CLIMATE RESILIENT PLANNING

Government of Nepal
National Planning Commission

A Tool for Long-term Climate Adaptation

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This document was prepared to facilitate the preparation of resilient periodic development plans. It is based on a report submitted by a group of experts which, under the technical assistance of the ADB, supported the National Planning Commission in preparing a climate-resilient three-year periodic development plan for the period 2011-2013. UNDP provided support for disaster risk reduction component of the plan. The experts were Mr. Govinda Gajurel, facilitator and coordinator; Mr. Adarsha Pokhrel, water resource expert; Mr. Madhukar Upadhya, natural resource expert; Mr. Suresh Raj Regmi, transport and infrastructure expert; and Mr. Bal Krishna Prasain, disaster risk reduction expert.

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FOREWORD

Even though Nepal's contribution to global warming is insignificant, the retreating of glaciers and the thinning of snow deposits in the Himalayas is a wake-up call for the nation to begin preparing to address the potential threat of emerging climate change. The increased incidence of droughts and the delays in the monsoon rains over the past few years, changes which have resulted in a decline in food production, have already shown that the threat of climate change to the nation's development efforts and to its economic base is serious. Floods caused by the ever-increasing number of events of intense rainfall have also decreased agricultural harvests. In addition to having to address growing food insecurity, Nepal is already saddled with the challenge of dealing with disasters that cause billions of rupees worth of damage to infrastructure and property. Indeed, every year, thousands of hectares of land are damaged by floods.

Climate change is expected to increase these threats, thereby undermining Nepal's development efforts and making it even more difficult for it to realize its overarching goals of reducing poverty and enhancing economic wellbeing. Recent reports provide ample evidence of the adverse impacts that changes in precipitation and temperature have had on agriculture, biodiversity, infrastructure and disaster events. Water scarcity in several places in the hilly region has forced people to migrate valleys, and both cold and heat waves have threatened lives and agriculture production in the Tarai plains.

The government has accorded high priority to addressing climate issues. It has initiated several measures, including the preparation of a national plan of action that deals with immediate and urgent needs and the implementation of a pilot program on adaptation. In addition, it has responded to the global call to mitigate climate change by launching initiatives in reducing emissions from deforestation and forest degradation (REDD+). While these efforts do indicate that action to address some of the critical issues of climate change is underway, there is still a need to mainstream climate-risk management in long-term plans and policies, and in particular, to integrate climate risks and risk reduction efforts into periodic development plans. For this reason, the National Planning Commission (NPC), in its approach paper to the three-year interim plan of 2011-2013, emphasized the need to adopt a mechanism to screen development plans and programs and make them climate-resilient. It envisioned integrating current and future vulnerabilities into the planning process, enhancing climate knowledge at the implementation level, and identifying areas for inter-sectoral cooperation aimed at building synergy in efforts to address long-term climate threats. The NPC received technical support from the Asian Development Bank (ADB) in developing ways to screen its plans for natural resources and the water, transportation and infrastructure sectors and from the UNDP in screening disaster risk reduction plans. The insights generated during the screening process have been invaluable in launching climate-resilient planning. This publication presents the methods and tools that were developed in the expectation that they will benefit planners as well as development organizations.

The framework proposed and the tools and approaches recommended draw from current understandings of global and national climate adaptation and are well within the capacity of development organizations to implement. We feel proud to be a part of this important initiative at this very critical time and hope that this document will help development organizations formulate climate-resilient plans and programs.

Barry J. Hitchcock
Country Director
Asian Development Bank

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This document is intended to facilitate ministries, departments and development organizations in analyzing sector-specific climate issues with a greater understanding of climate variables at the local level and in adopting measures to reduce the emerging and anticipated climate threats which face development plans and programs. It is hoped that the proposed tools will help see climate concerns being integrated into development plans and programs at the implementation level.

The document has been enriched by the valuable insights, suggestions, advice, and comments of the honorable Vice-Chairman of the National Planning Commission, Dr. Dinesh Chandra Devkota, who provided every support needed to clarify the concept of resilient planning and improve the document. Appreciation is also due to the former Vice-Chairman of the NPC, Dr. Jagadish Chandra Pokharel, and to the former Member Secretaries of the NPC, Mr. Yub Raj Pandey and Ms. Bindra Hada Bhattarai, for providing valuable inputs. Special thanks are due to Mr. Gopi Nath Mainali, the Joint Secretary of the NPC, for organizing interactions with various ministries and consultative meetings with sectoral experts and stakeholders. Joint Secretary Mr. Aatmaram Pandey; Dr. Badri Pokharel; Program Directors Mr. Sagar Acharya, Mr. Manahari Khadka and Mr. Radhakrishna Pradhan; Planning Officer Mr. Chakra Bahadur Budha, Computer Officer Mr. Subash Dhakal, and Computer Operator Mr. Bed Prasad Subedi; and other staff members of the NPC are also highly acknowledged.

The process of developing the proposed screening tools benefited substantially from discussions held with the planning officials of various development ministries and with other stakeholders at workshops organized by the NPC. The contributions of high-level officials of the ministries and the departments of Irrigation, Energy, Agriculture and Cooperatives, Forest and Soil Conservation, Physical Planning and Works, and of PPCR experts in conceptualizing and shaping resilient planning are highly commended. Thanks are also due to all those officials and experts of various ministries and organizations who provided valuable comments and suggestions at various occasions during the process.

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1. THE CONTEXT

Mountain ecosystems are susceptible to global environmental change; in fact, they are considered an indicator ecosystem as they are among the first to show the impacts of that change. Some early signs of the impact in Nepal are the rapid retreat of Himalayan glaciers and cycles of unusually heavy rain followed by long spells of drought. The all-Nepal maximum temperature increased by 1.80 °C between 1975 and 2006, with high-altitude area showing an annual increase of 0.120 °C during the dry season and lower altitude areas experiencing a rise of 0.060 °C between 1971 et al., 1991 and 1994. Days and nights are becoming warmer and cool days and cool nights are becoming less frequent (Shrestha et. al., 1999; Baidya et al., 2008). Climate modeling projects higher increments in temperature are projected over western and central Nepal than over eastern Nepal for the years 2030, 2060, and 2090 (NAPA, 2010).

The majority of the glaciers in the Khumbu region of Nepal Himalayas retreated by 30-60 m between 1979 and 1989, and the glacier surface thinned by nearly 12 m (Yamada et al., 1992; Kadota et al., 1992; Naito et al., 2000). Glaciers in the Dudh Koshi basin are retreating at rates of 10 ma–1 to 60 ma–1 and many small glaciers (<0.2 sq. km) have already disappeared (Bajracharya et al., 2007). Imja Glacier retreated 34 ma–1 from 1962 to 2000 and 74 ma–1 from 2000 to 2007, giving an average rate of retreat of 59 ma–1. This makes it one of the fastest-retreating glaciers in the Himalaya (Ives et al.; 2010; Bajracharya & Mool, 2009). The impact of glacial retreat is felt in the reduced water reserves for dry-season flow in snow-fed rivers. The rise in temperature has also caused the areas of glacial lakes to increase. About 21 are already large enough to pose a threat (Mool et al., 2001).

Projections for overall precipitation are mixed. Annual average summer precipitation is predicted to increase 15-20% in the Mid-hills and the Tarai. It is expected that in Western Nepal winter precipitation will not experience any change but that in Eastern Nepal it will increase 5-10% (NAPA, 2010). In the last few years the monsoon has arrived about two weeks late and there was virtually no winter rain in 2005 and 2008. Even though precipitation records have not shown any significant change in the overall trend, an analysis of daily precipitation records for 46 years from 1961 to 2006 shows that number of events of precipitation extremes is on the rise. In particular, the number of days with 50 mm or more of precipitation has increased.

Mountain systems are inherently prone to natural hazards, and climate change has exacerbated their vulnerability. Current changes in the climate and its variability directly impact the hydrological cycle and increase the risk for a multitude of water- and climate-induced hazards. For this reason, making linkages between climate change adaptation and disaster risk reduction is becoming increasingly important, particularly in the Himalayas. It is increasingly important to understand the ongoing changes, some of which are quite dramatic and which will no doubt have lasting impacts on the Nepalese society. Furthermore, it is important to understand local people's responses to these changes and to foresee how their present coping responses can be developed into sustainable resilience- building and adaptation that can be supported or built on further.

The emerging climate scenario demands that development plans and programs be made resilient enough that they can adapt to the changing situation and context. In fact, the integration of climatic risks in development plans and programs is essential to ensure the sustainability of development interventions. Sustainability depends on identifying climate threats and designing risk-reduction measures to mitigate or prevent them.

Community Resilience and Adaptation

Resilient communities are capable of bouncing back from adverse situations which confront them suddenly and periodically. In Nepal, rampant poverty and hunger and low levels of education and awareness have left most people incapable of influencing and preparing for economic, social and environmental change. According to Brigit and Cartwright (2008), the resilience perspective embraces the dynamic character of communities and human-ecosystem interactions and sees multiple potential pathways within them. It provides a powerful way of understanding how a community's positive response to change can be strengthened and supported. Development plans need to take into consideration and build on autonomous and adaptive responses in order to ensure a community's resilience and, ultimately, the success of planned interventions. Future interventions must focus on increasing resilience-capacity by building on the resources and adaptive capacities of a community.

Nepal has two notable successes in community development: its community forestry program and its farmer-managed irrigation systems. Community forestry demonstrates that community-based management can enhance adaptive capacity in two ways: a) by building the sorts of local networks that are important for coping with extreme events and b) by retaining the resilience of the underpinning natural resources and ecological systems. Tompkins and Adger (2010) argue that building resilience into both human and ecological systems is an effective way to cope with environmental change characterized by future surprises or unknowable risks.

Development Scenario and Climate Change

Despite enormous challenges, Nepal has done fairly well in certain areas of development. The GDP increased from USD 180 in the early 1980s to USD 472 in 2009 and the population below the poverty line has dropped to 25.4%. The infant mortality rate has fallen to less than 41/1000 and 80% have access to a supply of potable water. Irrigation water is available to over 1.25 million hectares of crop land. About 65% of all Nepalis are literate and gender parity has been achieved in primary enrolment. Life expectancy has increased significantly (66.3 years) in the last four decades. Hydropower generation has reached 691 MW and over 2.3 million people have access to telephone services. More than 19,700 km of road provide access to 73 of Nepal's 75 districts. Domestic airlines operate more than 30,000 flights a year connecting remote areas of the hills and mountains. Tourist arrivals have substantially increased with improved travel and accommodation facilities in major tourist destinations.

These gains and prospects for future attainments are jeopardized by the potential impacts of climate change. Irreversible glacial melt, unpredictable precipitation patterns, flash floods in the hills and downstream flooding, temperature fluctuation, extreme rainfall events, dwindling agricultural outputs, and degraded ecosystem services will affect food security, livelihoods, power generation, domestic income sources, and the state of physical infrastructures. In addition to meeting the existing challenges of mobilizing resources and improving governance for the effective implementation of development plans and programs, development organizations must address the felt and anticipated threats of climate change by adopting a resilient-planning framework in order to achieve the overarching goal of sustainable development.

2. RESILIENT PLANNING

Conventional approaches to responding to the impacts of climate change are often limited to designing measures to address the felt impacts in specific development sectors. Such actions are largely short-term, tactical, and reactive. In contrast, enhancing the resilience of development plans to climate risk in its entirety is a strategic and proactive move requiring that anticipated climate threats be assessed before implementing plans so that measures to reduce those threats can be built into the plan itself. A proactive move helps to assess how climate change might impact the sustainability of a proposed development work and the possibility that the proposed development work might impact natural systems, inadvertently amplifying the climate threats. A proactive effort to enhance the resilience of development plans and programs can be concurrent or anticipatory.

A resilient development plan is one that takes stock of felt as well as anticipated risks, creates synergy between mitigation and adaptation, improves climate knowledge, and helps improve the governance of development. A resilient plan provides the opportunity to explore ways to build partnerships among development actors and to devise innovations which make development works sustainable and cost-effective. In essence, resilient planning requires redefining development issues to address unaccustomed and new threats that cut across multiple features of interdependent areas. It also

requires responding to the physical, social, and economic impacts of climate change by establishing linkages that often lie outside the domain of conventional sectoral plans.

Increasing our level of awareness about the inter-linkages among climate variability, climate-change hazards, vulnerability, and development is a prerequisite to recognizing climate risks, which, in turn, is required to make a plan climate-resilient. Integrating climate considerations into sectoral plans helps enhance our understanding of the climate risks facing them. Screening development plans by using a climate lens helps evaluate them, in particular, identifying risks, inter-linkages, potential areas for building synergy, and ways to enhance local-level climate knowledge at the implementation level. The sort of in-depth analyses required to understand risks are often sector- and area-specific. Each development sector has its own sets of specific environmental requirements as well as vulnerabilities to particular hazards. Geographical location and the local environment add additional layers of complexity to these already intricate analyses, as do the socio-economic characteristics of the affected population.

The complexity entailed in the evaluation of risk can be simplified by using a conceptual framework that helps isolate natural and human-constructed systems for analysis: a systemic approach. A systemic analysis facilitates the quick application of a climate lens to evaluate both whether a plan or program is at risk from climate change and whether it will increase risks. If a development action is assessed to be at risk, the systemic approach allows for the identification of the nature of the hazard(s), an assessment of the extent of the risk, a working out of response options, and the identification of appropriate intervention(s). The approach also helps minimize the risk of inadvertently increasing climate threats by revealing areas where adaptation by one development sector may increase climate risks to another. The approach also assists in recognizing areas for building synergy.

3. SECTORAL VULNERABILITY TO CLIMATE THREATS

Natural Resources

Land, water, and forests are Nepal's key natural resources. The degradation of these resources not only has an adverse affect on agriculture and livestock, including dairy farming, transportation, infrastructure, forest-based industries, and hydropower, but also intensifies disasters such as landslides, floods, and soil erosion which have lasting consequences. The fragility and sub-optimal management of the natural resources of mountain ecosystems has left Nepal facing many problems. The shortfalls in resource management are inefficient resource exploitation, ineffective coordination among institutions, and limited information and knowledge about area-specific problems. Even though the protection and management of forest resources has had a number of successes, including the establishment of protected ecosystems and community forestry, the overall status of natural resources, including land and water, is in the decline, as is manifested in the increase in the number of disaster events, water shortages, declining or stagnant land productivity and the dismal state of the biomass-based rural economy.

The difficulty in managing natural resources is further compounded by a contradiction: environmentalists want more forest cover to maintain biodiversity and ecology, while agriculturists need more land to produce enough food for the growing population. Water managers fear that unless Nepal reduces its water footprint, it will be extremely difficult for it to meet the water demands of the growing economy and to meet the needs of the food production system so that the food supply can be maintained. The challenge for resource managers is to strike a balance between these competing desires.

The degradation of natural resources and widespread poverty is the outcome of a complex interplay of natural phenomenon (erosion, floods, droughts, and storms) and the social processes (migration, rising aspirations, and so on) within which they occur. Global climate change is expected to cause a significant alteration in Nepal's temperature regime and rainfall patterns, which will in turn affect the quality of and have a lasting impact on its water, agriculture and biological resources. Responses which address both natural and social processes require an interdisciplinary approach, one that considers living and nonliving environments, including human-built systems (infrastructure and institutions) as well as the complex inter-linkages among them that are subject to constant changes.

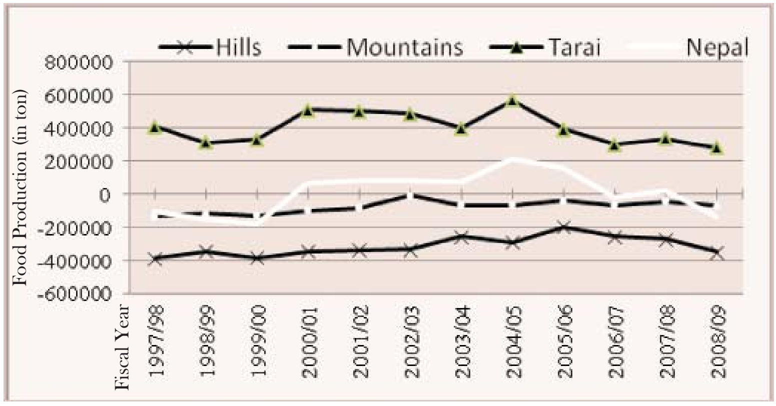
The climate impacts encountered in the forest, agriculture, water, disaster, and infrastructure sectors are largely related to changes in precipitation and temperature. Adaptation to climate change depends on the ability to recognize inter-linkages among various aspects of natural resources and development interventions. Such recognition will help enhance the adaptive capacity of private and public institutions and that of the communities to manage natural resources prudently. Making development plans climate-resilient provides an opportunity to identify key areas where such linkages among development partners can be established.

Agriculture

Nepal has accorded high priority to agricultural development since its very first development plan adopted in 1956, yet the majority of hill and mountain districts (about 45) are not able to produce enough food to meet the local demand. Dominated by small-scale and marginal farming, agriculture employs about 60% of the population. The proportion of the total land area devoted to agriculture has increased, but the overall per capita landholding decreased due to land fragmentation.

Agriculture productivity has remained stagnant or declined across the country. The food balance situation between 1997/98 and 2008/09 was not encouraging: most hill and mountain districts report a food deficit and even though many Tarai districts produce surplus food, whether or not they do and how large that surplus is depends on monsoon rain. The vagaries of monsoon rain (whether it is delayed or below average or so heavy as to cause flooding) affects food production in Tarai, often making the national food balance figure negative. For example, the years 1997/98, 1998/99, 1999/00, 2006/07 and 2008/09 were all food-deficit years (see Figure 1). Furthermore, due to the poor transport network in the mountains and the comparatively lower incomes of mountain dwellers, the surplus in the Tarai plains does not easily flow to upland areas. Food adequacy at the national level, therefore, does not guarantee food security in the hills and mountains.

Figure 1: National and Regional Food Balances



(Source : Ministry of Agriculture)

Agriculture in Nepal is largely monsoon-dependent and sowing times usually coincide with the advent of rainfall. Maize in the uplands is sown in April and harvested in August. Millet is planted as a relay crop with maize. Rice is transplanted with the onset of the monsoon in mid-June. The lower temperatures mean that crops take longer duration to ripen in the temperate upland areas than in sub-tropical lowland but all summer crops are harvested before the temperature begins to fall in November. Since agriculture is sensitive to climate fluctuations (FAO, 2007), delayed or below-average rainfall, including extended drought or the shortening of the maturation period, will impact production adversely.

Climate change is expected to modify agricultural activities by causing an upward shift in the altitudinal boundaries of agro-ecological zones and the movement of certain crops, livestock and fish species to higher altitudes. Such a shift may cause losses in agro-biodiversity due to the limited adaptability of various species and the shrinking of habitats for livestock and fishery. Increased events of drought and uncertain rainfall patterns will lead to soil moisture depletion and to less water being available for irrigation as springs dry out sooner at high elevations. More events of intense rain will, in contrast, lead to increased soil erosion and land degradation. Agriculture in the plains and valleys will be affected by floods, sand-casting and inundation. Weeds, diseases and pests are likely to increase and invasions of exotic species increasingly possible. The overall impact will be a decline in the quantity and quality of some crops and animal products. The fact that changes in temperature and precipitation patterns may change crop phenology is another reason the productivity and quality of agricultural crops may deteriorate.

Although there is still uncertainty about how the impact of climate change will play out locally, it is possible that temperate regions that cover a small area could benefit from the rise in temperature, while the vast warm regions will be impacted negatively. Given the fact that agricultural productivity is already stagnant or declining, climate change is likely to have devastating consequences. The changes outlined above will weaken the livelihood bases of poor people as they suffer from the losses of physical capital (damage to infrastructure), human capital (malnutrition and disease), social capital (forced migration), natural capital (degradation of soil and water) and financial capital (reduced income). As a result, farmers' capacity to adapt to climate shocks and stresses will diminish.

Biodiversity

Nepal's flora and fauna are diverse at the genetic, species and ecosystem levels. This diversity is found in the dense tropical monsoon forests of the Terai (67–100 masl), the deciduous and coniferous forests of the subtropical and temperate regions (2000–3000 masl), and the sub-alpine and alpine pastures and snow-covered peaks of the Himalayas (> 3000 masl). Much of the nation's flora and fauna of Nepal has global significance; in fact, a good number are globally-threatened plant and animal species.

There are 118 major ecosystems within Nepal's 147,181 sq. km. and forests occupy 39.6% (5,830,360 ha) of that area. The heavily populated plains of the Tarai are dominated by sal forests, tropical deciduous riverine forests, and tropical evergreen forests. The Mid-hills have the greatest diversity of ecosystems and species due to the diversity in topography and climate, which ranges from subtropical to temperate. Further up, the High Mountains have harsh environmental conditions and thus have relatively less diversity in flora and fauna compared to the Mid-hills and lowlands. However, a large number of endemic species are found in the 38 major ecosystems found in the High Mountains. Nepal's grasslands are also rich in biodiversity. About 12% of the total land area is occupied by different types of grasslands, including subtropical savannahs, temperate grasslands, alpine meadows, and the cold, arid steppes of the trans-Himalayan region.

Agriculture is equally diverse. Various types of cereals, pulses, oilseeds, and fruits are found in Nepal. The principal crops grown include rice, maize, wheat, millet and potatoes. Rice, beans, eggplant, buckwheat, soybeans, foxtail millet, citrus fruits and mangoes have high genetic diversity. Many crop species owe their variability to the presence of about 120 wild relatives of the commonly cultivated food plants. Nepal's wetlands also support considerable biodiversity.

In addition to existing problems, such as high population pressure, the low level of public awareness about the importance of biodiversity, insufficient data and information for management planning, poor understanding of ecosystem sensitivity, and the absence

of integrated land and water management, climate change has imposed new threats in the form of shifting altitudinal boundaries for plants, the shrinking of plant habitats, plant migration, species loss, forest fire, and extended drought with a lasting impact on biodiversity. Diseases and pests will be more common, particularly in the river valleys where the predicted increase in the levels of humidity will create a favorable environment for them to flourish. Plant communities in transitional areas between two microclimatic zones will be most affected.

Since biological diversity in Nepal is closely linked to livelihoods and economic development, its protection is crucial. The government's commitment to protecting biological resources and ecosystems for the benefit of the people and its honoring of its obligations under the Convention on Biological Diversity led to the formulation of a biodiversity strategy. This strategy helps to consolidate successful past efforts and to draw a future course of action to reduce climate threats.

Infrastructure

Since infrastructures such as transport, hydropower, irrigation, water supply and sanitation, housing, and communication are the lifelines of socioeconomic development, it is not surprising that about half of the annual development budget is spent on their development and maintenance. Floods, landslides, and siltation during the monsoon render many of these lifelines dysfunctional every year and their repair and reconstruction costs the nation dearly. In addition, damaged infrastructures impede the functioning of other economic sectors-sometimes for long periods-incurring a huge economic loss. A damaged road, for example, hinders the movement of people and goods and adversely affects industry, business, markets, and all other allied activities. When a hydropower plant is damaged, it is not only the production of electricity that stops, but all output of industries that rely on electricity from that plant. Protecting infrastructure against

disasters is crucially important to lower the costs of repair and maintenance as well as to continue to allow the unobstructed pursuit of business activities.

Climate change, which forebodes ever more extreme events at ever greater intervals, is likely to pose a great threat to existing as well as future infrastructures. Increased instances of drainage congestion, scouring, inundation, slope instability, land subsidence, erosion, and collapse of structures are likely. Floods, landslides and debris deposits will affect hydropower, roads, bridges, irrigation, settlements, water supply and sanitation, while the drying up of water sources will impact drinking water and sanitation, irrigation, and micro hydro plants.

In addition, temperature variations tend to accelerate structural fatigue and materials failure in road pavements and metal structures. The impacts could be severe in areas where infrastructures are not designed to cope with the effects of climate change. If investment in infrastructure is to be productive and sustainable, it needs to be made climate resilient by incorporating anticipatory measures during design and implementation.

Water

Water is perhaps the most complex of natural resources to analyse because the hydrological system is so complex. Water is available in a finite quantity for a limited period in the form of snow, surface water, groundwater, and soil moisture depending upon the land system. Precipitation replenishes water resources, while gravity and temperature, including humidity, deplete them constantly because water either flows, percolates or evaporates. When a precipitation event disperses more water in a short duration than is required or can be used for replenishment, the surplus runs off as floodwater. The process involving precipitation, source refill, flooding and depletion is collectively understood as the hydrologic cycle. Every river basin has a unique cycle which leaves some areas water-rich and others water-poor.

Forests, pastures, and dry-land agriculture use the available soil moisture, whereas demands for other economic or domestic uses are met by surface and groundwater and usually require that water be taken away, altering the hydrologic processes at both the source and the destination. Any change in the hydrologic cycle or temperature or both affects the amount of water available, the time at which it is available, and the duration for which it is available. In other words, water is very sensitive to changes in precipitation and temperature. Climate model simulations suggest that climate change will impact total flows, seasonal runoff, high- and low-flow conditions, and surface-groundwater interactions

Documented evidence shows that the incidence of high-intensity precipitation is increasing and that the temporal incidence of precipitation is changing. The rapid melt of snow and glaciers has affected the hydrology of many snow and glacier-fed rivers. New glacial lakes have been formed and existing glacial lakes are expanding rapidly. The impact of climate change on the water sector is going to increase threats of glacial lake outburst floods (GLOFs), floods, drought, siltation, inundation, mass wasting, erosion, and water source depletion. Tourism will also be hurt as many of Nepal's tourist destinations are located at high elevations and mountain expeditions are a big draw.

The likely effects of the rise in temperature on rainfall patterns is difficult to assess; however, it is possible that the cloud line has risen due to the warming of the atmosphere, causing it to rain in areas that received very little or no rain in the past. Because clouds are higher, they can now cross mountains that were previously insurmountable. As a result, rain shadow areas such as Mustang have begun to receive rainfall in the summer, perhaps at the cost of rain on the windward side. This and other spatial shifts in rainfall have upset local-level precipitation patterns.

Water sources situated at high elevations are more sensitive to reduced rainfall than sources at low elevation because less water is retained in the high groundwater systems. Springs at high elevations are drying early and the annual period of flow of rain-fed streams and rivulets has grown shorter. The frost line also has shifted up. Variability in rainfall patterns and timing will increase the incidence of drought, which in turn will affect forests, pasture and rain-fed agriculture. In fact, droughts are already occurring more frequently.

The prolonged droughts which have occurred annually since 2005 have forced farmers in Eastern Nepal to turn way from cereals and embrace horticulture. Some farmers were even forced to abandon farming altogether. When water sources in the immediate vicinity of a household dry up, villages must travel to distant sources for drinking water and the number of disputes rises. People have to make do with whatever water is available, regardless of its quality and the health implications. Sanitation levels decline with a decline in water (ICIMOD, 2009).

The impact of climate change on hydropower generation has serious implications. As most of the existing hydropower plants are run-off-river type, stream-flow variability makes the energy sector vulnerable. An increase in the maximum average temperature by 0.06 ºC per year would increase the theoretical hydropower potential by 5.7% by 2030 but it would then decrease and be down 28% by the end of the century (Chaulagain, 2007).

Disaster Risks

Nepal is exposed to a multitude of hydro-meteorological hazards, including floods, landslides, droughts, windstorms, hailstorms, cloudbursts, fires and epidemics. Of the 75 districts, 49 are prone to floods and/or landslides, 23 to wildfires, and one to windstorms (NDR, 2009). According to German Watch Index 2006, Nepal is ranked the sixth most vulnerable country in the world in terms of vulnerability to climate change-induced hazards. The records between 1971 and 2006 reveal that climate-related disasters accounted for almost 25% of deaths, 84% of the disaster-affected, and 76% of economic losses. In the last 20 years, properties worth nearly USD 288 million, or about USD 23 million a year, have been lost. In 2007 alone, 100,000 ha of paddy fields were lost to floods.

Disasters are a serious impediment to Nepal's development and have undermined its development gains and its achievements in poverty alleviation and the millennium development goals. The poor and the disadvantaged are hit the hardest by disasters. Climate change is likely to increase the frequency and magnitude of floods, flash floods, GLOFs, landslides, hailstorms, windstorms, forest fires, heat and cold waves, droughts, and epidemics.

Poverty and Environment

Nepal's vulnerability to climate change is compounded by socio-economic and environmental factors, including increasing pressure on natural resources and weak governance. Heavy reliance on forests for fuel wood, timber, land, and infrastructure development not only threatens biodiversity but also increases the incidence of floods and landslides. The absence of a clear policy on land use and tenure rights continues to result in rapid unplanned urbanization. Access to clean energy in rural areas is also a major challenge: most rural people depend on bio-mass based energy. Communities engaged in the conservation of water resources have few incentives to continue their work.

The government's Poverty-and-Environment Initiative (PEI) focuses on improving the management of natural resources for more inclusive and sustainable development. It aims to strengthen the capacity of central and local authorities to integrate poverty and environmental issues into development and fiscal planning, in turn strengthening the capacity of local governments to deal with climate change and adaptation.

Health

Climate change is expected to increase morbidity and mortality associated with communicable diseases. Increased flooding and the resulting contamination of water supplies will lead to an increase in the occurrence of diseases like typhoid, diarrhea, kala-azar, malaria, cholera, dengue fever, encephalitis, and jaundice. The area in which vector- and water-borne diseases are endemic is expected to expand.

4. CLIMATE FRAMEWORK STRATEGY

Framework Context

A climate framework has been developed on the basis of Nepal's vulnerabilities, adaptation needs, and mitigation potential in accordance with the country's needs as well as in accordance with its commitments to global initiatives.

The Interim Constitution of Nepal, 2007: The framework observes the spirit of the Interim Constitution of Nepal (2007), which states that the state shall have the responsibilities of raising the standard of living of the general public by fulfilling the basic needs of the people of all regions; and by protecting the forest, vegetation and biodiversity and ensuring their sustainable use and equitable distribution of the benefits derived from them.

Sustainable Development Agenda: Sustainable Development Agenda: The Sustainable Development Agenda of Nepal (2003) envisages integrating environment and development in the national policymaking and planning framework by stressing public participation in ecosystem conservation at the landscape level in order to protect valuable biological diversity and agro-biodiversity and the sustained harvesting of non-timber forest products.

Millennium Development Goals: Nepal endorsed the Millennium Development Goals of the UN in 2002 and has committed itself to the global call for reversing the loss of environmental resources by integrating principles of sustainable development into national policies and programs.

Food Security: The government has expressed its obligation to maintain food security in its Agricultural Policy (2004), which aims to conserve, promote and utilize natural resources, the environment and biodiversity in order to maintain food sovereignty by ensuring food security.

The Strategic Vision for Agricultural Research (2011-2030): recognizes the need to assess the impacts of excessive rainfall, drought, and disease and pest infestation – factors whose negative impacts will be exacerbated by climate change. Agricultural research will focus on adapting to water shortages and fostering technologies to exploit the benefits of or to counter any negative effect arising from climate change.

Environmental Protection: The degradation of land, loss of biodiversity, and shortage of water are major environmental problems in Nepal. Solid waste is an environmental problem common to urban areas. The disposal of waste in rivers has degraded the quality of their water and the aesthetic value of rivers and cities. The impacts of poor quality water on human health are substantial. The IEE and environmental impact assessment (EIA) processes are mandatory for certain types of development projects. The sectoral development policies regarding various infrastructures and the forest, and water sectors ensure that environmental impacts are minimized while developing new projects and that mitigation measures are implemented if they are required.

Biodiversity Conservation: The government ratified the Convention on Biological Diversity and the Convention on Climate Change, which requires the signatory to integrate conservation and the sustainable use of biological resources into national decision-making. The government has since developed the Nepal Biodiversity Strategy to honor its obligations and to ensure that its biologically diverse resources are protected and wisely used for the benefit of the people. This strategy provides a platform to support climate adaptation by integrating matters related to livelihoods, agricultural productivity and sustainability, water resources, human health and nutrition, indigenous knowledge, gender equality, and economic development.

Disaster Risk Reduction: The National Action Plan for Disaster Management (1996) prescribes measures for preparedness, response, reconstruction, and rehabilitation to minimize disaster impacts. A new bill providing for the establishment of a national disaster Management Council is in the process. To honor its commitment under the Hyogo Framework of Action (HFA 2005), the government developed the National Strategy for Disaster Risk Management in 2009.

The Approach Paper: The NPC's approach paper (NPC 2010) to the government's three-year national development plan for 2010-2013 recognizes the potential threats posed by climate change to the sustainability of development activities and emphasizes the need to make all proposed development plans climate resilient by incorporating measures to reduce the risk. The paper specifically stresses the need to address climate-change impacts in the sectoral strategies for natural resources, water, poverty alleviation, food security, infrastructure and disaster risk reduction.

Guiding Principles

The proposed climate-change framework adheres to the following guiding principles in order to provide a basis for addressing climate risks, vulnerabilities, adaptation needs, and mitigation potential as per Nepal's requirements.

1. The framework envisions a climate risk-resilient Nepal.

2. Nepal, as a party to the UN Framework Convention on Climate Change, adheres to global commitments and the principle of common but differentiated responsibilities.

3. The impact of climate change will have significant temporal and spatial variations in Nepal due to its geographical diversity.

4. The state will take proactive measures to anticipate, prevent and minimize the risk of climate change and its adverse impacts. The lack of scientific evidence will not be used as a reason for postponing the addressing of serious threats or irreversible damage.

5. Adaptation and mitigation measures will adhere to the core principles laid out in the international conventions and treaties to which the state is the party.

6. Though the national priority will be adaptation, the mitigation of the adverse impacts of climate change and the adoption of a low-carbon development path will be used to maximize the benefits reaped from adaptation measures.

7. Action will be focused on poor, deprived, disadvantaged and marginal communities to ensure they get equal and equitable protection.

8. The adaptive capacity of vulnerable communities will be enhanced and the resilience of natural resources to climate change will be increased.

9. The principle of complementarities shall be observed to ensure that no action in one sector restricts the initiatives of any action in another sector or violates its mandates as provided for by law.

10. The framework recognizes the role of the private sector, the civil society and the media in ensuring multi-stakeholder participation and partnership in climate change initiatives and thus envisions the development of policies and incentive mechanisms to facilitate their participation and partnership.

5. THE FRAMEWORK

Vision:

The climate framework envisions achieving a society and economy that is resilient to a changing climate.

The above vision statement can be elaborated as follows. In a resilient society, all people, including the poor and vulnerable, have the capacity to respond in an adaptive (as opposed to reactive) way to current and future climate risks. They will have many choices, feel secure, and will be willing and able to invest in improving their livelihoods. Formal and informal institutions will reinforce the abilities of individuals to predict, prepare for, and recover from climate shocks. They will learn to monitor and respond to changing conditions in a timely, flexible and efficient manner. Practitioners and policymakers will be equipped with the knowledge, tools, enabling policies and sustained funding needed to implement decisions in a manner that increases resilience.

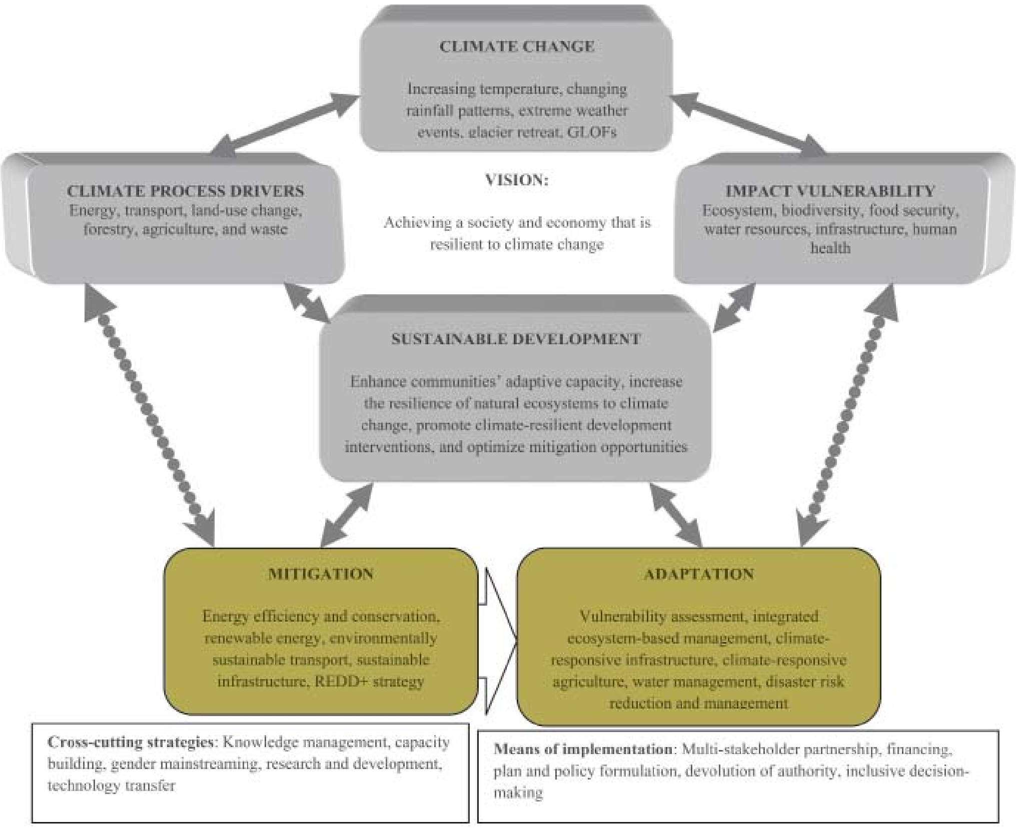
Mission:

The mission of the climate framework is to set in motion the preparation of periodic development plans by developing an understanding of climate risks and adopting measures that would make the plans climate-resilient. To achieve this, the framework considers the vulnerable aspects of key sectors that are likely to be directly affected by climate change and identifies linkages between and among sectors.

Climate Framework

The framework broadly recognizes various issues of climate change, including its drivers and impact vulnerability, and outlines mitigation and adaptation measures to achieve its fundamental goal of sustainable development under the felt and anticipated climate scenarios. The framework also identifies cross-cutting issues that are crucial for the effective implementation of climate-resilient development interventions in order to realize the nation's development vision.

Figure 2: Climate Framework



(Source: Adapted from NFSCC, 2010)

Climate-Process Drivers

The framework recognizes the universal climate-process drivers and their significance in the Nepalese context. The major climate-process drivers in Nepal are biomass- and fossil fuel- based energy and transport, land-use changes, deforestation, agricultural activities and waste generation. These activities generate greenhouse gases (GHGs), which is a major cause of global warming. Nepal's contribution to GHG emission is very low, so the prospect of reducing GHG emissions is not significant. However, Nepal has substantial potential to generate clean energy using hydro, solar, and wind power, as well as biogas in order to reduce its dependency on fossil fuel-based energy. Nepal could adopt alternative modes of transport, such as ropeways using hydroelectricity or gravity power, to control its GHG emissions. Managing wastes in urban centers offers the potential, though not on a significant scale, of reducing GHG emissions by converting wastes into energy and organic manure. Nepal can contribute substantially in reducing atmospheric carbon dioxide by increasing the area under forest in part by reducing deforestation and in part by engaging in plantation and other activities which increase greenery. The amount of GHGs emitted through agricultural activities is difficult to assess as the activities are scattered and carried out by a large number of small farmers across a diverse topography with varied climatic conditions. Agricultural activities need to be considered for GHG emission when commercial farming and large-scale dairy farming begin to come into existence.

Impacts and Vulnerability

The framework accepts that there will be key climate-change impacts such as the increased frequency of extreme events, including floods and droughts; significant warming, particularly at higher elevations, leading to a reduction in snow and ice coverage; and overall increase in regional precipitation during the wet season but a decrease in the Mid-hills. The framework considers that water security, food security, the state of biodiversity and human health will face negative impacts with and that people's vulnerability to shortages and to disease will increase. The number of climate-induced disasters is expected to increase.

The impact of climate change is more concentrated and more evident at high altitudes than it is in the Mid-hills and the Tarai, where it is less obvious but more widespread and more harmful to the economy. Even within a particular ecological region, some places will be impacted more than others. The areas around all the major river valleys of the Mid-hills, for example, exhibit an altitudinal variation in their climate as humidity levels decline with altitude.

While the focus should be on assessing the vulnerability of development interventions to the changing context, the lack of information about the changing climate at the local level is a major obstacle. Nepal's diverse terrain and latitudinal range (between 26 and 30 degrees) adds to the complexity: the nation's climatic conditions range from subtropical to alpine and from semi-arid to per-humid. In between these climate ranges there are transitional areas where a mixture of climatic conditions prevail. Such transitional areas are sensitive to even the smallest of changes in temperature or moisture condition. The initial signs of climate impacts seen in such sensitive areas are plant migration, pest infestation, and the occurrence of diseases.

Sustainable Development

The framework provides a basis for planning climate-resilient projects and programs based on the principles of sustainable development. In order to achieve the overarching goal of sustainable development under the felt and anticipated climate scenario, the framework highlights three key areas that form the core of climate-resilient planning. Enhancing the adaptive capacity of the communities through resilient development plans and programs should be the leading strategy. Adaptive capacity is a function of access to information and technology, opportunities to diversify options, ability to access funds for implementing adaptive measures, and opportunities to identify areas for cooperation in building synergy.

The second strategy explores ways to enhance the resilience of natural ecosystems, primarily water sources, to climate change. This exploration will form the basis of evaluating development interventions for their impact on climate change, and its outcome will help planners take the needful actions if any intervention is found to aggravate climate-change impacts. The third strategy is to promote climate-resilient interventions which incorporate anticipated risks, create synergy between mitigation and adaptation, improve climate knowledge, and help improve the governance of development. Finally, it is important to explore opportunities to optimize mitigation opportunities if they contribute to adaptation.

Mitigation

Though Nepal's contribution to global GHG emission is insignificant, the government still recognizes the need to reduce GHG emissions without affecting overall economic development. Opportunities for mitigation are low, but Nepal is committed to taking all possible measures to promote a low-carbon development path in order to maximize benefits from adaptation. Nepal will embark on a mitigation strategy for two reasons. First, it must reduce its dependency on unsustainable and expensive fossil fuel, which costs Nepal a significant share of its revenue, and seek self-reliance by promoting renewable sources of energy for fuel-sustainable development. Second, the mitigation strategy will contribute to the global effort to reduce emissions by promoting renewable sources of energy and reducing emissions from deforestation and degradation. The strategic priorities for mitigation include the following:

- Promoting the reduction of Nepal's carbon footprint in the development and operation of infrastructure through energy efficiency and conservation;
- Promoting renewable energy sources to meet the demand for energy;
- Promoting environmentally sustainable infrastructure; and
- Implementing the REDD+ strategy.

Improving the transport sector is central to mitigation efforts. GHG emissions from the transport sector in Nepal increased from 643.7 Gg in 1994/95 to 2442.1 Gg in 2010 and are expected to reach 3768.6 Gg by 2020. With the current rate of increase in vehicle ownership - 12% per annum-emissions could go beyond the projected limit, thus rapidly expanding the country's carbon footprint and increasing pollution in urban areas. A low-carbon path in the transport sector is, thus, essential. The framework envisages improving the transport sector's efficiency in the following ways:

- Promoting clean energy-based alternate transport system such as railways and ropeways;
- Promoting models to improve the transport sector's efficiency and to demonstrate modal shifts;

- Converting public utility vehicles to liquid petroleum gas and renewable energy sources and establishing and expanding an efficient mass transport system; and

- Ensuring the movement of vehicles at optimum speed of fuel consumption by reducing congestion and maintaining road sand vehicles.

Adaptation

Adaptation not necessarily means developing completely new ways of doing things; it may simply mean adjusting or modifying ongoing activities in such a way that the threats are reduced and risks minimized. Adaptation entails modifying or developing ways to adapt to the emerging trends of increased temperature and diminished water availability. Adaptation concerns need to be incorporated into development plans and programs despite the fact that the lack of information about Nepal's diverse climatic conditions and the changes taking place within them hinders mainstreaming adaptation in the planning process.

Climate impacts are often first detectable within the water sector, the state of which is shaped by the hydrological cycle of a given river basin. Hence, as the approach paper recommends, adaptation needs to be enveloped within the ecosystem-based basin management and to emphasize climate-responsive agriculture, climate-responsive infrastructures, biodiversity conservation, water management, and disaster risk reduction and management measures.

Cross-Cutting Issues and Implementation

Addressing the cross-cutting issues in climate risk management broadly include knowledge management, capacity-building, gender mainstreaming, research and development, and technology transfer. The process needs to begin with managing knowledge systems in order to develop an understanding of underlying risks and cross-cutting issues. This knowledge, in turn, will help build the capacity of multiple sectoral actors to relate these risks and issues to the local conditions and encourage them to act collectively and cooperatively to address them. Only once the knowledge has been built, can climate-resilient plans and programs be implemented.

Implementing resilient plans and programs demands that synergy between and among development activities be built. The level of synergy that can be achieved is determined by the extent to which development activities share a resource or problem. For example, declining water availability in an area eventually affects not just the water sector, but all other sectors that depend on water availability. An extended drought often results in crop failures, a drop in the production of hydropower, a reduction in milk and meat production, and a shortage of domestic water supply in downstream areas. None of these downstream sectors can effectively increase water availability; it is augmenting infiltration in upland areas for a longer duration during a rainfall event that can. Paradoxically, those who augment infiltration in upland areas do not benefit from the water they save and water users downstream are not present in the upland areas to participate in the expanding of augmentation. Connecting these two groups of people by introducing the concept of 'green- water credit' is sensible as it will reduce water problems in downstream areas and increase income for people upstream.

The example above points to the fact that the implementation of plans and programs needs to consider those concerns that lie at the interfaces between and among various sectors and that the creation of multi-stakeholder partnerships can yield adequate financing for implementation. The government needs to formulate a policy landscape in order to ensure that such partnerships will plan and implement climate-resilient plans and programs. The devolution of authority for inclusive decision-making will be a key component of the policy.

6. SCREENING APPROACH

International Learning

Various terms such as "climate-proofing," "climate risk-screening," "risk analysis," and "risk assessment" are used to refer to managing climate risks. "Climate-risk management" is a generic term used to refer to an approach to promoting sustainable development by reducing vulnerability associated with climate risks. While climate-proofing focuses on project-level implementation and analyses specific activities, mainstreaming deals with the integration of climate concerns and adaptation responses into relevant policies, plans, programs, and projects at the national, regional, and local scales. Resilient planning requires both.

A number of donors have conducted climate screenings of their projects using a variety of tools that are in the process of being designed and developed by researchers and donors. A stocktaking report published by UNDP in 2010 provides a brief description of screening tools and guidelines that support the mainstreaming of climate change adaptation. The screening exercise uses a climate lens to evaluate a development plan or program to find out whether it is at risk from climate change or not. If it is not at risk, no further work needs to be done, but if it is, further work is required to identify the extent of the risk, assess climate-change impacts and design interventions to reduce the risk.

Commonly used screening tools are Climate - FIRST (ADB), ORCHID (DfID), CRiSTAL (SDC, IISD, SEI, IUCN), and ADAPT (WB). Though all these tools are used to assess vulnerability and adaptation needs in a participatory way and to create awareness about climate change and development, they differ in terms of aim, approach, level of analysis and target groups. Many are software-based. Their essence can be distilled for use in screening periodic plans and programs.

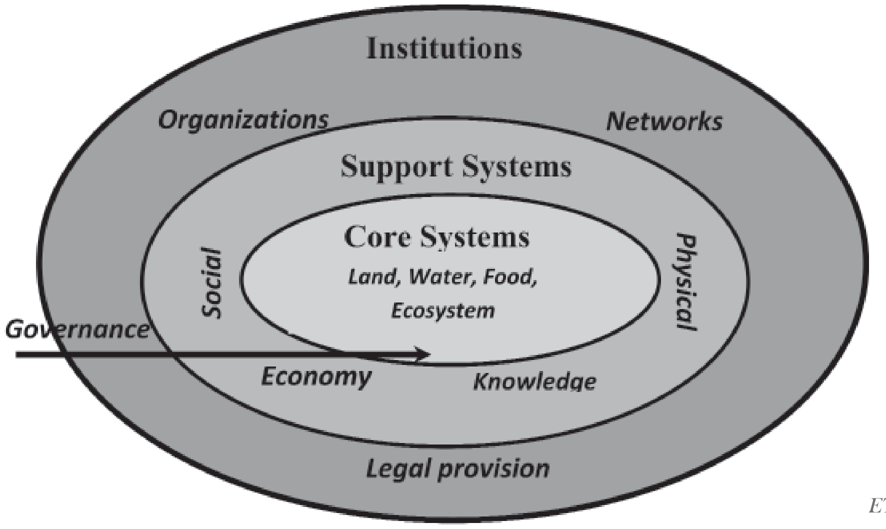
Nepal's IEE and EIA frameworks for evaluating a project for its environmental impacts are well-established and stakeholders are familiar with their application and procedures involved. What is required for climate risk-screening is to take one step further and to evaluate a proposed plan or program in terms of how it will be affected by and/or aggravate the emerging climate threat. The method proposed below for resilient planning builds on both global and regional experiences in using various screening tools as well as on Nepal's IEE and EIA frameworks and follows a systemic approach so that the complexity of systems can be incorporated with qualitative knowledge in order to carry out climate screening.

The Systemic Approach

To adapt to climate change, Nepal needs to consider multiple factors, including some that do not fall directly under the environmental domain. For example, reduced rainfall hinders paddy cultivation and subsequently affects food security, but the same amount of rain could well support maize cultivation. A sound proposition could be made to shift from the cultivation of paddy to the cultivation of maize in order to maintain food security. Social considerations, however, may make this proposition untenable: the social value of rice is much higher than that of maize, so people may not accept the substitution. As this example makes clear, any analysis of the risks to and vulnerability of a society which is considering adaptation options requires a thorough understanding of various interdependent and interconnected variables.

Brenkert and Malone (2005) and ISET (2008) have suggested using a systemic approach to analyze the complexity of systems. According to them, a systemic approach recognizes three broadly-defined systems: core, support and institutional. Core systems include physical entities, such as land, water, and ecosystems, which will be directly impacted by changes in precipitation and temperature. Declining water availability, loss of biodiversity, plant migration, increasing incidence and severity of disasters, outbreaks of pest infestations and diseases, and declining food security are related to components within the core systems. Support systems include those physical, social, and economic infrastructure that play an important role in managing core systems and promoting

Figure 3: Schematic Diagram of System Approach



ET, 2008)

adaptation. Support systems play a crucial role in devising climate-resilient development plans. Their strength determines the extent to which technology, financial support and social capital are available to develop adaptation options. The most encompassing system is that of institutions, including organizations, networks and legal provisions. Institutions are not affected directly by climate change, but their arrangements influence the strength of support systems, which do deal directly with the impact of climate change on core systems. Governances cut across all systems and the level of governance determines the state of each system.

Since every place and its set of vulnerable or resilient characteristics is unique, the systemic approach help define a relatively small set of interaction types, and helps to integrate the qualitative knowledge needed to formulate the precise intervention needed to make a proposed project resilient to climate stress. Furthermore, it helps analyse different conditions created by development interventions that exacerbate climate impacts. A systemic approach also helps to assess the likelihood that large-scale projects or the introduction of inappropriate economic activities will degrade natural resources and thereby result in declining water availability, increasing floods, and disturbances to the local hydrology. In short, the systemic approach allows us to segregate key areas in which development plans can be evaluated for their resilience.

7. SCREENING STEPS

The climate screening of a development plan or program is done in four steps. They are (1) identifying sector-specific limitations, (2) understanding impact linkages in order to identify points of entry, (3) developing an area-specific sectoral sensitivity matrix, and (4) screening a plan or programme against system components.

Sector-specific Limitations

Climate screening requires identifying potential risks using appropriate indicators. However, it is difficult to identify potential risks and to estimate the extent of their impact without local-level information about various climatic factors. A broad picture of climate change does not reveal the differences in climate risks and impacts from sector to sector. For instance, a slight change in temperature may affect agriculture by altering the flowering time of a crop, but it does not pose any threat to infrastructure, whereas a prolonged drought will pose a threat to agriculture, water supply, hydropower projects, and health but the consequences for each will be strikingly different. The information which is needed to evaluate the threat to one sector is likely to be different from that required by another sector.

Our understanding of climate change is largely limited to the cause of climate change and its impact in a broad sense. There is a lack of clarity about what a particular development sector should focus on in order to make its plans and programs climate-resilient. Development organizations need to come to terms with their own specific limitations and to identify those potential climate risks that might jeopardize their sectoral goals. A good grasp of limitations and potential risks can help each sector to search for relevant information or to generate its own set of information for use in evaluating the climate risks to a specific development activity. It will, however, take a long time to establish a sound procedure to obtain local-level information and identify the risk by linking it with a specific development activity in a particular geographical region, and addressing climate change cannot wait until such procedures are established. In any case, addressing climate change is a long-term undertaking which needs a gradual building-up of capacity through "learning by doing". Therefore, it is suggested that Nepal begin to use a climate lens in evaluating its development activities against potential risks and to formulate responses by considering the water sector as the "point of entry" from which to establish linkages and the sequence of risk outcomes.

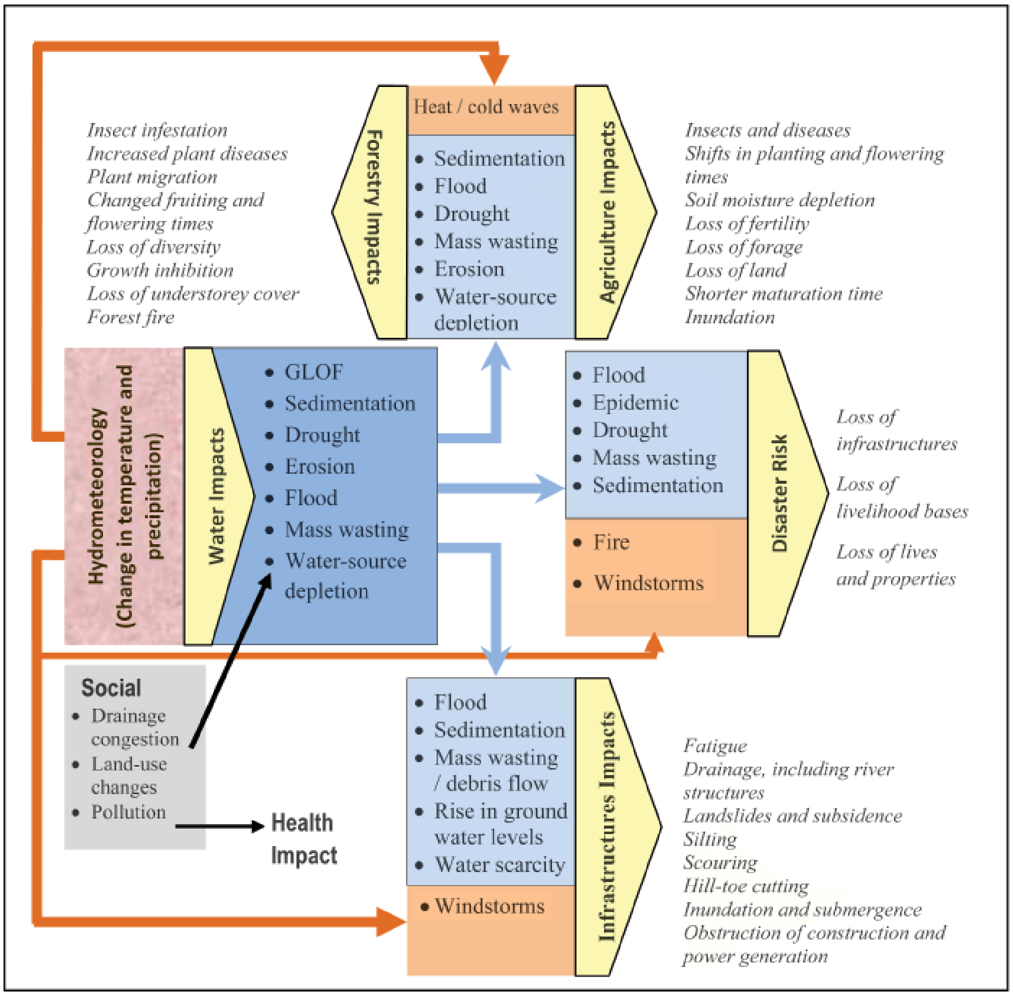
Understanding Inter-linkages

It is well established that climate impacts on various development sectors are interlinked and interdependent, and that most are linked with water. Understanding the inter-linkages between climate change and the subsequent impacts on various sectors are of utmost significance for building knowledge in order to enhance adaptation capabilities. To begin with, the changes in

temperature and precipitation impact the water sector, resulting in GLOFs, floods, droughts, and so on. Such impacts then become hazards for agriculture, forests, infrastructures, and disaster risk reduction initiatives. Recognizing the sequence of interaction types between water and other sectors helps to reduce the ambiguity in creating a knowledge base establishing who needs what information and from whom and to build synergy among development sectors for adaptation. The water sector can provide information about what might happen to water as a result of both the changing climate as well as human-induced stress in a specific area. Other development sectors can use the information provided by the water sector to assess the risks to their specific development intervention. With information about potential threats in hand, the sector can formulate risk-reduction strategies if required. The following example clarifies the concept of linkage analyses.

Intense precipitation affects agriculture by (1) inundating crops, and (2) destroying cultivated land by landslides or sand-casting. The same flood could wash away roads, water supply systems and buildings and displace or kill people and damage property. Similarly a GLOF, though it is caused by an increase in temperature (not in precipitation), wreaks havoc in the same manner. In fact, floods, whatever

Figure 4 : Climate Impact Linkages



their cause, are threats to the agriculture, infrastructure, and disaster sectors. Increasing our understanding about the possibility of a flood occurring can help these sectors to reduce the overall risks to their development plans and programs. This information needs to be generated by the water sector because this it is this sector which is equipped with the knowledge and tools needed to generate such information. The impacts of a change in temperature are felt independently by different sectors or in combination with water. For instance, a rise in temperature causes snow reserves to melt and glaciers to retreat, plants to migrate to higher altitudes, insects and pests to increase, soil moisture to deplete faster, and cropping times to change. Since these impacts are independent of each other, each development sector needs to assess the risks independently.

Figure 3 shows the sequence of climate impacts, which, for the most part, begin with water. The water sector is directly influenced by changes in temperature and precipitation, resulting in GLOFs, floods, mass wasting, erosion, sedimentation, droughts, and water-source depletion. The nature of these impacts is further affected by the land-use changes and drainage congestion caused by human activities. Together, these natural and human-induced impacts in the water sector immediately influence other sectors. In particular, it is the forestry and agriculture sectors that are most heavily influenced by floods, drought, water-source depletion, mass wasting, erosion, and sedimentation. The anticipated problems for agriculture include the depletion of soil moisture, loss of soil fertility, loss of land, loss of forage for livestock, and inundation. The rise in temperature and the possibility of more heat and cold waves impact agriculture by increasing the incidence of insect pests and diseases and weed infestation, shortening the ripening period, and shifting planting and flowering times.

Problems caused by water impacts in the forestry sector include the loss of biodiversity, the inhibition of growth, and the loss of understory cover. The change in temperature could result in more incidences of insect infestations and

plant diseases, plant migration, shifts in flowering and fruiting time, and more frequent and devastating forest fires.

Floods, droughts, mass wasting, and sedimentation-all outcomes of climate impacts on the water sector-are major concerns for the disaster risk reduction sector. Epidemics, fires, and wind and rain storms are both temperature- and water-related problems. The anticipated impacts of these are the losses of infrastructure, livelihood bases, and lives and properties.

The infrastructure sector is influenced by floods, mass wasting and debris flow, sedimentation, rises in groundwater levels, and rain and windstorms. The anticipated problems include damage to infrastructures, increased fatigue of infrastructures, silting of drains, increased instability of land through the weakening of river banks or hill toes or land subsidence, and inundation and submergence of infrastructures.

An approach which follows such a sequence will help bridge the knowledge gap by identifying the particular source of the problem for each sector and focusing on sector-specific anticipated impacts. For example, water managers need to develop an understanding of the changes taking place in the nation's hydro-meteorological status and their impacts on water that may result in floods and drought and reduce land stability and water availability. In addition, they need to understand the complexity added by the impact which changing social dynamics have on water sources through increased water demand, pollution and changes in land use and their impacts on drainage and infiltration because human-induced stresses compound the climate impact on water.

Natural resource managers require knowledge of the risks posed by floods, droughts and so on to plants, plant productivity and biodiversity. Additionally, they need to identify the impacts of changes in temperature on the flowering times and maturation of crops as well as the likelihood of disease outbreaks and insect and other pest infestations.

Infrastructure planners need to build their knowledge about the impacts of floods, inundation, and mass wasting on infrastructures. Disaster experts, on the other hand, will need to examine the likelihood that floods and other natural hazards will put lives and properties at risk.

Sensitivity Matrix Development

The sensitivity of a plan or program to climate change can be identified using the matrix illustrated below (see Figure 5). The anticipated impacts for each development sector have different sensitivities to different hazards, each of which serves as a point of entry. For the water sector, the points of entry for analyses are changes in temperature and precipitation that have various impacts. Since human activities such as land-use change also stress the water sector, they, too, need to be taken as a point of entry. For other sectors, both temperature and the anticipated impacts in the water sector are taken as points of entry for analyses. Since the climate sensitivity of a plan or program is area-specific, a particular development plan or program may not have the same sensitivity to any given hazard in different locations. The anticipated impact shown in the matrix below is only indicative—as it cannot help but be. It must be emphasized that while screening a particular activity of a plan or program, the sensitivity matrix needs to be developed for the location where it is being implemented. There may be other location-specific impacts not shown in the matrix. Similarly, there may be more points of entry for any given development activity. The sensitivity of anticipated impacts to different hazards is ranked as high (H), medium (M), and low (L). If the impact is expected to grow from low to high, which is likely in some cases, the change should be indicated by LH.

Once the matrix is prepared, a scenario can be built to examine the most sensitive components of a development activity. A component with low sensitivity may cope with the stress, but in the case of a component with high sensitivity, intervention options to reduce the risk need to be identified. This is done by screening the activity in the next step.

Figure 5 : A Sensitivity Matrix for Water Resources

WATER RESOURCES / Point of Entry \ Anticipated Impacts	GLOF	Sedimentation	Erosion	Flood	Mass wasting (debris, landslide, gully)	Water source depletion	Drought	Water quality	Others
Temperature	H	-	-	-	-	H	H	H	
Precipitation	M	H	H	H	H	H	H	M	
Land-use change	-	H	M	M	H	M	L	M	
Drainage congestion	-	-	-	H	H	-	-	M	
Pollution	-	-	-	-	-	-	-	H	
Any other stresses									

Figure 6: A Sensitivity Matrix for Disaster Risk Reduction

DISASTER RISK REDUCTION	Loss of infrastructures					Loss of livelihood bases				Loss of lives and properties			
Point of Entry / **Anticipated Impacts**	Transportation	Drinking water & irrigation	Hydro power	Buildings	Transmission lines	Farmland	Livestock	Forests and grassland	Trade and Industry	Human deaths	Standing crops	Other properties	Others
Floods	H	H	H	H	H	H	H	M	H	H	H	H	
Drought	-	H	H	-	-	-	M	H	M	-	H	-	
Epidemic	-	-	-	-		-	-	-		H	-		
Mass wasting	H	H	M	M	H	M	M	M	L	H	M	M	
Sedimentation	L	M	M	-	-	H	-	M	-	-	H	-	
Fire	-	-	-	M	L	-	-	H	M	H	-	M	
Windstorms	L	-	-	L	M	-	-	H	-	H	H	-	
Any other stresses													

Figure 7: A Sensitivity Matrix for Infrastructure

INFRASTRUCTURES **Point of Entry** / **Anticipated Impacts**	Fatigue	Drainage including river structures	Landslides & subsidence	Silting	Scouring	Hill-toe cutting	Inundation & submergence	Obstruction of construction & power generation	Others
Temperature	H	-	-	-	-	-	-	-	
Wind storm	-	H	-	-	-	-	-	-	
Flood	-	H	-	H	H	H	H	M	
Sedimentation	-	-	-	H	-	-	-	H	
Mass wasting	-	H	-	H	H	-	-	H	
Rise in ground water levels	M	-	H	-	-	-	-	M	
Water scarcity	-	-	-	-	-	-	-	H	
Any other stresses									

Figure 8: A Sensitivity Matrix for Agriculture

AGRICULTURE Point of Entry / Anticipated Impacts	Insects/ diseases	Shift in planting flowering time	Soil moisture depletion	Loss of fertility	Loss of forage	Loss of land	Ripening period	Inundation	Weed infestation	Storage	Livestock habitat change	Livestock diseases	Others
Temperature	H	H	H	-	H	-	H	-	M	M	M	H	
Sedimentation	-	-	H	H	H	H	-	-	M	-	M	-	
Floods	M	-	-	-	M	H	-	H	-	H	-	M	
Drought	H	L	H	M	H	-	L	-	M	M	H	M	
Mass wasting (debris, landslide,gully)	-	-	H	H	M	H	-	-	M	-	-	-	
Erosion	-	-	M	H	M	-	-	-	M	-	M	-	
Water source depletion	M	-	H	M	H	-	-	-	M	-	M	-	
Humidity	H	L	L	-	-	-	-	-	M	H	M	H	
Frost	-	H	-	-	H	-	M	-	-	-	-	-	
Fog	H	H	-	-	M	-	M	-	-	H	-	M	
Hailstorms	-	-	-	-	M	-	-	-	-	M	-	-	
Any other stresses													

Figure 9: A Sensitivity Matrix for Forests

FORESTS — Point of Entry / Anticipated Impacts	Insect infestation	Incidence of diseases	Plant migration	Shifts in fruiting & flowering time	Loss of diversity	Growth inhibition	Understores vegetation cover	Forest fire	Wildlife migration	Others
Temperature	M	M	H	H	M	-	-	M	H	
Sedimentation	-	-	M	L	M	-	M	-	M	
Floods	L	L	-	-	M	-	M	-	-	
Drought	H	H	-	-	LH	H	M	H	M	
Mass wasting (debris, landslide, gully)	-	-	L	-	L	L	-	-	-	
Erosion	-	-	-	-	L	L	M	-	-	
Water-source depletion	-	-	-	-	L	-	L	-	H	
Humidity	M	M	-	-	-	-	M	H	-	
Frost	-	M	-	M	-	-	M	-	-	
Fog	-	-	L	M	-	-	-	-	-	
Hailstorms	-	-	-	-	L	-	M	-	-	
Any other stresses										

SCREENING

The purpose of screening a plan or program is to identify the climate risks associated with it and to develop measures to reduce those threats. Its intention is not at all to discourage or restrict the implementation of a plan or program that is at risk. Another aim is also to ensure that the proposed plan or program does not exacerbate the climate impact by inadvertently adding additional stresses to an already stressed environment. Overall, screening a plan or program promotes climate adaptation. The sustainability of adaptation depends not only on the climate threats to core systems like land, water and vegetation but also on how support and institutional systems help or hinder the adaptation processes. A climate-resilient development plan needs to consider various interdependent and interconnected variables, and their dynamics at the systemic level in order to assess climate risks and help formulate sustainable adaptation strategies. The three proposed screening formats presented below are intended to help consider these dynamics at the systemic level in order to make development interventions climate-resilient.

The formats each outline several subsystems, as shown in Figure 3, as well as key components within each subsystem. The variables to be assessed for each key component have been given as questions to facilitate the screening process. Answers to these questions will be ranked as low (L), medium (M) or high (H) based on available facts or the questioner's expert judgment. The questions have been structured so that if the answer to a question indicates a high (H) risk, an intervention must be identified and implemented simultaneously with the development activity in order to reduce the risk associated with that variable. Risk reduction measures may be implemented at a later stage if the risk is assessed as medium (M). For variables that are assessed as being at low (L) risk, adaptation measures may be developed after a more in-depth understanding is developed—if they are needed at all.

Some variables may not be applicable to a particular plan or programme. In this case, the response should be noted as "not applicable" (NA). However, if the answer to a particular variable is not known, it should be noted as "unknown". Since development activities are implemented in particular locations, local-level climate information must be available in order to assess the climate threats to them. But there may be gaps. In fact, given that the availability of local-level climate information and data is limited, it is very likely that it may not be possible to assess many of the variables presented in the proposed format. The lack of information or knowledge could hinder the ability to formulate the sort of intervention needed to make the proposed development plan climate-resilient. In this case, simply planning to generate information at the local level could be a step forward in climate-resilient planning in the long term. Indeed, in the case of all unknown risks, the required adaptation intervention is the type of information that needs to be generated, the agency who will generate it, and the time within which it must be made available.

Since ranking variables is a subjective task, ranks may change from one evaluator to another and from one place to another. What is key is to begin screening development plans and programs so that a doable procedure to make all development plans, from the local to the national level, climate-resilient can be developed over the course of time.

Screening Format

CORE SYSTEM								
Sub system	**Key Component**	**Variables to be assessed**	**Risk ranking**					**Intervention required**
			Unknown	NA	L	M	H	
Water	Surface water	Does water extraction by the proposed program put water stress on existing sources?						
		What is the likelihood that the plan will be affected by a reduction of water at the source?						
	Ground Water	Will the plan obstruct groundwater recharge?						
		Will a fall in the groundwater table affect the plan?						
		Will a rise in the groundwater table affect the plan?						
	Flood	Does the plan result in drainage congestion that will add to floods?						
		Will there be any risk to the plan (due to wash-out, submergence, drainage congestion and/or the scouring and silting of drains) if there is a flood?						
Food	Food security	Does the plan adversely affect food production?						
Energy	Emission	Will the plan increase GHG emissions?						
Eco system	Biodiversity	Does the plan destroy and/ or damage forests and other vegetation?						
		Does the plan affect wetland resources by adding sediment or reducing water flow?						
Land	Erosion/mass wasting	Does the plan adversely affect critical habitats or ecologically sensitive areas?						
		What is the likelihood that the plan will increase erosion and/or mass wasting?						
		What is the likelihood that erosion or mass wasting will damage structures constructed under the plan?						
	Landuse change	Does the plan change land use in a way that affects hydrological regimes (inundation, reduced infiltration and other effects)? If yes, to what extent?						
	Land subsidence	What is the risk due to land subsidence?						
	Hill toe cutting	Will the plan increase the risk that hill-toes will be cut away and slopes rendered unstable?						
		Is embankment and/or hill-toe cutting likely to damage the structures that are built?						
Air	Wind Storm	What is the risk of windstorms?						
	Temperature Rise	What is the risk of an increase in average temperature?						

SUPPORT SYSTEM								
Sub system	**Key Component**	**Variables to be assessed**	**Unknown**	**Ranking**				**Intervention required**
				NA	**L**	**M**	**H**	
Physical	Infrastructure	Is the proposed plan likely to pose a threat to infrastructure?						
	Geographical zone	Does the plan exacerbate climate stress in the Himalayas?						
		Does the plan exacerbate climate stress in the Mid-hills?						
		Does the plan exacerbate climate stress in valleys or the Tarai?						
Social	Compatibility	Is it likely that people will not accept the plan?						
		Is it likely that making the plan climate-resilient will be expensive?						
		How much effort does the plan make to reach vulnerable groups?						
		What level of constraints will the plan face in reducing poverty?						
Knowledge	Data / information	To what extent do data constraints impede the preparation of a climate-resilient plan?						
		What constraints are there on generating knowledge about local climate issues?						
	Awareness	How aware are stakeholders about climate issues?						

INSTITUTIONAL SYSTEMS								
Sub system	**Key Component**	**Variables to be assessed**	**Unknown**	**Ranking**				**Intervention required**
				NA	L	M	H	
Organizations	Intersectoral context	Is it possible that the plan will have an adverse impact on the activities of other sectors?						
		What constraints are there on creating synergy with the activities of other sectors in order to boost climate resilience?						
	Public private partnership	What level of effort is required to get support from the private sector?						
Networks/ linkages	Grass root focused	What constraints are there on involving grassroot-level networks in implementation?						
	Central	How difficult will it be to get support from central level networks?						
Legal provisions	Acts/rules/ regulations	What legal constraints exist?						
	Compliance	What constraints are there on complying with legal provisions?						

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