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COUNTRY REPORT
CLIMATE RISK MANAGEMENT FOR AGRICULTURE IN NEPAL

Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES)
July, 2013

United Nations Development Programme

CRISIS PREVENTION AND RECOVERY

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LIST OF ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
ADED	Agricultural and Development Economics Division
AEPC	Alternative Energy Promotion Centre
APP	Agriculture Perspective Plan
BDP/EEG	Bureau for Development Policy Energy and Environment Group
CBS	Central Bureau of Statistics
CCN	Climate Change Network
CDRC	Central Disaster Relief Committee
CDRMP	Comprehensive Disaster Risk Management Programme
CIF	Climate Investment Fund
CRM TASP	Climate Risk Management Technical Assistance Support Project
CV	Coefficient of Variation
DDC	District Development Committees
DoC	Department of Cooperatives
DFID	Department of International Development
DHM	Department of Hydrology and Meteorology
DLS	Department of Livestock Services
DNA	Designated National Authority
DOA	Department of Agriculture
DoF	Department of Forestry
DOI	Department of Irrigation
DoLIDAR	Department of Local Infrastrucutre and Agricultural Roads
DPNet	Disaster Preparedness Network
DRR	Disaster Risk Reduction
DWIDP	Department for Water Induced Disaster Prevention
ECHAM	European Centre/Hamburg Model
ENSO	El Niño Southern Oscillation
EOC	Operations Centers
EPC	Environment Protection Council
EU	European Union
FAO	Food and Agriculture Organization
GCM	Global Climate Model or General Circulation Model
GDP	Gross Domestic Products
GEF	Global Environment Fund
GLOF	Glacial Lake Outburst Flood
GoN	Government of Nepal
HH	House Holds
IFRC	International Federation Red Cross and Crescent Society
IMR	Infant Mortality Rate

ITCZ	Inter Tropical Convergence Zone
LAPA	Local Adaptation Plans of Action
MAC/MOAC	Ministry of Agriculture Cooperation
MAGICC	Coupled Gas-Cycle/Climate Model
MDG	Millennium Development Goals
MLD	Ministry of Local Development
MLRM	Ministry of Land Reform and Management
MOCS	Ministry of Commerce and Supplies
MOE	Ministry of Environment
MOEN	Ministry of Energy
MOF	Ministry of Finance
MOFSC	Ministry of Forest and Soil Conservation
MoHA	Ministry of Home Affairs
MOHP	Ministry of Health and Population
MOI	Ministry of Industry
MOI	Ministry of Irrigation
MOST	Ministry of Science and Technology
MT	Metric Tones
NAPA	National Adaptation Programme of Action
NARC	Nepal Agricultural Research Council
NASDP	National Agriculture Sector Development Priority
NCAER	National Council of Applied Economic Research
NCDB	National Cooperative Development Board
NDDB	National Dairy Development Board
NDVI	Normalized Difference Vegetation Indices
NEOC	National Emergency Operation Center
NER	Net Enrolment Rate
NPC	National Planning Commission
NPR	Nepalese Rupees
NRRC	Nepal Risk Reduction Consortium
NSDRM	National Strategy for Disaster Risk Management
NSET	National Society for Earthquake Technology
NVC	Nepal Veterinary Council
PPCR	Pilot Program for Climate Resilience
REDD	Reducing Emissions from Deforestation and Forest Degradation
RegCM3	Regional Climate Model
RIMES	Regional Integrated Multi-hazard Early Warning System for Africa and Asia
SCENGEN	Spatial Climate-Change Scenario Generator
SEN	Small Earth-Nepal
SPCR	Strategic Program for Climate Resilience

SRES B2	Emission Scenario
UNDP	United Nations Development Program
UNDP CO	United Nations Development Program Country Office
UNISDR	United Nations International Strategy for Disaster Reduction
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
USD	United States Dollar
VDC	Village Development Committee
WB	World Bank
WECS	Water and Energy Commission Secretariat
WFP	World Food Program
WMO	World Meteorological Organization
WRI	World Resources Institute

FOREWORD

Climate change has the potential to exacerbate conflict, cause humanitarian crises, displace people, destroy livelihoods and set-back development and the fight against poverty for millions of people across the globe.

For example, it is estimated that over 20 million people in the Mekong Delta and 20 million in Bangladesh could be forced to move as their homes are affected by saltwater incursion from rising sea levels. Entire populations of some low lying island states, such as Nauru or the Maldives may have to be relocated. In countries like Honduras, where more than half the population relies on agriculture, climate induced risks, such as hurricane Mitch in 1998, which caused over USD 2 billion in agricultural losses, will continue to pose a staggering potential for damage. Similarly, climate risk assessments in Nicaragua show that changes in rainfall patterns, floods and drought could put human health at risk by increasing the prevalence of respiratory and water borne diseases and malnutrition.

Long-term incremental changes will mean that people everywhere must learn to adapt to weather or rainfall patterns changing, or to shifts in ecosystems that humans depend upon for food. Perhaps more worrying however, is that climate variability and change will also bring unpredictable weather patterns that will in turn result in more extreme weather events. Heat waves, droughts, floods, and violent storms could be much more common in the decades to come. Climate change is "loading the dice" and making extreme weather events more likely. These disasters will undermine the sustainability of development and render some practices, such as certain types of agriculture, unsustainable; some places uninhabitable; and some lives unliveable.

As climate change creates new risks, better analysis is needed to understand a new level of uncertainty. In order to plan for disasters, we need to understand how climate change will impact on economies, livelihoods and development. We need to understand how likely changes in temperature, precipitation, as well as the frequency and magnitude of future extreme weather will affect any sector, including agriculture, water-use, human and animal health and the biodiversity of wetlands.

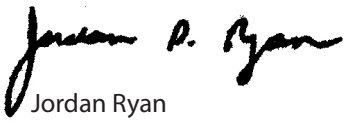
This report is a product of the *Climate Risk Management – Technical Assistance Support Project*, which is supported by UNDP's Bureau for Crisis Prevention and Recovery, and Bureau for Development Policy. This is one in a series of reports that examine high-risk countries and focus on a specific socio-economic sector in each country. The series illustrates how people in different communities and across a range of socio-economic sectors may have to make adaptations to the way they generate income and cultivate livelihoods in the face of a changing climate. These reports present an evidence base for understanding how climatic risks are likely to unfold. They will help governments, development agencies and even the communities themselves to identify underlying risks, including inappropriately designed policies and plans and crucial capacity gaps.

This series is part of a growing body of climate change adaptation resources being developed by UNDP. The Climate Risk Management – Technical Assistance Support Project has formulated a range of climate risk management assessments and strategies that bring together disaster risk reduction and climate change adaptation practices. The project is designing a common framework to assist countries in developing the necessary capacity to manage climate-induced risks to respond to this emerging threat. The climate risk assessments discussed in this report and others in the series will feed into a set of country-level projects and regional initiatives that will inform the practice of climate risk management for decades to come.

Addressing climate change is one of UNDP's strategic priorities. There is strong demand for more information. People at all levels, including small communities want to understand the potential impact of climate change and learn how they can develop strategies to reduce their own vulnerability. UNDP is addressing this demand and enabling communities and nations to devise informed risk management solutions. UNDP recognises that climate change is a crucial challenge to sustainable development and the goal of building resilient nations.

As the full effect of climate change becomes apparent, it is assessments such as these that will become the lynchpin of national responses and adaptation strategies for many years to come. Like the threat from many disasters, there is still time to prepare for the worst impacts of climate change in developing countries if we expand our understanding now.

This knowledge must be combined with real preparedness and action at all levels. Only then will we be able to stave off the worst impacts of climate change in the most vulnerable and high risk countries of our world.



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The Project, its methodology and analytical framework was conceptualized by Maxx Dilley, Disaster Partnerships Advisor and Alain Lambert, Senior Policy Advisor, Disaster Risk Reduction and Recovery Team (DRRT), BCPR with key inputs from Kamal Kishore, Senior Programme Advisor, DRRT, BCPR and in consultation with Ms. Bo Lim, Special CC Advisor, Environment and Energy Group (EEG), BDP.

Within BCPR, the Project implementation process has been supervised by Alain Lambert and Rajeev Issar who provided regular inputs to ensure in-depth climate risk assessments and identification of tangible risk reduction and adaptation options. From BDP, Ms. Mihoko Kumamoto and Ms. Jennifer Baumwoll provided their inputs and comments to refine the assessment and recommendations. The climate risk assessment has also benefitted immensely from the strategic guidance provided by Jo Scheuer, Global Coordinator, DRRT, BCPR and by Ms. Veerle Vandeweerd, Director, EEG, BDP.

The Project team would like to acknowledge and give special thanks to the main authors of the Report from RIMES.

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The climate risk assessments under the CRM-TASP project have been undertaken with the funding support of the Government of Sweden.

EXECUTIVE SUMMARY

Nepal is a land-locked low income country with a population of 26.6 million people and per capita income of USD 742. The economic structure of the country continues to be dominated by the primary sector with agriculture and-agro processing sectors contributing 40 percent of the GDP. Similarly, about 75 percent of the population remain dependent on the agricultural sector for livelihood and sustenance, with a per capita income of USD 140.

Agricultural growth and development appear to be sluggish. For instance, the sector remains subsistence-based, the growth rate during the last few years is 1.5 percent, and only 15 percent of the agricultural produce are traded. Despite a huge percentage of people depending on agriculture, the sector has suffered from years of under-investment, limited research (e.g., on improved agricultural practices), and a general lack of technological and knowledge services for farmers, among others. These create challenges to the goals of achieving food security and reducing poverty. Indeed, more than 90 percent of the poor in Nepal are self-employed in agriculture. The recent progress in poverty reduction is primarily due to remittances from Nepalese workers working abroad while agriculture remains an insignificant contributor in this regard.

Nepal is making efforts to revitalize the agriculture sector for it to absorb a large number of agricultural workers. However, government attempts at prioritizing the sector to increase rural incomes, reduce poverty, and ensure food and nutrition security are met with problems like low agricultural productivity. One of the reasons for the latter is climate risks: less than half of the cultivated land has reliable irrigation while only 7 percent of the households own a pump. Indeed, more than 70 percent of the crop area depends on rains brought about by the summer monsoon (June-September with 80 percent of the total rainfall), which is a major cropping season in the country.

Climate risks brought about by weather events as late onset of rains, long dry spells during the monsoon season, early withdrawal of monsoon, heavy rainfall episodes in October, deficient winter (November-March) rainfall, cold waves in December-January and hailstorms and thunderstorms during March-May affect agriculture operations. Except in 2003 and 2007, the years from 2001 to 2010 saw crop production being affected significantly with losses ranging between 5 and 35 percent. A total of 14.3 million people were affected – 12 million (83 percent) by droughts, 2 million (14 percent) by floods, and 0.3 million (3 percent) by landslides.

The total value of crops exposed to climate sensitivity amounts to around US$ 1.5 Billion. Annual loss of USD 75 million was caused by droughts compared to USD 4 million caused by other hazards. Losses to droughts in 2001-2010 for paddy crop alone amounted to USD 753 million whereas damages due to all hazards for all sectors were USD 57 million. In the case of 2006 and 2009, extreme droughts led to food deficits of 400,000 tonnes resulting in the rise of food prices of up to 117-300 percent in various locations. These reductions in food grain production and increases in food prices affected the vast majority of the population who were subsequently forced to cope with risks by reducing food consumption, selling productive assets, migrating due to distress, among others. In view of all these, the climate risk assessment conducted under the CRM TASP identifies drought as the principal climatic hazard impacting the livelihoods of people far greater than other quick onset hazards such as floods and landslides.

However, the perception of policymakers in Nepal is primarily oriented towards disaster risk management for quick onset climate hazards such as floods, landslides. This is largely because risks related to intra-seasonal variations are not fully captured nor acknowledged in the databases of both the Ministry of Home Affairs (MoHA) and the Department of Water Induced Disasters (DWID). Additionally, government investment for agriculture is only around 6 percent of the total budgetary resources. But since the sector supports 75 percent of the population, the risks and impacts to such need to be assessed and managed holistically.

One of the key recommendations that came out of this report is the use of weather and climate information to assess and manage the risks, and reduce impacts. Analysis shows a conservative estimate of the value of weather information to be around US$ 50 million per annum in the context of Nepal. Agriculture production could increase if climate risks are managed effectively using currently available climate risk management tools and practices such as integrating 5-10 days forecast information in agricultural operations. This means that there is a huge opportunity to minimize climate risks, and/or maximize potential benefits. While there is currently no policy and/or institutional mechanism that enables the integration of CRM in agriculture, increased awareness of climatic risks and impacts has led to initial processes of designing an information system to manage risks in the sector. Based on this foundation, a program may be designed to promote CRM policy, establish institutional arrangements, and build capacity of all key stakeholder institutions at national, district and local levels.

INTRODUCTION

It is now widely acknowledged that climate change can further alter the observed climate mean, cause changes in the nature of extremes (i.e., severity, frequency, spread, duration and timing) and present possible 'surprises'. The resulting climate risks could resemble current climate variability patterns, but with higher amplitude variations. The climate risk management (CRM) framework and approach suggests that these patterns of risks could be anticipated, and the experiences of present systems in dealing with these risks could be drawn upon towards building resilience to long-term climate change. Similarly, human experiences in dealing with extreme climate events may provide guidance for dealing with the uncertainties associated with climate change-related risks, including climate 'surprises'. This means that the promotion of resilient development and the building of capacity for institutions and systems to manage current climate extremes are critical for these institutions and systems to cope with 'surprises'.

CRM is an inter-disciplinary, multi-stakeholder process that involves the analysis of weather and climate-related risks for a consensus-based identification and prioritization of response strategies that anticipate and manage both extant and emerging climate risks. The framework was developed by UNDP's Bureau for Crisis Prevention and Recovery (BCPR), which is responsible for assisting countries to develop capacity to better manage disaster risks, and Bureau for Development Policy Energy and Environment Group (BDP/EEG), which is responsible to assist countries to develop capacity to adapt to climate change. With the goal of assisting countries to manage risks associated with climate variability and change, the Climate Risk Management Technical Assistance Support Project (CRM TASP) was developed to facilitate the application of the CRM framework and approach by integrating relevant concepts from disaster risk reduction (DRR for short-term natural hazards), climate change adaptation (CCA for long-term hydro-meteorological hazards), and development. The said project was implemented by the Regional Integrated Multi-hazard Early Warning System for Africa and Asia (RIMES). RIMES' work focused on assessing the capacity needs and risk management priorities for development planning in six countries in Asia, including Nepal.

APPROACH AND METHODS

The CRM TASP was initiated through a regional inception meeting organized for the UNDP focal points and key government representatives from the six countries at Pondicherry, India in July 2010. In Nepal, the project involved the United Nations Development Programme (UNDP), the Department of Hydrology and Meteorology (DHM), the Department of Agriculture (DOA) and Small Earth-Nepal (SEN), a non-governmental organization working with farmers and local communities in the country. Table 1 outlines the implementation process.

TABLE 1.1: PROJECT STEPS AND METHODS

PROJECT STEP & PURPOSE		SPECIFIC STEPS APPLIED IN NEPAL
1. Initiation	• Introduce CRM TASP • Country engagement in Nepal facilitated by UNDP Country Office (UNDP CO)	• Inception Meeting and discussions with key stakeholders • Discussions with the DHM and the DOA resulted in identification of agriculture sector as priority, and agriculture risk management as entry point for CRM
2. Climate risk assessment	• Participatory risk assessment involving stakeholders	• Reference to on-going initiatives including the FAO supported project on agriculture risk management • DOA identified need for a comprehensive solution including agriculture information management, integration of weather and climate information, generation of suitable advisories and applications in different agro-climatic, and development regions
3. Institutional mapping and capacity assessment	• Participatory capacity assessment involving stakeholders	• Assessing needs and receptivity of DOA in integrating CRM in DOA plans and operations • Identification of priority initiatives, namely: integrated information management system and agro-advisories
4. Capacity building on agriculture risk management	• Identify stakeholder needs to integrate CRM into agriculture	• An agro-advisory information management system was developed and demonstrated at the DOA, where it was well-received • The system is being reviewed by the DOA for further improvements (e.g., provision and incorporation of specific agricultural domain knowledge into the system) • Engagement with Small Earth Nepal, a local NGO helped provide a community perspective on the current level of information available for agriculture, additional information requirements and willingness to utilize specific information • UNDP CO expressed interest to pilot-test the system in collaboration with DOA
5. Documentation & Report writing	• Documentation and finalisation of CRM TASP report	• Synthesis of the process used to develop the CRM Nepal Country Report, which was shared with UNDP CO

The activities undertaken in Nepal involved the following processes:

- Climate analysis, which includes assessments of historical, current and projected climate data, trends and risks;
- Climate impact identification to establish actual and potential impacts of climate variability and/or climate change on key socio-economic and climate-sensitive sectors like agriculture;
- Generation of evidence-based support for CRM through assessments of the full range of impacts of hazards – from tangible direct impacts to intangible, indirect and cumulative impacts and losses that generally extend beyond agriculture;
- Decision analysis and support to facilitate the selection of CRM response options based on such factors as sector, geographic areas, socio-economic condition, among others;
- Assessment of institutional and policy structure and capacity to address governance, policy and capacity deficits through stakeholder analysis, institutional mapping and research;
- Prioritization of CRM interventions in key sector plans and operations.

From the regional inception workshop in July 2010, participants from Nepal identified key priorities for CRM-TASP in the country. Subsequent discussions with the UNDP, DHM, DOA and a range of key stakeholders and institutions narrowed down the priorities to the agriculture sector. This is because of the sector's sensitivity to weather and climate risks, and the overwhelming dependence of a significant proportion of population on agriculture for livelihood and subsistence. The agriculture sector is in fact also identified as a national priority in the National Adaptation Programme of Action (NAPA) Project and as part of on-going CRM initiatives under the Comprehensive DRM Programme.

The compilation and analysis of climate data were undertaken in close collaboration with the DHM, while the assessment of climate risks and impacts for the agriculture sector was undertaken with the DOA. There were also discussions with a range of institutions, organizations and communities to validate the analyses with experiences and observations on-the-ground. The discussions among stakeholders were facilitated by the UNDP CO, each of which was participated by DHM to ensure systematic project implementation and follow-up.

REPORT STRUCTURE

This report documents the analyses and outcomes of the CRM TASP in Nepal. This chapter presented the project process while Chapter 2 focuses on the development context and trends as well as the rationale for selecting agriculture as a priority sector for CRM. Chapter 3 outlines the past, present and projected climate profile and corresponding hazard features of the country. Based on past climate risks and anticipated climate change projections, Chapter 4 discusses climate threats to development while Chapter 5 outlines the current institutional and policy arrangements relative to CRM. Based on an assessment of these aspects and an analysis of needs and gaps, key CRM recommendations for risk reduction and adaptation are made in Chapter 6.

DEVELOPMENT PROFILE

This chapter examines the environmental context, socio-economic conditions and trends in Nepal. The later sections focus on the agriculture sector, which is considered a priority due to its role in providing livelihoods to a relatively high number of people, as well as its sensitivity to climate risks.

CURRENT DEVELOPMENT CONDITIONS, TRENDS AND CHALLENGES

Nepal is a land-locked country located between China on the north, and India in the south, west and east. It is largely a mountainous country with the Himalayas in the north, hills in the central region and river plains in the south along the border with India. Nepal has the distinction of possessing eight of the ten highest mountain peaks in the world (including the tallest, which is Mount Everest) along its borders with China and India.

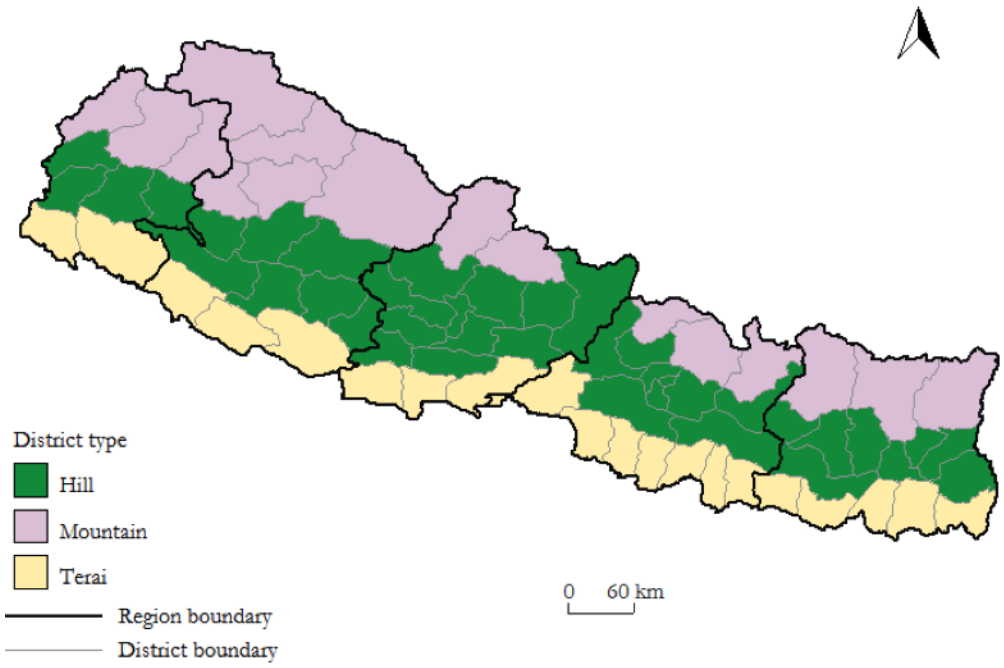


Figure 2.1: Regions in Nepal

Nepal has an area of 147,181 km^2 with an average length of 885 km from east to west and a width of 193 km from north to south. A census in 2011 estimates the population at 26.49 million with over 1.9 million living abroad (NPHC, 2011). This figure has grown from 23.15 million in 2001, at a rate of 1.35 percent per year. More than half (50.27 percent) of the people live in the plains (Terai), 43 percent in the hills and 6.73 percent in the mountain region. The urban population comprises 17 percent of the total population compared to 13 percent in 2001. This means that a staggering 83 percent continue to live in rural areas, about 6 million of whom (or 27 percent) live below the poverty line in addition to another 16 percent of the urban population living below USD 1.25 per day. Indeed, Nepal is one of the least developed countries in the world with a per capita income of USD 742. On a positive note, the proportion of the poor (with purchasing power parity that is less than USD 1.25 per day) has decreased in recent years from 53.1 percent in 2004 to 24.8 percent in 2011 although over 57 percent still earn less than USD 2 per day (World Bank, 2013).

A majority (over 55 percent) of the country's poor households rely on agriculture. This is not uncommon particularly because the sector employs over 75 percent of the country's population (CIA, 2013). It also remains a major contributor to the country's Gross Domestic Product (GDP) at a rate of 30-35 percent per year during the last ten years. Indeed in 2011-2012, the primary sector led by agriculture contributed an estimated 35.68 percent of Nepal's GDP of 1.418 Trillion Nepal Rupees at current prices (CBS, 2011). On the other hand, the secondary and tertiary sectors contributed 14.02 percent and 50.31 percent respectively.

Despite internal conflict issues, the GDP grew by 4.56 percent in 2011 with the primary and tertiary sectors as drivers of growth. The primary sector grew at 4.93 percent while remittances by Nepali citizens abroad accounted for 18 percent of Nepal's GDP in 2011 (CBS, 2012). While remittances have helped the country's GDP, this trend in migration also means that the more productive labour force (i.e., those aged between 20 and 40) move away from agriculture, or from Nepal altogether, potentially reducing the sector's and/or the country's growth potential. In 2010 alone, migrant departures totalled over 300,000 and saw over USD 3 billion inflows due to remittances.

NATIONAL DEVELOPMENT VISION, OBJECTIVES AND PRIORITIES

The National Planning Commission prepares five year plans to guide development planning. These were recently replaced with three Year Plans in view of the significant need for an effective transition and peace-building at national level. The Three Year Interim Plan (2007-2010) focused on reducing poverty and inequality through inclusive, productive and targeted programmes (NPC and UNDP, 2011), and on reconstruction and rehabilitation of physical infrastructure. The next Three Year Plan (2010-2013) aimed to achieve the vision of accelerating the pace of socio-economic transformation through employment-oriented social development programs that reduce poverty and achieve the Millennium Development Goals (National Planning Commission, 2010). In addition to the development targets outlined in the Plan, there was an aim for an agriculture growth rate of 3.9 percent per year as opposed to 3.3 percent in 2009-2010. This growth is achieved through increased commercialization in the sector with special focus on promoting cooperatives, development of infrastructure such as irrigation, and agriculture roads, provision of access to credit, dissemination of research and transfer of technology, rural electrification and development of market mechanisms to increase production and productivity, as well as investments from the private sector.

CONDITIONS AND TRENDS OF THE PRIORITY SECTOR

The major food grains in the country are paddy, maize, wheat, millet and barley, all of which account for 77 percent of the cultivated area. Among the cereals, paddy covers about 46 percent of the total cultivated area and accounts for 56 percent of total cereal outputs.

The central and eastern regions cultivate as much paddy as 60 percent of its total crop production, compared to other regions. Similarly, maize is grown in 0.248 mi ha (or 27.3 percent) of cultivated area in the eastern region, and about 0.237 mi ha (or 26.2 percent) in the western region, which produces 27.6 percent of Nepal's maize production. On the other hand, the western hills contribute more than 25 percent of the national maize production and almost 35 percent of Nepal's millet production. The central mountains, hills and Terai altogether contribute almost 30 percent of the country's wheat cultivation area and over 32 percent of its production, while the mid-western region has almost half of the barley cultivation areas that produce over 45 percent of Nepal's barley.

Although agriculture's contribution to the country's GDP has been declining over time (see Table 2.1), the sector remains to be the largest, sustaining at least 15 million people. Its contribution to GDP is still significant at 35-36 percent, and a huge percentage of the population continue to rely on the sector for livelihood and support.

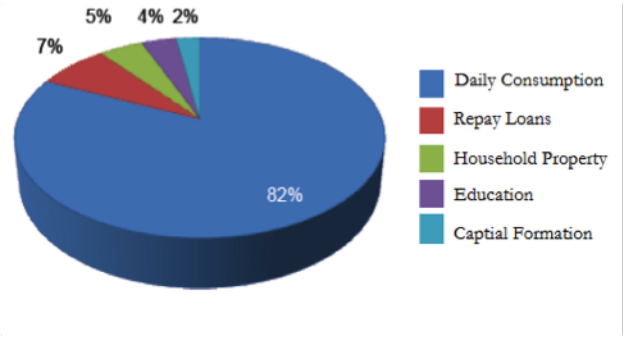
TABLE 2.1: POSITION OF AGRICULTURE IN THE ECONOMY

PARTICULARS	SHARE OF AGRICULTURE (%)			
	1980-81	1990-91	2000-01	2010-11
GDP	57.40	48.80	40.10	36.54
Total households	84.90	82.20	84.08	
Total Population	85.70	87.90	85.80	74%

Sources: ES, MOF, 1998/99 and 2001/02; CBS, 1994/2001; CBS, 2012, NPC, Approach Paper

Dependence on the agricultural sector despite the lack of technological progress means that agricultural growth and/or productivity is sluggish. Aside from the lack of technology, low productivity could be attributed to other social factors such as the lack of agricultural labour due to large-scale migration, and the 10-year long conflict which ended in 2006. The annual migration of 300,000 young adults aged 20-40 years from rural areas is a great loss to the agriculture sector (Shishido, 2011). Such migration, however, is

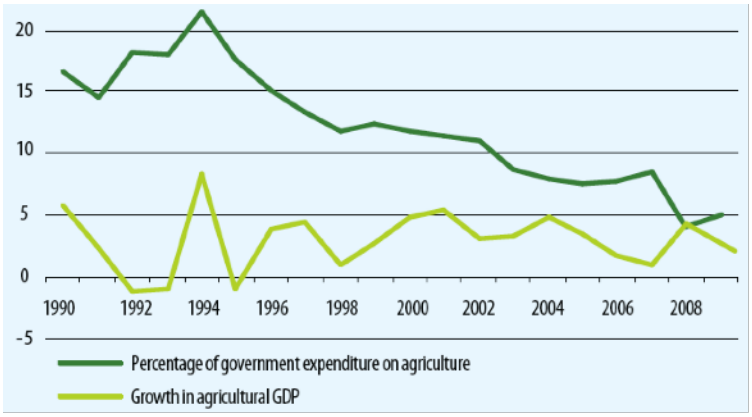
due to the fact that agriculture remains a high-risk venture. This vicious cycle of migrating in search of better opportunities, which the agriculture sector cannot provide, further marginalizes the sector particularly when migrants begin remitting, leading to higher local consumption levels. Figure 2.2 shows how remittance money is spent.



Source: CBS, 2011

Figure 2.2: Use of remittance income

It is clear that a very large proportion (82 percent) of the remittance is spent on daily consumption, 7 percent to repay loans, 5 percent towards household property investments and only 2 percent for capital formation, indicating that remittances do not bring any significant benefits, and may instead restrain agriculture development. In the same way, government expenditure on the sector has been decreasing during the past few years (see Figure 2.3). Much of the allocations for the sector are towards recurrent expenditures as opposed to capital expenditures, which are essential for ensuring growth and productivity. In 2009-2010, capital expenditure allocations were less than NPR 10 billion.



Source: WFP, 2009

Figure 2.3: Percentage of government expenditure on agriculture, and agricultural growth

Nepal was food self-sufficient and even exported food until the early 1980s. Over the past decades, however, the country has been experiencing food shortages. One of the major reasons for these is severe weather conditions like drought, floods, landslides, and hailstorms among others. Food grain trends in the past decades show positive growth in production except the years 2005, 2006 and 2007, when there was food shortage mainly due to weather conditions. In general, climate variability is one of the major causes of inconsistent crop yields and food production in the country. During the years 2008 and 2009, for instance, the total food grain deficit reached 132,916 mt, affecting nearly 700,000 people across the country (Dahal and Khanal, 2010). The deficit was highest in the mountain region (19 percent), followed by the hills (14 percent), whereas Terai had a surplus of 11 percent (MOAC, 2009).

Another reason for low productivity is land tenure and access. The average size of landholding is about 0.5 ha, and land is often fragmented in scattered parcels. About 45 percent of the farmers even have less than 0.5 ha and share only 13 percent of the total land (CBS 2004). Additionally, many of the areas lack adequate road infrastructure and transport that provide linkages to markets. The untenable small farm holding sizes and the lack of access are major constraints in improving the living conditions of farmers. For this, the government is advocating for the commercialisation of the sector to increase investments in the sector, and to connect production to demand markets.

Thus far, government efforts to boost the agricultural economy have focused on easing dependency on weather conditions, increasing productivity and diversifying the range of crops for local consumption. Solutions include the use of irrigation systems, chemical fertilizers and improved seed varieties as well as the provision of access to credit and technical advice. These strategies are based on two key policies: i) Agriculture Perspective Plan (APP), and ii) Agriculture Development Strategy, 2012.

The Agriculture Perspective Plan (APP) was developed in 1995 to improve agricultural productivity and production for the next 20 years. The APP promoted groundwater irrigation but power is a constraint with up to 14 hours of load shedding in a day. To date, irrigated areas form less than half (i.e., 48 percent) of the total cultivated area, and only a third (400,000 ha) of these irrigated areas have reliable irrigation. The rest are dependent on small, seasonal and oftentimes dysfunctional irrigation infrastructure. It aims to accelerate agriculture growth through increased productivity, commercialize agriculture through diversification and realization of comparative advantage, expand employment opportunities to improve living standards, alleviate poverty, and promote overall economic transformation. These are met through technology-based green revolution, production of high-value agriculture commodities, public policy and investment in human capital and in physical and institutional infrastructure, and recognition of complementarities of public and private investment and coordination in the country's approach to development.

KEY MESSAGES

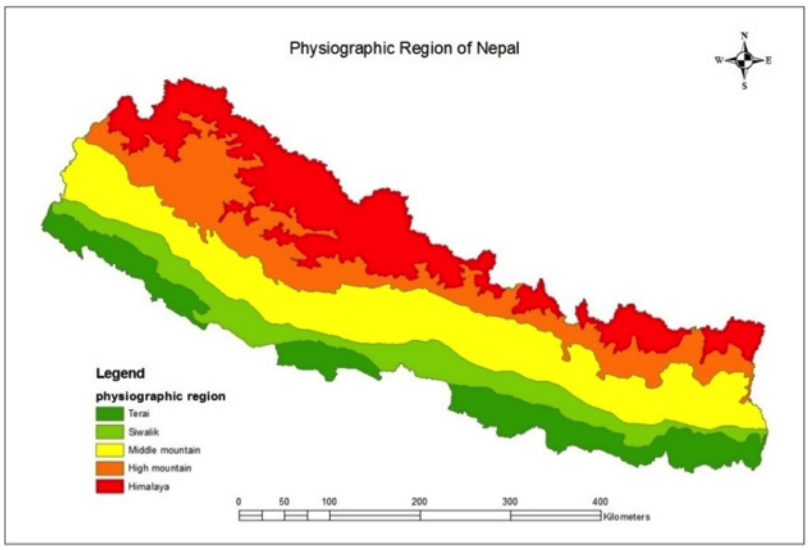
- The agriculture sector in Nepal continues to contribute significantly to the country's GDP and support 75 percent of the population.
- The sector, however, has low productivity and is not able to maximize on opportunities due to problems of migration and the resulting lack of skilled productive labour, the decade-long long conflict that only ended in 2006, the lack of (capital) investments, and concerns on land tenure and access to, or linkages with, markets.
- Some of the above issues (e.g., migration) are also caused by the lack of opportunities in agriculture per se: low productivity, for instance, could induce migration, and in turn further marginalize the sector.
- The revitalization of the sector is one of the major development goals of the Government of Nepal in order to reduce (rural) poverty and ensure food and nutrition security. However, this goal is yet to be seen and translated into resource allocation. There are currently very limited resources allocated and invested in the sector, consequently perpetuating agriculture's current low productivity status, as well as the regional development imbalances in the country.

CLIMATE PROFILE

This Chapter provides baseline information on climate, current and future climate hazards and related trends at national and regional levels.

NATIONAL WEATHER AND CLIMATE CONTEXT

The climate of Nepal varies according to the physiographic zone. Using Thornthwaite's model, Nayava (1975) classified the climates of Nepal into five namely tundra, taiga, microthermal, mesothermal and tropical. Figure 3.1 shows which physiographic region each of these five classes fall into.



Source: Department of Hydrology and Meteorology, Nepal

Figure 3.1: Physiographic regions of Nepal

In general, Nepal has three main climatic zones: the Himalaya and High Mountain in the North, the Middle Mountain in the Center, and the Siwalik and Terai in the South. Table 3.1 outlines the climate classification, precipitation and temperature of these zones.

TABLE 3.1: CHARACTERISTICS OF THE THREE CLIMATIC ZONES OF NEPAL

ZONE	CLIMATE	MEAN ANNUAL PRECIPITATION	MEAN ANNUAL TEMPERATURE
Himalaya/High Mountain	Arctic/Alpine	150 – 200 mm/snow	<3 – 10 0C
Middle Mountain	Cool/Warm	275 – 2300 mm	10 – 20 0C
Siwalik/Terai	Sub-tropical/Tropical	1100 – 3000 mm	20 – 25 0C

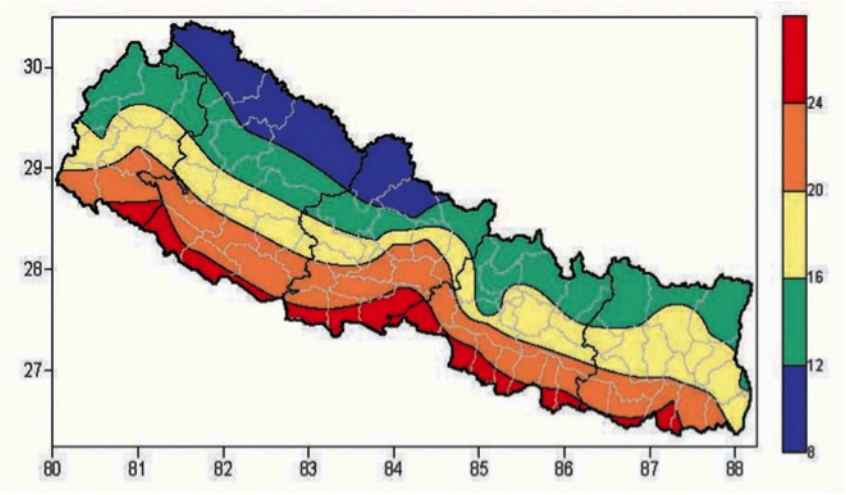
Source: WECS, 2005

The climate of Nepal is influenced by the Himalayan mountain range and South Asian monsoon. The country has four seasons: pre-monsoon (March to May), monsoon (June to September), post-monsoon (October to November), and winter (December to February) (MoEnv, 2010).

Temperature

Temperature is lowest during winter (December - January) and increases as spring advances due to increase in solar insolation. However, the arrival of monsoon rain increases the temperature so that May or (early) June are the hottest months. The temperature starts decreasing from October with December or January being the coldest months.

Apart from seasons, temperature is directly related to altitude and topography of the location. It varies from north to south, and decreases with altitude (see Figure 3.2). The Terai belt is the hottest while the high mountains or the Himalayas are the coldest in the country. Similarly, the mean maximum temperature in the Terai belt goes beyond 30 °C. This gradually decreases towards the north where altitudes are higher: about 26-30 °C in the Siwalik range, 22-26 °C in the middle hills, and below 22° C in the high hills and high mountains (Practical Action, 2009).



Source: Department of Hydrology and Meteorology, Nepal

Figure 3.2: Mean Temperature (^{0}C) over Nepal

Rainfall

Monsoon rainfall contributes about 80 percent of the country's annual rainfall, which is about 1800 mm per year. However, there are huge spatial and temporal variations in annual rainfall, from less than 150 mm in some parts to more than 5000 mm in others. For example, monsoon rains are most abundant in the east and decline westwards, while winter rains are high in the northwest and gradually decrease south- eastwards.

CURRENT CLIMATE VARIABILITY AND CLIMATE EXTREMES

For the most part, climate variability is driven by changes in the summer monsoon originating from the Bay of Bengal, by westerly disturbances coming from the Mediterranean Sea, and by thunderstorms. On the other hand, the onset and retreat of easterly monsoon is associated with the change in the direction of seasonal winds and the northward and southward shift of the Inter Tropical Convergence Zone (ITCZ). Nepal receives heavy precipitation when the position of ITCZ is close to the foothills of the Himalayas.

For the past century, important deviations from the average climate in Nepal have been observed. Data on intra-annual rainfall and monsoon rainfall for the years 1921-2010 show trends going from negative to positive deviations. Similarly, a study on dates of onset and withdrawal of monsoon for the period 1948-2011 reveal that the onset date is now later than the normal date of 10 June for a majority of the years, with the maximum delay being 18 days in 2009. The dates of withdrawal are also found to be later than the existing normal date of 23 September, the maximum delay being 25 days in 2008. Finally, the duration of the monsoon is found to be longer than normal with increasing trends in recent years, especially after 1990. Analysis show that the standard deviation of onset and withdrawal dates is 6 and 9 days respectively, while the standard deviation for duration is 11 days. These late onsets coupled with late withdrawals and longer durations suggest a general shift in monsoon activity.

Winter precipitation is brought about by the westerly disturbances originating from the Mediterranean Sea. The lows formed there are steered and swept eastwards by the westerly aloft. These disturbances bring snow and rain, during the winter season and most significantly, in the northwestern parts of the country. Indeed, winter precipitation contributes extensively to the annual total precipitation of Nepal's northwest region. It plays a major role in the mass balance of glaciers in western Nepal and a secondary role in the glaciers of eastern and central Nepal.

Climate Hazards and Extremes

Nepal is exposed to various climatic hazards such as floods, landslides, droughts, heavy rainfall, thunderbolts and snow avalanches among others.

Floods - Floods in Nepal are usually provoked by high intensity rainfall, continuous rainfall for several days, glacial lake outburst and landslide dam outburst. The middle mountain region of Nepal has experienced flash floods in the past, and the Terai has been affected by riverine floods more often than other areas (see Table 3.2). This is because high sediment loads from the mountain region are carried by the rivers and deposited in the plain areas of Terai where the river bed level rises resulting in the water outflanking the banks. Floods most often occur between June and September, when the summer monsoon is most active. Bursting of temporary lakes formed by landslides, and glacial lakes can also provoke flash floods. For example, Seti floods in Kaski district (Pokhara) occurred in the month of May, 2012 triggered by an avalanche/cloudburst.

TABLE 3.2: SPATIAL AND TEMPORAL VARIATION OF PEAK FLOOD FLOWS IN RIVERS IN NEPAL

TIME OF PEAK FLOWS	FLOOD MAGNITUDE	LOCATIONS
July-August	Low	Central to eastern high mountains, high Himalayas and eastern middle mountains
	Intermediate- High	Western-central areas
August	Low	Far western Nepal, eastern basins
	Intermediate- High	Higher elevation of eastern-central and eastern Nepal
August-September	Low-Intermediate	Central middle mountains

Source: Hannah et al, 2005

Landslides - Heavy rainfall also causes landslides particularly in the hilly areas. Indeed, landslides and slope failure are among the most common hazards in the country. Gullies, badlands and landslides are responsible for more than 90 percent of the losses in cultivated lands (Kienholz et al, 1983). These landslides occur through a mixture of climatic and non-climatic variables. For instance, the cultivation of slopes could increase soil moisture so that even small amounts, intensities and/or duration of rain could already trigger landslides. Already, an estimated 10 tons/ha of soil is eroded every year during the rainy season (Poudyal-Chhetri and Bhattarai, 2001).

Droughts - Droughts in parts of the country typically occur from the end of March through June, that is, until the arrival of the monsoon season. However, some parts of the Trans-Himalayan region are extremely dry throughout the year. Droughts are also more common in Terai and in the western hills. This has been confirmed in a study on climate change vulnerability mapping conducted by the Ministry of Environment (NAPA Nepal, Sept., 2010). The results show that the districts of hill and mountain ecological zone of Far and Mid-Western Development Region, and Terai ecological zone of Eastern Development Region are prone to drought risks.

Heavy Rainfall - Large amount of rainfall within a short period causes flash floods, massive landslides and soil erosion in the hilly and mountainous regions, as well as sedimentation and inundation in the plain areas. It must be noted that extreme rainfall distribution in the country is different from annual or seasonal distribution (see Figure 3.3). In particular, the Siwalik and Terai belts, which generally receive less total seasonal rainfall, actually have the highest 24-hour rainfall.

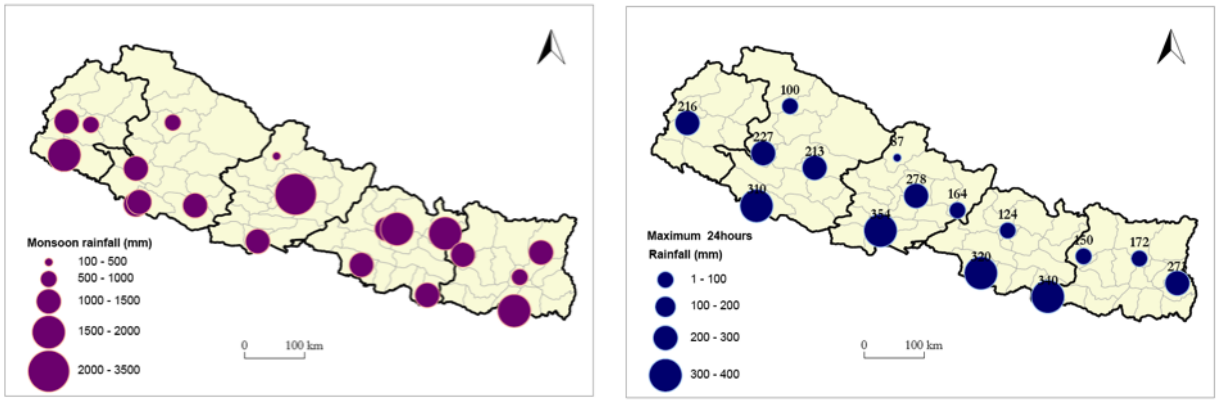


Figure 3.3: Spatial variability of monsoon (left) and extreme (right) rainfall in Nepal

The maximum 24-hour extreme rainfall recorded was in Hariharpur Gadi, Sindhuli (482.2 mm) on 20 July 1993. On the other hand, the highest extreme rainfall was in the foothills of Mahabharata and Siwalik in the central development region, and in the foothills of Siwalik in the western development region. These and the Terai of central and western development regions are, therefore, prone to landslide, flash flood and inundation.

Other Hazards - Other significant hazards that affect the country and/or its population include lightening, hailstorms, thunderbolts[1], snow avalanches, cold and heat waves, all of which also result in considerable loss of life and properties. Avalanche, heavy snowfall and unexpected hailstones occasionally destroy paddy, millet, wheat and maize resulting in food deficits in remote districts. Another observed hazard is glacial lake outburst flood (GLOF) brought about by the formation of glacial lakes at mountain tops. The latter is mainly due to the melting of snow and glaciers, which is also a consequence of rising temperatures.

OBSERVABLE CHANGES IN CLIMATE VARIABLES AND HAZARDS

Temperature

Records of the last 30 years indicate that temperatures in Nepal are increasing, and the warming seems to be consistent and continuous after the mid-1970s. Spatially, the warming is more pronounced at higher altitude regions of Nepal and significantly lower or lacking in the Terai and Siwalik regions. Temporally, warming in winter is more pronounced compared to other seasons. Long-term (current and previous decades) hydrological and meteorological data from the DHM indicate consistent warming and rise in maximum temperatures at an annual rate of 0.04 – 0.06 ^{0}C. Studies also confirm that the observed warming trend is not uniform across the country. Shrestha et al (1999) have analyzed the maximum temperature data from 49 stations in Nepal for the period 1971–94 and showed that there are warming trends after 1977, ranging from 0.06 to 0.12 ^{0}C yr^{-1} in most of the Middle Mountain and Himalayan regions, while the Siwalik and Terai (southern plains) regions show warming trends of less than 0.03 ^{0}C yr^{-1}. A more recent analysis of the maximum temperature data from 44 stations for the period 1976 to 2005 shows that the maximum temperature is rising with a trend of 0.04 ^{0}C yr^{-1}. While this is relatively less compared to the average warming of 0.06 ^{0}C/year during the years 1977–1994, the figure still suggests an increasing trend in mean annual maximum temperature for almost all parts of the country. On the other hand, the mean minimum annual temperature is in decreasing trend in the northern areas and in large portions of the mid-western and far-western development regions of the country, while most of the southern parts and eastern hilly parts of the country observed increasing trends. Finally, the annual mean temperature is increasing in almost the entire country (Practical Action Nepal, 2009).

Precipitation

Precipitation in Nepal is found to be influenced by, or correlated to, several large-scale climatological phenomena including El Niño Southern Oscillation (ENSO), regional scale land and sea-surface temperature changes and extreme events.

1 Existing records show that thunderbolt occurs during the pre-monsoon months of April, May and June, followed by floods and landslides, which are common during the monsoon season.

Analysis of the annual precipitation of 166 stations for the period 1976 to 2005 showed an increasing trend in annual precipitation except for the far-western and northern parts of western, central and eastern Nepal where there is a declining trend. A general decline in pre-monsoon precipitation is also seen in far- and mid-western Nepal despite a general trend of increasing pre-monsoon precipitation in the rest of the country (Practical Action Nepal, 2009). Similarly, there is an overall declining trend in monsoon precipitation in the mid-western and southern parts of western Nepal, with a few pockets of declining rainfall in the central and eastern regions. For the rest of the country, monsoon precipitation generally increased. On the other hand, post-monsoon precipitation is increasing in most of the mid-western and southern parts of eastern and central/western Nepal. Winter precipitation shows an overall increasing trend except for the northern part of mid-western, western and eastern Nepal.

Climate Hazards and Extremes

Each year, about 300 people in Nepal die due to climate-induced disasters. In addition, an estimated 80 percent of the total economic loss of disasters since 1970 (i.e., about USD 1,036 million) is due to climate-induced disasters (MoHA, 2009).

Heavy Rainfall - The cases of record-breaking extreme rainfall events in recent years point toward trends of their increased frequency. Figure 3.4 shows the number of extreme rainfall events for the period 1971 to 2001 for 14 selected stations in Nepal. These events include the 24-hour, 482.2 mm rainfall on 20 July 1993 at Hariharpur Gadhi, Sindhuli, and the one-hour, 95.4 mm rainfall on 16 September 2011 at Gulariya, Bardiya.

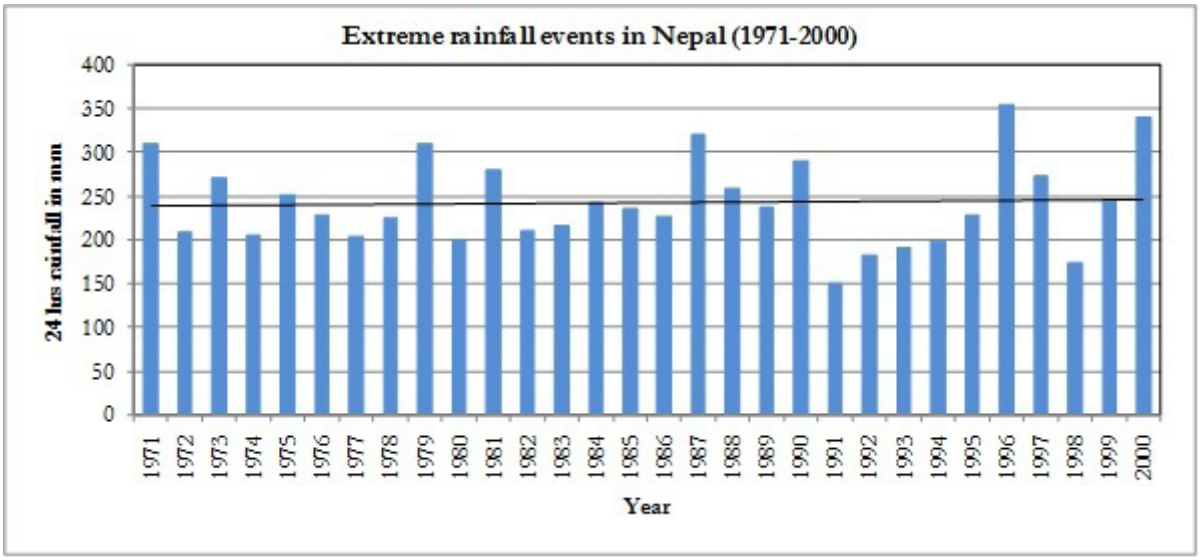


Figure 3.4: Extreme rainfall events in Nepal from 1971-2000 (14 selected stations)

Glacial Retreat and GLOFs - The shrinking of glaciers in the Himalayas and the formation and expansion of glacial lakes are some of the indicators of global warming. The Rika Samba, Lirung, and Khumbu glaciers are retreating at an alarming rate while the formation of glacial lakes has become relatively common due to rapid melting of glaciers. The Imja, Tsho Rolpa, Thulagi and Barun glacial lakes are expanding. The increasingly visible glacial shrinking and the formation of lakes have led to a number of GLOF events over the past few decades. The occurrence of GLOF implies that there is indeed some warming happening. It also means that the overall pattern of risks is changing.

PROJECTED CLIMATE TRENDS

General Circulation Models (GCMs) run with the SRES B2 scenario show the mean annual temperature to increase by an average of 1.2 ^{0}C by 2030, 1.7 ^{0}C by 2050 and 3 ^{0}C by 2100 compared to a pre-2000 baseline (refer to Table 3.3).

TABLE 3.3: GCM ESTIMATES OF TEMPERATURE AND PRECIPITATION CHANGES FOR NEPAL

YEAR	TEMPERATURE CHANGE (°C) MEAN (STANDARD DEVIATION)			PRECIPITATION CHANGE (%) MEAN (STANDARD DEVIATION)		
	ANNUAL	WINTER (DEC-FEB)	MONSOON (JUN-AUG)	ANNUAL	WINTER (DEC-FEB)	MONSOON (JUN-AUG)
Baseline Average				*1433 mm*	*73 mm*	*894 mm*
2030	1.2 (0.27)	1.3 (0.40)	1.1 (0.20)	5.0 (3.85)	0.8 (9.95)	9.1 (7.11)
2050	1.7 (0.39)	1.8 (0.58)	1.6 (0.29)	7.3 (5.56)	1.2 (14.37)	13.1 (10.28)
2100	3.0 (0.67)	3.2 (1.00)	2.9 (0.51)	12.6 (9.67)	2.1 (25.02)	22.9 (17.89)

Source: OECD, 2003

Table 3.3 shows higher temperature increments during winter compared to the monsoon seasons. As per the Fifth Assessment Report (AR) of IPCC, GCM projections indicate a temperature increase between 0.5 ° C and 2.0°C with a multi- model mean of 1.4°C by the 2030s. Additionally, extremely hot days and nights (the hottest 5 percent of days and nights in the period from 1970 to 1999) are projected to increase by up to 55 percent by the 2060s and up to 70 percent by the 2090s.

There is also a projected overall increase in annual precipitation, with relatively more pronounced increase during the summer monsoon months of June, July and August. IPCC's Fifth AR projects a wide range of precipitation changes, especially during the monsoon: from a decrease of 14 percent to an increase of 40 percent by the 2030s.

In another study, Karmacharya et al (2007) ran the RegCM3 regional climate model over the South Asian domain for the base period 1961-1990, and the mid-21st century (i.e., 2039-2069) using ECHAM5 GCM dataset for A2 scenario. Focusing on mean temperature and precipitation, the authors analysed spatial distribution, area average comparison and annual cycle comparison. Table 3.4 shows some of the study results, which indicate warming in all the seasons during the mid-21st century compared to the base period. Their analysis found that warming is higher in the northern part over high Himalayas than in the south. Moreover, warming is highest during winter and minimum in the pre-monsoon season for west and east Nepal.

TABLE 3.4: CLIMATE CHANGE IN 2039-2069 COMPARED TO BASE LINE 1961-1990

SEASON	TEMPERATURE CHANGE °C		PRECIPITATION CHANGE (%)	
	WEST	EAST	WEST	EAST
Winter	2.2	2.1	-0.6	-9.6
Pre-monsoon	1.7	1.8	1.0	-2.1
Monsoon	2.1	1.9	-8.4	-18.1
Post-monsoon	2.2	2.0	5.7	-5.9
Annual	2.0	1.9	-4.1	-13.2

Source: Karmacharya et al, 2007

The study also found a decrease in precipitation in eastern Nepal for all seasons and significant increase in the southwestern and northwestern parts during the monsoon and pre-monsoon seasons. On the other hand, the annual cycle analysis shows the peak delay in precipitation (by one month) in western Nepal.

Finally, a more recent study by NCVST (2009), which used General and Regional Circulation Models projects the mean annual temperature to increase by 1.4 ^{0}C by 2030, 2.8 ^{0}C by 2060 and 4.7 ^{0}C by 2090. Higher increments in temperature are also projected over western and central Nepal compared to eastern Nepal for the years 2030, 2060, and 2090, with projections for western Nepal being greatest. Similar trends are projected for the frequency of hot days and nights for 2060 and 2090. The outputs suggest that extremely hot days (the hottest 5 percent of days in the period 1970-1999) are projected to increase by up to 55 percent by 2060 and 70 percent by 2090. In the same way, extremely hot nights (the hottest 5 percent of nights in the period 1970-1999) are projected to increase by up to 77 percent by 2060 and 93 percent by 2090.

Meanwhile, GCMs project a wide range of precipitation changes, especially in the monsoon: -40 to +143 percent by 2030, increasing to -52 to 135 percent by 2090 (see Table 3.5).

TABLE 3.5: PRECIPITATION PROJECTION FOR NEPAL

YEAR	ANNUAL MEAN RAINFALL		MONSOON RAINFALL	
	MULTI-MODEL MEAN	RANGE	MULTI-MODEL MEAN	RANGE
2030	0 %	-34 to 22 %	2 %	-40 to 143 %
2060	4 %	-36 to 67 %	7 %	-40 to 143 %
2090	8 %	-43 to 80 %	16 %	-52 to 135 %

Source: NCVST, 2009

The NCVST (2009) projections show no precipitation change in western and up to 5-10 percent increase in eastern Nepal for winter. During the summer months, precipitation is projected to increase for the whole country in the range of 15 to 20 percent. On the other hand, a regional circulation model study projects both rise and decline in mean annual precipitation with no clear trends. In terms of spatial distribution, the study projects an increase in monsoon rainfall in eastern and central Nepal compared to western Nepal. Further, the projections indicate an increase in monsoon and post-monsoon rainfall, an increase in overall intensity of rainfall, and a decrease in winter precipitation.

CLIMATE AND HAZARD INFORMATION AT NATIONAL AND REGIONAL LEVELS

A relatively complete picture of current and future climate hazards and trends can be obtained from the database of, and the various studies conducted by, the Ministry of Environment (Ministry of Environment, 2010). Thus far, the main driving factors and the general characteristics of Nepal's climate variability are well understood. Similarly, the main zones of influence are known for key hazards such as extreme temperature, intense rainfall, floods, landslides, droughts and GLOFs. Recent and robust climate projections are also available using temperature and rainfall as parameters. Nevertheless, important capacity and knowledge gaps remain. Past weather data remains patchy. For example, the temperature data used in the analysis by Practical Action Nepal Office (2009) relies on only 44 weather stations located mostly in the middle mountain region since many stations have not recorded data continuously for a sufficiently long period. Indeed, continuous data is only available for a few decades making it difficult to discern current climate trends with certainty. In addition, there is no data available from the Himalayan region. There is also no national data available on snow and glacier mass balance.

Nepal's early warning systems are also in their very early stage of development. However, some initiatives like formation of network of institutions working on EWS in the lead of DHM have been able to expand coverage of EWS in Nepal. The Department DHM does not have computational tools and models nor the experts to model and analyse risks. Because of this, return periods for extreme events have only been calculated in a few cases. Climate projections rely mainly on GCMs with a coarse resolution of 250x250 km and cannot project changes in hydrological cycles at regional scales. Regional climate models have not been used extensively in the

region as they are still being tested and developed. As a result, local projections are uncertain, particularly for rainfall, where spatial variations are high. The hilly landscape of Nepal exacerbates this problem, since changes in atmospheric circulation can induce large variability at the local scale. Furthermore, a large part of the rainfall in Nepal is occurring in the context of summer monsoon, which may not be well captured by current climate models. This gets even more difficult with projections of extreme events.

While some of the gaps (e.g., climate models) need to be addressed at the international level, Nepal also needs to invest for instance in better equipped weather stations and climate experts of its own.

KEY MESSAGES

- Due to its geophysical location, there are extreme spatial and temporal climate variations in Nepal, from Tropical to Arctic in a span of only about 200 km.
- The major drivers of climatic conditions in the country include the South Asian Summer Monsoon and Western disturbances from the Mediterranean Sea. These regional climate drivers are also influenced by ENSO.
- Some of the key hazards affecting Nepal are droughts, floods, landslides, GLOF, hailstorms, lightening, snow avalanches, cold and heat waves, all of which result in considerable loss of life and properties.
- Early warning system for various sectors such as agriculture, climate change induced disasters such as floods, landslides, drought etc. tourism sector trekking/hiking etc. is needed to be developed and strengthened.
- There are already noticeable variations in the onset, withdrawal and duration of the summer monsoon rains.
- Climate models also project further changes such as the rise in temperature and summer monsoon rainfall. Temperature increases are expected to be greater for the Himalayan and mountain regions of central and western Nepal, and particularly pronounced during winter. On the other hand, rainfall projections indicate an increase in the intensity of rainfall and a decrease in winter precipitation, potentially increasing the risks of landslides, floods and GLOFs. However, these models need to be downscaled for better analysis and results.
- While there is available data including studies focusing on climate change in Nepal, there are still important capacity and knowledge gaps in generating and managing weather/climate information. To date, the network of weather stations remains sparse; there is very limited continuous data series available; and knowledge and expertise are rather dispersed among various institutions.

CLIMATE RISKS AND IMPACTS ON AGRICULTURE

This Chapter outlines the linkages and trends between climate and development, highlighting the impacts of climate-related risks particularly on the agriculture sector.

PAST CLIMATE CHANGE IMPACTS

From 1971 to 2006, more than 25,000 people were killed and another 4.7 million were affected in disaster events of all types (see Table 4.1). Direct losses of more than USD 150 million were reported.

TABLE 4.1: DISASTER LOSSES IN NEPAL (1971 -2006)

EVENTS	DEATH	INJURY	PEOPLE AFFECTED	BUILDINGS DESTROYED	LAND LOSS (HA)	LIVESTOCK DEATH	REPORTED DIRECT LOSS (M USD)
Drought	1	-	1,512	-	329,332	-	0.1
Earthquake	873	6,824	4,539	33,710	-	2,257	0.8
Epidemic	15,529	37,773	323,896	-	1	78	0.0
Fire	1,081	735	218,128	62,634	352	113,922	70.2
Flood	2,862	349	3,315,781	70,115	196,955	31,117	41.7
Forest Fire	24	13	10,718	1,698	3,173	82	11.6
Landslide	3,899	1,188	480,069	16,799	21,797	9,046	9.4
Other	2,385	2,670	360,725	3,917	290,323	79,935	22.8
Total	26,656	49,570	4,715,828	188,875	841,954	236,459	156.0

Source: MoHA and DPNeT, 2010

Although not as huge as fire, climate-related hazards like floods, landslides, forest fires and droughts are among those that impact the country significantly.

Floods - Flood is one of the most frequent and prominent disasters in Nepal. From 1954 to 2002, floods affected over a million people in the country, killed 5,003 (i.e., 24 percent of deaths from all disasters), left almost 70,000 homeless (45 percent) and resulted in damages amounting to USD 990,613 (75 percent) (Vivian, 2003 in Alam and Regmi, 2004). About 32 flood events have been reported during the last three decades (i.e., 1980-2010). Indeed, floods of different scales occur annually in a number of locations in Nepal, and pose greatest risk to life and property. During the years 1996-2009, floods affected 314,412 families, caused the deaths of 2,147 people and 8,120 livestock, destroyed 70,251 houses, and brought an estimated USD 57.7 million worth of damages (MoHA and DPNET, 2009). Rural flooding, on the other hand, damages crops and properties, and causes inundation, soil erosion, siltation and debris deposit on agricultural land potentially making it uncultivable.

Landslides - Data from the National Society for Earthquake Technology shows that during the years 1971-2006, landslides killed over 3,500 people, affected over 400,000 and caused over USD 22 million in damages. In 1993 alone, more than 2,000 landslides occurred along highways and mountain slopes. Similarly, a string of landslides (nearly 20 incidents) in 2007 caused widespread disruption by killing 43 people, injuring 46 and affecting nearly 4,250 families across many districts of the country. Petley et al. (2007) suggest that there has been an increase in landslide events in recent years (e.g., 1995–2003) than in the period 1960-1994 due to such factors as increased road construction activity, among others.

Fires - Fire disasters occur during the dry season (February to May) impacting forests and biodiversity in all physiographic regions of Nepal. Annual loss from fire disasters is estimated to be approximately USD 2.79 million. From 1993 to 2003, about 959 people died and about 60,243 houses were destroyed. In particular, a severe fire in 2003 affected 1,162 families and caused USD 8.25 million in losses (MoHA, 2008).

Droughts - In general, MoHA's disaster datasets fail to capture the full range of impacts caused by droughts. Because of this, the government's views and priorities are mostly oriented towards floods and other climate-induced hazards. But from a livelihoods perspective, and with 75 percent of the people depending on agriculture, the impacts and losses are intensified. Below is an outline of the risks and impacts of droughts on the agriculture sector in particular, and on the community and/or country's economy in general.

Drought Impacts

Table 4.2 outlines the causes of, regions affected, and the crop production loss brought about by some of the more significant droughts in the country.

TABLE 4.2: IMPACTS OF VARIOUS DROUGHTS IN NEPAL

YEAR	CHARACTERISTICS OF RAINFALL	REGION AFFECTED	MAJOR CROP* LOSS IN TONNES
1972	Late onset	Eastern and Central	333,380
1976	Poor distribution during September	Western	218,480
1977	Late onset	Eastern and Central	322,320
1979	Late onset	Western	544,820
1982	Late onset	Eastern	727,460
1986	Poor distribution during August and September	Western	337,410
1992	Late onset	Eastern	917,260
1994	Poor distribution	All region	595,976
1997	Poor distribution	Eastern	69,790
2002	Poor distribution		83,965
2006	Poor distribution during July and August	Eastern and Central	774,884
2008**	Poor distribution of rainfall during Nov 2008 to Feb 2009	All region	56,926
2009 2012+	Late onset Late onset. Long dry Spell	Eastern and Central	499,870 757,629

**Iincludes paddy, maize, millet and wheat; **Winter drought*

+ Poor summer monsoon due to late onset and long dry spell during growing season caused crop loss (Source : Ministry of agriculture and FAO WFP crop situation joint assessment report 2012)

Source: Adapted from Nayava, 2008

An estimate of impacts between 2000-2010 shows that floods affected 2,097,434 (14 percent) people while landslides impacted 366,884 (3 percent) (EMDAT, 2013). In contrast, droughts resulted in production loss of 1,725,416 tonnes, thereby affecting about 12,077,912 people -- an overwhelmingly large number of people compared to hazards like floods and landslides[2]. The following cases illustrate the causes and impacts of some of the more recent droughts – summer drought 2006, winter drought 2008 and summer drought 2009.

BOX 1. CASE STUDY 1 – CAUSE AND IMPACTS OF SUMMER DROUGHT 2006

Cause: The variations in spatial and temporal patterns of rain were the main cause of the drought. Although the monsoon started earlier, rain intensity was weak with below normal precipitation and dry conditions in the districts of Saptari, Siraha, Dhanusa and Udayapur. By July, the Eastern, Central and Western regions received 40 percent less than normal precipitation (Figure 4.1). August was a particularly dry month with the entire country facing a lack of rain. Exceptions to this general pattern were areas in the Far- and Mid-Western regions, which received more than 180 percent of normal rainfall. Indeed, heavy rainfall on 27 August caused floods and landslides in the Western, Mid-western and Far-Western districts. It was only in September and October that precipitations returned to normal or above normal in most parts of Nepal.

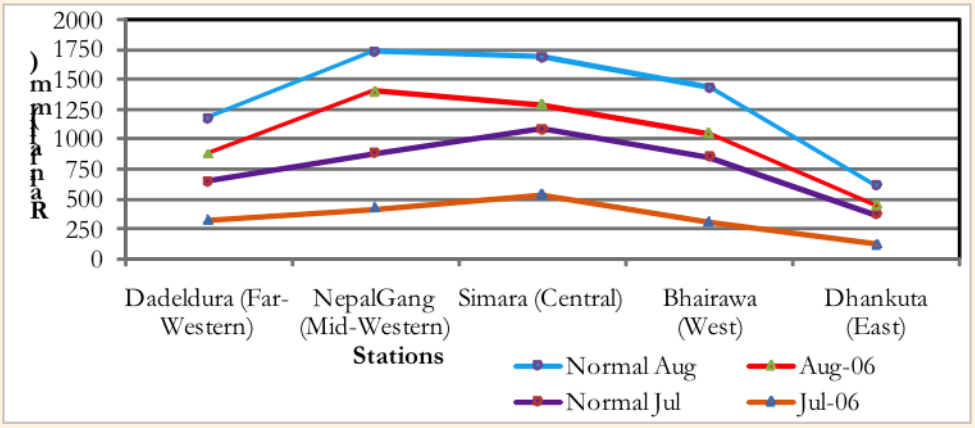


Figure 4.1: Rainfall change in July and Aug 2006 from Normal

Impacts. Paddy was the most affected crop. This is because paddy is generally transplanted in June/July and harvested in October/November. A delay in the monsoon, or a dry spell at planting time, as what happened in the summer of 2006, can significantly affect the area planted and the production output. Overall, paddy production declined by 13 percent, with some of the most affected districts reporting a decline of as much as 46 percent compared to the average of the previous five years. Water shortage during the transplanting season resulted in late planting and in some lands left fallow, particularly in Eastern Terai (FAO and WFP, 2007).

2 The figure is based on the assumption that at least 7 persons are affected for each tonne of production loss.

BOX 2. CASE STUDY 2 – CAUSE AND IMPACTS OF WINTER DROUGHT 2008

Cause: Rainfall data from DHM's 35 stations indicated an average of more than 50 percent reduction from November 2008 to February 2009 (see Figure 4.2).

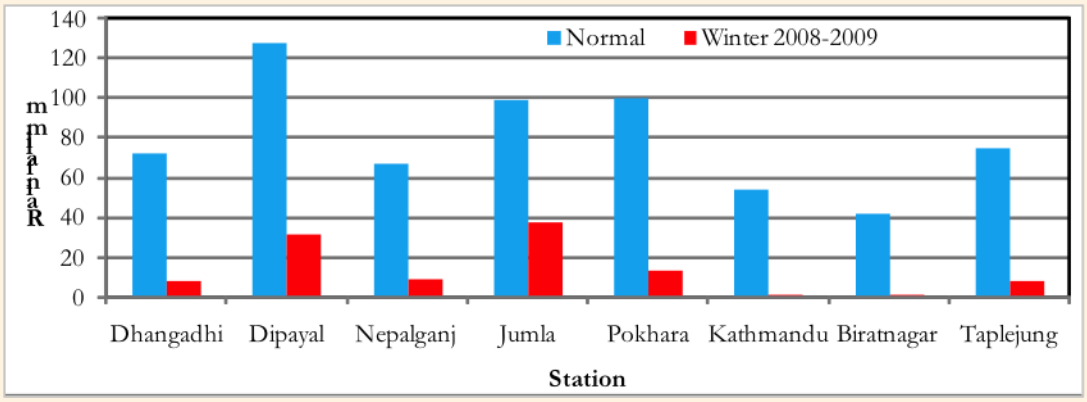


Figure 4.2: Normal versus winter (Nov 2008–Feb 2009) rainfall in selected stations

Impacts: Crop production was heavily affected especially wheat and barley, which declined 14.5 and 17.3 percent respectively compared to 2007/2008. Crop production in the Mountain, Hill, and Terai districts decreased by 40, 25 and 10 percent respectively. The most affected food production areas were predominantly in the Hill and Mountain regions, and in districts with (rain-fed) crops that rely heavily on rains due to a lack of (or minimal) irrigation. These include districts in the Mid-Western Mountains (50 percent average loss in wheat), Far-Western Mountains (46 percent) and the Far-Western Hills (36 percent) (MAC, WFP and FAO, 2009).

BOX 3. CASE STUDY 3 – CAUSE AND IMPACTS OF SUMMER DROUGHT 2009

Cause: The 2009 monsoon was significantly delayed. It started on 23 June and became active only after 25 July. It remained active until 15 October, extending the retreat period by more than 20 days. This was in contrast to the normal monsoon start of 10 June and being active until 23 September. Because irrigation is only available in about one-third of the cultivated area, most summer crops rely heavily on rain for irrigation so that June and July are critical months for planting. The amount of rain was considerably low compared to previous years (see Figure 4.3), even lower than in 2006 when the country experienced one of the poorest summer harvests on record (DHM).

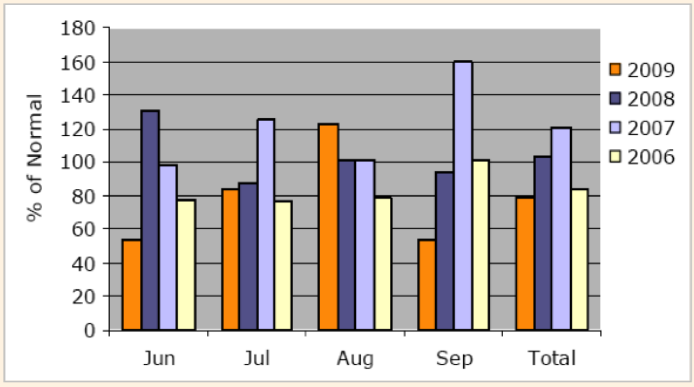


Figure 4.3: Monsoon rainfall over Nepal from 2006 to 2009

BOX 3 CONTINUED

By October 4-8, there was excessive rain, causing floods and landslides in the Mid- and Far-Western districts. Indeed, the total amount of rainfall during those four days exceeded the total monthly rainfall in some areas. Weather stations of Sundarpur and Dipayal in the southwest corner of the Far-Western Region recorded 1000 percent of the normal rainfall for the month. Many districts in the Mid- and Far-Western Regions including Banke, Bardiya, Kanchanpur, Kailali, Dadeldhura, Doti, Achham, Bajura, Darchula, Bajhang, Jumla, Dailekh, Dang, Jajarkot, Rukum, Rolpa and Pyuthan received excessive rainfall, considerably damaging summer crop production.

Impacts: The late onset of monsoon affected paddy adversely. Planting occurred only in 95 percent of the areas and farmers had to plant mature seedlings especially in the hills and mountains, resulting in low paddy productivity. The Ministry of Agriculture Cooperation (MOAC) estimates paddy production was reduced by half a million MT (i.e., 11 percent decline) compared to 2008. Production of maize, the second largest crop, declined by 4 percent while millet increased by 2.3 percent. The increase, however, was not large enough to compensate for the losses from paddy and maize due to the very small share of millets (about 4 percent) to national cereal production. In general, productivity in 2009 was reduced by more than 6 percent (MAC and WFP, 2010).

FUTURE RISKS AND IMPACTS

A warming trend, which is particularly more pronounced in the higher altitudes, is already observed in the past decade. Increased temperatures in these altitudes have led to the retreat of glaciers, hence the reduction of dry season flows of rivers fed by glacial melt. Warming has also increased the size and volume of glacial lakes, potentially increasing the risks of GLOFs. Unfortunately, projections suggest that the trends will possibly continue in the coming years due to global warming. Climate models also show an increase in monsoon intensity that will likely change river flows (OECD, 2003). The likely future climate change scenario and its potential impacts are shown in Table 4.3

TABLE 4.3: FUTURE CHANGES IN CLIMATE, AND THEIR IMPACTS

FUTURE CLIMATE CHANGE	IMPACTS
Increased temperature	• Significant increase in volume (and size) of glacial lakes at higher altitudes • Pest outbreaks impacting the agriculture sector • Vector outbreaks that lead to human health issues
Reduction of monsoon precipitation in Eastern Nepal	• Prolonged periods of drought (seasonal and localised) leading to: - Agricultural and horticulture crop production loss in the Terai - Hydro-power supply loss - Changes in land use - Changes in livelihood opportunities - Increased pressure on already limited resources (e.g., charcoal production) - Health issues - Ecosystem and wildlife change - Water security concerns
Increased Precipitation (while average precipitation is expected to decrease, extreme events could increase)	• Flooding in North and Western Nepal leading to: - Landslide and soil erosion - Crop damage - Pest outbreaks - Vector outbreaks
Increased evaporation	• Reduction in annual length of growing period

Source: DANIDA, 2008

As mentioned, increased temperatures help aggravate GLOFs. Indeed, ice avalanches triggered by rising temperatures constitute nearly 50 percent of GLOF events in the Himalayas. Richardson and Reynolds (2009) also suggest that the frequency of GLOFs increases during the monsoon season. In addition to these, the Himalayan environment is prone to earthquakes, dam breaks and break away of hanging glaciers, all of which increase the risks of GLOF events.

AGRICULTURE VULNERABILITY TO CLIMATE HAZARDS

The average yield of paddy in Nepal is 2,750 kg/ha as of 2008, and the annual yield of maize and wheat is 2,250 kg/ha. Droughts in the country are typically due to intra-seasonal monsoon variations such as late onset, long dry spells, and intensive rainfall spells after long dry spells, all of which lead to crop losses. But despite the losses, existing data and statistics fail to adequately capture crop sensitivity to climate variability and change.

Climate Sensitivity

In view of the above, an attempt was made to assess intra-seasonal variation and its impact on crop production. The analysis reveals that from 2000 to 2009, an average 70,000 ha of paddy crop area is affected by droughts annually and in extreme years like 2006, the affected area goes up to 270,000 ha. This means that every year, at least some districts are affected by droughts. On the other hand, more widespread (i.e., nationwide) droughts occur once every five to seven years. Table 4.4 presents the outcomes of a climate sensitivity analysis for five major crops planted in various districts. For paddy, the coefficient of variation (CV) for the majority of districts (58 percent) is 10-15 percent. This means that yields vary between 10-15 percent from the mean. Maize is more variable with more districts (i.e., 46 and 32 percent) having yields that vary between 10–15 and 15–20 percent. The case is relatively similar for wheat and barley where yields for the majority of districts fall between the 10-20 percent range. On the other hand, millet is more resilient with most districts (62 percent) having less than 10 percent CV. These results indicate that some crop yields are indeed more variable than others in particular districts and less in other districts.

TABLE 4.4: VARIABILITY OF DISTRICT-LEVEL AVERAGE CROP YIELDS

DISTRICT-LEVEL COEFFICIENT OF VARIATION IN MEAN YIELD	PADDY	MAIZE	MILLET	WHEAT	BARLEY	TOTAL
<10%	23%	15%	62%	4%	26%	26%
[10% to 15%]	58%	46%	30%	30%	40%	41%
[15% to 20%]	13%	32%	6%	51%	31%	26%
> 20%	6%	6%	3%	15%	3%	7%
Total Districts	100%	100%	100%	100%	100%	100%

Source: MOAC, 2007 cited in World Bank, 2009

Indeed, different regions of Nepal have varying susceptibilities to climate due to their different agro-climatic context. Table 4.5 builds on the data from Table 4.4 and provides specific values of exposures for nine different crops in three different regions, including a total for the country. The total value of crops exposed to climate sensitivity is around NRS 106 billion (US$ 1.5 billion).

TABLE 4.5: TOTAL VALUES AT RISK FOR 100% YIELD COVERAGE LEVEL (NRS. MILLION)

CROP	MOUNTAINS	% OF VALUES	HILLS	% OF VALUES	TERAI	% OF VALUES	TOTAL NEPAL	% OF VALUES
Paddy	1,358	1.3%	10,800	10.2%	32,394	30.6%	44,551	42.1%
Maize	1,566	1.5%	12,344	11.7%	3,503	3.3%	17,413	16.5%
Millet	509	0.5%	1,973	1.9%	76	0.1%	2,558	2.4%
Wheat	870	0.8%	5,213	4.9%	10,610	10.0%	16,693	15.8%
Barley	66	0.1%	23	0.0%	0	0.0%	89	0.1%
Oilseed	16	0.0%	316	0.3%	1,644	1.6%	1,977	1.9%
Potato	2,217	2.1%	7,383	7.0%	8,863	8.4%	18,463	17.5%
Tobacco	0	0.0%	0	0.0%	225	0.2%	225	0.2%
Sugarcane	0	0.0%	0	0.0%	3,831	3.6%	3,831	3.6%
Total	6,603	6.2%	38,052	36.0%	61,145	57.8%	105,800	100.0%

Source: MOAC, 2007 cited in World Bank, 2009

Data shows that climate risks could cost the country a total loss of 42 percent of the paddy crop followed by potatoes at 17.5 percent, maize and wheat at 16.5 percent and 15.8 percent respectively. Delayed onset of monsoon has also been affecting crop production while some harvesting seasons have been badly hid by the heavy rainfall and hailstorm. Since paddy is the most climate sensitive crop, analysis was made to assess the impact of intra-seasonal variation (e.g., late onset of rains, long dry spells and early withdrawal of monsoon) on paddy for the years 2001–2010. Analysis estimates the total risk from weather exposure at USD 753 million, about 30 percent of which is due to extreme events during the years 2006 and 2009, which resulted in as much as USD 229 and USD 125 million in production loss respectively (see Figure 4.4).

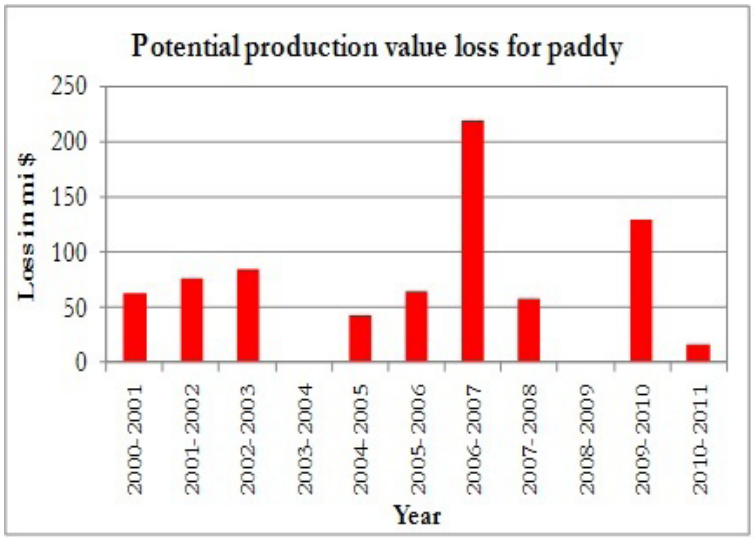


Figure 4.4: Paddy production value loss from 2001 to 2010

During the last decade, the estimated annual loss due to climate variations on intra-seasonal scales is therefore USD 75.3 million[3].

3 In the last 10 years, 2 had extreme events resulting in USD 350 million loss, and another 6 years were normal but even the weather variations during those years caused USD 404 million in damages for an accumulated total loss of USD 753 million for the decade, or an average of USD 75.3 million/year.

Production Loss, Economy and Food Security

It must be noted that the impacts of climate risks like droughts do not have spatial, temporal and sectoral boundaries. Rather, they extend beyond the (agriculture) sector, beyond the season and the area with which the drought occurred. For instance, droughts in one season could continue to cause crop losses in subsequent years despite normal monsoon as elements like water and soil need to recover. Similarly, crop losses contribute towards national loss both in terms of income and food security. Figure 4.5 shows how GDP growth rate is influenced by the rise and/or fall in agricultural growth rate. This is because the sector continues to contribute significantly to the country's GDP.

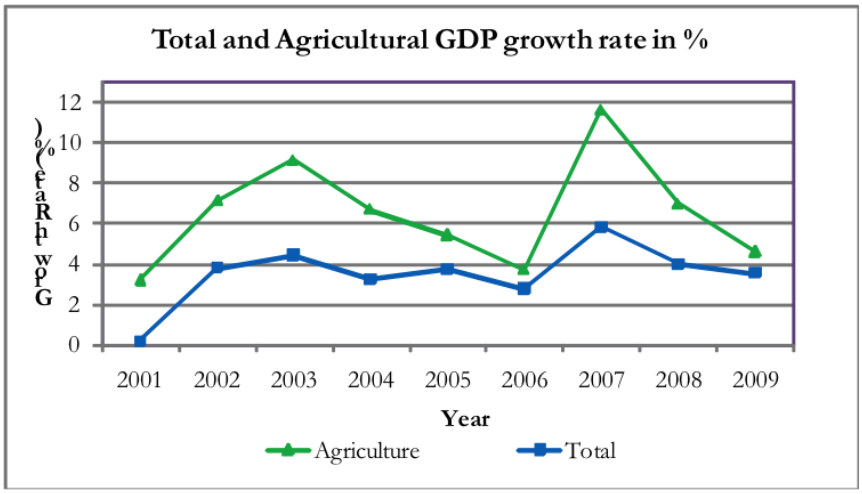


Figure 4.5: Total and agricultural growth rate in Nepal from 2001 to 2009

Food production loss is directly tied to food shortages and inflation. Indeed during the 2008 winter drought, almost 50 percent of the districts had food deficits ranging from 5 percent to 29 percent resulting in increased food prices. For some remote regions, the food price inflation went up to 177 percent. The stresses associated with such food insecurity forced households to resort to distress coping strategies in the far and mid-western, as well as in the hill regions of the country (MAC, WFP, FAO, 2009).

ADAPTIVE CAPACITY

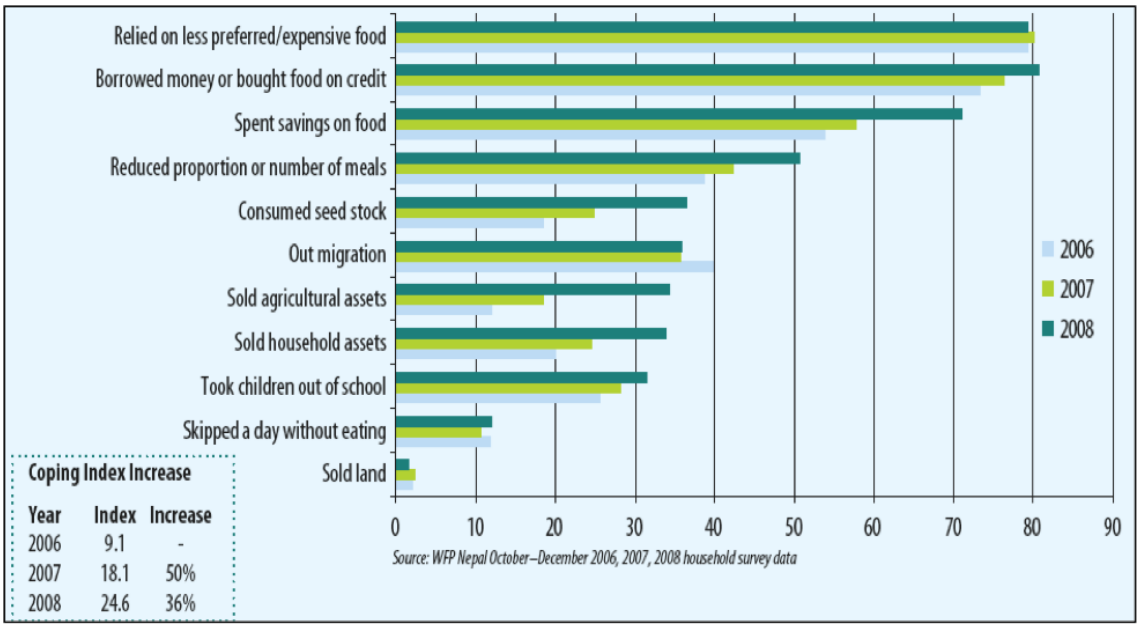
The vulnerable groups in Nepal make up more than 9 million people, many of whom depend heavily on agriculture for livelihood (see Table 4.6).

TABLE 4.6: VULNERABLE GROUPS IN NEPAL

VULNERABLE GROUP	NUMBER OF PEOPLE	SHARE OF POPULATION IN REGION (%)
Marginal farm households* in the Mountains	691 100	45
Marginal farm households* in the Hills	3 415 600	35
Marginal farm households in the Terai	2 644 000	48
Agricultural labour households in the Terai	934 054	4N
Rural service castes	1 337 667	6 N
Porters	167 498	1 N
Urban poor involved in the informal economy in the Kathmandu Valley	8919	0 N
Total vulnerable population	9198838	38

**Including landless labourers and sharecroppers; [N] – % share of national population*
Source: ADED, 2004

These vulnerable groups resort to a number of risk management strategies at the individual and community level including changing expenditure and consumption patterns, borrowing money and food, selling assets, intensifying use of common property resources, changing livelihoods and/or migrating for paid employment, as well as changing social identities (ADED, 2004). Figure 4.6 shows some of the more common coping mechanisms that these population groups use.



Source: WFP, 2009

Figure 4.6: Increase in coping (October—December 2006, 2007 and 2008)

During the years 2007and 2008, the coping index increased by 50 percent and 36 percent respectively compared to the 2006 baseline, indicating some of the (rather delayed) impacts of drought 2006. In other words, distress coping continued despite a normal monsoon in 2007, which meant the impacts of the 2006 drought lingered, and that recovery was slow. Then before people could recover, another drought in 2008 aggravated the distress, considerably weakening the adaptive capacities of affected populations. Even if non-farm income and remittances helped enhance the capacities of Nepalis, these resources were insufficient during climate shocks due to the drastic reduction in farm income. Non-farm remittances could not compensate the loss and income shortfall of farm incomes, which constitute around 50 percent of typical total incomes of households. Because of this, people migrate making periodic climate shocks as one of the impetuses for outmigration, and the consequent further marginalization of the sector.

CLIMATE THREATS TO KEY DEVELOPMENT OUTCOMES

Climate variability and change processes have a close association with development processes at country and community level. Climate-related risks and impacts have a close bearing on achievement of Millennium Development Goals (MDGs) in many countries and more so in a developing context like that of Nepal. These directly impact the achievement of MDG 1 and MDG 7 as explained in the figure 4.7 below:

Millennium Development Goals		CLIMATE CHANGE RISKS
MDG 1 	Eradicate extreme poverty and hunger	**Depleted livelihood assets**, reduced economic growth, and **undermined food security**.
MDG 2 	Achieve universal primary education	**Reduced ability of children to participate in full-time education** by loss of infrastructure, livelihoods (forcing children to work), and displaced families.
MDG 3 	Promote gender equality and empower women	**Additional burdens on women's health** and time to participate in decision-making and income-generating activities.
MDGs 4 5 6 	Reduce child mortality; Improve maternal health; Combat HIV/AIDS, malaria and other diseases	**Greater prevalence of vector- and water-borne diseases**, heat-related mortality. Declining food security, maternal health and availability of potable water.
MDG 7 	Ensure environmental sustainability	**Negatively impacted natural resources** and productive ecosystems.

Figure 4.7: Climate change risks to MDGs

Poverty Alleviation: Poverty alleviation is one of the key priorities for the Government of Nepal. While livelihoods are threatened by all extreme events – droughts and floods in particular are responsible for keeping poorer sections of the population under the poverty line. With about 75 percent of the population engaged in and dependent on agriculture, any adverse impact on the sector such as crop production and income loss could negate progress made towards reducing poverty.

Although the overall poverty rate in the country is decreasing, the incidence of poverty vary across different parts of the country ranging from a low of 3.3 percent in Kathmandu to 38.1 percent in rural Western Terai and 42.9 percent in rural Eastern Hills, indicating the prevalence of regional inequalities. These inequalities could worsen with the occurrence of extreme events, which drags a large section of those just above the poverty line down into the poverty trap again (CBS, WFP and WB, 2007).

Food and Nutrition Security: Table 4.7 outlines the various dimensions of food and nutrition security, which are affected by climate risks.

TABLE 4.7: CLIMATE RISKS AND FOOD AND NUTRITION SECURITY

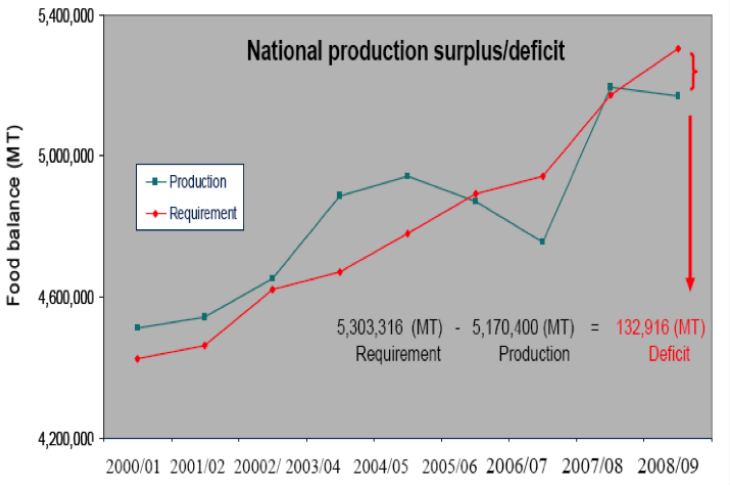
DIMENSIONS	ISSUES	EVIDENCE	CLIMATE RISKS
Availability	• Low and/or stagnant productivity • Population growth, hence demand, is higher than cereal production growth • Limited infrastructure and storage facilities	• Productivity of major crops is lowest among South Asia • Country is net importer of food products	• Crop production (hence food availability) is affected by climate risks both on inter-annual and intra-seasonal basis (e.g., 2008 drought caused production loss of 400,000 tons and a deficit of 130,000 tons to meet the required 5.2 million tons of grains)

TABLE 4.7 CONTINUED

DIMENSIONS	ISSUES	EVIDENCE	CLIMATE RISKS
Accessibility	• Poor connectivity, which limits both physical and economic access (e.g., to inputs, extension services, markets) • Rising food prices since 2005/06, with rates higher than general inflation, severely affecting the poor who allocate almost three quarters of their income to food	• Road density in Nepal is only 6.39 km/100 sq. km, a meagre figure compared for instance to India's Himachal Pradesh and Uttarakhand, where it is 58.5 and 133.6 respectively • Only 30 % of the population has access to all weather roads, and more than 60% of the road infrastructure is located in the Terai. • High food prices in Kathmandu and high hills	• Hazards like landslides, flash floods, floods and heavy rains further disrupt the transport of food • High food inflation rates reduces the poor's access to (certain kinds of) food as evidenced by the 2008 winter drought, where price increases of up to 177% in the western mountain regions resulted in distress coping
Absorption and Utilization	• Low dietary diversity and insufficient attention to utilization of minor crops • Social, geographical and temporal variations as well as changes in consumption behaviors (e.g., growth of fast foods, sedentary lifestyles, fats and sugar consumption leading to obesity and diabetes) and health indicators • Low awareness on food safety • Assessment of food security based only on cereal production and availability	• About 40-60% of the population is unable to meet the minimum daily per capita intake of 2,144 kcal, and about 49% of <5 year-old children are stunted, 13% wasted and 39% underweight • About 51% of women suffer from anemia in FWR against 31% in ER • Vulnerable communities such as Dalits, Adivasi, Janajatis and ex-bonded laborers often struggle to access sufficient food • The DFTQC's recent report on pesticide use shows high pesticide residues in both urban and peri-urban areas	• Epidemics associated with heavy rainfall are common in Nepal. These affect the health of vulnerable populations, by impacting absorption and utilization.

Source: Adapted from ADB, 2011

Climate risk is indeed a major threat to food and nutrition security, mainly because food demand and supply in Nepal is delicately balanced (see Figure 4.8). Periodic climate shocks can easily upset this balance, particularly in the hilly and mountainous areas of the Western and Far-Western Regions.



Source: MAC, WFP and FAO, 2009

Figure 4.8: National production surplus/deficit

Figure 4.8 shows that for the years 2000–2005, production was more than the required amount. The balance was tipped in 2006 when the drought occurred. Impacts extended over to 2007, and when it was about to meet demand, another drought occurred in 2008 leading to the deficit.

KEY MESSAGES

- While climate hazards such as floods (including GLOFs), landslides, hailstorms and cold waves all pose significant risks to lives and property, the major risks for agriculture are caused by droughts associated with intra-seasonal variations.
- Analysis findings estimate the annual losses from drought at USD 75 million per annum compared to the annual loss of USD 4 million for other hazards during the years 2001-2010. Similarly, a total of 12 million people were affected by droughts compared to around 2 million by all other hazards from 2001 to 2010.
- Despite the widespread impacts of drought, Nepal's disaster risk management policies are built with an inherent bias towards quick onset hazards. To change this perception, there is a need to comprehensively assess the true costs of climate risks – from direct and tangible impacts on affected communities to indirect, cumulative and intangible impacts that extend from the affected season, area and sector to impact the broader population and/or the country's GDP.

CURRENT CLIMATE RISK MANAGEMENT

Most of the CRM initiatives in Nepal focus on managing extreme events, and prioritise rapid-onset events such as riverine flooding, flash floods, landslides and GLOFs. Policies and institutions related to risk management are also biased towards these hazards while other risks such as from droughts, intra-seasonal variations in rainfall and temperature fluctuations have been largely ignored. This Chapter outlines the existing CRM policies and strategies, and highlight some of the gaps in implementing a comprehensive CRM framework in the country.

INSTITUTIONAL AND POLICY ARRANGEMENTS FOR CRM

To date, there are three distinct frameworks related to risk management in Nepal: i) development planning, ii) disaster management, and iii) climate change adaptation. These three domains remain isolated although a process of integration is currently underway.

Development Planning

The National Planning Commission leads the development planning process with a mandate to coordinate national development plan preparation with the participation of all the sectors. The NPC screens development plans and programs using an approach for climate resilient planning, which includes tools to assess the sensitivity of various sectors. This approach was applied in the preparation of the Three Year Plan (2010/11–2012/13), leading to the integration of climate sensitive programs and activities in the sectoral plans of government agencies.

The Three Year Plan (2010/11- 2012/13) is a guide for development with a long-term vision to transform Nepal from a least developed to a developing country. Some of the goals emphasized in the plan are employment, poverty reduction, food security and the management of risks posed by climate variability and change. The Three Year Plan also highlights key areas like agriculture and food security, forestry and watershed management, and hydropower and alternative energy to manage some of the challenges from climate change. From the plan, resources are provided for the local bodies to undertake responsibilities assigned through local governance. These tasks are in line with the local action plans prepared by sectors in collaboration with the Ministry of Federal Affairs and Local Development. The Government of Nepal has also brought out the Climate Change Budget Code and CC Resilient Planning tools.

For the agriculture sector, the plan focuses on i) community-based agricultural biodiversity conservation, ii) development of appropriate technology and infrastructure for conservation and utilisation of indigenous knowledge and natural resources, iii) encouragement of production based on agricultural biodiversity, and employment and income generating activities, and iv) promotion of market centres and entrepreneurship (National Planning Commission, 2011). For its part, the National Agriculture Sector Development Priority (NASDP) for the Medium-term (2010/11 to 2014/15) provides a broad framework that outlines eight key priorities over the next few years:

i. Enhancing food and nutrition security and safety;

ii. Enhancing application of "getting-better" technologies and tools;

iii. Promoting enabling environment;

iv. Promoting market orientation and competitiveness;

v. Sustaining natural resource conservation and utilization;

vi. Developing infrastructure support facilities;

vii. Enhancing integration of gender in agriculture;

viii. Managing the effects of migration of agriculture labour.

Disaster Risk Management Framework

The Natural Calamity Relief Act of 1982 provides for the establishment of the Central Disaster Relief Committee (CDRC) under the MoHA. However, the Act is focused largely on post-disaster activities such as relief and rescue although a draft legislation that encompasses wider disaster risk reduction functions is now being considered.

The National Strategy for Disaster Risk Management (NSDRM) is the key document on DRM in Nepal which was endorsed by GoN in October 2009 to achieve the goal of disaster resilient Nepal by providing guidance for improving the policy and legal environment, and by prioritizing the strategic interventions. UNDP Nepal, with core financial support from the European Commission Humanitarian Aid Department, provided the management support and technical leadership. The NSDRM has led to a paradigm shift in disaster risk management from a reactive intervention in the form of relief to a proactive approach of mitigation.

In addition to NSDRM, there are some other policy documents/ interventions such as:

- Natural Calamity Relief Act 1982, amendment in 1989 and 1992;
- National Action Plan for Disaster Management 1996;
- Des-Inventar database system introduced in 2003;
- Nepal joins DRR Hyogo Framework of Action (HFA) 2005;
- DRR integrated in Local Self Government Act; Tenth FYP (2002-2007); Three Year Interim Plan (2008- 2010 and 2010- 2013);
- NRRC's Flagship Programmes (5 Flagship Areas- US$ 195.8 Mil for 5 years);
- National Strategy on DRM 2009;
- Focal Points- CC and DRM established in the key ministries and departments;
- Local and District Disaster Risk Management Planning Guidelines - 2011;
- Disaster Preparedness and Response Plan- 2011;
- Emergency Operation Centre (EOC) at various levels – 2010;
- National Strategy for EWS (Proposed)- 2010;
- Disaster Recovery Framework, U-SAR Plan and Open Spaces 2013;
- Networks- such as DPNET and others;
- Dead body management guidelines.

Linkages between development planning and disaster risk management can be seen such as in the inclusion of a specific chapter on DRM beginning in the Tenth Plan (2003-08), and in subsequent three year plans. But while some Village Development Committees have made their own DRM budget allocations, many others do not have the financial capacity nor support for local level risk reduction (PreventionWeb, 2011).

In terms of institutional set-up for Disaster Management in Nepal, the Ministry of Home Affairs is the National Focal Point. MoHA formulates and implements national policies, plans and programs for disaster risk management (DRM). As a lead agency, MoHA is responsible for coordinating the activities related to disaster preparedness, mitigation and reconstruction as well as rehabilitation with other disaster management related agencies. This includes data collection and dissemination, and disbursal of rescue and relief resources to people affected and displaced by disasters.

A Central Disaster Relief Committee (CDRC), comprising of related ministries and security agencies along with voluntary organizations like Red Cross, which is under the Chairmanship of the Home Minister, provides policy guidelines and directives to the operating agencies for rescue and relief works. The CDRC formulates and implements national policies and programmes on relief, rehabilitation, reconstruction and preparedness, as well as guide the actions of the district and local committees (including Disaster Management Committees) at village levels.

Another institution whose work relates to disaster risk management is the Nepal Risk Reduction Consortium (NRRC) which was established in May 2009. The NRRC is a partnership involving the Government of Nepal, financial institutions and development partners, including ADB, IFRC, UNDP, UNOCHA, UNISDR, World Bank, UK, and USA, with MoHA as Chair of the Steering Committee and UNDP as the lead agency for DRM policy and institutional support. Given an estimated budget of USD 147 million, the NRRC prioritized five flagship areas: i) school and hospital safety, ii) emergency preparedness and response capacity, iii) flood management in the Koshi river basin, iv) integrated community-based disaster risk reduction, and v) policy/institutional support for disaster risk management.

During the year the NRRC was established, the government also developed the National Strategy for Disaster Risk Management (NSDRM), which recommended the creation of a national disaster preparedness agency, the setting up of a nationwide early warning system and investments on weather forecasting capacities. The NSDRM also proposed the setting-up of a National Disaster Management Council under the Chairmanship of the Prime Minister to work as the high level body for DRR. It also proposed a Disaster Management Authority as Secretariat of the Council to streamline the institutional processes involved in cross-sectoral and multi-level initiatives (PreventionWeb, 2011).

Climate Change Framework

The country's National Adaptation Programme of Action (NAPA), which was developed in 2010, guides adaptation actions across various sectors. Similarly, the Climate Change Policy formulated in 2011 is used to identify overall climate change priorities. Based on these, a National Climate Change Strategy is under preparation at the Ministry of Environment to guide climate change adaptation projects and actions. More localized versions of the NAPA have also been formulated. Developed in consultation with local communities, these Local Adaptation Plans of Action (LAPA) are expected to be undertaken in coordination with various sectors including agriculture, forestry, health, water and sanitation. For the agriculture sector, priority programmes include integrated management of agriculture, water management, improved systems, livelihood diversification, access to agriculture development services, identification of potential drought areas, early warning and forecasting for adverse temperature, floods and other hazards impacting the sector. Other prioritised programs include community based disaster management, GLOF monitoring and risk reduction, forestry and ecosystem management, public health, sustainable management of water resources and promotion of climate-smart urban settlements.

Another climate change related initiative is the Strategic Program for Climate Resilience (SPCR) under the Pilot Program for Climate Resilience (PPCR) and supported by the Climate Investment Fund. The SPCR aims to integrate climate risks and resilience into core development planning with various focus, some of which relate to agriculture including improved extension services, crop diversification, improved crop varieties and storage, and integrated water resource management. Component-2 of the PPCR "Building Resilience to Climate-related Hazards" is dedicated to weather and agriculture.

As for institutional set-up, the Climate Change Council is the highest advisory body providing high level policy and strategic inputs, as well as coordinating financial and technical support for climate change policies and programs. This is headed by the Prime Minister and composed of 25 members from sectoral departments and technical experts. Also established at the national level is a Multi-stakeholder Climate Change Initiatives Coordination Committee (MCCICC) comprised of ministries, national institutions, international and national NGOs and the private sector. It is responsible for enhancing collaboration and coordination on climate change, and facilitating the development of financing strategies. A related national climate change focal point was created within the Ministry of Environment because of its mandate to formulate, implement, monitor and evaluate policy, plans and programs on environment, science and technology, and climate change (National Planning Commission, 2011). Indeed, activities related to climate change adaptation are coordinated by the Ministry while the National Planning Commission, for its part, developed the Climate Resilient Planning, a tool used for screening development plans and programmes to ensure they are climate resilient.

CLIMATE RISK MANAGEMENT PROGRAMS AND ACTIVITIES

Table 5.1 outlines the programs and projects related to climate change and risk management in Nepal.

TABLE 5.1: PROGRAMS/PROJECTS RELATED TO CLIMATE CHANGE AND RISK MANAGEMENT

NAME OF THE PROJECT/PROGRAM	DONOR	AMOUNT (USD MILLION)		REMARKS
		GRANT	LOAN	
Nepal Climate Change Support Program	DFID/EU	18.9		Pipeline
Pilot Project for Climate Resilience (PPCR)	Climate Investment Fund (CIF)	50.0	36.0	Pipeline
Scaling-up of Renewable energy program	CIF	40.0		Pipeline
Energy Sector Assistance Program	DNIDA, Norway, Germany, DFID	60.0		Ongoing
Rural Energy for Rural Livelihood	WB, UNDP	3.3		Ongoing/pipeline
Renewable Energy Project	EU	18.0		Ongoing
Biogas Support Program	SNV, KFW	2.4		Ongoing
Improved Water Mill Support Program	ADB	1.1		Ongoing
Global Environment Fund Allocation for Nepal (Bio-Diversity Climate Change and Land Degradation) for next 4 years	GEF	8.3		Pipeline
Micro Hydro Power Development Fund	Germany	7.0		Ongoing
REDD forestry and Climate Change	World Bank Trust Fund	3.4		Ongoing
Energy Efficiency through loss reduction	ADB	0.3	65.0	Ongoing
Kathmandu Sustainable Urban Transport	GEF	2.5		Ongoing
Kathmandu Sustainable Urban Transport	ADB	10.0		Ongoing
Total		**225.0**	**101.0**	

Source: National Planning Commission, 2011

In addition to the list above, there are disaster risk management programmes and projects implemented by the government and its development partners. One notable UNDP programme is the Comprehensive Disaster Risk Management Programme (CDRMP), which focuses on:

i. Strengthening the institutional and legislative system for disaster risk reduction;
ii. Building strategic linkages with other sectors to mainstream disaster risk reduction;
iii. Promoting climate change related risk management;
iv. Reducing communities' vulnerability to natural disasters;
v. Improving emergency preparedness and response capacities;
vi. Building UNDP Nepal's capacity for providing early recovery support;

A historical disaster database (DesInventar) covering most events in Nepal since 1971 has been established with support from UNDP and the National Society for Earthquake Technology (NSET). Risk and hazard mapping have also been carried out through several projects at local levels, while a recent World Bank-supported national level initiative on multi-hazard risk mapping has been undertaken by MoHA. However, full (and effective) integration of risk assessments and responses into development planning and policy-making by key sectors is yet to be seen.

CAPACITY ASSESSMENT FOR CLIMATE RISK MANAGEMENT

An assessment of climate risk management capacity using the World Resources Institute's National Adaptive Capacity Framework (WRI, 2009) revealed the following findings for Nepal:

1. Assessment: Overall, Nepal lacks the resources and institutional capacities for comprehensive assessments. Although several hazard and risk assessments have already been conducted, especially the multi-hazard risk assessments under the Comprehensive DRM Programme (CDRMP) in eight districts representing three ecological regions, these hazard assessments do not take into account the risks faced by various occupation groups and sectors in the country. For example, agriculture in Terai faces greater climatic risks than the mountain/hill regions in terms of production loss but these have not been fully recognized. Additionally, there is a lack of complete assessments of risks and impacts on agriculture and allied sectors like livestock or animal husbandry. The backward and forward linkages between these sectors could magnify the impacts of weather and climate risks on markets and the economy.

   Most risk assessment and risk management initiatives are based solely on episodic events. The analysis done in Section 4.1.1 suggests that losses due to intra-seasonal variation of climate are higher than from highly visible, episodic events like floods. For instance, the analysis revealed that climate features like erratic, late onset, long dry spells or early withdrawal of monsoon rains led to a loss of USD 75 million annually during the years 2001–2010. However, there is currently no concerted effort to understand and assess these risks from intra-seasonal aberrations on different farming and/or water resource management systems. This indicates a major gap underscoring an urgent need to redefine the climate risk assessment process in the country. Such assessments would require: i) collaboration between MOAD, DHM, WECS, MoHA, Ministry of Irrigation and MoFALD to integrate meteorological variables and their impacts to bio-physical systems and to society, ii) capacity development among these agencies, and iii) inter-departmental exchange of data and information.

   Real-time collation and analysis of data remains another major gap. MoHA does not collect data on drought impacts, and MOAD does not integrate meteorological parameters with data on agricultural impacts. The latter also has limited coordination with VDCs for information on drought impacts on farmers' livelihoods. The country's agriculturists are spread over vast and inaccessible areas, with very few agricultural officers to address their needs. Estimates show that there is just one Agriculture Officer per 2,000 farmers, hence the difficulties in ensuring the depth and breadth of risk and impact assessments.

   Some research on climate parameters vis-à-vis other factors are sometimes undertaken by the National Agriculture Research Council (NARC). However, there are no effective linkages between research outputs and the implementation of related programs of the Agriculture Development Council, MAC, NPC and MOF.

2. Prioritization: Although NAPA and other national strategies consider agriculture as a national priority, the prioritization of response strategies and actions is not fully informed by comprehensive assessments of risks and impacts. Hazard risk assessments undertaken by MoHA do not take into account impacts of intra-seasonal variations and droughts. For instance, the Far Western Region is currently considered a low-risk area whereas estimates of drought impacts actually make it a high priority area. Similarly, climate risks and impacts are only marginally considered in the NASDP's 8 key priority areas. While climate risks could negatively influence all the key areas and outputs, climate considerations figure as only one of the 29 outputs of the framework. For instance, the key priority area on 'Increasing Production and Productivity' does not factor in comprehensive assessments of climate risks, which comprise at least one-third of the risks to agriculture. Similarly, the priority area on 'Promoting Enabling Environment' does not consider an explicit, diagnosis-based assessment.

   The prioritization process needs to be guided by appropriate assessments so that response strategies can be better planned. Prior assessment of areas prone to dry spells and their impacts are essential for contingency planning and prioritization. For example, dry spells that last for two weeks during the cultivation season in July or August can cause droughts. However, the impacts of these can be managed by digging shallow tube-wells about 4-5 days before the event to provide critical irrigation facilities, making the difference between a sure crop loss and a successful harvest. Indeed, the impacts of the 2006 drought could have been avoided by promoting shallow tube-wells. But because these strategies were not prioritized, subsidies to farmers for shallow-tube wells were removed even if they could have benefitted about 2 million ha of rain-fed agriculture.

   Climate sensitivity of maize crop has not been assessed thoroughly as well. Important both as staple for hill farmers and as poultry feed, the planting of maize particularly in hilly areas is dependent on rainfall from isolated thunderstorms during March/April.

   The cases above underscore the need to thoroughly explore the linkages between production shortfalls, climate risks and impacts. While there have been limited response priorities and strategies to aid production, a recent study by the National Planning Commission (2011) indicates that one third of budgetary resources are actually available for initiatives related to climate change. Table 5.2 outlines the budgets as well as expenditures of key line ministries in activities related to climate change.

TABLE 5.2: CLIMATE CHANGE BUDGETS AND EXPENDITURES OF KEY LINE MINISTRIES

NO.	MINISTRY	2009/10 (ACTUAL) NRS '000	2010/11 (REVISED ESTIMATE) NRS '000	2011/12 (BUDGET) NRS '000
1	Ministry of Local Development	30,560,983	35,067,404	44,500,591
2	Ministry of Physical Planning and Works	23,974,147	30,157,380	43,794,678
3	Ministry of Agriculture & Co-operatives	6,882,607	9,537,342	12,431,084
4	Ministry of Irrigation	8,463,024	7,168,855	10,028,384
5	Ministry of Forests & Soil Conservation	3,353,958	4,209,265	5,286,327
6	Ministry of Environment	3,510,137	2,611,758	2,878,329
7	Ministry of Industry	1,270,874	1,759,387	2,315,714
8	Ministry of Energy	714,870	661,213	1,363,312
9	Relevant for CC Ministries Total	78,730,600	91,172,604	122,598,419
10	Total Government (incl Financing)	259,689,106	306,270,386	384,900,000
11	Relevant Ministries as % of Government	30.3%	29.8%	31.9%

Source: National Planning Commission, 2011

[P.S.: Some ministries have been merged and/or renamed subsequently.]

About 75 percent of the total budget is used for adaptation purposes while the rest is for climate change mitigation purposes. Despite the fact that the major responsibility for addressing climatic risks lies with MOAC, the budget allocation to this ministry is very low.

3. Coordination: Coordination remains a challenge since most agencies and/or organizations are only beginning to understand, assess and manage the links between development, DRR and CCA. To date, there is still fragmentation of functions in various departments along with frequent restructuring which further adds to confusion of roles and mandate. New laws and regulations are enacted without being synchronised with existing ones, further complicating the functioning of departments. For example, even of the Water Resources Department is now divided into Soil Conservation and Irrigation Departments, the earlier Water Conservation Act is still operative. Some departments are established through Parliamentary Acts while others are created through Cabinet Notifications. Indeed, there have been a number of legal and administrative constraints due to overlapping Acts and Notifications that hamper the operationalization of programmes in a coordinated manner.

Apart from the inter-departmental challenges and coordination gaps, the lack of harmony in intra-sectoral policy and planning is further restricting a synergistic approach to key challenges faced by the sector. For example, the production policies of the Agriculture Department focus on increased use of fertilizers to improve production while the Integrated Pest Management Department advocates lesser use of fertilizers. Similarly, the Ministry of Irrigation, and the Ministry of Forest and Soil Conservation and Watershed Development independently adopt the river basin adaptation approach.

UNDP is working with Department of Soil Conservation and Watershed Management (DSCWM) and Department of Water Induced Disaster Prevention (DWIDP) in selected watersheds in order to bring their expertise together for synergy thereby establishing upstream and downstream linkages for integrated CRM.

In order to enhance/strengthen the coordination among the related line agencies, the CC and DRM focal point system is expected to be useful. There is no coordination between these two ministries in carrying out their programs nor is there any linking of agriculture development initiatives with irrigation and water management programs (see Table 5.3).

TABLE 5.3: LIST OF INSTITUTIONS WHOSE WORK RELATE TO, OR AFFECT, AGRICULTURE

	AGENCY/ORGANIZATION	ASSOCIATED ACTIVITIES
A. MINISTRIES CONTRIBUTING TO AGRICULTURE AND ASSOCIATED SECTORS/SUB-SECTORS		
1	Ministry of Agriculture and Development	Crop, livestock, horticulture, fishery and market development
2	Ministry of Land Reform and Management (MLRM)	Land reform and land management
3	Ministry of Irrigation (MOI)	Irrigation facility
4	Ministry of Energy (MOEN)	Rural energy
5	Ministry of Forest and Soil Conservation (MOFSC)	Soil conservation and watershed management, leasehold forestry, and medicinal and aromatic plants
6	Ministry of Local Development (MLD)	Rural development
	Ministry of Environment (MOE)	Environmental regulation and programs
7	Ministry of Health and Population (MoHP)	Nutrition, health and sanitation
8	Ministry of Finance (MOF)	Budget allocation to all line ministries
9	Ministry of Industry	Promotion of agro-based industry
10	Ministry of Commerce and Supplies (MoCS)	Promotion of export potential agro-based and industrial products
11	Ministry of Science and Technology (MoST)	Promotion of appropriate technology

TABLE 5.3 CONTINUED

B. DEPARTMENTS, BOARDS, CORPORATIONS AND COMPANIES		
1	Line departments such as the Department of Agriculture (DoA), Department of Livestock Services (DLS), Department of Food Technology and Quality Control, Department of Cooperatives, Department of Irrigation (DoI), Department of Forestry (DoF), Department of Local Infrastructure and Agricultural Roads (DoLIDAR)	Line functions of the departments include agriculture extension and related services management, livestock service management, food quality regulation, cooperatives registration and regulation, management of irrigation programme, forest management, development of rural roads
2	Autonomous institutions such as Agriculture Information and Communication Centre, National Agricultural Research and Development Fund, Seed Quality Control Centre	Functions indicated include dissemination of agricultural information, agricultural research programme support, seed quality regulation
3	Affiliated corporations such as Dairy Development Corporation	Specified development functions including procurement of milk from rural areas and supply in urban centers
4	Companies (Established under the Company Act 1964) such as Agricultural Input Company, National Seed Company	Procure and supply of fertilizers, management of seeds
C. AUTONOMOUS ENTITIES		
1	Nepal Agricultural Research Council (NARC)	Agriculture research
2	Nepal Veterinary Council (NVC)	Veterinary services
3	National Cooperative Development Board (NCDB), National Tea and Coffee Development Board	Policy support for cooperative development, policy support for tea and coffee
4	National Dairy Development Board (NDDB)	Dairy development
D. PUBLIC SECTOR INSTITUTIONS OUTSIDE OF GOVERNMENT		
1	Institute of Agriculture and Animal Science	Train technical graduates through vocational education (e.g., forestry)
2	Center for Technical and Vocational Training	
3	Institute of Forestry	
4	Agriculture Enterprises Centre, FNCCI	Agro industry/private sector development
5	Agriculture Development Bank Ltd.	Agricultural credit supply
6	Rural Microfinance Development Center	Provision of rural credit
7	National Cooperative Federation of Nepal Ltd.	Support cooperative movement
8	Trade and Export Promotion Center	Promotion of commodities trade
9	National and Local NGOs	Service delivery
10	Development partners	Support development projects

Source: ADB, 2011

As the table above shows, there are numerous agencies and/or organizations, indicating the daunting task involved in planning and implementing routine agriculture development programmes and activities. The integration of CRM into the existing organizational structure is further challenging since it is essentially a new way of managing risks that entails huge capacity building and coordination.

The inherent coordination problems within departments and between ministries indicate the need for a higher level of intervention to address the institutional issues, and ensure convergence. There is also the need to improve linkages between national policies for CCA and CRM and their implementation by local government departments. The latter have guidelines to prepare climate resilience, adaptation and/or development programmes but lack the capacity to organize and analyze the information needed to develop such.

In terms of CRM, a number of organizations with CRM in their agenda already exist (see Table 5.4).

TABLE 5.4: AGENCIES/ORGANIZATIONS WITH CRM IN THEIR AGENDA

INSTITUTION	TYPE	RELEVANT OBJECTIVE	STRUCTURE
Parliamentary Committee on Environment	Advisory body	- Review bills on environment management, and recommend to the Parliament for approval - Monitor and evaluate the performances of line ministries and provide guidance to improve performance	Committee of parliamentarians headed by a parliamentarian
National Planning Commission (NPC)	Government body	Prepare plans and policies for development	Commission is headed by Rt. Prime Minister along with ministers, secretaries, and representatives of the private sector, academia, and experts. Climate screening is the responsibility of the NPC.
Environment Protection Council (EPC)	Government council	- Provide advice to the government on setting policies and strategies to achieve the objective of sustainable development - Coordinate with the highest level of government, private sector, academia, and other sectors to facilitate policy/ strategy implementation	Council is headed by Rt. Prime Minister along with ministers, secretaries, and representatives of the private sector, academia, and experts
Ministry of Environment (MoE)	Government institution	Formulation, implementation, monitoring and evaluation of policy, plans, and programs on environment	Focal Point for Climate Change and secretariat for the Designated National Authority (DNA) for CDM
Ministry of Home Affairs (MoHA)	Government institution	- Responsible for delivering critical services to the citizens and for maintaining security in the nation, both of which are carried out by the regional and districts offices - Responsible for disaster management in the country	MoHA coordinates all activities relating to disaster preparedness, mitigation and reconstruction. It is the focal point for rescue and relief, collection and dissemination of data, distribution of funds and resources.
Department of Hydrology and Meteorology (DHM)	Government institution	Collect and disseminate hydrological and meteorological information for water resources, agriculture, energy, and other (development) sectors	DHM is the focal point for the IPCC, WMO, and meteorological initiatives of the SAARC. It prepared the initial national communication to UNFCCC in 2004

INSTITUTION	TYPE	RELEVANT OBJECTIVE	STRUCTURE
Department for Water Induced Disaster Prevention (DWIDP)	Government institution under the Ministry of Irrigation	Minimize human casualty and infrastructure damage of water induced disasters through appropriate management and conservation of rivers and river basins	- Prepare and implement water-induced disaster management policy and plans - Undertake hazard and risk mapping - Enhance community awareness
Alternative Energy Promotion Centre (AEPC)	Government institution (autonomous)	Provide suggestions to the Government of Nepal in the formulation of alternative and renewable energy technology policies for their promotion, extension, development and dissemination	The Centre is managed by a Board, which is headed by the Minister of MoEST.
Designated National Authority (DNA)	CDM management committee	Facilitate and regulate the Clean Development Mechanism under the Kyoto protocol	Three sub-committees have been formed to deal with the CDM project
Climate Change Network (CCN)	Network of government and non-government organizations	Coordinate with stakeholders (government, NGO, private sector etc.) before and after COP meetings	Composed of 29 member organisations chaired by the Secretary of MoEST.
Disaster Preparedness Network (DPNet)	Network of non-government organizations	Enhance the capacity and improve the performance of network members/ partners to share, design, implement and sustain disaster preparedness activities in Nepal	Promote and spread sustainable (disaster) preparedness and management activities with a view to link disaster and development throughout Nepal

Source: DANIDA, 2008

4. Information Management: In general, the country has limited observation capacities as well as weak data collection, processing and analysis capabilities. The national observation system for weather and climate monitoring maintained by DHM is currently being improved to increase observation quality (through telemetry of observation stations to transmit real-time data) and quantity (by increasing the number of observation stations). Despite this, the observation network remains less dense than recommended (as per WMO standards), considering the terrain of the country.

   In 2011, DHM started to generate quantitative forecasts of up to 3 days based on numerical weather prediction techniques, which are made available on an experimental basis. These forecasts could be improved further by integrating observation data from within Nepal and the region. Since a number of adverse weather impacts in the country are due to large-scale systems that originate in the Bay of Bengal, it is possible to get increased lead-time information, and build early warning systems for use by various sectors.

   To date, there are limited mechanisms for sharing and/or integrating information collected by different sectoral agencies (e.g., agriculture, water), hence the gaps in utilizing information including those currently available. A related issue is the limited use of climate knowledge (except as indigenous practices). It would be helpful if Nepal establishes a system for information sharing and management, and builds the organizational and community capacity to such information (e.g., weather, climate, crop systems) in planning and decision-making.

5. Climate Risk Reduction: Similar to limitations in assessment, prioritization, coordination and information management, the country is experiencing challenges in terms of developing and implementing comprehensive CRM programs. In fact, many of the on-going initiatives do not sufficiently take climate risks into consideration, and therefore remain ineffective at reducing

climate-related risks and impacts. This means that strategies and actions need to be framed with due cognizance of climate risks like late onset of rains or dry spells that impact various sectors like agriculture. Table 5.5 shows the probable CRM options for the agricultural sector, and the constraints in operationalizing these options.

TABLE 5.5: CRM OPTIONS AND CONSTRAINTS – IMPACTS OF RAINFALL VARIABILITY IN AGRICULTURE

YEARS	CHARACTERISTICS OF RAINFALL	REGIONS AFFECTED (INSTANCES)	PRODUCTION LOSS IN TONNES*	OPTIONS TO REDUCE RISKS	CONSTRAINTS
1972 1977 1979 1982 1992 2009	Late onset	Eastern (5), Central (3), Western (2)	3,053,206	- Change of paddy nursery planning operations - Choice of short-duration crop varieties - Crop calendar adjustments - Supplementary irrigation (wherever possible)	- Lack of capacity to generate farmer need-based climate information - Lack of DoA capacity to communicate risks due to late onset - Lack of response options at farmer levels
1976 1986 1994 1997 2002 2006 2008**	Poor distribution of rainfall	All (2), Eastern (1), Central (1), Western (2)	6,106,412	- Preparations to undertake appropriate moisture conservation techniques - Irrigation management, wherever irrigation infrastructure is available - Change to crop varieties that withstand long, dry spells	- Lack of capacity to generate farmer need-based climate information - Lack of DoA capacity to communicate risks due to poor rainfall distribution - Lack of response options at farmer levels

**Only for major crops like paddy, maize, millet and wheat; **Winter drought*

Source: Nayava, 2008

The use of CRM suggests the possibility of maximizing potential climate gains in addition to reducing climate risks through the use of weather and climate information. A study by the National Council of Applied Economic Research (NCAER, 2010) reveals that the benefits of weather information for different agricultural operations like changing of cropping patterns, sowing, harvesting, scheduling irrigation, moisture stress management, fertilizer application and spraying pesticides could save as much as 50 percent of the investment.

Overall, there are still structural barriers that constrain existing policies and programs from contributing to effective CRM. The generation and integration of risk information – from short-term (up to 3 days) to weekly, monthly, seasonal and annual timescales require capacity building within DHM, and other stakeholders. Some of the key constraints include: i) the lack of capacity to continuously assess climate risks and impacts, ii) the absence of mechanisms for organizing the assessments, ii) limited strategies and interventions that address climate-induced risks, and iv) the lack of policy, program and funding support to implement the strategies and interventions. The DoA, for instance, has to grapple with such issues as limited planning and implementation as well as weak monitoring and evaluation capacities due to a lack of human and financial resources (ADB, 2011).

Government of Nepal and UNDP in collaboration with the FAO supported the Ministry of Agriculture and Cooperatives (MOAC) to implement the above project for strengthening capacities for climate risk management and disaster preparedness in the agricultural sector. Based on the pilot reslts of the project the MoAC prepared a 10 year **Priority Framework for Action (PFA) for the agriculutre sector of Nepal.** The PFA is based on the outcomes of field experiences gained from the district and community level interventions, vulnerability and risk mapping, farmers support services as well as climate/weather related early warning information system and advocates for using cliamte resistant seed varieties and cultivation techniques.

KEY MESSAGES

- The institutional mechanism to manage climate risks comprehensively is still evolving. To date, the three distinct frameworks related to risk management in Nepal – development planning, disaster management, and climate change adaptation – remain isolated although a process of integration is currently underway.
- There is currently no policy and institutional mechanism and/or capacity to assess and integrate climate risks and impacts in the agriculture sector.
- While the agriculture sector has noble policy aims and objectives, these are not translated into tangible results due to its low financial and resource allocation of less than USD 7 million (6 percent of the total national budget allocation).
- Despite the huge advantage in harnessing and using weather and climate information – estimated at USD 601 million – there is very limited capacity to maximize the said benefits.
- CRM programs such as the CRM Information Management System need to be developed and institutionalized.

RECOMMENDATIONS

This Chapter outlines the recommendations for CRM in Nepal based on the limitations identified in Chapter 5.

CLIMATE RISK ASSESSMENT

A policy and institutional mechanism needs to be established to facilitate continuous assessment of risk factors that impact agriculture. Such system would improve decision-making through appropriate anticipatory response strategies.

In the case of agriculture, capacities need to be built among relevant stakeholders – DoA, DHM, NPC and MoF – to collect, integrate and analyse all relevant data (e.g., weather data, agricultural data on crops, varieties of crops, areas of cultivation, impacts at disaggregated level, socio-economic conditions and existing policies and programmes) during the planning and budgeting process. Their analyses need to identify potential risks and possible response options for managing risks in the sector. In addition, risk assessment and management need to cover allied sectors like livestock, animal husbandry and fisheries since these are closely linked to agriculture, and are also sensitive to climate risks. Such process can be done following the steps below:

i. Capacity building of research institutions to undertake focused research;

ii. Integration of research results into operational programmes;

iii. Building capacities among agriculture extension services to identify response options;

iv. Training of farmers to use effective response options, along with policies and programmes that aid such response (e.g., funding for the creation of shallow tube wells to address short dry spells, contingency support such as providing alternative seeds, etc.).

One crucial aspect of the above-mentioned process is facilitating the linkages among key stakeholders – MOAD, MoF, MoHA (responsible for disaster risk management), NPC, DHM, Fisheries, Animal Husbandry, Irrigation – and support institutions such as agriculture insurance and markets. Such will also help establish the required linkages between CRM, development planning and budgeting, and will help institutionalise the information and application system for agriculture. MoFALD plays a crucial role in establishing linkages of farmers or farmer groups to the concerned agencies through sub-national and local level institutions like the DDCs and VDCs.

PRIORITIZATION

There is a need to integrate CRM in all the 8 priority areas of the National Strategy for Agriculture Development, the key theme of which is to ensure productivity and food security as well as reduce poverty. The generation and application of weather and climate information could further help in:

i. Promoting an enabling environment. There is a need to establish well-defined policy and institutional framework where CRM roles and responsibilities are assigned to different organizations with a coordinating responsibility assigned to MOAC. This means that the budgetary support to agriculture needs to be increased to ensure sustained agriculture growth and development in view of the weather and climate risks the sector experiences.

ii. Enhancing food and nutrition security and safety. Climate risks affect all dimensions of food and nutrition security. However, the risks and impacts on food production could be reduced through the use of (advanced) climate information. The later could be used in designing anticipatory response strategies and measures that, for instance help get through physical inaccessibility due to floods or landslides, or enable pre-positioning of food grains in strategic locations for easy availability and distribution to vulnerable populations. Similarly, a climate-information based nutrition surveillance system could enhance preparedness and hence reduce the potential for epidemics.

iii. Promoting market orientation and competitiveness. Agriculture-related policies in the Three Year Plan (2010/11- 2012/13), the White Paper (2011), and MOAC's Agri-business Promotion Policy (2006) have all emphasized commercialisation of agriculture through diversification, service delivery, private sector involvement in infrastructure for post-harvest operations, marketing and processing. Commercialisation is also expected to involve land use and crop system changes. But in the absence of information on the exact zones proposed for specific crops, activities and configuration of the agro-businesses, the recommendations cannot be very detailed. Regardless, climate screening could be undertaken for all the initiatives proposed to guide the commercialisation programme. Climate risk information is useful in establishing cropping systems, managing production risks and in protecting investments through appropriate response options and tools like insurance. Indeed, if agriculture insurance schemes could be linked with the provision of climate information, the premiums could be made lower, making them more attractive and affordable, thereby increasing insurance coverage.

    Weather and climate information can also help in the management of market risks involved in production. For instance, weather affects the availability of agro-based raw materials, which in turn affect all links in the supply chain, from processing to packaging, marketing and retailing.

    Climate change due to increased temperatures could be beneficial for Nepal as it could free large amounts of (hill area) land for horticulture, which is one of the priorities of the Government of Nepal. The promotion of horticulture in new areas needs to consider climate risks in siting (physical location) as well as in operating and managing the farms (e.g., during flowering or fruiting stages).

iv. Sustaining natural resource conservation and utilization. Around 35,000 ha of crop areas are routinely impacted by heavy rainfall-induced sedimentation and siltation, making these areas at permanent risk to climate hazards. Again, climate information and knowledge on specific locations vulnerable to climate risks could be used to manage these areas better or to avoid such areas for exploitation.

v. Developing infrastructure support facilities. Climate risk information is useful in developing and managing rural infrastructure. For instance, increased incidence of landslides is attributed to increased intensity of road constructions that do not take into consideration the risks involved. Similarly, most irrigation structures are inappropriately sited and poorly designed, either getting washed away or silted to be of effective use.

    The integration of climate risks in rural market and communication infrastructure development requires close coordination among Physical Planning, Agriculture, Irrigation, DHM, and Environment.

vi. Managing the effects of migration of agriculture labour. The migration of productive agricultural labour affect agricultural production, and hence the economy. If a climate risk information system could be established, at least 30 percent of the risks that impacts agriculture (i.e., from climate) could be managed, potentially improving rural incomes and livelihoods that depend on agriculture. These developments when coupled with agricultural transformation through agro-based industries could help make the sector more competitive and reduce migration.

vii. Enhancing application of "getting-better" technologies and tools. Most new technologies and management practices and tools for agriculture production are introduced with the assumption of a normal climate. Climate information could enhance effective application of these technologies through well-informed decision-making. Indeed, climate information, per se, could be a "getting-better" technology for agriculture in Nepal.

viii. Enhancing integration of gender in agriculture. Due to out-migration, female members of the family are increasingly tasked to manage agriculture activities, hence the need for a conscious effort to incorporate women-farmer groups in building capacities for CRM so that agriculture extension services could help enhance the capacity of an adequate number of women farmers to manage climate risks.

INFORMATION MANAGEMENT

A conservative estimate of the value of weather information (in minimizing climate risks and maximizing potential gains) for the agricultural sector is estimated at USD 601 million per annum. For this to happen, a dedicated institutional system needs to be built within MOAC. The establishment and institutionalization of a user-relevant climate information system involves:

i. Assessment of users' information requirements. Different users have different climate information requirements. Within the same group of users, information requirements are guided by planning horizons that vary from 20-25 years at the ministerial level to 5 years and below at the directorate level.

ii. Tailoring of climate information to users' needs. Forecast resolution and lead times vary with user type. For example, climate projections of 20-25 years lead times at a spatial scale are useful for adaptation.

iii. Characterizing and packaging uncertainties associated with climate information of different timescales. The uncertainties inherent in longer-lead climate information need to be characterized and communicated to facilitate application of climate information in a risk management framework. This would also prevent untrained and non-technical users from immediately perceiving and attributing climate variability-related phenomena to global warming.

iv. Interpretation and translation of climate information. Climate information should be interpreted in terms of sector-specific thresholds, jointly determined by institutional users and communities.

v. Application in a risk management framework. Climate information is applied in planning and decision-making, cognizant of the risks due to uncertainties in the information.

vi. Demonstration of the economic benefits in using climate information and adopting the CRM framework. Appreciation of the economic and social benefits derived from investing in an end-to-end climate risk management system (e.g., time, human resources, and finances) shall lead to the adoption of the CRM framework and institutionalization of the CRM system.

CLIMATE RISK MANAGEMENT

To support effective climate risk reduction functions in agriculture the following pre-requisites are essential:

i. Functional agriculture risk information system;

ii. Investments in agriculture infrastructure – irrigation systems and services – including extension services;

iii. Contingency crop planning capacitated with logistics support, such as provision of alternate seeds and fertilisers, and;

iv. Mechanism for delivery of information and services through capacity building of VDCs, DDCs. It is essential to involve local government institutions like VDCs and DDCs since DOA would be unable to meet requirements in all regions on its own.

Building a CRM system would help reduce climate risks in agriculture, and address a huge loss of about USD 137 million each year due to weather risks and impacts on major crops like paddy, maize, millet and wheat. A policy shift from low investment of 6 percent on agriculture to at least 20 percent can help build research capacities and systems for agriculture extension services, information management, identification of response options, among others.

Below is a list of alternative risk reduction strategies, the best options of which depend on specific assessments of particular problems:

i. Contingency crop planning;

ii. Farm ponds;

iii. Use of drought-resistant crop varieties;

iv. Alternate crop calendars that address weather risks likely to manifest in specific locations (e.g., millet crops as inter-crops);

v. Climate risk management for supply-chain;

vi. Roof rainwater harvesting;

vii. Community Seed Production Groups (CSPG) and Community Seed Banks (CSB);

viii. Tunnel farming for off-season vegetable cultivation.

A conscious investment of resources would help not only generate better returns but also address the pressing issue of migration from rural areas by providing better income and employment opportunities.

An analysis of the historical climate and disaster data/information, current observable trends and future climatic projections indicates that: i) temperature increase, ii) shifting patterns of rainfall marked with wide fluctuations and uncertainty, iii) floods including flash floods, iv) droughts, and v) impacts emanating from higher climate sensitivity, are all likely to be the key hazards in the country. These are likely to alter the overall risk profile and have wide-ranging impacts on key socio-economic development indicators including community livelihoods.

The heightened risk profile underscores the importance of promoting CRM and disaster resilience in Nepal including the following elements:

- Appropriate investments need to be made in weather and climate data gathering, monitoring and tracking, analysis and dissemination of relevant outputs/information to concerned agencies and departments including regional authorities and communities. This will help address the current data gaps and improve climate analysis.

- It is imperative that efforts for real-time, regular and effective monitoring of climate and weather patterns with requisite institutional and technical infrastructure are made. This will help compile data and information related to climatic risks and impacts, analyze shifting patterns and help decision-makers develop appropriate interventions to address the same. The establishment and activation of an early warning system for drought and flood risk management need to be synchronized with the climate and weather monitoring system. This will help develop an integrated information and early warning system in the country.

- Effective and real-time monitoring and dissemination will require skilled human resources with requisite technical capacity. It will be useful to develop a human resource management and capacity building strategy based on detailed assessment of capacity gaps. Initiatives to build capacity of weather monitoring agencies and their staff should be prioritized to enable them to analyze and interpret weather/climate data and information for accurate prediction of likely climatic risks and impacts. Setting up of hydro-met stations and building staff capacity/expertise will help collect real-time data and transmit climate forecasts.

- Flood risk management assumes significance in the context of likely increase in extreme events especially for the urban as well as industrial/commercial centers.

- Drought risk management initiatives focusing on short-term to long-term risk reduction and adaptation interventions will help address some of the immediate and long-term impacts as well as potential challenges to key sectors such as agriculture, livestock, water, pastures, etc.

- Natural resource management including environment management, water conservation, alternate livelihoods, social forestry, development of social and economic safety nets, among others must be made an integral part of risk reduction and adaptation interventions.

- Climate risk management interventions need to focus on climatic as well as non-climatic drivers accentuating risks and impacts of processes related to climate change.

- The need to formulate holistic CRM programs incorporating elements of risk reduction and adaptation to address the same including better monitoring, tracking and analysis of precipitation and temperature data, conduct of detailed hazard, risk and vulnerability assessments, identification and mapping of hazard-prone and vulnerable communities/regions/ sectors and implementation of comprehensive initiatives involving natural resource management, water management and conservation, among others.

- Mapping of various regions in Nepal needs to be undertaken to better assess the impacts of climate hazards and extreme weather events including mapping of areas especially vulnerable to floods and droughts. Information management tools like GIS may be used to facilitate informed decision-making.

- With a view to better assess the impacts on key socio-economic sectors like industry, agriculture and water or others to be identified in accordance with governmental priorities, an integrated sector-specific climate risk assessment may be conducted for key development sectors.

- Research on drought and flood resistant varieties of crops by National Agriculture Research Council (NARC) and other relevant agencies, inter/multi cropping, drip irrigation/rain water harvesting, tunnel farming, bio-pesticides etc.

- Recognizing the widespread impacts of climate change, key national development policies and plans, including sector-specific strategies, may be reviewed to mainstream climate and disaster risk reduction into the overall development planning process to make it resilient.

- The absence of an over-arching national framework to coordinate disaster/climate risk reduction and adaptation activities is leading to piece-meal impacts. It will be appropriate to develop a national framework for DRR and CCA advocating a multi-stakeholder and multi-sectoral approach for effective CRM.

- Recognizing the strong private sector stake in mitigating the impacts of climate change, it will be important to promote a Public-Private-Partnership approach for CRM in the country. A policy document specifically facilitating private sector engagement especially in core socio-economic sectors should be formulated to facilitate the process. An economic assessment of climate risks and impacts for identified sectors can be undertaken with the involvement of the private sector.

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