is therefore critical to develop a mechanism where women and members of other socially excluded groups can participate equally in initiatives to address the climate change challenges.

8. There is need for focused efforts to promote conservation and sustainable use of scarce mountain resources such as water, biodiversity, forests, and grasslands. This can be attained through sustained efforts to increase awareness, prudence and efficiency in the use and management of natural resources in mountain areas, and by implementing specific measures for adaptation and mitigation.

Regional Efforts

1. Mountain countries and regions need to develop mountain specific adaptation and mitigation policies, institutions, knowhow, and capacities to overcome the challenges posed by climate change to ensure sustainable development.
2. It is important that regional countries share information, coordinate activities, avoid duplications, and develop regional capacity for addressing climate change impacts, and expedite the implementation of climate change adaptation measures.
3. The best practices and knowledge on climate change adaptation and mitigation – both modern and traditional – need to be documented and disseminated through training, education, and capacity-building initiatives tailored to the needs of mountain people.
4. The impact of climate change is disproportionately high on the most vulnerable groups, and this needs to be addressed through appropriate policies, financing instruments and technical interventions.
5. Regional centers of excellence and knowledge development need to be created and strengthened for continuously assessing the state of ecological, economic, and social changes in mountain regions, and for sharing information for developing regional plans and programs to address common issues and problems.

International Efforts

1. Mountain ecosystems need better recognition for the goods and services they provide, and this would require greater attention on livelihood issues faced by mountain communities, and on maintaining/enhancing ecosystem services.
2. There is a need to provide increased and sustained finance to develop and transfer technologies, capacity building support and additional funding mechanisms for meeting the costs of adaptation and sustainable development in mountain countries. Support for developing and monitoring, forecasting and modeling of climate change impacts can help improve understanding for planning resilience-building measures.
3. The efforts made by mountain communities need to be complemented and supported for ensuring environmental stewardship needed for assuring continued availability of water, biodiversity, renewable energy, and bicultural heritage.
4. The Rio+20 conference should recognize the role of mountain systems in terms of the value of ecosystem goods and services for sustainable development and human wellbeing, and needs to make clear commitment for actionable programs in supporting incentive-based systems such as PES for maintenance of ecosystem services. It should also recognize the critical role of mountains as global resources supplying water for life, food for survival, biodiversity for ecological security, and clean energy for prosperity.
5. Developed mountain countries can and need to play crucial roles in providing knowledge and expertise and building the capacity of developing mountain countries for sustainable development.
6. The global stakeholders need to revisit the Mountain Agenda (Chapter 13 of the Agenda 21) to incorporate new changes and challenges that have emerged since 1992 for holistically addressing the increasing impacts of climate change, globalization and social changes.
7. Existing knowledge and information gaps on the importance of mountain ecosystems need to be updated for addressing the high incidence of poverty and inequity, the vulnerability of upstream and downstream populations, and the threats to the availability of mountain ecosystem goods and services, especially water.
8. It is necessary to develop a common understanding and framework for effective collaboration amongst mountainous countries and regions to work with global and regional agencies working in mountain areas for

making joint efforts to reduce climate change risks and vulnerabilities, and build resilient communities through long-term adaptation and sustainable development actions.

9. Research and knowledge development, capacity building, and regional exchange of experiences and good practices can help in protecting fresh water resources, conserving critical biodiversity, maintaining vital gene pools by managing forests, wetland, and rangeland ecosystems better, and for enhancing livelihoods and wellbeing of people, nationally, regionally and globally.
10. It is necessary to advocate a revisit of the Mountain Agenda for incorporating new knowledge on the importance of mountain ecosystems for downstream communities, the high incidence of poverty and inequity, the vulnerability of upstream and downstream populations, and the threats to the availability of mountain ecosystem goods and services that are vital for planning corrective interventions. Collaborative efforts of mountainous countries are needed for implementing the commitments in article of 4.8 of the UNFCCC, in which the Parties agreed to consider the actions necessary for funding, insurance and transfer of technology, to meet the specific needs and concerns of mountainous ecosystems arising from the adverse effects of climate change and/or the impact of the implementation of response measures.
11. Mountainous countries need support for strengthening innovation capacity to generate appropriate technologies, enhance extension services and improve market infrastructures for increasing the productivity of agriculture and natural resources. It is also necessary to develop easily adoptable and resilient technologies that meet the needs of the poor, women and excluded groups and communities.
12. Mountainous countries have comparative advantage in high value products and services, such as non-timber forest products (NTFPs), medicinal and aromatic plants (MAPs), indigenous honeybees, and eco-tourism. Support is needed to enhance their access to technology and markets.
13. Country-wide blanket development models do not match the specific development needs of mountain people. Therefore, a collaborative effort is needed for designing and implementing mountain-friendly development models.
14. It is necessary to develop a common framework for effective collaboration of mountainous countries and regions to work with global and regional agencies working in mountain areas for making joint efforts to reduce climate change risks, vulnerability and build resilient communities through long-term adaptation actions to ensure supply of vital ecosystem resources for human well being.

1

COUNTRY BACKGROUND

1.1 PHYSIOGRAPHY AND CLIMATE

Nepal is a mountainous country situated in the central Himalayas between 26°22' and 30°27' N latitudes and 80°40' and 88°12' E longitudes; the altitude varies from 60m in the lowest point in the south to 8,848m in the north, the highest point on Earth (Mt. Everest). Nepal is bordered by India in the east, west and south, and the People's Republic of China in the north. The country is about 850 km long (east-west) and about 200 km wide (north-south). For administrative purposes, Nepal is sub-divided into five development regions and 75 districts. The 147,181 km² area of Nepal is broadly divided into three ecological regions: the Terai/Churia Range (plain area and low hills, 23% of total area), the Middle Mountains (42%) and the High Mountains (35%) and five physiographic regions: High Himal, High Mountain, Middle Mountain, Siwalik (the Churia Range), and the Terai. Each physiographic and ecological unit extends in the east-west direction and varies in altitude, climatic variability and geology.

Nepal's climate is influenced by the Himalayan mountain range and the South Asian monsoon. It experiences a wide range of climates varying from the sub-tropical in the south to the alpine type in the north within a span of less than 200 km (north-south). Nepal has four distinct climatic seasons: pre-monsoon (March-May), monsoon (June-September), post-monsoon (October-November) and winter (December-February). The average annual rainfall is about 1800 mm (MoEnv, 2010). The climate and topography nurture about 118 ecosystems, 75 vegetation types and 35 types of forests (Bhujju et al. 2007). Four biodiversity hotspots (Himalaya, Indo-Burma, Mountains of South-West China and Mountains of Central Asia) are found within Nepal Himalaya.

Nepal has a very high species diversity falling in the 25th position globally and the 11th position regionally although it covers only about 0.3 percent landmass of Asia and 0.1 percent of the World (MoPE (a), 2000). Out of top 10 biodiversity hotspot countries of Asia, Nepal stands at the 5th, 9th and 10th position on respectively species diversity of birds, mammals and angiospermic flowering plants respectively (MoPE, 2000a). Nepal harbours about 2 percent of the flowering plants, 3 percent of the pteridophytes, and 6 percent of bryophytes of the world's flora (MoPE, 2000b).

Table 1.1: Climate characteristics in different ecological belts of Nepal

Physiographic Zone	Ecological Belt	Climate	Average Annual Precipitation	Mean Annual Temperature
High Himal	High Mountain	Arctic/Alpine	Snow/150 mm -200 mm	<3°C-10°C
High Mountain				
Middle Mountain/Hills	Middle Mountain	Cool/Warm	275 mm -2300 mm	10°C-20°C
Siwaliks	Churia/Terai	Tropical/Sub-tropical	1100 mm -3000 mm	20°C -25°C
Terai				

Source: WECS (2005)

The climate characteristics in different ecological belts in Nepal are presented in Table 1.1. Nepal has a varied climate. While tropical and subtropical climates exist in the Terai region, subtropical to temperate climates are found in the hills and mountains. Temperature data collected from the mid-1970s from 49 stations in Nepal (Shrestha et al. 1999 and Shrestha and Aryal, 2011) indicate that: a) the average temperature between 1977 and 1994 increased at a rate of 0.06°C per year; b) the rise in temperature was greater at the higher altitudes; and c) increases in temperature were more pronounced during the cooler months (0.06–0.08°C per year from October–February, for all of Nepal) than for the warmer months (0.02–0.05°C per year for March–September). Studies also indicate that the observed warming is not uniform across the country and is more pronounced in high altitude regions compared to the Terai and Siwalik regions (MoEnv, 2010).

Unlike temperature trends, precipitation data for Nepal does not reveal any significant trends (Shrestha et al. 2000; Practical Action, 2009). The inter-annual variation of rainfall, particularly monsoon precipitation, is so large that observed trends are very uncertain and could be a part of natural cycles (MoEnv, 2010). Based on data from 1947 to 1993, Sharma et al. (2000) found that the precipitation trend in the Koshi Basin (Eastern Nepal) shows an increasing trend while the eastern and central parts of Nepal face a negative trend of <700 mm/decade. Annual average precipitation is decreasing at the rate of 9.8 mm/decade (MoPE, 2004).

Various studies (Shrestha et al. 1999; Practical Action, 2009; NCVST, 2009; WECS, 2011) have made climate change projections using different models with temperature and precipitation-related data recorded for different periods. The OECD study on General Circulation Models (GCM) run with the SRES B2 scenario shows that the mean annual temperature is likely to increase by an average of 1.20C by 2030, 1.70C by 2050 and 3.0C by 2100 compared to a pre-2000 baseline. Similarly, the (NCVST, 2009) study that used GCM and Regional Circulation Models (RCM) projected the mean annual temperature to increase by 1.40C by 2030, 2.80C by 2060 and 4.70C by 2090. In terms of spatial distribution, these studies show a higher increases in temperature over western and central Nepal compared to the east for the years 2030, 2060, and 2090, with highest increases in western Nepal.

Precipitation projections show no change in the western Nepal, and up to 5-10 percent increase in eastern Nepal during winter. During the summer precipitation is projected to increase for the whole country in the range of 15 percent to 20 percent. A RCM projects both rise and fall in the mean annual precipitation with no clear trends. In terms of spatial distribution, a MoEnv study projected an increase in monsoon rainfall in eastern and central Nepal compared to western Nepal. Further, the projections indicated an increase in monsoon and post-monsoon rainfall as well as an increase in the intensity of rainfall, and a decrease in winter precipitation (MoEnv, 2010).

About 23 percent of Nepal's total area lies above the permanent snowline of 5000m (MoPE, 2004). In 2001 about 3.6 percent of Nepal's total area was covered by glaciers (Mool et al. 2001). About 10 percent of the total precipitation in Nepal falls as snow (UNEP, 2001).

Various climate change vulnerability assessments show that Nepal is highly vulnerable to climate change. More than 1.9 million people are estimated to be highly vulnerable and another 10 million are exposed to increasing risks (MoEnv, 2010). Nepal is the 4th most vulnerable countries in the world from climate change vulnerability (Maplecroft, 2010).

1.2 ECONOMY

Nepal is a least developed country (LDC) with per capita income of USD 642 (CBS, 2011a) and a human development index (HDI) 0.418 (UNDP, 2010). More than one fourth of the population (25.2%) are below the national poverty line (CBS, 2011b).

The livelihood and economic progress of a large number of Nepalese people is primarily based on natural resources. Agricultural sector contributes about 35 percent to GDP and is the main source of employment for over 76 percent of the population (CBS, 2011b). About 70% of the population has access to electricity and the Nepalese are among the lowest per capita users of electricity in South Asia (about 70 kilowatt-hours per year) and majority of people still depend upon biomass-based energy.

Nepal's population has been growing at a rate of 1.4 percent while the average economic growth rate in the last decade (2001-2010) was just 3.8 percent (CBS, 2011c; MoF, 2011).

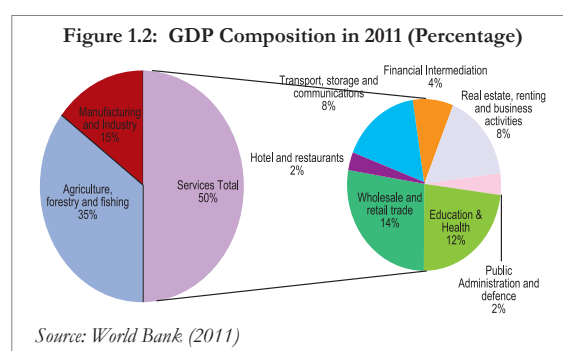
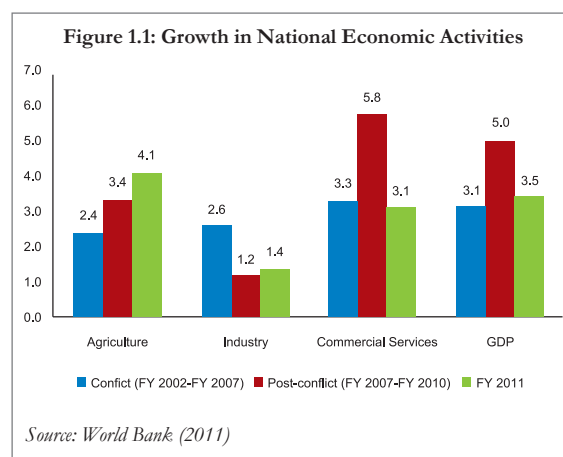
The decade long (1996-2006) armed conflict and protracted political instability as well as the weak security situation caused the investment climate to deteriorate. This led to serious setback in the growth of industrial sector. Real GDP grew by 3.5 percent in 2011, below the five percent average achieved during 2007-2010 but slightly above the 3.1 percent average of the conflict period 2002-2006 (Figure 1.1). The services sector contributes about half of the GDP (Figure 1.2).

The low growth rate and inadequate employment opportunities at home have compelled Nepalese youth go abroad seeking employment (Figure 1.3). Their remittances constitute 23 percent of the GDP.

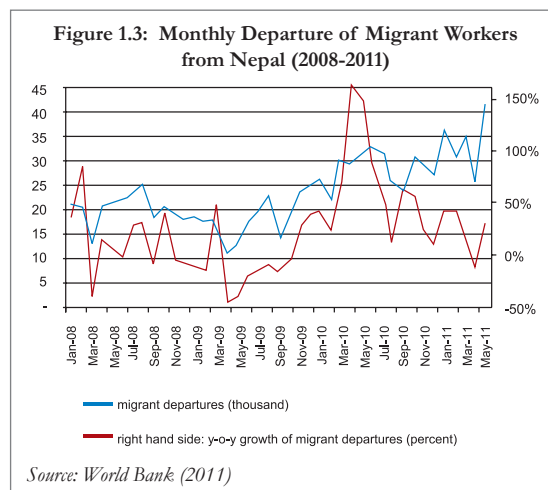
1.3 MOUNTAIN INITIATIVE OF NEPAL

Mountains cover around 24 percent of the Earth's land surface, host about 13 percent of the world's population and provide essential ecosystem services to the billions of people living in the downstream valleys and plains. But mountain issues are not addressed adequately in various international deliberations, including the UNFCCC and Rio+ processes. Mountain countries have been raising their concerns at various forums but so far have not been able to influence the negotiation processes to the desired extent, particularly in the context of Climate Change Conventions and other Multilateral Environmental Agreements (MEAs). Realizing the need for coordinated efforts at the international level, during COP15 of UNFCCC in 2009 in Copenhagen, Denmark Nepal's the then Prime Minister Madhav Kumar Nepal appealed to all mountain countries and stakeholders to form a common platform to make sure that mountain concerns receive due attention in the international deliberations. In a chain of following development, in the 16th SAARC Summit in Bhutan (28-29 April 2010), the regional leaders welcomed Nepal's initiative to organize the Conference of Mountainous Countries in Kathmandu.

Nepal launched the Mountain Initiative in May 2010 and has designated the Ministry of Environment (MoEnv) as the Focal Ministry for taking the idea forward. The Government of Nepal also organized three side events (2



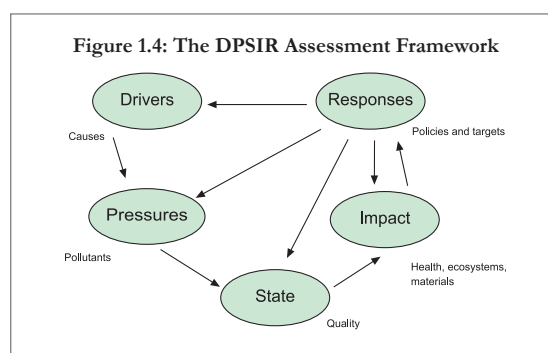
in Bonn, Germany and 1 in Cancun, Mexico) in 2010, and one in Durban, South Africa in 2011 during the UNFCCC meetings of subsidiary bodies and COP to share information on this initiative with other mountainous countries. The International Conference of Mountain Countries on Climate Change in Kathmandu on 5-6 April 2012 will bring together Environment Ministers of the mountainous countries from Latin America, Africa, Central Asia and the Hindu Kush Himalaya region, including representatives from the United Nations systems and other international organizations working on climate change and mountain ecosystems. The conference is expected to provide opportunities to share knowledge and experiences on the impact of climate change on mountains and to deliberate on common risks, and approaches to deal with specific concerns relating to mountain ecosystems and livelihoods. This is one important events of Mountain Initiative.



Further, there are concerns that the prevailing economic development model suffers from a series of market and institutional failures that render it inefficient, unsustainable and inequitable, making it a poor vehicle for advancing sustainable development goals (UNDPI, 2011). Meanwhile, several concurrent global crises have unfolded during the last decade: climate change, biodiversity loss, fuel, food, and water shortages, and more recently, the meltdown of the global financial system. Global leaders have been rethinking growth and development strategies since 2008 in response to the global economic downturn and increasing environmental degradation (CDKN, 2011).

The Conference is expected to discuss common issues related to climate change impacts, vulnerability and adaptation options and come up with some common ideas for streamlining adaptation, mitigation and financing approaches. It is also expected to contribute to reshape regional as well as global development models to make it climate compatible and sustainable - economically, environmentally and socially.

The present national report of the Government of Nepal intends to communicate the impacts of climate change at the national level within a broader framework of major driving forces, pressure, state, impacts and response measures (Figure 1.4). Driving forces, in the form of social, economic or environmental developments, exert Pressures on the environment and, as a consequence, the State of the environment changes. This leads to Impacts that may elicit societal Responses that feed back to the Driving forces. In this report the driving forces and pressures are dealt together.



This report is more a qualitative synthesis based on review of literature, and experts and stakeholder consultations. The main objectives of this report are to inform and present the challenges posed by climate change, share initiatives that Nepal has undertaken in this regard and put forward country's agenda for national, regional and global cooperation.

2

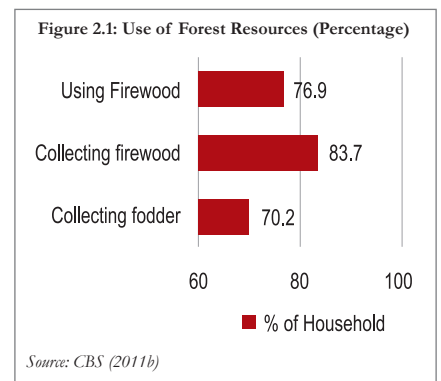
DRIVING FORCES AND PRESSURE

Human activities, particularly those resulting from the use of resources and energy, land use changes, and production processes produce GHG emissions, which in turn affect the climate. There are several forces that contribute to the increase of GHGs in Nepal. Transport, industrial processes, power generation, agriculture and deforestation all contribute to GHG emissions. The emissions from energy use arise not only from the industries, but also from transport, manufacturing industries, services and households. Transport is one of the major sources of emissions in the urban areas. Nepal's contribution to the global annual GHG emission is 0.025% (MoPE, 2004). The total GHG emission from Nepal is estimated at 39,265 Gega gram (Gg) and per capita emission is 1,977 kg (MoEST, 2008a) compared to the global average of 3.9 tons. The GHG contribution, in absolute terms, has no or little value in terms of global warming (MoEnv, 2009). Nepal's compounded annual growth rate of CO₂ equivalent emission is the lowest of any developing country at two percent per annum (NPC/UNCT, 2010).

For a decade (1996-2006), Nepal's development was seriously constrained by political instability and a violent insurgency resulting in major disruption of livelihoods for millions of rural households, a significant increase in migration to urban areas, and a steady loss of economic productivity (World Bank, 2008). The conflict and political instability also weakened governance. In this situation, the forest resources were under heavy pressure.

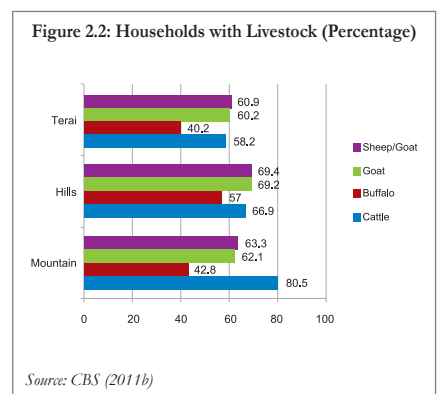
2.1 DEFORESTATION AND DEGRADATION OF FOREST RESOURCES

Forests cover nearly 40 percent of the total land area of Nepal (DFRS, 1999) and the per capita forest area is 0.27 ha. The annual loss of forest and shrub land was around 0.5 percent during the period 1978/79 - 1994/95. As of March 2007, the protected area covered about 19.7 percent of the total area of the country. The traditional livelihood and energy use practices overexploit the natural resources resulting in deforestation or forest depletion and land degradation (Figure 2.1). The increased pressure on the land – through deforestation, overgrazing and cultivation practices – causes a decline in soil fertility and production, and thus aggravates vulnerability leading to increase in poverty.

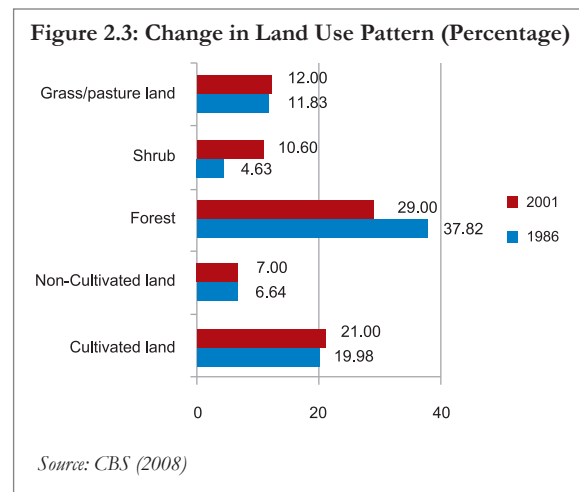


Livestock constitutes an integral part of Nepalese agricultural system. A majority of agricultural households keep livestock (Figure 2.2).

Fuel wood is the main source of energy in households, and small and traditional industries. The industrial sector accounts for 1.5 percent of the total fuel wood consumption. About 30 percent of the energy requirements of the industrial sector are met by fuel wood. Land requirements for infrastructure development also increase deforestation. One study estimates that 40 percent of forest fires were accidental and 60 percent were deliberate (Sherpa, 2010).



Degradation and destruction of forest cover in the mountains accelerates the denudation of watersheds. In the absence of vegetation, there are no barriers to cushion the rain during the monsoon season. The consequences have been sudden swelling of streams and flashfloods in the hills, and severe floods in the plains. Nepal has around 4.27 million hectares of forest, 1.56 million hectares of shrub land and degraded forest, 1.7 million hectares of grassland, 3.0 million hectares of farmland, and about 1.0 million hectares of uncultivated lands (MoFSC 2002). It is estimated that forest cover in the Terai and hill areas decreased at an annual rate of 1.3 percent and 2.3 percent, respectively, between 1978/79 and 1990/91 (DFRS, 1999). On average, forested areas have decreased at an annual rate of 1.7 percent and shrub lands have decreased at an annual rate of 0.5 percent. The cultivated land increased by slightly more than one percent while the forest area declined by about nine percent in the past 15 years (Figure 2.3).



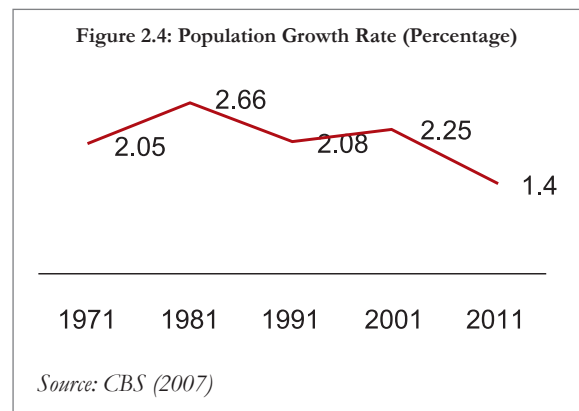
2.2 AGRICULTURAL PRACTICES IN THE MOUNTAINS

Unsustainable agriculture practice is common in the mountains. Rural inequality and inadequate alternative livelihoods has undermined the use of local knowledge and skills on good practices in conservation. Development activities such as road building have led to increase in landslides and erosion. Livestock grazing has also accelerated soil erosion. Landslides and erosion in the mountains have caused riverbeds to rise, which in the plains are rising by 35-45 cm annually (Dent, 1984). Silting, flooding and debris have also affected the productive of land along riverbanks. This change is one example of the upstream and downstream linkages in livelihoods and reason for increasing focus on mountain development for ensuring the wellbeing of all people, including downstream residents. Similarly, wind erosion affects about four percent of the area in the higher altitude and trans-Himalayan regions. About 28 percent of Nepal's total land area is degraded, when all the poorly managed forests, sloping terraces and pastures and areas damaged by floods and landslides are considered (MoEST, 2008b).



2.3 POPULATION GROWTH

A major driving force influencing environmental resource availability in Nepal is population. According to preliminary results of the 2011 Census, the population has reached 26.6 million and is growing at an annual rate of 1.4 percent (CBS, 2011c) (Figure 2.4). The degree of inequality of income and dependency on natural resource for livelihoods of people will generally determine the intensity of pressure on environmental resources.



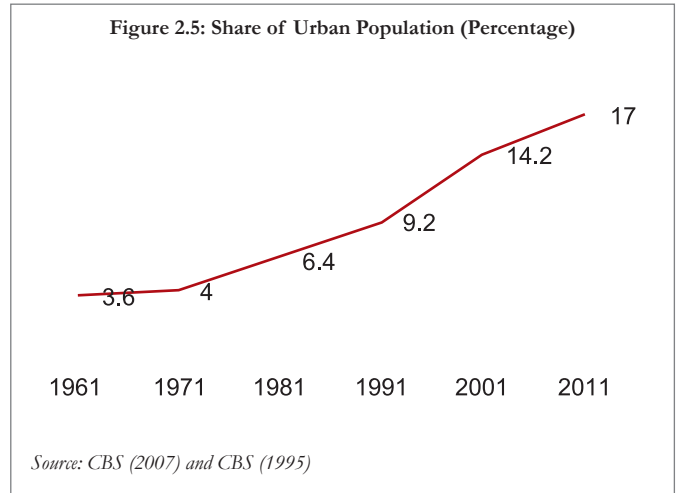
Rapid urbanization has increased pressure on environment-related services and environmental health, particularly in areas associated with solid waste, air quality, and industrial pollution management (IBRD/World Bank, 2008). Between 1952 and 2001, the number of designated urban centers grew from 10 to 58, with a corresponding increase in the urban population, from 0.2 million to 3.2 million, a 16-fold increase. With addition of 41 municipalities in 2011, the number of municipalities across the country has

reached 99. The share of urban population in the total population is 17 percent in 2011 (Figure 2.5). Increasing trend in the number of the squatter settlements is one of the key issues related to uncontrolled urban growth in Kathmandu valley. It was estimated that there were only 17 squatter communities in Kathmandu in 1985, but now the number has grown to 40 squatter settlements. There are 12,726 people (6,612 male and 6,114 female) living in 2,735 households in the 40 squatter settlements of the valley. An increasing trend of these settlements have significant impacts in the local environment of the valley (Lumanti, 2008).

The haphazard dumping of Municipal Solid Waste (MSW) at open place or poorly engineered landfill site in the municipalities is substantially contributing to the emission of greenhouse gases in Nepal. An estimate by Khatiwada et al. (2009) postulated that the total waste generation of 58 municipalities of Nepal was 1400 tons/day indicating the per capita waste generation to be 0.25 kg/person/day. Municipal authorities were able to collect only about 42% of total generated MSW. The municipal solid waste had about 72% of organic content. Recyclable materials like paper, glass, metal and plastic content accounted not more than 16% of the total waste. The study further showed that in 15 municipalities of Nepal, total methane emission was 52 GgCO₂eq in 2007. Limited resources, low priority for the waste management and weak political situation are the major factors leading to the absence of a comprehensive Municipal Solid Waste Management (MSWM) approach. Nepal being the signatory of Kyoto Protocol can be benefited through Clean Development Mechanism (CDM) that provide the source of fund and contribute to the local effort in the management of greenhouse gases.

Poverty is both a cause and consequence of climate change. There is also close inter-linkage between population growth, resource depletion, environmental degradation, and low level of social development. The cumulative effect is the increasing extent of poverty which is both a cause and effect of environmental degradation (EPC, 1993). Poverty forces people to increase reliance on natural resources and increased pressure on resources affect the natural production systems resulting in greater marginalization of the poor. In Nepal land is a major asset for the majority of people. Seventy-four percent of all households are agricultural and have some land, and roughly two percent don't own land. A majority of agricultural households (53 percent) operate less than 0.5 ha of land (small farmer) and four percent operate two ha or more (big farmers). The estimated Gini concentration index is 0.51 (CBS, 2011b), which exhibits a skewed distribution. Small farmers and landless agricultural households are bound to cultivate even on the unsuitable marginal lands and rely on forest resources for their livelihoods.

Figure 2.5: Share of Urban Population (Percentage)

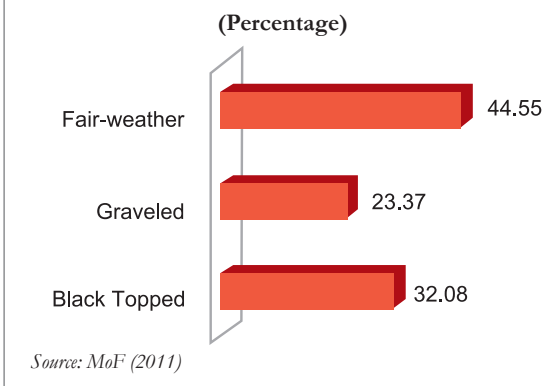


In Nepal air pollution is largely a result of human activities, in both urban and rural areas. Their effects are more evident in major cities and industrial areas. Transport, industry, road conditions, and population growth are major factors contributing to urban air pollution. Forest fires and dust are major air polluters in rural areas. In rural Nepal, use of traditional fuels like wood, cow-dung, and agricultural residues for cooking and heating has polluted the indoor air, adversely affecting the health of the inhabitants (UNEP, 2001). Unregulated consumption of petroleum products, mainly for transport, increasing number of vehicles, low fuel quality, non-compliance of standards, and poor road condition have all contributed to degrade urban air quality.

2.6.1 Status of Road

By the end of 2009/10, Nepal had 6,669 km of blacktopped roads, 5,007 km graveled and 9,417 km earthen roads. One year later in mid-March of 2010/11, it had 6874 km blacktopped and 5036 km of graveled roads, and built 9545 km of earthen roads. Fair-weather, graveled, and blacktopped roads grew by 44.55 percent, 23.37 percent and 32.08 percent respectively (Figure 2.6). The total length of road was 21,455 km (MoF, 2011). Hill roads have accelerated land degradation, loss of topsoil, water quality changes in surface water and groundwater flows, and biodiversity impacts due to damage to wildlife habitat and plant species (IBRD/World Bank, 2008).

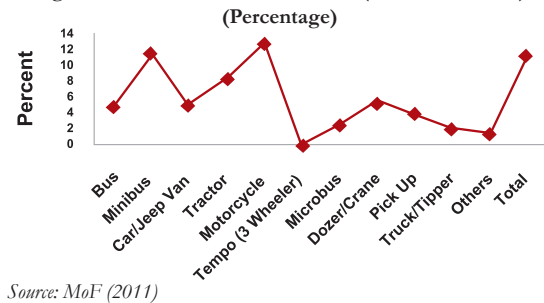
Figure 2.6: Growth Rate of Roads (2009/10 -2010/11)



2.6.2 Growth of Vehicles

From 1988/89 to the end of 2009/10, number of vehicles in the country totaled 1,015,271, while in the first eight months of the 2010/11, it increased by 11.06 percent, i.e. by 112,320 reaching a total of 1,127,591 (Figure 2.7). In the end of the mid-March of the 2010/11, the average number of vehicles on per kilometer of road of the country grew to 53 from 45 in 2009/10 (MoF, 2011). Most of the vehicles lack pollution reduction devices, and use sub-standard fuel, thereby degrading air quality.

Figure 2.7: Growth Rate of Vehicles (2009/10 -2010/11)



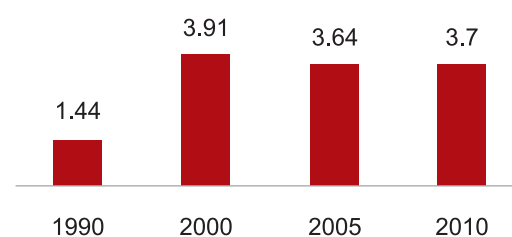
2.6.3 Consumption of Petroleum Products

In 2009/10, the consumption of Petroleum Products (POL) rose by 25.2 percent totaling 913,198 Kiloliters (KL) while that of LP Gas increased by 21.9 percent to 141,171 Metric Tons (MT). In 2009/10, the consumption share of diesel, kerosene, petrol and aviation fuel in overall use of POL products was 67.1 percent, 6.1 percent, 17.7 percent and 9.1 percent, respectively (MoF, 2011). While the increase in use of POL products has increased health risks in urban areas in the mountains, people are susceptible to respiratory diseases caused by burning of fuel wood in poorly ventilated houses. In addition since most urban centers are in valleys much of the vehicular emissions remain in the atmosphere for longer periods.

Nepal's economy is gradually becoming consumption oriented, mainly pushed by remittance income, thereby causing a decline in savings and investment. The consumption to GDP ratio increased from 88.3 percent in 2000/01 to 93.3 percent in 2010/11 (CBS, 2011a). As a result, the rate of domestic savings has come down to 6.7 percent from 11.7 percent. A consumption-oriented economy leads to dependency resulting in shortages of resources for investment, particularly in environmental

sustainability. Hence, creating the foundation for economic growth through enhanced savings and investments by discouraging unnecessary consumption remains an issue (MoF, 2011). The changing consumption pattern has also begun to adversely impact environmental resources (urban air quality, rivers, and soil) (NPC, 2011c). Compared to 1990, the shift has been towards more energy intensive consumption (Figure 2.8).

Figure 2.8: Commercial Energy use per unit of GDP (toe/mRs)



Source: NPC 2010

Mountain issues are commonly addressed through sectoral legislation related to agriculture, forestry, land or water. Such policies and laws have not paid adequate attention to fragility and other specificities of mountain ecosystems and the differentiated needs, interests and capacity of mountain people, comprising largely of vulnerable groups, including indigenous groups. Decision-makers tend to perceive mountains as hinterlands that supply resources, while failing to consider their specific challenges of development. Further, mountain people have limited access and decision-making role in development. The sectoral policies and programmes that underscore are often inadequate in terms of both a sustainable mountain development focus and implementation. The immediate consequence of mountain insensitive development and non-implementation are disasters that affect large areas sometimes covering the entire watersheds or river systems. Such events harm both the mountain communities and also the people and ecosystems downstream.

Weak governance and poor institutional capacity have also contributed to the inadequate implementation as these institutions lack capacity (human, technological, and financial) and resources for climate change risk management. Inadequate coordination has also limited planning and implementation and avoidance of duplication of works at all levels. Lack of election for the last several years has made the governance weak. In addition, low capacity, and financial resources also have aided towards inadequate implementation of programmes, policies and plans.

3

STATE OF ENVIRONMENT

3.1 WATER

Glaciers, glacial lakes, rivers, groundwater and wetlands form the major sources of water in Nepal. The Himalayas function as the “water tower of Asia” and are the most highly glaciated area in the world outside of the Polar region. Currently, about 10% of total precipitation in Nepal falls as snow (UNEP, 2001). About 23% of Nepal’s total area lies above the permanent snowline of 5000m (MoPE, 2004). There are 3,252 glaciers covering an area of 5,323 km² (about 3.6% of Nepal’s total surface areas) with an estimated ice reserve of 481 km³. There are 2323 glacial lakes in Nepal covering an area of 75 km² (Mool et al. 2001).

The surface water available in the country is estimated to be about 225 billion cubic meter (BCM) per annum or equivalent to an average flow of 7,125 m³/sec, out of which only 15 BCM per annum is in use (WECS, 2003). Around 95.9% of 15 BCM has been used for agriculture, 3.8% for domestic purpose and only about 0.3% for industry. It is observed that around 78% of the average flow of the country is available in the first category river basins, 9% in the second category basins and 13% in the numerous small southern rivers of the Terai. Studies have shown that the first category of rivers have surplus flow but the second category rivers have deficit flow in the dry season. In addition to the surface water, 8.8 BCM of water is also available in shallow and deep aquifers annually.



Nepal has been experiencing water deficit, for four to five months outside the monsoon seasons and further warming may worsen the situation (ADB, 2010). The decline in natural recharge of aquifers (due to drought, low precipitation, and intense localized precipitation) and over exploitation of groundwater have led to rapid drop in the groundwater table in many regions. For example, in the region close to Narayani River, the groundwater level has dropped from 50 to 70 feet below ground level (in the Terai part), and spring water is drying reducing discharge by up to 90 percent during winter in the hilly regions (NCVST, 2009). A study (Pandey et al. 2010a) conducted in Kathmandu valley reveals the increasing population density, urbanization, and increasing number of hotels altogether acted as driving forces for 2.25 times higher groundwater extraction over recharge (extraction = 21.56 and recharge = 9.6 million cubic meter-a-year during 2000 -2008), decrease in groundwater levels (13–33 m during 1980–2000 and 1.38–7.5m during 2000–2008, decline in well yield (4.97–36.17 l/s during mid- 1980s to 1998) and deterioration in water quality). Similarly, in drought prone areas, farmers are using river water for irrigation and drinking in such ways that it has affected the minimum base flow downstream, resulting in environmental degradation.

3.2 BIODIVERSITY AND FOREST

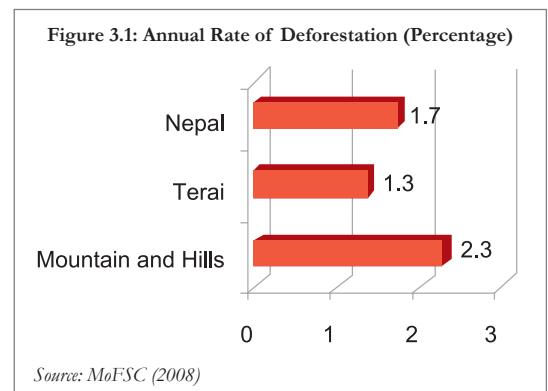
Nepal's unique biodiversity is a result of its unique geography and climatic variations. Nepal has 54 Important Plant Areas (IPAs) (Hamilton and Radford, 2007), including about 2,000 species of medicinal plants and non-timber forest products. The richness of species in Nepal is high compared to global number. In terms of floral diversity, Bryophytes Pteridophytes and Gymnosperms have 5.1, 4.7 and 5.1 percent of the global diversity respectively while Angiosperms has 2.7 percent of the global share. Faunal diversity is also high in Nepal. For example, Birds and Mammals have 9.5 and 4.5 percent of the global diversity respectively.



The number of taxa in Nepal are being regularly updated with increasing species number. Altogether, 342 plant species and 160 animal species have been reported as being endemic to Nepal (MoFSC, 2002)

The biodiversity in Nepal is supported by terrestrial and aquatic ecosystems mainly forests, rangeland, and wetland. To protect these ecosystems, the Government of Nepal has established protected areas, namely national parks, wildlife reserves, conservation areas and buffer zones. It is also important to note that conservation of forests and environment is also linked with cultural and religious practices of different indigenous and ethnic groups in Nepal.

Forests occupy about 5.8 million hectares of land, which is 39.6% of the total area of the country. Of this, 29% is forests and 10.6% is shrub-land (DFRS, 1999). Nepal's deforestation rate of 1.7% (Figure 3.1) is well above the Asian average of one percent and the global average of 1.3% (MoFSC, 2008). Forest degradation rate is higher than deforestation. A comparative study of forested areas in between 1979 and 1994 shows that the deforestation rate was 1.6% while the annual degradation rate was eight percent (MoFSC, 2009).



3.3 AIR

Nepal has carried out emissions tests for different sectors: residential and commercial, industrial, agricultural, and transport. Air pollution is emerging as a major problem in Nepal's urban centers, particularly in the Kathmandu Valley and large cities. The main sources of air pollution in urban areas are vehicles, industries, re-suspended road dust, and burning waste. An air pollution inventory in Kathmandu Valley indicates that the main sources of air pollution are vehicle emissions, road dust, and emission from brick kilns. In 2005, vehicle emissions were responsible for 37 percent of the total PM10. Re-suspended dust, which is also caused by vehicles, accounted for 25 percent of the PM10, and brick kilns were responsible for 11 percent of total PM10 emissions (IBRD/World Bank, 2008).

Nepal is among the countries that consume the highest traditional fuel in Asia. A large number of people still depend on simple, even primitive, low efficiency, and locally fabricated biomass fuel combustion devices that cause considerable indoor air pollution. The concentration of pollution in Nepalese homes is very high compared to both international and national standards. Women spend considerable time indoors and young children who stay close to their mothers also end

up breathing polluted air. Women who generally are in charge of cooking spend a large amount of time in the kitchen and therefore bear a larger burden of disease as a result of their higher exposure to indoor air pollution (UNDP, 2009). There is evidence-linking smoke from solid fuel use in developing countries with three important diseases—child pneumonia, chronic obstructive pulmonary disease (COPD), and lung cancer (Dherani et al. 2008).

3.4 LAND USE CHANGE

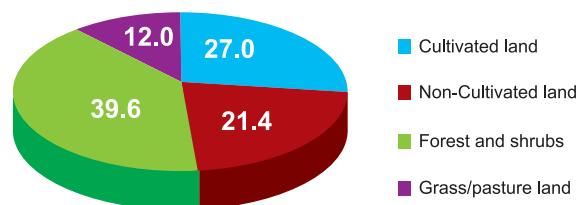
There are seven types of land-use changes that cause alterations in carbon stock: (1) conversion of natural ecosystems to permanent croplands, (2) conversion of natural ecosystems to shifting cultivation (3) conversion of natural ecosystems to pasture, (4) abandonment of croplands, (5) abandonment of pastures, (6) harvest of timber, and (7) establishment of tree plantations (Houghton, 2004).

Land resource base supports the livelihood of the majority of people. The great diversity in landscapes and climates is reflected in the complex usage of land. In general, land use category includes agriculture, forest, and pasture, snow cover and other lands (MoPE, 2000b). Land use change is noticeable in forest and agricultural land. There is a tendency to cultivate marginal lands. Several studies have concluded soil erosion to be a major environmental concern for Nepal. In terms of land degradation, about 0.4 percent, 1.5 percent and 11.7 percent of the watersheds are reported in very poor, poor and fair conditions, respectively (Wagley, 1997). It is also estimated that about 1.8 million tons of plant nutrients (N, P₂O₅, K₂O and Ca) are removed by crop harvesting (0.5 million tons) and the soil erosion process (1.3 million tons) (Joshi et al. 1997). Out of this, only 0.3 million tons (16 percent) are replenished by organic and mineral fertilizer sources.

According to National Land Use Policy 2011, Nepal has 27.0 percent of the cultivated land, 39.6 percent of forests and shrub land and 12.0 percent of grass/pasture land (Figure 3.2). The policy has divided the land into seven categories as follow:

1. Agriculture
2. Residential
3. Commercial
4. Industrial
5. Forest
6. Land for public use
7. Others

Figure 3.2: Land Use Pattern in 2011 (Percentage)



Source: Ministry of Land Reform and Management (2011)

3.5 HABITAT LOSS

Change in temperature, moisture regime, and timing of precipitation progressively alter natural habitats. Evidences indicate that the habitats for snow leopard have reduced due to rise in temperature. Animals like yak thrive in cold climates and increase in temperature can threaten their survival.

Cutting of trees and wildfires also cause habitat loss. Several animals like tiger, rhinoceros, snow leopard and red panda are in the verge of extinction mainly due to deforestation and illegal poaching. In addition, many plant and bird species, and reptiles are also threatened by illegal exploitation and trafficking. Further, pollution from untreated effluents has also aided towards habitat loss of aquatic flora and fauna.

The Nepal Red data Book (NRDB) lists 59 mammal species, 279 bird species, 35 Herpeto fauna species, and 34 fish species, of which four species of mammals and seven species birds are believed to be extinct, according to

the updated checklists. Altogether, 173 mammal species (nearly 94% of total 185 mammal species) are listed as threatened by IUCN. Of the total number of bird species (874), three species are critically endangered (the Slender-billed vulture *Gyps tenuirostris*, the Pink-headed duck *Rhodonessa caryophyllacea* and the White-rumped vulture *Gyps bengalensis*). Sixty-four species of herpeto fauna (34% of total herpeto faunal species) are listed in the IUCN Red List. Infrastructure projects such as road and irrigation in forest areas have fragmented the natural habitats which has also affected the movement of wild animals and accelerated the use of plant resources.

3.6 MOUNTAIN TOURISM

Nepal's tourism is primarily nature-based with its landscapes, mountains, glaciers, lakes, rivers and flora and fauna as major attractions. Mountaineering, trekking, white water rafting and jungle safaris are the main nature-based tourism activities. Trekking is the most popular tourism activity, as about 43 percent of all tourists trek in the Himalayan foothills (MCTCA, 2004). Jungle safaris are also popular with the one-horned rhinoceros, tigers and elephants as major attractions in the lowlands. White water rafting is a major attraction for tourists. Around one-fourth of all international tourists visit in mountain destinations (Nepal, 2003). The combination of ecotourism and tourism has helped to develop the economy, but it has also raised concerns with regard to the changing cultural values, lifestyles, environmental degradation, inflation, housing and labor shortages, and community cohesion (Nepal, 2011).

The tourism industry and particularly the tourist destinations are sensitive to climate variability and change. Climate defines the length and quality of tourism seasons and plays a major role in destination choice and tourist spending. Climate can affect a wide range of the environmental resources that are major tourist attractions, such as snow conditions, wildlife and biodiversity, water levels and quality.

The most obvious and visible impact of mountain tourism is forest depletion and ecological change. Use of firewood by trekking groups has been forbidden since the late 1970s. However some visitors might still be using fuel wood in the high mountain region. Another severe problem related to tourists and trekking is waste disposal. It is estimated that one group of trekkers (of 15 people) creates 15kg of waste that is not biodegradable or burnable during a 10 day trek (Walder, 2000). Another study has estimated about 17 metric tons of garbage per kilometer of tourist trail in the Everest region (Mountain Agenda, 1999). The prospect of climate change as a result of global warming, has heightened concern over the ability of this region to maintain its natural beauty and, consequently, its tourism base (Alam and Regmi, 2004).

3.7 SOCIO-ECONOMIC CONDITIONS

The increasing exploitation of mountain areas by diverse influences such as agricultural systems, increasing reliance on mono-cropping, commercial logging and tourism enterprises put additional pressure on the fragile ecosystems. Similarly, dams and roads can be hazardous if they are not properly constructed and managed. Unsustainable development practices have exacerbated the pressure on resources, which in turn have led to the problems of food insecurity and malnutrition in mountain areas, while mountain livelihoods are becoming increasingly vulnerable to external economic shocks.

Climate change will worsen the living conditions of most mountain dwellers and will also heavily impact the lives of people downstream. Crop failure and the loss of livestock will threaten the livelihoods of mountain farmers who are already vulnerable and food-insecure, while changes in snow patterns will affect the tourism industry and cause enormous economic losses. The likely increase in the number and intensity of disasters will require expensive measures to protect infrastructure and settlements. The expected changes in water availability will seriously affect upstream-downstream relationships and are likely to lead to conflicts. And the poor are more vulnerable as they have less capacity to cope with climate-induced changes, and natural disasters and are more dependent on natural resources for livelihood.

4

CLIMATE CHANGE IMPACTS

Hydro-meteorological data collected by the government agencies shows marked changes in the temperature and the precipitation patterns (MoEnv, 2010; WECS, 2011). However, their impact in economic and physical terms remains to be assessed. Much of the discussions are based on available studies/reports that project likely scenarios rather than actual impacts.

The climate change risk differs across ecological regions. Floods, droughts, debris flows, vector and water borne diseases, forest fire and degradation of ecosystems are the major climate change risks in the Terai-Churia regions. In the Middle mountains it is landslides, debris flows, flash floods, droughts, drying up of springs, prevalence of insects and plant diseases and forest fires. Rapid melting of glaciers, glacial lake outburst flood (GLOF), landslides, shifting and deterioration of habitats, biodiversity loss and ecosystem degradation are major climate change risks in the High Mountain (SPCR, 2010).

Box 4.1: Climate Refugees in Mustang

In the first recognized case of climate change refugees in Nepal, the settlement of Dhe, in Surkhang VDC of upper Mustang, is being resettled in Thangchung in lower Mustang. A total of 150 people (23 households) of Dhe are being shifted due to the adverse impact of climate change on their livelihoods. Dhe has been facing an acute shortage of water for irrigation over the last 6-7 years. The irrigated land over the period has also been reduced to less than 50 percent and animal husbandry (particularly goat keeping) has declined to 40-45 percent (Shah, 2010).

4.1 WATER

Global warming is often accompanied by changes in the hydrological cycle e.g. changes in rain and snowfall patterns, snow and glacier melt, more atmospheric water vapor and evaporation, and changes in soil moisture and runoff. These changes have significant impact on water in glaciers, rivers, wetlands and underground aquifers and affect agriculture, energy, human health, water-related disasters and water supply. The most severe climate change impact on water may be broadly categorized as given below.

'Too Little Water'

Drought has caused drying of springs, groundwater depletion, reduction in river water discharge, and wetland degradation. A field survey conducted during the SPCR preparation revealed that many springs in the mid-mountains had reduced discharge causing water scarcity (SPCR, 2010). Box 4.1 depicts a case of climate refugees in Nepal. There were also cases where wells and shallow tube wells had dried out in the Dune valleys. There were also reports of decreasing in river water discharge in Mid-mountain causing hydropower generation adversely. Drying of water sources has promoted migration, closure of micro-hydro (water mills), and triggered water use conflicts. It has also resulted in increase in fallow land as owing to scarcity of water for irrigation. Several studies have reported the degradation of wetlands caused by climate change (Sharma et al. 2009). A recent study by Chaulagain (2006) predicts that the total water availability in the country will increase from the present 176 km³/year to 178 km³/year in 2030, and then drop to 128 km³/year by 2100. This would have significant consequences on wetlands at lower elevations that depend largely on upstream runoff. Rapidly filling up of lakes with debris from

the surroundings, sedimentation due to intense precipitation and flash floods, increased rate of evaporation due to increasing temperature and drought, landslides and soil erosion, and over exploitation are some of threats facing the Himalayan wetlands (Bhandari, 2007).

The “too little water” situation has particularly affected women and children who have to travel long distances to fetch water. They also face diseases caused by poor sanitation resulting from water scarcity. A study in the Koshi River Basin has revealed that people use less water for general hygiene and sanitation activities when it becomes scarce (Dixit et al. 2009).

‘Too Much Water’

Heavy precipitation in the form of extreme events have resulted in devastating floods and triggered landslides that have caused loss of lives and destroyed infrastructures downstream. Glacial Lake Outburst Floods (GLOFs) are fairly new phenomena in the Himalayan region. A GLOF is a sudden release of water following failure of the moraine dammed lake filled with melt water. The moraine dam of Tam Pokhari glacial lake in the Mt. Everest region breached on 3 September 1998 releasing about 18 million cubic meters of water that caused a catastrophic flood downstream (Osti et al. 2011). Extreme climate events such as heavy localized precipitation in the Siwalik and Mahabharat range result flash floods in small tributaries, which contribute to floods in the main river basins in the Dune valleys and Terai. Such floods may deposit sand and debris on cultivated land, sweep away bridges, irrigation canals, drinking water infrastructures, hydropower plants, trails, and fertile land making people landless and homeless. Since low-income and marginalized people generally reside on the riverbanks in poorly constructed buildings, they face the brunt of flooding. Floods affect the weakest sections – children, disabled and the elderly – of society the most.

‘Water Pollution’

The extreme climate events that result in too much water degrade drinking water sources. Similarly, prolong droughts may cause reduction of discharge, which in turn, again makes water unfit for drinking and is therefore a major risk to human health (SPCR, 2010).

4.2 HUMAN HEALTH

Climate change impacts on public health are a global concern. Nepal like other countries has been experiencing an increased climate change impacts on public health (MoEnv, 2010). There is an increase in the prevalence of vector and water borne diseases. Disasters, particularly floods, also have a direct impact on public health. With climate change subtropical and warm temperate regions could be more vulnerable to malaria and kala-azar. Further, a rise in temperature could make the subtropical regions more vulnerable to Japanese encephalitis. Many of the common diseases in Nepal are climate related. With climate change ailments such as malaria, Japanese encephalitis and kala-azar may spread to new regions (Regmi and Adhikari, 2007).

The NAPA report (MoEnv, 2010) said it was difficult to relate the changing patterns of disease prevalence with climate change but many of the health-related concerns of communities are related to water, food, and disasters. Declining domestic water supply will directly impact hydration and indirectly impact people because of poor sanitation.

4.3 ECOSYSTEM

Nepal Biodiversity Strategy 2002 identified five ecosystems in Nepal, which are forests, rangelands, wetlands, mountains and agro-ecosystems. All of these are variously affected by climate change. Forest ecosystems are

deteriorating and this affects biodiversity. This is probably related to higher temperatures in lower altitudes, upward shifting of vegetation, encroachment of invasive species and thereby colonization, and increased prevalence of disease and pests. The impacts observed in the forest ecosystems include a) Increased dryness and fires b) Physical disturbances from erratic rain, landslides and erosion c) Altered natural life cycles, d) Encroachment by alien species e) Disease and pests and degradation of species diversity. Likewise, the impacts on rangeland ecosystems include a) More grass due to rise in temperature, b) Reduced availability of NTFP, and c) Damage by fires. In case of mountain ecosystems, the likely impacts are a) Risk of GLOFs, and b) Spread of diseases. Furthermore, the impact on wetland ecosystems are, a) Degradation of species, b) Encroachment by alien species, and c) Degradation of livelihood resources. The agro-ecosystem would witness: a) Reduced production, and b) Loss of local crop diversity.

Climate change might also induce ecological succession at faster rate and grasslands could be converted to woody vegetation at comparatively shorter periods. Species having low tolerance to climate variability and location-specific species might also be wiped out and change the structure of ecosystems. Increased temperature and rainfall variability have resulted into shifts in agro-ecological zones, prolonged dry spells, and higher incidences of pests and diseases (MoEnv, 2010).

4.4 GLACIERS

Different scholars have studied the glaciers of the Kanchenjunga, Khumbu, Langtang, and Dhaulagiri regions since the 1970s. Asahi (2001) of the Glaciological Expedition in Nepal and Kadota et al. (1997) measured glacier retreat in the Khumbu and Shorung regions and positioned benchmarks in the vicinity of the termini of 19 small debris free glaciers. They found that glaciers in the Shorung region retreated by an average of eight meters per year; and glaciers in the Khumbu region retreated an average of five to 10m per year. They concluded that the glacier retreat rate accelerated after 1990. Between 1970 and 2000, the loss of glacier area in the Tamor River sub-basin (Bajracharya et al. 2006) was about 5.9 percent or 0.2 percent per year. Further, Fujita et al. reported a higher glacier retreat rate between the 1970s and the 1990s in the Shorung Himal area in east Nepal and also in the Rika Samba glacier of the Dhaulagiri region in the west (Fujita et al. 2001).



The glacial studies of the past three decades have established that significant changes have occurred in the overall temperature regime. Rising temperatures have expanded the glacial lakes increasing the threat of GLOFs (Ives, 1986; Yamada, 1998). About 21 glacial lakes are already reported to have reached sizes large enough to be critical (Mool et al. 2001). Twenty glacier lakes are highly vulnerable. The rate of retreat of some glaciers is estimated to be as high as 20 m/year. The average minimum glacier retreat rate was 10 m per year – observed at the Langdak, W. Lhotse and Setta glaciers. Out of the 2323 glaciers lakes inventoried, 330 lakes have expanded to become larger than 0.02 sq. km and are still expanding (Bajracharya et al. 2005). Photographic evidence in the Main Rongbuk glacier (in Mount Everest) shows that it has lost 330 feet of vertical ice, at a rate of more than four feet a year, between 1921 and 2007. Snow and glacier melt might increase water in Nepal's river system by about 5.7 percent till 2030, and decrease by 28 percent by the end of this century (Chaulagain, 2007).

Agriculture is very sensitive to climate change and more so in Nepal where it is dependent on weather. Higher temperature, increased evapotranspiration, lower soil moisture and decreased winter precipitation can result in droughts from November to April. Crop production depends on weather. An increase in temperature by 3°C would cause an increase in annual irrigation water demand by 11 percent, while keeping other parameters of water demand constant. Nepal is already experiencing water deficit during 4-5 months in the non-monsoon season. Further, about 64 percent of Nepalese agriculture depends on monsoon rainfall and productivity is determined by both the magnitude and timeliness of the rains.

Nepal's economy is largely based on agriculture, which contributes about 35 percent of GDP and employs about two-thirds of the population. However, it is largely rain fed, and is also affected by droughts, floods, erratic rainfall, and other extreme weather events. Increased temperature and rainfall variability have resulted in shifts in agro-ecological zones, prolonged dry spells, and resulted in higher incidence of pests and diseases. Productive agricultural lands in Terai are shrinking owing to drought and precipitation variances while land under agriculture is increasing in the hills. The following indicators suggest how climate change could be affecting agriculture (Malla, 2008):

- Nepal has experienced 12 warmest years in the period from 1975 to 2007.
- Nepal experience late or early monsoons, unusual precipitation, decreasing number of rainy days and intense rainfall events – causing more runoff and low groundwater recharge.
- Extreme fog conditions have been observed in the Terai region.
Rainfall of Mid-June and Mid-July has shifted to Mid-August and Mid-September. This has caused reduction in paddy production.
- Less rain in the eastern Terai in 2005/2006 caused crop production to fall by 12.5 percent. Nearly 10 percent of land was left fallow due to rain deficit but the Mid-western Terai faced heavy rain and floods, which reduced production by 30 percent that year (Regmi, 2007).
- Early maturity of crops due to increase in temperate may help to have more crops in the same crop cycle.
- Shifting of climatic zones.

Local communities have identified changes in climate as being responsible for declining crop and livestock production (MoEnv, 2010). Nepal's vulnerable subsistence farming economy faces risks arising from unreliable stream flow, intense and erratic monsoon rain, and floods. Decline in rainfall from November to April adversely affects the winter and spring crops. Rice yields are particularly sensitive to climatic conditions and these may decline in the Western region where a majority of the poor live, and this could threaten overall food security. Rainfall distribution is uneven across the cropping seasons. Summer crops often get more water or are flooded. Most winter crops and those planted during spring are affected by prolonged dry spells.

A report released in September 2009 by British aid agency Oxfam said that one million Nepalese face severe food shortages because of climate change. It said that changing weather patterns, extreme temperatures, drier winters and delays in the monsoon have already affected crop production, leaving farmers unable to properly feed themselves and pushing them into debt. Further, vulnerability assessments of rice yield have shown that a 4°C rise in temperature and 20 percent increase in precipitation could result in marginal increase in yield from 0.09 percent to 7.5 percent. Beyond that, the yield would decline.

Nepal faces many natural hazards such as earthquakes, floods, GLOFs, landslides and debris flows resulting from its steep topography, on-going mountain building process, highly fractured rocks, diverse climate and intense precipitation. On the basis of Climate Change Vulnerability Index (CCVI), 16 countries have been rated as being 'extreme risk,' with the South Asian nations of Bangladesh (1), India (2), Nepal (4), Afghanistan (8) and Pakistan (16) among those with the most exposure to climate change, whilst Sri Lanka (34) is rated 'high risk' (Maplecroft, 2010).



A recent study has revealed the occurrence of 21 GLOF events (Mool et al. 2001) in the Himalayan region. Thirteen of these occurred between 1964 and 1998; nine occurred in the Tibetan Autonomous Region (China). The latter affected the areas downstream along transboundary rivers like the Sun Koshi, Arun, and the Trishuli in Nepal. A GLOF damaged a hydropower plant and many houses in 1981 near Namche Bazar. In 1985, a similar event swept away three persons, one hydropower plant, 14 bridges and 35 houses along the Dudh Koshi River. Twenty-six glacial lakes have been identified as potentially dangerous. Quoting database of Ministry of Home Affair, Government of Nepal for the period 1983-2005, Shakya (2007) has mentioned that 938 persons lose their lives every year due to different type of natural disasters in Nepal. The loss of live due to flood and landslide alone is counted to be 303 persons per year. The economic loss due to different natural disaster on an average is nearly Rs. 1208 million per year.

Due to climatic and geographic conditions, men and women in Upper Mustang, of which 40 percent is rangeland, have to work long hours. Further, around 60 percent of the land is threatened by degradation and desertification (Sherpa, 2007). The snowline in the mountains is moving northwards due to climate change and global warming, resulting in the depletion of rangelands. Since the livestock have to be moved to higher elevations for grazing, this is affecting the lives of mountain women. One outcome is the shortage of dung for cooking. The shortage of dung has forced people to resort to firewood that adds pressure on the rangeland forests. The receding pastures have resulted in shortage of food for livestock, which ultimately affects the livelihoods of the herders.



Water is another important resource affected by climate change. Access to safe drinking water is a big issue in Nepal's Himalayas. Women of Upper Mustang and Olangchung areas work nearly 17 hours on average compared to 10.5 hours a day for men, the time spent on fetching water is one reason. Further, women walk for long hours to high rangelands to collect bio fuels and livestock dung for cooking and heating.

Climate change threatens critical ecosystems services and livelihoods and well being of billions of people living not only in the mountains but also in the downstream areas. Available trends and projections suggest that there could be major impacts: a) Mountain glaciers, snowfields and water supply, b) Mountain forests and biodiversity, c) Water induced disasters, and d) Livelihoods of mountain people.

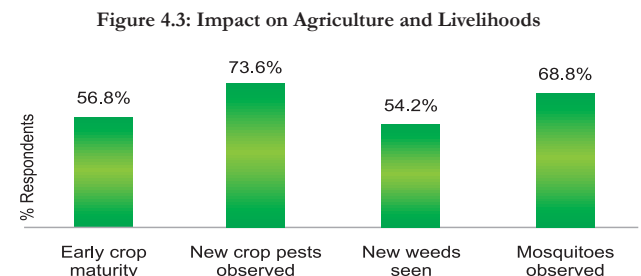
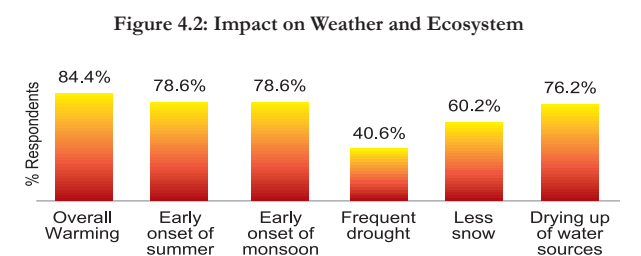
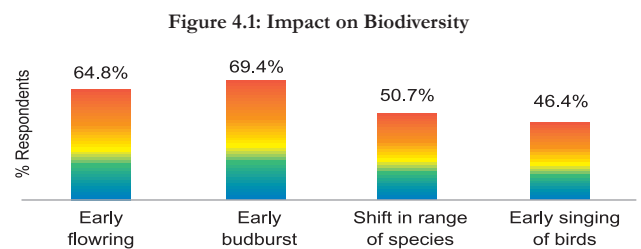
Data on impacts of climate change on livelihood in Nepal is limited and therefore it is difficult to assess the potential impacts. There is circumstantial evidence that the changing climate is already affecting agriculture, livestock and freshwater availability.

Figures 4.1, 4.2, and 4.3 show results of a community perception study (Chaudhary et al. 2011) and they suggest that 84.4 percent of the people believe that their environment is getting warmer, and nearly 78.6 percent believe that onset of summer, and monsoon has advanced during the last 10 years. More than 40 percent of the people also said that droughts had become more frequent 'than before'. The key informant surveys revealed that the nature and intensity of rainfall have also become more erratic and unpredictable and that heavy but short- duration downpours have become more prevalent. The locals also felt that winter was shrinking while summer was becoming longer.

4.9.1 Impacts on Vulnerable Groups

Poor and rural populations are most vulnerable to climate risks.¹ They depend largely on subsistence agriculture for livelihoods that can be disrupted by the impacts of climate change on natural systems. Floods, droughts, and degraded ecosystems directly affect their livelihoods but unlike other groups, the poor are also least capable to manage or adapt to the changes. Within this group, women are likely to be most affected. They typically have disproportionate access to resources and opportunities – less pay for the same work as men, lower access to schools, lower

access to health services, lower social and political status than men.² Women's daily activities, particularly in rural areas, largely relate to natural resources. Changes in precipitation and temperature patterns affect the availability of



Source: Chaudhary et al. (2011)

1 Climate change also has risks for urban populations. These include urban floods, pollution of water bodies and outbreaks of water and vector borne diseases, disruption of supplies by landslides, etc.

2 Case Study: Gender and Climate Change in the Hindu Kush Himalayas of Nepal, ICIMOD Unpublished report

fuel wood, fodder, grasses and drinking water and because women typically collect these resources they are likely face greater workloads once the resources become scarce. Climate induced disasters in the mid-mountain and Churia-Terai regions, could force more people, mostly male, to migrate in search of work leaving behind women, children and the elderly to look after the farm.

4.10 PRIVATE SECTOR GROWTH AND SUSTAINABILITY

Climate-sensitive economic sectors or those based on natural resources (water and agricultural products, NTFP, etc.) as well as small and medium enterprises are likely to be affected by climate change and that will affect production. The private sector must therefore be included into initiatives to strengthen Nepal's climate resiliency and it can contribute to adaptation initiatives by developing innovative technology, designing resilient infrastructure, development and implementation of improved information systems, managing projects through public private partnership, and through efficient delivery of goods and services.

5

RESPONSES TO CLIMATE CHANGE

5.1 POLICY, PROGRAMME AND INSTITUTION

The Interim Constitution of Nepal 2007 has recognized the ‘right to a clean environment’ as a fundamental right (Article 16.1). It also requires conservation of at least 40 percent of the natural forest area of the country (NPC/UNDP, 2011). The government has made efforts to set up appropriate institutional and policy regimes to facilitate the implementation of plans and programmes addressing climate change. In January 2011, the government endorsed the Climate Change Policy 2011 with the objectives of establishing a Climate Change Center; and adopting a low-carbon development path by pursuing climate-resilient socio-economic development, among others.

The Three Year Plan (2011-2013) has explicitly stated the sustainable development as a goal and for the first time explicitly focused on the climate-resilient planning of infrastructure sector. Furthermore, National Planning Commission has prepared a Climate-Resilient Planning Document for mainstreaming climate resilience perspectives in planning processes.

Besides periodical plans and policies, sectoral policies also focus on conserving the environment and natural resources, and minimizing atmospheric pollution. The National Conservation Strategy, 1988 is the foundation for natural resource and species conservation. The Sustainable Development Agenda, 2003 stresses managing resources, reducing pollution, promoting renewable energies and minimizing the adverse impacts of climate change. Although a separate law on climate change does not exist, there are several laws related to natural resource management, clean energy development and pollution control that could contribute to address the adverse impacts of climate change.

The National Parks and Wildlife Conservation Act (1973) and its associated regulations are the principal legal instruments that govern the management of protected areas in Nepal. The government has also brought forward Buffer-Zone Management Regulations, 1996 which give local communities rights to manage the forests around the protected area to fulfill their needs and at the same time maintain the buffer-zone forests as security belt to conserve core protected area involving local communities. The Act provides provision to share 30 to 50 percent of the total benefits generated in the protected areas with the local people.

In September 2010, the Government of Nepal endorsed the NAPA to implement urgent and immediate adaptation actions in priority areas. Later, the government also developed a national framework and approved Local Adaptation Plan of Action (LAPA) in November 2011 for operationalizing the NAPA. The LAPA provides opportunities to implement adaptation actions and integrate adaptation options into local and national planning processes. The government established the Climate Change Management Division under the Ministry of Environment (MoEnv) in March 2010. Similarly, in 2011 the National Planning Commission also prepared a working document for making the development policies climate resilient. There are other sectoral policies, strategies, and plans that include sustainability and natural resources management but do not directly address climate change risks.

The government constituted the Climate Change Council chaired by the Prime Minister in July 2009. This highest body also includes experts as its members. The Council is a high-level coordinating body that provides guidance and direction for formulating and implementing climate change-related policies and programmes; and integrating climate change into the long-term policies, plans and programmes. The MoEnv is the secretariat of the Council.

The National Planning Commission, and Ministries of Finance, Forests and Soil Conservation, Agriculture and Cooperatives, Energy, Irrigation, Local Development, Population and Health, and Home Affairs are the major ministries engaged in formulating and implementing climate change-related policies. Nepal also has a Multi-stakeholder Climate Change Initiatives Coordination Committee (MCCICC) formed to ensure functional coordination and promote implementation of collaborative programmes. The Committee has representatives from government ministries, local bodies, academia, I/NGOs, experts and development partners and is chaired by the Environment Secretary.

5.2

CLEAN ENERGY, ENERGY EFFICIENCY AND LOW CARBON DEVELOPMENT PATH

Nepal has been promoting clean energy solutions. The country has potential to develop 42,000 MW of hydropower but has so far generated only a very small proportion of the potential. As result, only nine percent of the population use renewable energy resources. The Three Year Plan (2010/11 -2012/13) aims to provide access to electricity to an additional seven percent of the rural population through alternative sources (15 MW micro hydropower to benefit the 150,000 households, and through 125,000 Solar PV home systems, and 100,000 small solar systems). It plans to generate 1 MW of electricity using wind. For the cooking, Nepal has promoted household biogas plants and improved cooking stoves. During the current Three Year Plan (2010/11-2012/13), a total of 90,000 domestic biogas plants, 50 community biogas plants and 75 institutional biogas plants are to be built. Likewise, the plan is to install 300,000 improved stoves in the mountain and Terai regions (NPC, 2011a).

The Government of Nepal provides fiscal benefits (custom and VAT subsidy) to “clean” vehicles particularly for the promotion of battery-operated zero emission vehicles. Nepal has promoted CDM projects, inter alia, in areas of biogas, micro-hydro and improved cooking stoves. The biogas CDM projects have received certified emission reductions (CERs) from the CDM Executive Board (EB) since August 2011. Other CDM projects have also been registered with CDM-EB and waiting for CERs. Nepal has also issued procedures for the approval of the CDM projects to benefit from Kyoto Protocol provisions. Nepal has further promoted renewable energies and considers important measures to reduce GHGs emissions, although she has a share of 0.025 percent of emissions globally. Nepal’s Climate Change Policy, 2011 equally focus on promoting the use of renewable energy and opens avenues for the development and implementation of low carbon development strategy.

5.3

REDUCING EMISSIONS FROM DEFORESTATION AND FOREST DEGRADATION

Reducing Emissions from Deforestation and Forests Degradation (REDD+) programme provides opportunities to reduce GHGs emissions and offers an opportunity to put a monetary value on standing forests and could give a way to contribute more substantially to the goal of emission reduction while protecting the forest resources and bringing investments in forest-related sustainable development for the dependent communities. The Bali Action Plan agreed to include REDD as mitigation strategy. REDD+ is a set of steps designed to use market/financial incentives for reducing the emission of greenhouse gases by preventing deforestation and forest degradation and contribute to biodiversity conservation and livelihood improvement.

The activities that can contribute to mitigation under the REDD-plus mechanism are:

- Reducing emissions from deforestation
- Reducing emissions from forest degradation
- Conservation of forest carbon stocks
- Sustainable management of forests, and
- Enhancement of forest carbon stocks

The Ministry of Forests & Soil Conservation (MoFSC) has established a three-tiered institutional arrangement for implementing REDD+. It comprises of the Multi-stakeholder Coordinating and Monitoring Committee as the apex body; the REDD Working Group (RWG) at the operational level; and the REDD-Forestry and Climate Change Cell (REDD Cell) as the coordinating entity. Participatory forest management intervention in Nepal not only reduces GHGs emissions but also add carbon stocks. Nepal has joined the Forest Carbon Partnership Facility (FCPF) under the World Bank to develop Readiness Preparation Proposal (R- PP) and its implementation. Nepal's forest carbon storage in 2005 was estimated at 897 million tons, and community forests annually sequester an average of 1.8 tons of carbon per hectare. Nepal's annual mitigation potential from reduced deforestation, and forest degradation is estimated at 15.97 and 4.4 million tonnes of CO₂ respectively.

Several pilot projects are being implemented since 2009 to develop methodologies and mechanisms on various aspects of REDD+. Nepal is expected to develop a policy framework to reduce carbon emissions from deforestation and forest degradation while accounting for its national interest by 2013.

5.4 CLIMATE ADAPTATION

5.4.1 National Adaptation Programme of Action (NAPA)

Nepal prepared its NAPA in 2010 with the following nine priorities:

1. Promoting community-based adaptation through integrated management of agriculture, water, forest and biodiversity.
2. Building and enhancing adaptive capacity of vulnerable communities through improved systems and access to service for agricultural development.
3. Community-based disaster management for facilitating climate adaptation.
4. GLOF monitoring and disaster risk reduction.
5. Forest and ecosystem management for supporting climate-led adaptation innovations.
6. Adapting to climate challenges in public health.
7. Ecosystem management for climate adaptation.
8. Empowering vulnerable communities through sustainable management of water resources and clean energy supply, and
9. Promoting climate-smart urban settlements.

The preliminary cost estimate for NAPA implementation is about USD 350 million. An implementation framework for NAPA has been prepared for facilitating the channeling of financial resources and technical expertise for adaptation at the local level. Depending on the nature and size of the project, it is envisaged that the operating costs will be kept to a minimum by ensuring that at least 80 percent of the available financial resources are spent on local-level adaptation activities.

5.4.2 Local Adaptation Plan for Action (LAPA)

In line with Nepal's Climate Change Policy(2011), and as a means of implementing NAPA and integrating adaptation options into development planning processes, Nepal has approved Local Adaptation Plan for Action (LAPA) in November 2011. LAPA provides a basis to implement location-specific people-centric plans and integrates adaptation options into local, regional and national development plans.

5.4.3 National Communication

In its Initial National Communication (INC) Nepal has identified and suggested adaptation strategies for the sustainability of the production system and for ensuring food security. These strategies include (a) Resource Conservation for Agricultural Sustainability (b) Development of Genetically Adaptive Varieties (c) Full-scale Production System of Hybrid Maize Programme (d) Encouragement to Crop Diversification Programme (e) Promotion of Organic Farming (f) Development of Early Warning Systems (g) Management of Methane Emission (h) Promotion of Biogas as a Source of Energy and (i) Management of the Livestock Population.

5.5

GREENING THE ECONOMY WITH LOW CARBON GROWTH STRATEGIES

Although mountainous regions of Nepal face numerous challenges, the Green Economy model being developed in the context of sustainable development and poverty alleviation is likely to open windows of opportunity to rectify the weakness of earlier development models which tended to emulate the conventional model, while excluding the concerns and interests of the mountain regions. The Green Economy approach can provide a framework for valuing and compensating critical services of mountain regions that benefit downstream communities and in the process encourage conservation and development addressing mountain poverty. The Green Economy concept, if developed in keeping with particular needs and vulnerabilities of the mountain regions, will have potentials to optimize the use of mountain natural resources while incorporating mountain values in sustainable development. Opportunities for developing mountain regions in the context of a Green Economy are discussed below.

5.5.1 Realizing the Value of Mountain Ecosystem Services

The Green Economy for a least developed country like Nepal should be a means to an end for sustainable development, poverty reduction and inclusive and equitable economic growth. Regional and global markets must provide preferential access to green products from the mountains, and provide clear price signals that reflect the scarcity value of natural resources. Further, property rights of primary stakeholders must be defined for encouraging optimal use of natural resources both individually and collectively. The Green Economy must recognize the value of ecosystems goods and services for downstream economies, and for securing overall human wellbeing at local, national, regional, and global levels. This recognition followed by reward or compensation factor can provide a powerful incentive to mountain people to be better stewards of mountain ecosystems goods and services. In Kulekhani, Nepal, villages in the upland catchment area receive part of the hydropower royalties paid by the power company to the government. The payments are channeled through District Development Committees to the recipient villages and managed under an Environment Management Special Fund. The money is used for conservation and development activities (Joshi, 2011).

5.5.2 A Growing Market for Niche Mountain Products

Mountain products and services such as medicinal and aromatic plants and other NTFPs, mountain crafts, and ecotourism hold special cultural, aesthetic, and intrinsic value and have niche markets. Enabling policies, competent institutions, and supporting rules and regulations for processing and marketing mountain products can benefit mountain regions and help them to receive equitable return for their products and efforts. Distinctive features and values of mountain products can be promoted in novel ways such as through green certification and eco-labeling, access and benefit sharing initiatives, green marketing, and buyers-sellers meet, developing common facility centre and organizing special trade fairs. Care, however, has to be taken to ensure that the greening of the economy does not create barriers to trade of and investment in mountain products.

5.5.3 Linking Livelihoods with Environmental Services

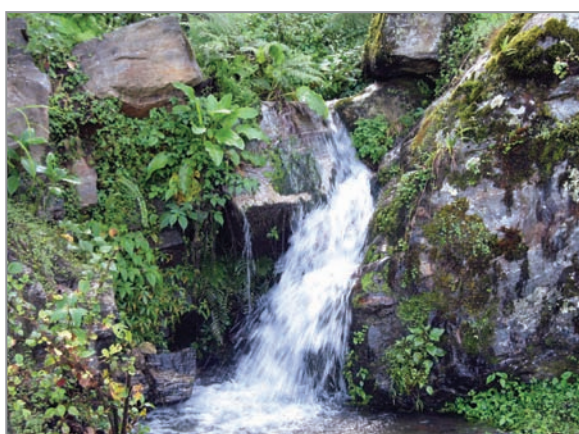
By linking natural resource-based livelihoods to production of ecosystem services, the Green Economy –based programmes and plans can help reduce poverty and enhance environmental sustainability. For example, many mountain people depend on collection of fuel wood, fodder, leaf litter, medicinal plants and other non-timber products from forests to earn their livelihoods and raise their income. Ensuring that mountain communities receive equitable benefits for providing these services can enhance and secure livelihoods in mountain areas while bringing environmental benefits.

Introducing incentive-based mechanisms for mountain ecosystem services

Ongoing global and national efforts to develop policies, strategies, and regulatory frameworks for better ecosystem services are creating new markets for mountain ecosystem services. Incentive-based mechanisms such as Payment for Ecosystem Services (PES) and Reducing Emissions from Deforestation and Forest Degradation (REDD+) are emerging opportunities for financing conservation and development programmes in mountain regions. While many countries have recognized the contributions of ecological services from their hill and mountain regions, the introduction of REDD+ (which includes biodiversity and livelihoods values from the sustainable forest management) as one of the most important GHGs reduction measures offers an entirely new opportunity for the global community to recognize the continuing contribution of mountain people in managing global commons.

Water resources management

Water is a premium resource of mountain regions. There is ample scope for investments in scaling up low-carbon growth or green practices in water and watershed management. Scaling up of green practices has both opportunities and challenges. Promotion of more efficient use and conservation of water will require investment in technological innovations (e.g. mountain appropriate snow and water harvesting for drinking water, and water conservation technologies, management of glacier lakes) and will also require integrated water governance measures/mechanisms (e.g. access and benefit sharing).



Diversification and value addition in mountain agriculture

Farming on the mountain slopes is hazardous. However, in spite of difficulties and limitations to cultivate, agriculture remains the only or the main economic activity in mountain regions – accounting for between 30 percent and 60 percent of GDP and employing up to 80 percent of the workforce in Nepal. The hills however have high potentials to grow organic crops since market for the organic products is likely to grow which creates opportunities for mountain regions to diversify its agriculture. The diversification following agro forestry

and other mixed farming systems need to adopt market-based approaches by promoting commercialization, organic farming, horticultural development, herbal and traditional medicine-based value chain development, and value-added products such as handmade paper, tea, bamboo-based handicrafts, floriculture and mushroom processing, among others.

5.5.4 Hydropower and Renewable Energy

Energy is the prime mover of the economy and society. Nepal has abundant water resources. Estimates suggest that Nepal has about 42,000 MW of commercially exploitable hydropower, including over 100 MW of micro hydropower (WECS, 2010); 2,100 MW of solar power for the grid; and 3,000 MW of wind power (AEPC, 2008). Nepal can also install another 1.1 million domestic biogas units (AEPC, 2009). However, so far only 658 MW of hydropower has been tapped.

Two government task forces on hydropower development have identified the list of projects that could generate 10,000 MW in 10 years and 25,000 MW in 20 years. However, considering both the absorption and financing capacity, National Planning Commission has set a target of generating 17,000 MW by 2030 in its Nepal Development Vision 2030 (NPC, 2011b).

Based on progress of the Three Year Interim Plan (2010) and the expected achievement of first two years of Three Year Plan, and other variables, the government prepared a quantitative energy generation target for 10 years (2010-2021) in 2011. Accordingly, the mini and micro hydropower development target for the first five years is 42 MW and 62 MW for the remaining five years. In case of solar home systems, the target is to install units at 245,000 households in first five years and 300,000 in the next five years. Similarly, biogas plants are to be installed in 165,000 households in first five years and 135,000 households in the next round. The plan also makes projections for increasing the number of improved cooking stoves.

5.5.5 Community-based Biodiversity Conservation

Since 1990s, the government has been pursuing a policy of participatory conservation and has been trying out different conservation governance models such as protected areas with buffer zone, NGO-managed conservation area, community managed conservation and government managed conservation areas. Further, conservation agencies have also been promoting community-based landscape conservation approaches since late 2000s (MOFSC, 2009) which has been largely successful. The national development plan (2010/11-2012/13) has identified ecosystem services and poverty reduction as important objectives of protected area management (NPC, 2011). As result of community involvement in conservation the area under protection has tripled between 1990 and 2011.

5.5.6 Promotion of Community, Collaborative and Leasehold Forests

Nepal's forests have multiple uses. Trees sequester carbon dioxide and increase carbon stocks till they mature. When the mature tree is cut and wood is used to substitute iron, steel and cement in construction and that reduces the production of iron, steel and cement. The reduction in the production and the use of iron, steel and cement means the reductions in GHGs. Nepal's forests have the potential to contribute GHGs reduction significantly, given the expansion of, among others, people-led and managed re-forestation and community-based management and conservation efforts.

Nepal has 15,256 Community Forest Users Groups (CFUGs) (MoF, 2011) managing around 1.65 million ha of forests. These CFUGs involve 35 percent (2.18 million household) of the population in managing more than 28

percent of the country's 5.8 million ha forest area. In addition to CFUGs, there are 83 Buffer Zone forest users groups managing 41,000 ha, and about 5,300 leaseholds forestry groups managing approx. 35,000 ha. Also, eight collaborative forestry committees, representing about 0.2 million households, have been managing about 18,600 ha in the Terai (NPC, 2011c).

5.6 CREATING GREEN JOBS IN MOUNTAIN AREA

Nepal's current development plans and programmes need to move towards a Green Economy that can increase the demand for environmental services. Provided that adequate financial instruments, technology transfer facilities and capacity building measures combined with enabling policies are put in place, this can open up new opportunities for mountain communities through locally led development interventions and creation of green jobs leading to development of green infrastructure. Some of these avenues waiting for harnessing are:

5.6.1 Non-Timber Forest Product (NTFP)

NTFPs are important sources of income for poor mountain communities. The most important category, Medicinal and Aromatic Plants (MAPs), are used by herbal medicine and essential oil industries (Regmi et al. 2000). Nepal has recorded 161 species of NTFPs harvested for commercial purposes. More than 100 of these species are of high value NTFPs that are traded in national and international markets. Trade in NTFPs supports the livelihood of a large number of the people living in the mountain regions, particularly in the Mid- and Far-western regions. Nepal's NTFP exports are estimated at over NRs 2.5 billion (US\$35 million) in 2001/02 (Subedi, 2006). The NTFP sub-sector has the potential to generate 26.55 million person days of employment for local people, equivalent of 180 days a year of employment for 147,500 persons (Pandey et al. 2010b). Prioritization of the potential commodities, value chain development and institutional support for processing and marketing are some of the interventions needed.

5.6.2 Tourism

Nepal aims to increase the share of GDP of the tourism industry by 3-5 percentage points in 2030 from around two percent focusing on certain priority interventions (NPC, 2011b). The long-term objectives of tourism are to achieve sustainable development of tourism industry, emphasizing on market and product diversification for enhancing income generation and poverty alleviation; strengthening, upgrading and developing accessibility/connectivity to provide enhanced, safe, reliable and adequate air and road services to both domestic and international visitors; and conservation of historical, cultural, religious and archaeological heritage and natural resources. The dimensions of tourism development should entail, a) developing natural, religious, historical, sports and medical tourism, b) developing hill stations and home stay, c) promoting tourist-friendly affordable hotel facilities and services, and d) developing road networks, security, and information, communication technology (ICT).



5.6.3 Potential Green Enterprises

Due to their specific environmental and resource-related features, mountains have unique and niche products and services that provide them with comparative advantages over plains areas, even though production is generally

unable to compete in terms of large-scale agricultural production. The comparative advantage results from high mountain conditions such as biodiversity, climate, topography, culture, and landscape. For example, certain valleys provide a habitat for special medicinal plants, and some mountains are a source of unique services or products such as mountain tourism or certain agricultural products.

There is substantial scope for generating more income locally by supporting mountain people to promote and harness unique and niche products and services. In fact, niche or comparative advantages remain largely dormant in mountain areas unless circumstances are created to harness them. The focused commercial and sustainable harnessing of high value products and services presents a significant opportunity for mountain communities to generate employment and income by using the natural resource endowment and comparative advantages of the Himalayan ecosystem (Hoermann et al. 2010).

Nepal's agriculture and forestry sector provide scope to develop a vibrant green enterprise sector due to its comparative advantages. Some of the community-based ventures that are suitable for women and the rural poor people are: production of organic essential oils such as chamomile, grass and natural fibers; organic farming – for vegetables; vegetable seeds, cash crops, and other niche products through contract or leasehold farming; village-tourism – village/home-based/eco-tourism with training and investments on diversifying the tourism products.

6

THE WAY FORWARD

There is no doubt that Climate Change is impacting Nepal rather disproportionately in view of the country's state of development and also a very negligible contribution of the GHGs. The rapidly retreating glaciers, sharp rise in temperature (average of 0.06°C per annum), increasing trend of extreme rainfall events and consequences of devastating floods and droughts are some of the effects Nepal has faced during the last few years. Most of the major rivers of Nepal are glacier-fed, therefore, water resources and hydroelectricity will be seriously affected by the changes in glacier reserves, snowfall and natural hazards. Nepal has no option but to adapt to these effects to reduce their impacts on people and their livelihoods. Nepal is largely a mountainous country and current indications are that the mountain regions are more vulnerable to increased warming trends. These alarming scenarios not only make Nepal's major sectors of economy such as agriculture, biodiversity, tourism and energy more fragile but also endanger the health, safety and wellbeing of the people. Landscape and biodiversity resources of Nepal are global heritages and the impact of rapid melting of ice and snow and invasive species will not only degrade them but also deprive the local people their access to medicinal plants and food crops. Climate change already threatens Nepal and needs immediate attention.

The globally accepted strategy to contain disastrous climate change impacts is Adaptation and Mitigation. Adaptation is priority for Nepal, and that would mean the effective implementation of NAPA whose aim is to address the most urgent and immediate needs of the people, reduce vulnerability and enhance resilience. Well-coordinated, quick and serious implementation of NAPA will be extremely important to adapt to the growing impacts of climate change. Nepal's central location in the Himalaya makes it a prime location for climate change impacts and therefore Nepal needs to play a leadership role at least in showing political will to address the threats and play a responsible role in regional and global forums. This is the context in which the way forward has been prepared.

The Framework Paper for the Mountain Initiative of the Government of Nepal (Macchi, M; ICIMOD, 2010) describes the context in which the Initiative was set and elaborates the specific vulnerability contexts and situation of mountain people and their social-ecological systems, highlights the importance of mountain ecosystem goods and services for mountain people as well as downstream communities, and also explores the opportunities created by climate change. In order to achieve the goal of sustainable mountain development, the paper calls for all to develop a common vision and strong voice to advocate the case for mountain people and ecosystems. Furthermore, The Government of Nepal's submission to the United Nations Conference on Sustainable Development 2012 (Rio+20) (NPC, 2011c) advocates that the mountain ecosystems need better recognition for the services they provide, and doing this can result in greater attention to the poverty, marginality, and livelihood issues faced by mountain communities, and on maintaining/enhancing ecosystem services that will benefit both upstream and downstream communities.

Considering the current global debate on climate change, biodiversity, desertification, and sustainable development and the initiatives undertaken nationally, regionally and globally over the last decade, as well as the analysis of the external and internal drivers of change especially the long- and short-term climatic changes and their impacts, this paper recommends more collaborative, coherent and synergistic solutions combining adaptation, conservation and sustainable development to address the issues holistically. Above all, actions are needed at all levels including national

coordination, regional co-operation and global support for effectively addressing the multiple issues, especially those related to climate change in the mountainous regions.

6.1 NATIONAL EFFORTS

The most effective way to address climate change effects in a least developed mountainous country like Nepal is through a holistic national policy and programme of adaptation and sustainable mountain development through country-level initiatives, programmes and activities carried out in coordinated and collaborative ways. To ensure that all relevant ideas, experiences and contributions are considered in the search for sustainable solutions, there has to be participation of multiple stakeholders – international, national and local, and should involve all stakeholder groups, including local communities, women and indigenous groups.

The following actions deserve special attention to enhance national initiatives:

1. Building resilient mountain socio-ecological systems requires adequate information, awareness and support of civil society, NGOs, civil society organizations (CSOs), community-based organization (CBOs), the private sector, universities, and other research institutions.
2. Effective mountain-specific policies and programs require addressing the specific development needs of mountain regions and the disproportionate vulnerability of social-ecological systems in the uplands. High fragility, loss of biodiversity, physical isolation, and political marginalization of mountains can be taken as a basis for formulating policies to address climate change impacts, and conserve the vital ecosystem services.
3. Policies, strategies, programs, and laws that explicitly address mountain issues and are better able to respond to challenges resulting from climate change, particularly those related to assuring food security and sustainable mountain development.
4. Sustainable mountain development strategies, integrated with Green Economy require institutional arrangements to allow mountain communities to benefit from emerging opportunities and reduce the pressure on mountain resources resulting from increasing demand.
5. Efforts to improve the economic situation of mountain communities need to consider innovative financing mechanisms and approaches such as payments for environmental services.
6. Supportive and enabling environment for the promotion of high-quality niche products and services from mountain areas would be critical for improving livelihoods and protecting mountain environments. This would require assuring access of mountain products to national and international markets.
7. The poorest and the marginalized people are usually affected first by changes of climate and extreme weather events such as floods, droughts, and heat waves. Further, existing gender inequalities, combined with social, economic and political factors make women more vulnerable. It is therefore critical to develop a mechanism where women and members of other socially excluded groups can participate equally in initiatives to address the climate change challenges.
8. There is need for focused efforts to promote conservation and sustainable use of scarce mountain resources such as water, biodiversity, forests, and grasslands. This can be attained through sustained efforts to increase awareness, prudence and efficiency in the use and management of natural resources in mountain areas, and by implementing specific measures for adaptation and mitigation.

6.2 REGIONAL EFFORTS

The Hindu-Kush Mountains are known as water towers of Asia, global biodiversity hotspots or eco-shelter for vulnerable faunal and floral species, and most importantly as regulators of the global environment. These are few of reasons why the region needs greater attention and better coordination in terms of achieving the goal of national and regional sustainable development.

The trans-boundary nature of mountain ecosystem services call for regional cooperation and collaborations, institutional partnerships, and strengthening of upstream-downstream relationships. In the context of growing economic integration especially in terms of infrastructure, markets, and energy upstream-downstream interdependency for natural resources especially water, minerals, markets, and technologies will only grow. Therefore there is a need for co-operative regional policies, institutional structures, funding mechanisms and support systems that promote multi-stakeholder involvement in managing natural resources. Other recommendations for taking the regional mountain agenda forward are:

1. Mountain countries and regions need to develop mountain specific adaptation and mitigation policies, institutions, knowhow, and capacities to overcome the challenges posed by climate change to ensure sustainable development.
2. It is important that regional countries share information, coordinate activities, avoid duplications, and develop regional capacity for addressing climate change impacts, and expedite the implementation of climate change adaptation measures.
3. The best practices and knowledge on climate change adaptation and mitigation – both modern and traditional – need to be documented and disseminated through training, education, and capacity-building initiatives tailored to the needs of mountain people.
4. The impact of climate change is disproportionately high on the most vulnerable groups, and this needs to be addressed through appropriate policies, financing instruments and technical interventions.
5. Regional centers of excellence and knowledge development need to be created and strengthened for continuously assessing the state of ecological, economic, and social changes in mountain regions, and for sharing information for developing regional plans and programs to address common issues and problems.

6.3 INTERNATIONAL EFFORTS

Concerted efforts are needed to implement the resolutions of international conventions to ensure that the outcomes of global and regional negotiations are translated into actions. The international community needs to recognize the high vulnerability of mountainous regions in the developing world and come up with enhanced policies, institutional structures, funding mechanisms and support systems to promote sustainable management and good governance of these global and regional public goods. Further,

1. Mountain ecosystems need better recognition for the goods and services they provide, and this would require greater attention on livelihood issues faced by mountain communities, and on maintaining/enhancing ecosystem services.
2. There is a need to provide increased and sustained finance to develop and transfer technologies, capacity building support and additional funding mechanisms for meeting the costs of adaptation and sustainable development in mountain countries. Support for developing and monitoring, forecasting and modeling of climate change impacts can help improve understanding for planning resilience-building measures.
3. The efforts made by mountain communities need to be complemented and supported for ensuring environmental stewardship needed for assuring continued availability of water, biodiversity, renewable energy, and bicultural heritage.
4. The Rio+20 conference should recognize the role of mountain systems in terms of the value of ecosystem goods and services for sustainable development and human wellbeing, and needs to make clear commitment for actionable programs in supporting incentive-based systems such as PES for maintenance of ecosystem services. It should also recognize the critical role of mountains as global resources supplying water for life, food for survival, biodiversity for ecological security, and clean energy for prosperity.
5. Developed mountain countries can and need to play crucial roles in providing knowledge and expertise and building the capacity of developing mountain countries for sustainable development.

6. The global stakeholders need to revisit the Mountain Agenda (Chapter 13 of the Agenda 21) to incorporate new changes and challenges that have emerged since 1992 for holistically addressing the increasing impacts of climate change, globalization and social changes.
7. Existing knowledge and information gaps on the importance of mountain ecosystems need to be updated for addressing the high incidence of poverty and inequity, the vulnerability of upstream and downstream populations, and the threats to the availability of mountain ecosystem goods and services, especially water.
8. It is necessary to develop a common understanding and framework for effective collaboration amongst mountainous countries and regions to work with global and regional agencies working in mountain areas for making joint efforts to reduce climate change risks and vulnerabilities, and build resilient communities through long-term adaptation and sustainable development actions.
9. Research and knowledge development, capacity building, and regional exchange of experiences and good practices can help in protecting fresh water resources, conserving critical biodiversity, maintaining vital gene pools by managing forests, wetland, and rangeland ecosystems better, and for enhancing livelihoods and wellbeing of people, nationally, regionally and globally.
10. It is necessary to advocate a revisit of the Mountain Agenda for incorporating new knowledge on the importance of mountain ecosystems for downstream communities, the high incidence of poverty and inequity, the vulnerability of upstream and downstream populations, and the threats to the availability of mountain ecosystem goods and services that are vital for planning corrective interventions. Collaborative efforts of mountainous countries are needed for implementing the commitments in article of 4.8 of the UNFCCC, in which the Parties agreed to consider the actions necessary for funding, insurance and transfer of technology, to meet the specific needs and concerns of mountainous ecosystems arising from the adverse effects of climate change and/or the impact of the implementation of response measures.
11. Mountainous countries need support for strengthening innovation capacity to generate appropriate technologies, enhance extension services and improve market infrastructures for increasing the productivity of agriculture and natural resources. It is also necessary to develop easily adoptable and resilient technologies that meet the needs of the poor, women and excluded groups and communities.
12. Mountainous countries have comparative advantage in high value products and services, such as non-timber forest products (NTFPs), medicinal and aromatic plants (MAPs), indigenous honeybees, and eco-tourism. Support is needed to enhance their access to technology and markets.
13. Country-wide blanket development models do not match the specific development needs of mountain people. Therefore, a collaborative effort is needed for designing and implementing mountain-friendly development models.
14. It is necessary to develop a common framework for effective collaboration of mountainous countries and regions to work with global and regional agencies working in mountain areas for making joint efforts to reduce climate change risks, vulnerability and build resilient communities through long-term adaptation actions to ensure supply of vital ecosystem resources for human well being.

In **conclusion**, Nepal being a mountainous country possesses some associated risks and vulnerabilities arising from climate change that would warrant carefully crafted policies, strategies, plans and programs and their implementation at local, regional and national levels. This needs sustained efforts to mainstream the mountain agenda into the national development processes and priorities. Reducing risks and vulnerabilities and optimizing opportunities and potentials emerging from such mountain resources as water, energy, biodiversity, agro-ecological and climatic variability and ethno-cultural diversity should be the prime concerns of mountain countries like Nepal. This would require cooperation and collaboration among all mountain countries at global and regional levels, based on the commonalities and convergence of problems, challenges and opportunities as well as approaches and strategies to address them.

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