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Sector Adaptation Plan Framework for Guidelines: Synthesis Report on Adaptation to Climate Change



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Pilot Program for Climate Resilience - PPCR3, Mainstreaming Climate Change in Development

Sector Reports	Report Name
Institutional Analysis	Department of Urban Development and Building Construction (DUDBC)
International Experience Paper	Urban
Climate Change Threats	Modelling results for the Infrastructure Sectors in Nepal
Synthesis Report	Urban
District Reports	Report Name
District Case Study Reports including:	Kathmandu
Baseline	Dolakha
Climate Change Vulnerability	Chitwan
Assessment	Myagdi
Adaptation Planning Report	Banke
	Panchthar
	Mustang
District Climate Change Profiles	Kathmandu
	Dolakha
	Chitwan
	Мyagdi
	Banke
	Achham
	Mustang
Guidance Reports	Report Name
MoSTE Guide	Climate Change Vulnerability Assessment and Adaptation Planning Methodology for Infrastructure Development in Nepal
Climate Change Risk Management Framework for Infrastructure Sectors in Nepal	A Guide for developing and implementing Sector Adaptation Plans for Action - SAPAs

RELATED TECHNICAL REPORTS IN THE SERIES: URBAN

EXECUTIVE SUMMARY

OBJECTIVE

This sector synthesis report reviews the work done in identifying the opportunities for mainstreaming climate change risk management into activities undertaken by the Department of Department of Urban Development and Building Construction (DUDBC). A particular focus being on those entry points into the sector planning and implementation cycles where tools can be most easily used to promote climate change resilience.

The report consolidates exercises undertaken in seven case study districts to apply a tailored vulnerability and adaptation methodology to audit key existing urban infrastructure assets based on future modelled climate change threats. A package of institutional and policy measures have been identified to enhance the capacity of DUDBC to plan for climate change related threats when making infrastructure investment decisions and strengthen the climate resilience of key urban infrastructure assets in Nepal. These measures will be the focus of policy reform and capacity building activities during the final phase of the project's implementation.

INTRODUCTION TO THE URBAN PLANNING SECTOR

Climate change and more extreme weather conditions are potential factors that could severely curtail or obstruct sustainable urban development in Nepal. To respond to climate change threats, planning authorities will need to have access to institutional measures, technical guidance and practical tools to limit the risks of climate change and disaster events in order to protect the livelihoods of citizens. As part of this effort, planning authorities can address the risks of climate change impacts by mainstreaming climate adaptation measures into policies, legislation, regulations, plans and guidelines for urban development.

To determine what types of interventions or reforms are required for mainstreaming climate adaptation measures, it was decided to analyze climate change threats and risks in seven case study districts in Nepal. These seven districts were selected as representative of various types of climate change threats and risks that could occur in a range of geographical conditions in the country. The selected case study districts for the urban sector include: Mustang, Dolakha, Kathmandu, Banke, Chitwan, Panchtar, and Myagdi.

Administratively, Nepal consists of 75 districts, 3915 Village Development Committees, and 130 municipalities. Urban development in Nepal is driven by rural to urban migration patterns characterized by high population growth in urban centers such as Kathmandu and some Terai towns. High urban growth is at the expense of out-migration from many rural areas and towns in the hill regions. Rapid urban growth in Kathmandu and Terai towns has strained the already insufficient urban infrastructure and provision of urban services. Moreover, haphazard urban development including non-compliance with the building code, encroachment of buildings on open space and natural ecosystems, and depletion of water supplies will increase the vulnerability of Kathmandu and other growing urban areas to climate change threats. Rural to urban migration is ongoing in the Nepal Himalaya and hill regions. The rise of slums and informal settlements in urban areas of Nepal is one indicator of this trend. The search for seasonal or long-term economic opportunities is a contributing factor to out-migration from the hilly areas.

CATEGORIES OF URBAN SECTOR INFRASTRUCTURE AND COMPONENTS

The DUDBC is a major department under the Ministry of Urban Development (MUD). The other key department under MUD is the Department of Water Supply and Sewerage (DWSS). DUDBC is organized into three main divisions: Housing; Building Construction; and Urban Development.

The overall functions and responsibilities of DUDBC can be stated as follows:

- Formulation, planning and implementation of urban development plans and policies with focus on physical planning and infrastructure development:
- Formulation, planning and implementation of housing plans and policies;
- Design, construction, repair and maintenance of the government buildings;
- Planning and infrastructure development and land use planning of emerging small towns and growing urban centres through the Town Development Committees (TDCs);
- Execution of National Building Code and undertaking research and development activities relating to building technology and materials; and
- Preparation of water retention and rainwater harvesting guidelines.

DWSS functions and responsibilities include urban water supply systems, sewerage management, and rainwater harvesting, and these assets are addressed in the Water Supply and Sewerage Sector Synthesis Report.

TYPICAL CLIMATE CHANGE THREATS AND IMPACTS FOR THE URBAN SECTOR

Climate change threat profiles were prepared for the seven urban sector case study districts consisting of localized projections of future climate change for the period 2040-2060 compared to a baseline period from 1980-2000. When selecting the 7 case study districts, a strong geographical focus was employed to ensure that all regions of Nepal were covered as well as varying types of climate change threats. The case study districts represent the following regions in Nepal: Mid Hills, Trans-Himalayan, Terai, inner Terai, and the Capital City of Kathmandu.

The urban sector can be categorized according to various components or assets. These asset categories include Government Buildings / Housing; Informal Settlements; Urban Drainage Systems; Urban Roads; Solid Waste Management Facilities; and Markets / Public Areas / Cultural Heritage Sites. The types of climate change threats that most impact urban assets include prolonged high temperatures, extreme rainfall events and high rainfall intensities, and high river flows including the potential for flash flooding.

For each of the seven case study districts for the urban sector analysis, two priority assets were selected from each district. The criteria used for selecting the priority assets are listed as follows:

- Infrastructure of national strategic importance,
- Infrastructure of district strategic importance,
- Infrastructure that has been impacted by past extreme events,
- Infrastructure located in areas prone to past extreme events.

The seven case study districts, the selected priority assets for each district, and the results of the climate threat vulnerability assessment (VA) for each asset are summarized in the following table.

District	Components (Assets)	Risks / Vulnerability
Dolakha	Charikot town core	Intense and prolonged rainfall, flooding, landslides due to insufficient drainage and non compliance with National Building Code resulting in destruction of homes and businesses.
	Singati Riverside Settlement	Intense and prolonged rainfall, flooding, landslides, and flash flooding due to location near confluence of two rivers; likely destruction of homes and market area since flooding and loss of lives has occurred in the past.
Kathmandu	Bagmati UN Park	Intense and prolonged rainfall, flooding and flash flooding and erosion / destruction of bridges, damage to historic temples, informal settlements, informal agricultural plots and the UNICEF water supply system adjacent to the Bagmati River.
	Pathivara Informal Settlement	Intense and prolonged rainfall, flooding and flash flooding and possible destruction of low income homes adjacent to Dhobi Khola.
Banke	Gabar Village-Churia Hills	Intense and prolonged rainfall, flooding and draught; flooding and possible destruction of homes and infrastructure.
	Nepalgunj-/Salyani Bag	Intense and prolonged rainfall, flooding and prolong pooling of water resulting in damage to homes and infrastructure.
	Souraha Settlement	Intense and prolonged rainfall, flooding and damage to homes and disruption of tourist economy.
Chitwan	Bharatpur Solid Waste Site	Intense and prolonged rainfall, flooding and damage to waste site and spreading of pollution to downstream areas.
	Jomson Town and Airport	Intense and prolonged rainfall, flooding / flash flooding of town and nearby airport, resulting in destruction of homes / businesses and disruption of tourist economy.
Mustang	Marpha, Tukuche, Lete, Kagbeni and Tiri riverside settlements	Intense and prolonged rainfall, flooding / flash flooding, debris flow and sedimentation, landslides resulting in damage in homes and businesses.
Myagdi	Kali Gandaki Riverside Settlement (Beni)	Intense and prolonged rainfall, river flooding, flash flooding, sedimentation, landslides resulting in destruction of homes and businesses
	Lower Beni Bazar Road	Intense and prolonged rainfall, river flooding and pooling resulting in destruction of homes and businesses
	Yasok Market Center	Decreased rainfall during dry season resulting in drought conditions.
Panchtar	Phidim Town Center	Intense and prolonged rainfall, flooding and

District	Components (Assets)	Risks / Vulnerability
		destruction of town core and infrastructure.

TYPICAL ADAPTATION MEASURES

Climate change adaptation measures are identified based on the sector district case study assessments. A fundamental climate change adaptation measure is the improvement in development and implementation of integrated Physical Development Plans and the Periodic Plan process for both towns and municipalities. Improvements will require changing steps in preparing the Physical Development Plans, as well as strengthening the capacities of the local institutions responsible for preparing and implementing the plans.

Other high priority structural and non-structural adaptation measures which would enhance resilience in urban infrastructure and components in both the short and long term are summarized in the following table.

Urban System	IMPACTS AND ADAPTATION MEASURES		
& Components	STRUCTURAL MEASURES	NON-STRUCTURAL MEASURES	
SHORT-TERM AD	APTATION MEASURES		
Housing / Buildings Riverside	 Regular removal of sediments from rivers to increase flow and reduce river flow surges Promoting better housing practices and materials that are climate resilient 	 Enforce the National Building Code Organize community early warning and emergency response plans 	
Urban Drainage	 Increased operation and maintenance (O&M) of existing drains 	 Organize drainage cleanup Users' Committee 	
Urban Roads	 Increased O&M with a condition assessment approach in key areas. 	 Organize road maintenance Users' Committee 	
Solid waste Disposal	 Protect the dumping site through a bund construction which would prevent the flood waters entering in to the site. 	 Implement a solid waste reduction and recycling program to reduce amount of waste generated and transported to landfill. 	
Markets/Public Areas/Cultural Heritage Sites	 Increased O&M with a condition assessment of properties and infrastructure. 	 Organize maintenance Users' Committee for both market areas and cultural heritage sites. 	
	 Place sand bag barriers around sensitive cultural heritage sites. 		
LONG-TERM ADAPTATION MEASURE			
Housing / Buildings Riverside Settlements	 Construct proper river-training works complying with international standards through combination of gabion protection, concrete retaining wall, soil stabilization and bio engineering techniques. 	 Implement climate resilient Physical Development Plans using GIS and hazards mapping techniques. Implement the National Building Code, and revise code where necessary. 	

Urban System	IMPACTS AND ADAPTATION MEASURES		
& Components	STRUCTURAL MEASURES	NON-STRUCTURAL MEASURES	
	 Construct more climate resilient housing and buildings. Relocate and resettle informal settlements to safer locations. 		
Urban Drainage	 Construct urban drainage systems in an integrated manner considering both surface drainage and wastewater drainage. 	 Prepare an Urban Drainage Master Plan, with coordination between DUDBC, DoR, and DWSS. 	
Urban Roads	 Plan new roads away from flood prone or hazardous areas. Upgrade existing roads with improved drainage facilities. 	 Prepare an Urban Drainage Master Plan, with coordination between DUDBC, DoR, and DWSS. 	
Solid Waste Management	 Relocate waste site to a more secured location with proper drainage. 	 Continue to implement waste reduction and recycling campaigns to reduce amount of waste transported to landfills. 	
Markets/Public Areas/Cultural Heritage Sites	 Preserve green areas and parks as a natural water management scheme and also as a climate change adaptation measure. Construct more robust houses and buildings in flood prone areas and on hilly topography. Construct protective bunds or walls around sensitive cultural heritage and religious sites. 	 Implement climate resilient Physical Development Plans using GIS and hazards mapping techniques. Implement the National Building Code, and revise code where necessary particularly for homes near hazardous or flood areas. Prepare an Urban Drainage Master Plan, with coordination between DUDBC, DoR, and DWSS. 	

REFORMS RQUIRED WITHIN URBAN SECTOR

Climate change impacts have not previously been directly addressed in urban national plans, policies, strategies and laws and regulations. Subsequently, climate change threats have not been dealt with in planning guidelines, manuals, and technical standards relating to the urban sector. The main actions and entry points for mainstreaming climate change impacts into policies, plans, laws, regulations and technical guidelines related to the urban sector are described in the following actions.

Prepare national Physical Development Plan model with climate change adaptation, and institutionalize the plan through a new Physical Development Act and Guidelines, or through amendment of the existing Town Development Act.

A key climate adaptation measure for the urban sector is strict application and enforcement of flood plain and land use zoning guidelines that specify areas that are vulnerable to climate change threats. The existing Town Development Act 1998 and Amendments give the Town Development Committees (TDCs) authority to classify various urban areas suitable for different types of development. With this authority, TDCs can restrict urban development in areas highly vulnerable to climate change threats such as flood plains, steep slopes and unstable ground areas. These types of vulnerable areas should be identified through a hazard mapping process conducted in consultation with planning authorities and local citizens. Further the TDCs are provided authority to establish green zones and to protect natural ecosystems in and around urban areas which serve as natural climate change adaptation systems by acting as natural rain retention and flood control systems. Identification of green areas or natural ecosystems can also be made through a consultative mapping process. All these reforms can be clearly stated in future revisions of the Town Development Act, or in implementing regulations or guidance documents.

Urban development is made operational through the Periodic Planning process for municipalities which requires cooperation between DUDBC and the Ministry of Federal Affairs and Local Development (MoFALD). The Periodic Planning process emerges from two separate legislations: the Local Self-Governance Act and Regulations (MoFALD) and the Town Development Committee Act (DUDBC).

There are numerous opportunities for introducing climate change adaptation measures at several stages of the Periodic Planning process. For example, the conceptualization of the long term strategic vision could include acknowledgement of the requirement for adapting to climate change projections. Further, data collection could include a detailed listing of past climate change extreme events and threats impacting the urban area. The town profile could also address the threats, challenges and opportunities regarding climate change. Finally, the Physical Development Plan could include requirements for inclusion of climate change adaptation tools such as preparing land-use and land development plans based on VA & AP process. Associated tools to adapt to climate change also include land-use zoning, GIS mapping with overlays, hazards mapping, identification of highly vulnerable areas, and preparation of safeguards bye-laws for various types of land use zones.

Demonstrate the effectiveness of an integrated urban planning process, using climate adaptation tools, during the formulation and implementation of the Mid-Hill Town Development Project.

DUDBC is in the process of developing and implementing the Mid-Hill Town Development Project. This project is a high priority initiative of national importance. The project involves the rebuilding and upgrading of ten towns along the 1,776 km Mid-Hills Highway corridor. The Mid-Hills Highway links Phidim Municipality in the far east to Patan town in the far western part of the country. The main objective of the Mid-Hill Town Development Project is to develop the ten towns into attractive urban centers with the purpose of preventing out-migration from the mid-hill and mountain regions of the country. It is expected that the project will benefit 7 million people living in the mid-hill region by providing urban areas planned in an integrated and participatory process and with full urban services and amenities.

Since the ten towns along the Mid-Hills Highways will undergo a process of redevelopment using land pooling schemes, there is an opportunity to include climate change adaptation tools and methods in the planning of the new towns. It is envisioned that the planning of the new towns could include the following climate change adaptation interventions:

- Use of the VA & AP tool,
- Mapping of land use zones,
 - Identification of flood prone and hazardous areas,
 - Identification of landslide prone areas,
 - Identification of natural resource and ecosystem preservation areas,
- Use of GIS overlays to select land uses,
- Downscaling of climate change projection threats to specific town areas.

DUDBC is currently in the process of preparing the Terms of Reference (ToR) for a consultancy to prepare the urban Master Plans for the ten towns. It is highly recommended that the climate change tools mentioned be included in the ToR for the consultancy.

Revise the National Building Code to include standards and norms to protect against climate change threats.

The Building Act promulgated in 1998, along with first Amendment in 2007, is a landmark piece of legislation to streamline and regulate the building activities in the country. The main purpose of the Building Act is to provide a legal framework for implementation of National Building Code. A key provision of the Building Act is to ensure that building structures are able to withstand physical impacts and destruction resulting from natural disasters like earthquakes, fire and other occurrences such as weather related events. The Building Act recognizes the threats to buildings due to natural disasters which are expected to occur with more frequency and magnitude as a result of climate change impacts. In future Building Act amendments, climate change can be specifically mentioned as a threat to the resilience of buildings.

Add a Climate Change / Disaster Management Section within the Urban Development Division at DUDBC.

The Urban Development Division currently has an Urban Environment Section headed by a gazetted second class officer. Climate change concerns are now being added to the responsibilities of the Urban Environment Section. The main challenges lie in bringing about needed changes in DUDBC's organizational structure to address the impacts of climate change at both the central and field offices levels, and securing adequate human and financial resources for this task.

In the future, the threats and opportunities regarding climate change can have a significant impact on urban development. For this reason, DUDBC should consider instituting a new section under the Urban Development Division, with a focus on both Disaster Management and Climate Change. Among the required technical personnel, the new section should include at least one GIS expert with expertise hazards mapping and land use zoning.

Currently there are 109 vacancies at the various levels within DUDBC at both the central and in the field division offices. To build capacity for adapting to climate change, the DUDBC could staff several vacancies at the central and field offices to provide the sufficient human resource for addressing climate change threats and impacts. More specifically, the Urban Development Division could employ an experienced drainage engineer to assist in preparing guidelines for urban Drainage Master Plans which would include drainage from wastewater, rainwater runoff, and urban roads drainage.

Prepare urban drainage master plan guidance in coordination with DWSS and DoR, and revise the Planning Norms and Standards 2013 to include revised drainage design guidance and siting criteria for critical physical and social infrastructure.

The Planning Norms and Standards 2013 could be revised to include more specific design provisions for urban drainage and to include specific criteria for locating new or relocating existing physical and social infrastructure to make these assets more climate proof. The DUDBC Planning Norms and Standards 2013 list the required Norms for various types of physical infrastructure for various urban classifications including Market Centers, Sub City, City, Sub Metro City, and Metro City. For all urban classifications except for Market Centers, there are provisions for providing Sanitation Sewerage Systems and Storm Water Drainage

systems. For the storm water and sanitation systems, planning norms and standards are detailed. However, for each city classification the same standard minimum trunk sewer drainage pipe of 200 mm diameter is specified. Instead of listing a standard minimum drainage size for all city classifications, DUDBC should provide some guidance on how to design drainage systems that take into account different city hydrological characteristics and projected rainfall intensities. This is a planning gap that should be addressed and filled, particularly considering the need for a robust urban drainage system to manage for intense and prolonged rainfall events that are projected as a result of climate change.

It is recommended that guidance is given for preparing and implementing Urban Drainage Master Plans. This guidance should involve collaborative inputs from DoR, DWSS and DUDBC.

ACRONYMS

ADB	Asian Development Bank
AP	Adaptation Planning
°C	Degree Centigrade
CCRS	Climate change risk management system
CGI	Corrugated Galvanized Iron
CIF	Climate Investment Fund
DDC	District Development Committee
DoR	Department of Roads
DUDBC	Department of Urban Development and Building Construction
DWSS	Department of Water Supply and Sewerage
GCM	General Circulation Model
GIS	Geographical Information System
GIZ	Deutsche Gesettschaft fur Internationale Zusammenarbeit
IPPC	Intergovernmental Panel on Climate Change
IWMI	International Water Management Institute
km	kilometer
m	Meter
mm	millimeter
LAPA	Local Adaptation Plan for Action
MoFALD	Ministry of Federal Affairs and Local Development
MoSTE	Ministry of Science, Technology and Environment
MUD	Ministry of Urban Development
NAPA	National Adaptation Plan for Action
NUP	National Urban Policy
0&M	Operation & Maintenance
SAPA	Sector adaptation plan for action
TDC	Town Development Committee
ToR	Terms of Reference
UN	United Nations
UNICEF	United Nations International Children Emergency Fund
VA	Vulnerability assessment
VDC	Village District Committee
WRF	Weather Research and Forecasting

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1 INTRODUCTION

This synthesis report was prepared as part of the TA – 7984 NEP: *Mainstreaming Climate Change Risk Management in Development Project* supported by ADB with funding from the Climate Investment Fund (CIF), and implemented by the Ministry of Science, Technology and Environment (MOSTE) in partnership with ICEM – International Centre for Environmental Management.

The project involves line departments working together with MOSTE in eight districts to develop and test a vulnerability assessment and adaptation planning approach tailored for their needs. The aim is to distil the lessons of the district experience into reforms at national level for planning and managing more resilient infrastructure. The national agencies are those concerned with infrastructure development throughout Nepal such as irrigation, roads and bridges, water induced disasters, urban planning and water supply and sanitation systems (Figure 1.1).



Figure 1.1: TA – 7984 NEP infrastructure sector department partners

A core group of technical staff from each of the departments participated in working sessions and missions to the eight districts of Kathmandu, Dolakha, Achham, Banke, Myagdi, Chitwan, Panchthar and Mustang (Figure 1.2) where vulnerability assessments and adaptation planning exercises were conducted for existing strategic infrastructure assets. The target districts were identified by core group members to reflect the diverse ecological

zones of the country and varying environmental and social conditions in which infrastructure is built. The district assessments were supported by climate change threat analysis and hydrological modelling at each case study location.

The core group comprised of some 30 members from 9 government agencies with each agency having a wider range of staff involved in the process of setting and implementing reform priorities with support from the project team (Figure 1.3). Sector focal points on the core group have a key role in promoting the climate change mainstreaming in their departments so that the design and management of existing and planned infrastructure progressively adjusts to become more resilient to the most significant projected changes and their associated potential impacts.



Figure 1.2: Target districts for developing an approach to infrastructure vulnerability assessment and adaptation planning

DUDBC & MOSTE | Mainstreaming Climate Change Risk Management in Development Urban Sector Adaptation Plan Framework for Guidelines: Synthesis Report



Figure 1.3: Infrastructure sector department climate change core group

Through the project, a "climate change risk management system" (CCRS) has been developed based on the district and international experience. The CCRS includes tools to facilitate climate change vulnerability assessment and adaptation planning and a dedicated process for the development of *sector adaptation plans for action* (SAPAs) that complement Nepal's existing climate change planning framework consisting of the National Adaptation Plan for Action (NAPA) and Local Adaptation Plans for Action (LAPAs).

The district case studies inform a sector vulnerability assessment and adaptation planning process that demonstrates the elements of a future SAPA process including the shape of SAPA reports (in the form of sector synthesis reports). The end result of this process is a sector oriented review of climate change vulnerability of key assets and a sector adaptation plan identifying the policy, procedures and structural reform priorities for building resilience in the sector and its infrastructure. The *sector synthesis reports* are being used as the basis for a sector specific training of government staff at the national and district levels on how to give effect to the reforms identified using the SAPA process and to apply the vulnerability assessment and adaptation planning tools developed by the core group and project team.

This Urban Sector Synthesis Report was prepared with Department of Urban Development and Building Construction (DUDBC) and involved a program of consultations in the districts and with the sector core group members and departmental officials. That process culminated in a national workshop at which government Urban Planning sector experts presented and discussed the synthesis conclusions and reform priorities. The government staff closely involved in the Urban Sector consultations and in the preparation and commentary on this report and the various linked Urban Sector district reports, climate change threat assessments and institutional analyses are listed in Annex I.

2 THE URBAN SECTOR

2.1 INTRODUCTION

Climate change and more extreme weather conditions are potential factors that could severely curtail or obstruct sustainable urban development in Nepal. Climate change threats will most likely exacerbate the many challenges related to urban development including the delivery of basic urban services and provision of adequate infrastructure. To respond to climate change threats, planning authorities will need to have access to institutional measures, technical guidance and practical tools to limit the risks of climate change and disaster events in order to protect the livelihoods of citizens. As part of this effort, planning authorities can address the risks of climate change impacts by mainstreaming climate adaptation measures into policies, legislation, regulations, plans and guidelines for urban development.

2.2 BACKGROUND

To determine what types of interventions or reforms are required for mainstreaming climate adaptation measures into policies, legislation, regulations, plans and guidelines, it was decided to analyse climate change threats and risks in seven case study districts in Nepal. These seven districts were selected as representative of various types of climate change threats and risks that could occur in a range of geographical conditions in the country.

The criteria adopted in identifying the case study district geographic focus were as follows:

- Area exposed to a significant level of climate change threat and vulnerability as reflected in the National Adaptation Program of Action (NAPA) and the International Water Management Institute (IWMI) national vulnerability assessments;
- Area representative of the three main ecological zones high himal, central hills and Terai -- and represented in the west, central and eastern regions;
- Area has adequate information to input into the impact and vulnerability assessment process;
- Area has a potential replicable demonstration for in other districts;
- Area includes ADB/Government existing or pipeline priority projects (eg infrastructure projects which will need to be climate proofed);
- Area identified in government policy and plans as a priority for action and support; and
- Includes infrastructure of strategic importance to the country.

The selection of the case study districts was undertaken through core group discussions and a consensus of criteria ranking. The selected case study districts for the urban sector include: Mustang, Dolakha, Kathmandu, Banke, Chitwan, Panchtar, and Myagdi.

This Synthesis report is based on three climate change oriented impact assessment working papers for each case study district. The working papers for each case study district consist of the following documents: a Baseline Study, a Vulnerability Assessment Report, and an Adaptation Planning Report.

2.3 URBAN AREAS IN NEPAL

Administratively, Nepal consists of 75 districts, 3915 Village Development Committees, and 130 municipalities. The distribution of urban areas in Nepal is shown in the map shown in Figure 2.1.



Figure 2.1 Distribution of Urban Areas in Nepal

Urban development in Nepal is driven by rural to urban migration patterns characterized by high population growth in urban centers such as Kathmandu and some Terai towns. The high urban growth in these locations is at the expense of out-migration from many rural areas and towns in the hill regions^{1,2}.

Kathmandu Valley is one of the fastest growing urban areas in South Asia, with a population of around 2.5 million³. Kathmandu Valley is experiencing a population growth rate 5% above the national average; and the informal squatter population is increasing at a rate of 11% per annum in Kathmandu. The rapid urban growth has strained the already insufficient urban infrastructure and provision of urban services. Moreover, haphazard urban development including non-compliance with the building code, encroachment of buildings on open space and natural ecosystems, and depletion of water supplies will increase the vulnerability of Kathmandu to climate change threats.

Rural to urban migration is ongoing in the Nepal Himalaya and hill regions. The rise of slums and informal settlements in urban areas of Nepal is one indicator of this trend. The search for seasonal or long-term economic opportunities is a contributing factor to out-migration from the hilly areas.

¹ Population Monograph of Nepal, Volume 1: Population Dynamics, Government of Nepal, National Planning Commission Secretariat, Central Bureau of Statistics, Kathmandu, 2014

² Nepal Centre for the Study of Labour and Migration, migration maps from <u>www.ceslan.org</u>

³ Nepal Central Bureau of Statistics, Kathmandu, 2014

Understanding the pattern of out-migration from upland regions of Nepal to urban peripheries or marginal or unsuitable lands in urban centers or to the Gulf countries is important for preparing a strategy for mountain development. To reverse the trend of outmigration, the Government of Nepal is undertaking a high priority New Town Development Project along 10 towns in the Mid-Hill Highway corridor. The plan is to create 10 well planned model towns with physical infrastructure, and health, education, employment, and food security facilities to attract people to these urban areas.

2.4 INSTITUTIONAL ISSUES

The Periodic Planning process for municipalities requires cooperation between DUDBC and the Ministry of Federal Affairs and Local Development (MoFALD) since the planning process emerges from two separate legislations: the Local Self-Governance Act 2099 and Regulations (under MoFALD) and the Town Development Committee Act 2088 (under DUDBC). DUDBC serves as a secretariat and provides physical planning inputs to the municipal bodies and Town Development Committees in the Periodic Planning process. By means of the Local Self-Governance Act, municipalities are under the authority of MoFALD and Town Development Committees under the Ministry of Urban Development (MUD). To streamline the planning process, close cooperation is required between MoFALD and DUDBC. Progress towards effective integrated urban planning and development could be realized if coordination between these Ministries was institutionalized through a Memorandum of Understanding or other types of mutual cooperation agreements.

With regards to rainwater harvesting as a climate change adaptation measure, both the DWSS and DUDBC have separate initiatives to undertake this program. As both departments are under the same Ministry, MUD, there is a need to consolidate the rainwater harvesting program under one department.

2.5 CONTENT OF SYNTHESIS REPORT

In the following sections, the Synthesis Report will first present a brief overview of DUDBC and the urban infrastructure sector. Next the report will summarize projected climate change threats and events that could impact urban areas in Nepal, along with some impacts and risks that could be result from hydro-meteorological events triggered by climate change or exacerbated by climate change threats. Then the report will describe some climate change adaptation options applicable to Nepali urban sector in accordance with local technical and institutional capacities and socio-economic conditions. Some of these adaptation options are to be implemented by government and city authorities while other options are targeted to be implemented by local communities, individual households, and the private sector.

In the final section, the Synthesis Report suggests some institutional reform areas (policy, legislation, regulations, and guidelines) that are required to enable the implementation of the proposed climate change adaptation measures.

3 CATEGORIES OF URBAN INFRASTRUCTURE AND COMPONENTS

This section outlines various types of urban infrastructure and components under the authority of DUDBC.

3.1 STRUCTURE AND ROLE OF DUDBC

DUDBC is a major department under the Ministry of Urban Development (MUD). The other key department under MUD is the Department of Water Supply and Sewerage (DWSS). DUDBC is organized into three main divisions: Housing; Building Construction; and Urban Development. The objectives of each division can be stated as follows:

- Housing Division Promote safe and affordable housing through development of planned settlements;
- **Building Construction Division** Promote construction and development of safe, economical, and environmentally friendly buildings which also encourage local architecture; and
- Urban Development Division Promote sustainable urban development and urban rural linkages through development of modern physical facilities, land use planning, and conservation of cultural, religious, and historical heritage sites.

The overall functions and responsibilities of DUDBC can be stated as follows:

- Formulation, planning and implementation of urban development plans and policies with focus on physical planning and infrastructure development:
- Formulation, planning and implementation of housing plans and policies;
- Design, construction, repair and maintenance of the government buildings;
- Planning and infrastructure development and land use planning of emerging small towns and growing urban centres through the Town Development Committees (TDCs);
- Execution of National Building Code and undertaking research and development activities relating to building technology and materials; and
- Preparation of water retention and rainwater harvesting guidelines.

DWSS functions and responsibilities include urban water supply systems, sewerage management, and rainwater harvesting, and these assets are addressed in the Water Supply and Sewerage Sector Synthesis Report.

3.2 HOUSING AND SETTLEMENTS

A responsibility of DUDBC is to promote safe and affordable housing through development of planned settlements. In the past, DUDBC has been involved in the upgrading of informal urban settlement, developing housing under the Peoples' Housing Program, planning of markets and public areas, and providing housing complexes in each development region for single women, children, elderly and disabled people. DUDBC also provides shelter units during natural disaster events.

3.3 BUILDINGS

DUDBC is responsible for managing the overall construction of government buildings. The entire construction process consists of the following: site survey and planning, detailed design, materials quantity survey and estimation; procurement of construction contractor and award of the contract per government procurement regulations; construction supervision by the concerned division office of DUDBC, and finally construction audit.

DUDBC is also responsible for the repair and maintenance of government buildings. Most of the government buildings located in urban areas are constructed with relatively modern technology consisting of brick masonry and reinforced concrete flooring and roofing with the sal wood used in crafting doors and windows. DUDBC is also responsible for retrofitting government buildings to bring them into compliance with the National Building Code.

3.4 URBAN DEVELOPMENT

One division at DUDBC is dedicated to the formulation, planning and implementation of urban development plans and policies with focus on physical planning and infrastructure development. Urban infrastructure consists of urban road networks, water and sanitation, storm drainage and solid waste management. With regards to urban development and planning, DUDBC is active in the following areas:

- Development of Physical Development Plans and Periodic Plans for municipalities, small towns/market centres including preparation of feasibility studies, Detailed Project Reports and urban mapping;
- Flood plain identification and land zoning guidelines;
- Urban drainage;
- National Building Code guidelines;
- Integrated Urban Environment Improvement program;
- Rain water harvesting and water retention programs;
- New Town Development for 10 new towns along Mid-Hill Highway corridor;
- Institutional and good governance strengthening for municipalities and towns; and
- Formulation and execution of physical improvement and infrastructure development master plans for religious, cultural and historic sites.

4 TYPICAL CLIMATE CHANGE THREATS AND IMPACTS FOR THE URBAN SECTOR

Climate change threat profiles were prepared for the seven urban sector case study districts consisting of localized projections of future climate change for the period 2040-2060 compared to a baseline period from 1980-2000.

Statistical downscaling for several temperature and precipitation stations was used to develop these projections using IPCC scenario A1B and four GCMs including PRECIS – Providing Regional Climate scenarios for Impact Studies; RegCM4 -- Regional Climate Model version 4, ARPEGE, and WRF - Weather Research and Forecasting model version 3.2. The downscaled datasets were prepared under ADB TA 7173 Strengthening Capacity for Managing Climate Change and the Environment. The datasets were obtained from Department of Hydrology and Meteorology, Nepal and Asian Disaster Preparedness Centre, Thailand.

The results of the downscaling were incorporated into a basin-wide hydrological model which computed changes in precipitation frequency, amounts and intensity, and river discharge and runoff for every 120 x 120 m grid cell in each case study district. Additional parameters computed include river water levels during extreme rain events. The climate change threats projections summarized in the following section are those threats that are likely to impact on urban infrastructure development in the seven case study districts.

4.1 REGIONAL THREATS AND IMPACTS ON URBAN SYSTEMS

When selecting the 7 case study districts, a strong geographical focus was employed to ensure that all regions of Nepal were covered as well as varying types of climate change threats. The case study districts represent the following regions in Nepal: Mid Hills, Trans-Himalayan, Terai, inner Terai, and the Capital City of Kathmandu.

Table 4.1 summarizes the key climate change threats and their impacts on various urban system components reviewed in the district case studies and which are an integral part of urban infrastructure.

Region	Case Study District (s)	Climate Change Threats
Mid Hills	Myagdi, Dolakha, Panchtar	 Settlements (small towns / market centres) located in hilly terrain subjected to more intense and prolong rainfalls resulting in landslides Drought conditions due to extended dry periods Riverside settlements prone to flash floods and river flooding
Trans Himalayan	Mustang	 Riverside settlements prone to river flooding, flash floods and snow storms Drought conditions due to extended dry periods
Terai	Banke	Urban centers subjected to more intense and

 Table 4.1
 Climate Change Threats for Different Regions

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Region	Case Study District (s)	Climate Change Threats	
		 prolong rainfalls resulting water inundation Rural settlements prone to increased river flooding 	
Inner Terai	Chitwan	• Town centers and waste disposal sites subjected to more intense and prolong rainfalls resulting in flooding and localized pooling	
Capital City	Kathmandu	 Squatter settlements in hazardous areas prone to flooding and landslides Cultural heritage sites prone to flooding and water inundation 	

An example of recent flooding resulting in water inundation and localized pooling is depicted in the photo in Figure 4.1 which shows the submergence and destruction of a World Heritage Site -- the ancient Ashoka Pillar near Lumbini.



Figure 4.1 World Heritage Site, 249 BC Ashoka Pillar Submerged and Cracking (Gotihawa, Kapilvastu)

Photo: Himalayan Times, 2 Sept. 2014

The urban sector can be categorized according to various components or assets. These asset categories include Government Buildings / Housing; Informal Settlements; Urban Drainage Systems; Urban Roads; Solid Waste Management Facilities; and Markets / Public Areas / Cultural Heritage Sites. The types of climate change threats that most impact urban assets include prolonged high temperatures, extreme rainfall events and high rainfall intensities, and high river flows including the potential for flash flooding. The impact of these climate change threats on the different categories of urban assets is summarized in Table 4.2.

	Typical Climate Change Threats		
Urban Components (Assets)	Increased Temperatures and Periods of Reduced Rainfall (Drought)	Increased Rainfall Amount and Intensity	Increased River Flow, and Flash Flooding
Housing / Buildings Informal Settlements	Poorly constructed houses or buildings, with no insulation, will become hotter endangering health of inhabitants, particularly the elderly and children. Vector and water borne diseases are projected to increase ⁴ .	Increased rainfall could severely impact poor quality housing, particularly weak roofing, resulting of flooding and destruction of households. Houses not in compliance with building standards or local zoning bye-laws could be swept away by landslides.	Houses next to rivers and not properly constructed could be flooded or swept away, potentially resulting in loss of property and lives.
Urban Drainage	Inferior quality drainage pipes could crack and fail under prolonged extreme temperatures.	Urban drains are either not planned systematically or non existent. Extreme rainfall events could cause severe flooding resulting in property and infrastructure destruction. ⁵	Drains discharging to rivers could become blocked by high river waters and sediment. High waters could enter drainage system and back-flow and flooding in towns.
Urban Roads	Concrete and bitumen roads could crack under prolonged extremely hot temperatures, resulting in potholes and more frequent maintenance.	Under extreme rainfall events, roads can be eroded, potholes formed, and destroyed by landslides in hilly areas.	Roads near rivers can be eroded or destroyed by flood events.
Solid Waste Management	Prolong extremely high temperatures could produce offensive odors in improperly managed waste.	Increased rainfall could inundate, flood and scatter waste that is not properly secured in landfills or collection points.	High river water or flash flooding could flood and scatter waste that is not properly secured in landfills or collection points.
Markets / Public Areas / Cultural Heritage Sites	Public market areas could become uninhabitable during extreme and prolonged high temperatures, severely disrupting commerce.	Market areas and cultural heritage sites without proper drainage could become flooded or destroyed, severely disrupting commerce.	Many cultural heritage sites are located near rivers and could be destroyed or heavily damaged by rising river waters or flash

Table 4.2 Key Climate Change Threats and Impacts on Urban Components

⁴ Climate Action South Asia, Assessing the Costs of Climate Change and Adaptation in South Asia, CASA Information Update No. 5, ADB, June 2014

⁵ The IPPC's Fifth Assessment Report, What's In It for Asia?, Executive Summary, 2014

	flooding.

4.2 MOST VULNERABLE URBAN ASSETS IN CASE STUDY DISTRICTS

For each of the seven case study districts for the urban sector analysis, two priority assets were selected from each district. The criteria used for selecting the priority assets are listed as follows:

- Infrastructure of national strategic importance,
- Infrastructure of district strategic importance,
- Infrastructure that has been impacted by past extreme events,
- Infrastructure located in areas prone to past extreme events.

The seven case study districts, the selected priority assets for each district, and the results of the climate threat vulnerability assessment (VA) for each asset are summarized in Table 4.3.

 Table 4.3
 Climate Change Risks / Vulnerability for Case Study Districts

District	Components (Assets)	Risks / Vulnerability	
	Charikot town core	Intense and prolonged rainfall, flooding, landslides due to insufficient drainage and non compliance with National Building Code resulting in destruction of homes and businesses.	
Dolakha	Singati Riverside Settlement	Intense and prolonged rainfall, flooding, landslides, and flash flooding due to location near confluence of two rivers; likely destruction of homes and market area since flooding and loss of lives has occurred in the past.	
Kathmandu	Bagmati UN Park	Intense and prolonged rainfall, flooding and flash flooding and erosion / destruction of bridges, damage to historic temples, informal settlements, informal agricultural plots and the UNICEF water supply system adjacent to the Bagmati River	
	Pathivara Informal Settlement	Intense and prolonged rainfall, flooding and flash flooding and possible destruction of low income homes adjacent to Dhobi Khola.	
Gaba Banke Nepa	Gabar Village-Churia Hills	Intense and prolonged rainfall, flooding and draught; flooding and possible destruction of homes and infrastructure.	
	Nepalgunj-/Salyani Bag	Intense and prolonged rainfall, flooding and prolong pooling of water resulting in damage to homes and infrastructure.	
	Souraha Settlement	Intense and prolonged rainfall, flooding and damage to homes and disruption of tourist economy.	
Chitwan	Bharatpur Solid Waste Site	Intense and prolonged rainfall, flooding and damage to waste site and spreading of pollution to downstream areas.	
Mustang	Jomson Town and Airport	Intense and prolonged rainfall, flooding / flash flooding of town and nearby airport, resulting in destruction of homes / businesses and disruption of tourist economy.	
	Marpha, Tukuche, Lete, Kagbeni and Tiri riverside	Intense and prolonged rainfall, flooding / flash flooding, debris flow and sedimentation, landslides	

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	settlements	resulting in damage in homes and businesses.	
Myagdi	Kali Gandaki Riverside Settlement (Beni)	Intense and prolonged rainfall, river flooding, flash flooding, sedimentation, landslides resulting in destruction of homes and businesses	
wyagui	Lower Beni Bazar Road	Intense and prolonged rainfall, river flooding and pooling resulting in destruction of homes and businesses	
	Yasok Market Center	Decreased rainfall during dry season resulting in drought conditions.	
Panchtar	Phidim Town Center	Intense and prolonged rainfall, flooding and destruction of town core and infrastructure.	

4.3 DISTRICT CASE STUDIES THAT BEST ILLUSTRATES THE THREATS AND IMPACTS

In this sub-section, examples are given that best illustrate the specific climate change threats and resulting risks and vulnerabilities for the priority urban assets/components in the case study districts. More detailed descriptions of each case study are presented in the respective District Baseline Reports for the urban sector.

BOX # 1: Singati Riverside Settlements and Market Area, Dolakha

Singati Riverside Settlement and the market areas are located near the confluence of the Singati and Tamakoshi rivers. The market is a strategic trade and economic hub for the northern part of Dolakha. The settlement and market areas are particularly vulnerable to river flooding since Singati houses and shops are mainly constructed of traditional building construction technology with a predominant use of wood, mud bricks and corrugated galvanized iron (CGI) roofing. In 1985, severe rainfall resulted in 36 deaths due to landslides and 6 people died after being swept away by flooding after 9 days of intense rain. The existing crude river embankment offers little protection against flooding.



Vulnerable Market Location and Weak Protective Embankment

To adapt to future flooding and landslide events, Singati buildings need upgrading in terms of improved design, and innovative application of more robust local materials and technology that can withstand future disaster events. More diligent application of the National Building Code will reduce the climate change vulnerability of Singati Market.

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BOX # 2: Bharatpur Solid Waste Disposal Site, Chitwan

The Bharatpur solid waste dumping site is unwisely located adjacent to the Narayani River about 1 km south of the Narayanghat bridge. The waste site is not protected by any built up embankment or dike system. Due to its vulnerable location, the asset is exposed to river flooding and river bank erosion. During flooding events, polluting waste can be readily dispersed into neighboring and downstream settlements.



Vulnerable Location of Waste Site with no Protective Embankment



Extreme Narayani river Flooding – 22 July 2013

Historically, flooding along the Narayani river has been unpredictable and erratic. It is foreseeable that weather events predicted from climate change projections will result in more extreme river flows and greater damage to the waste site.

A high priority adaptation measure would be to find an alternative waste disposal site in the Bharatpur area, and to decontaminate and decommission the existing waste site.

BOX # 3: The Urban Core of Charikot Town, Dolakha

The Charikot urban core is located on steep hillside slopes (20 - 50 degree slopes) and is prone to landslides which have previously occurred in the area. Projected higher intensity and prolonged rainfall events could make homes and infrastructure more vulnerable to flooding and landslides. The urban core is even more vulnerable due to poor quality of design, and construction of the mixed use multi-storied buildings (commercial and residential) are normally not in compliance with the Nepal Building Code. The urban core is particularly vulnerable to flooding because a proper drainage system has not been constructed. Flooding and landslides could disrupt transportation and commerce resulting in a loss of life, property and economic activity.



Settlements Along Vulnerable Hillside

Town Center -- No Drainage System



Green Watershed in Charikot Urban Area

The Charikot urban core is particularly vulnerable to flooding and landslides since the area was developed without any type of urban planning. Residential housing and business areas were establish haphazardly without any regards for slope stability or local hydrology. To adapt to climate change extremes, future urban development and redevelopment should consider implementation Physical Development Plans that include land-use zoning, hazards mapping, identification of highly vulnerable areas, and preparation of safeguard bye-laws for various types of land use zones. Green areas in the urban core should be preserved to absorb extreme rainfall runoffs and reduce the intensity of flooding.

BOX # 4: UN Park, Kathmandu

UN Park is located on both sides of 3.5 km stretch of Bagmati river and in a flood plain area. The eastern part of the public mixed use park is regularly flooded every 1-2 years. Extreme flood events occurred in 1993 and 2002 where water levels reached the lower level of nearby historic temple Ghats.



Informal settlements and ancient temples are located next to the Bagmati river and are situated in the flood plain. High velocity river flows resulting from intense and prolonged rainfall events could undermine Bagmati bridges and cause structural damage disrupting transportation. There is also the possibility for destruction of historic temples, Ghats, a school and the police barracks. A UNICEF constructed ground water supply and treatment system could be severely damaged and rendered non-functional. Also park greenery, bio-diversity and agricultural areas could be destroyed.



Historic Temple Ghats along Bagmati River

Regular Bagmati river bed sediment removal could reduce flooding intensity while in the long term existing river dike embankments may need to be heightened to adapt to future climate change events.

BOX # 5: Pathivara Informal Settlements, Kathmandu

Pathivara consists mostly of informal settlements located north of Chabahil Chowk in ward 3 of Kathmandu Metropolitan City. The settlement includes 165 households densely clustered next to the flood prone Dhobi Khola. Most family housings are poorly constructed using mud, bamboo and plastic sheet roofing without proper foundations.





Proximity of Housing to Dhobi Khola

Poor Quality Housing

More intense and prolonged rainfall events which are projected for this area could produce high river flows and even flash flooding that could destroy settlements next to the river. In past events, flood waters have breached the Dhobi Khola bank and have inundated the nearby access road.

Destruction of houses and in some cases loss of human life is a high concern since during daytime the area is mostly inhabited by women and children. This economically disadvantaged area has very limited resources to prepare for any emergency management procedures and evacuation.



Flooding Along Dhobi Khola Near Pathivara

A recent UN Habitat study (proposal for Pathivara Shelter Development Project, 2013) is a possible climate change adaptation measure for reducing vulnerability to possible disaster events in the Pathivara area. The proposal consists of housing upgrading, land sharing with legal owners, improved access, and provision of basic services.

BOX # 6: Flooding of Airport Area, Mustang

Jomsom airport is a key asset in Mustang District. The airport is a frequently traveled transportation hub for national and international tourists and is a main contributor to the district's economy. The airport is vulnerable to flooding resulting from intense and prolonged rainfall events because the airfield is not equipped with a drainage system. Extreme and prolonged rainfall events can result in flooding or flashing flooding from the nearby Kali Gandaki River. Closure of the airfield due to flooding could disrupt flights in and out of Jomson. In recent years, Jomson airport tarmac flooding has frequently caused disruption to air traffic and has reduced touristic income and economic opportunities.

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Jomsom Airport Area



Proximity of Jomson Airport to Kali Gandaki River

Some crude river training embankments have been constructed along the Kali Gandaki but projected increases in rainfall could comprise these existing flood protection measures.

BOX # 7: Yasok Market and Public Area, Panchtar

The asset consists of housing clusters and commercial buildings located in Ward 2 of Yasok VDC which is located in the southern western part of Panchthar District. The market provides significant economic benefits to the district.



Yaskok Market Area

Climate change projections for the area predict that temperatures will generally increase and rainfall will be reduced during prolonged periods resulting in drying up of scarce water sources. Insufficient water for households and for agriculture purposes will have negative impacts on human health and economic development. The area has experience drought periods in the past. Extreme periods of drought could further contribute to out-migration from the mid hill region. Increasing temperatures could also result in mosquito breeding and malaria, a disease that is currently uncommon in the hill regions.



10 Towns along the Mid-Hill Highway Development Project

DUDBC is now implementing the Mid-Hill Development Project, a high priority government project aimed to redevelop 10 existing urban areas in the mid hill region and to curtail out-migration. The development project will provide an opportunity for applying climate change adaptation interventions, including improved Physical Development Planning, in the urban restructuring process. The project could benefit Yasok Market which is strategically positioned near the Mid-Hill Highway.

5 TYPICAL ADAPTATION MEASURES

In Section 3, the impacts and vulnerabilities of urban systems and associated components are summarised and the geographic regions where they are most likely to occur identified. In this section, adaptation responses are identified based on the sector district case study assessments performed. The most important structural and non-structural adaptation measures which would enhance resilience in urban infrastructure and components are described.

A fundamental climate change adaptation measure presented throughout this section is the improvement in development and implementation of integrated Physical Development Plans and the Periodic Plan process for both towns and municipalities. Improvements will require changing steps in preparing the Physical Development Plans, as well as strengthening the capacities of the local institutions responsible for preparing and implementing the plans.

An example of the need for improved Physical Development Plans can be given for both Kathmandu Valley and the Mid-Hill towns that are scheduled for redevelopment under the high priority DUDBC Mid-Hills Town Development Project. Kathmandu Valley is experiencing a growth rate significantly above the national average resulting in slum areas expanding into marginal lands such as areas adjacent to flood prone rivers or on unstable hilly areas. An approach to solving this problem is to create satellite towns and resettlement areas outside of the urban centers. The development of the satellite towns and resettlement areas provides the opportunity to plan these new urban areas according to improved Physical Development Plan guidelines.

Likewise the 10 new towns to be developed along the Mid-Hill Highway corridor will have the opportunity to employ an improved Physical Development Plan process in the redevelopment of the existing towns. The existing 10 towns were developed haphazardly without any logical and planned system. The redevelopment of these towns through land pooling provides the prospect to plan the towns and associated infrastructure in a systematic and integrated manner.

The improved Physical Development Plan process involves utilizing land use classification and zoning as the main mechanisms for directing town or city growth. Zoning can be used to determine areas that are suitable for different types of urban development and infrastructure. It is recommended that land use planning and zoning take into account the following: (1) natural hydrological conditions based on historical records; and (2) preserving and utilizing natural eco-systems as a climate adaptation measure through provision of rain retention and flood control management systems, to increase resiliency and reduce vulnerability^{6,7}.

The recommended tool for determining zoning areas is the mapping process which can be undertaken either by using GIS technology or more simply by manually overlaying land use map layers on a large base map. Through mapping, the following types of areas can be classified: climate change threat hazardous areas (due to flooding, flash flooding, sedimentation, erosion or landslides), green or ecosystem areas to be protected, and safe

⁶ Climate Change and Development Strategy, Clean Resilient Growth, USAID, January 2014

⁷ Climate Change Adaptation Strategy, Ho Chi Minh City, Vietnam Climate Adaptation Partnership, Netherlands Government, 2013

and structurally stable areas suitable for housing and infrastructure. Once zones have been identified, then protective safeguards can be established through supporting bye-laws.

5.1 SHORT AND LONG TERM ADAPTATION MEASURES

The main objective of the adaptation planning (AP) process is to create climate resilient communities by protecting critical infrastructure and urban assets. An adaptation plan consists of proactive steps, or adaptation measures, to protect infrastructure from projected climate change threats. Adaptation is a collaborative process. Government urban planning officials, stakeholders, and the communities should work together to devise strategies for adaptation. Adaptation planning can be done in a series of steps, each of which is relatively straightforward to accomplish.

The adaptation measures aim to manage climate risk to an acceptable level, taking advantage of any positive opportunities that may arise. The potential adaptation options are adopted for specific projected climate change threats.

The adaptation measures are categorized as both short-term and long-term measures.

Short-term Measures

Short- term adaptation measures generally relate to an immediate fix involving small commitments of funds and / or resources. It is essential to initiate measures in a timely manner to prevent or mitigate climate change impacts that have a high likelihood of occurring and causing significant damage or loss of life.

Medium and Long-term Measures

Medium and long term adaptation measures usually require larger commitments of investments and resources in structural or institutional interventions to increase resilience of urban assets to projected climate change threats.

Table 5.1 summarizes the key climate change impacts on various urban systems and suitable structural and non-structural adaptation measures that can be implemented in both the short term and long term.

Urban System	IMPACTS AND ADAPTATION MEASURE			
& Components	ІМРАСТ	STRUCTURAL MEASURE	NON-STRUCTURAL MEASURE	
SHORT-TERM AD	APTATION MEASURE			
Housing / Buildings Riverside Settlements	 Intense and prolonged rainfall could produce high velocity and high river flows or landslides damaging homes and settlements. Force of intense and prolonged rainfall can structurally damage houses of poor quality. 	 Regular removal of sediments from rivers to increase flow and reduce river flow surges Promoting better housing practices and materials that are climate resilient 	 Enforce the National Building Code Organize community early warning and emergency response plans^{8,9} 	

Table 5.1 Key climate change impacts and adaptation measures for urban systems

⁸ Moving from Risk to Resilience, Sustainable Urban Development in the Pacific, ADB, 2013

⁹ Community-Based Disaster Risk Management, Critical Guidelines, Asian Disaster Preparedness Center, Bangkok, Thailand, January 2006

Urban System	IMPACTS AND ADAPTATION MEASURE		
& Components	ІМРАСТ	STRUCTURAL MEASURE	NON-STRUCTURAL MEASURE
	 Destruction of houses and in some cases loss of human life. Indirect impacts – Possible high loss of life, property damage and extreme disruption in peoples' livelihood. 		
Urban Drainage	 In urban areas without proper drainage, extreme or prolonged rainfall events could cause severe flooding resulting in property and infrastructure destruction. Drains discharging to rivers could become blocked by high river waters and sediment. High waters could enter drainage system and back-flow and flooding in towns. 	 Increased operation and maintenance (O&M) of existing drains 	 Organize drainage cleanup Users' Committee
Urban Roads	 Under extreme rainfall events, roads can be eroded, potholes formed, and destroyed by landslides in hilly areas. Roads near rivers can be eroded or destroyed by flood events. 	 Increased O&M with a condition assessment approach in key areas. 	 Organize road maintenance Users' Committee
Solid waste Disposal	 Increased rainfall could inundate, flood and scatter waste that is not properly secured in landfills or collection points. High river water or flash flooding could flood and scatter waste that is not properly secured in landfills or collection points. Public health hazards could occur. 	 Protect the dumping site through a bund construction which would prevent the flood waters entering in to the site. 	 Implement a solid waste reduction and recycling program to reduce amount of waste generated and transported to landfill.
Markets/Public Areas/Cultural Heritage Sites	 During heavy and prolonged rainfall events, market areas and cultural heritage sites without proper drainage could become 	 Increased O&M with a condition assessment of properties and infrastructure. Place sand bag barriers around sensitive cultural 	 Organize maintenance Users' Committee for both market areas and cultural heritage sites.

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Urban System	IMPACTS AND ADAPTATION MEASURE		
& Components	ІМРАСТ	STRUCTURAL MEASURE	NON-STRUCTURAL MEASURE
	 flooded or destroyed, severely disrupting commerce and causing economic loss. Many cultural heritage sites are located near rivers and could be destroyed or heavily damaged by rising river waters or flash flooding. 	heritage sites.	
LONG-TERM ADA	APTATION MEASURE		
Housing / Buildings Riverside Settlements	 Intense and prolonged rainfall could produce high velocity and high river flows or landslides damaging homes and settlements. Force of intense and prolonged rainfall can structurally damage houses of poor quality. Destruction of houses and in some cases loss of human life. Indirect impacts – Possible high loss of life, property damage and extreme disruption in peoples' livelihood. 	 Increase the existing river embankment wall height in line with climate change projections and strengthen wall structures to withstand flood events. Construct more climate resilient housing and buildings.¹⁰ Relocate and resettle informal settlements to safer locations.¹¹ Construct proper river- training works complying with international standards through combination of gabion protection, concrete retaining wall, soil stabilization and bio engineering technique. 	 Implement climate resilient Physical Development Plans using GIS and hazards mapping techniques. Implement the National Building Code, and revise code where necessary.
Urban Drainage	 In urban areas without proper drainage, extreme or prolonged rainfall events could cause severe flooding resulting in property and infrastructure destruction. Drains discharging to rivers could become blocked by high river waters and sediment. High waters could enter 	 Construct urban drainage systems in an integrated manner considering both surface drainage and wastewater drainage. 	 Prepare an Urban Drainage Master Plan, with coordination between DUDBC, DoR, and DWSS.¹²

¹⁰ How to Make a City Great, A review of the steps city leaders around the world take to transform their cities into great places to live and work, McKinsey & Company, 2013 ¹¹ Climate Change Adaptation in Urban India, GIZ, January 2012

¹² Climate Change Adaptation in Urban India, GIZ, January 2012

Urban System	IMPACTS AND ADAPTATION MEASURE				
& Components	ІМРАСТ	STRUCTURAL MEASURE	NON-STRUCTURAL MEASURE		
	drainage system and back-flow and flooding in towns.				
Urban Roads	 Under extreme rainfall events, roads can be eroded, potholes formed, and destroyed by landslides in hilly areas. Roads near rivers can be eroded or destroyed by flood events. 	 Plan new roads away from flood prone or hazardous areas. Upgrade existing roads with improved drainage facilities. 	 Prepare an Urban Drainage Master Plan, with coordination between DUDBC, DoR, and DWSS. 		
Solid Waste Management	 Increased rainfall could inundate, flood and scatter waste that is not properly secured in landfills or collection points. High river water or flash flooding could flood and scatter waste that is not properly secured in landfills or collection points. Public health hazards could occur. 	 Relocate waste site to a more secured location with proper drainage. 	 Continue to implement waste reduction and recycling campaigns to reduce amount of waste transported to landfills. 		
Markets/Public Areas/Cultural Heritage Sites	 During heavy and prolonged rainfall events, market areas and cultural heritage sites without proper drainage could become flooded or destroyed, severely disrupting commerce and causing economic loss. Many cultural heritage sites are located near rivers and could be destroyed or heavily damaged by rising river waters or flash flooding. 	 Preserve green areas and parks as a natural water management scheme and also as a climate change adaptation measure.¹³ Construct more robust houses and buildings in flood prone areas and on hilly topography. Construct protective bunds or walls around sensitive cultural heritage and religious sites. 	 Implement climate resilient Physical Development Plans using GIS¹⁴ and hazards mapping techniques. Implement the National Building Code, and revise code where necessary particularly for homes near hazardous or flood areas.¹⁵ Prepare an Urban Drainage Master Plan, with coordination between DUDBC, DoR, and DWSS. 		

 ¹³ Cities and Climate Change: An Urgent Agenda, The World Bank, Washington, DC, 2010
 ¹⁴ GIS-Based Municipal Information System for Improved Urban Planning, ADB, Cowater International Newsletter, February 2014

¹⁵ Cities and Flooding, A Guide to Integrated Urban Flood Risk Management for the 21st Century, The World Bank, Washington, DC, 2012

6 REFORMS REQUIRED WITHIN URBAN SECTOR

Climate change impacts have not previously been directly addressed in urban national plans, policies, strategies and laws and regulations. Subsequently, climate change threats have not been dealt with in planning guidelines, manuals, and technical standards relating to the urban sector. A main challenge for DUDBC is to adjust existing policies, plans, laws, guidelines and tools to reflect the existing and projected threats of climate change. In some instances, it may be necessary to prepare and implement new policies and procedures directed mainly at increasing resilience to climate change.

Institutional reform at DUDBC will also be required to mainstream new climate change adaptation into the working culture. Some organizational changes and capacity development support at DUDBC may also be needed.

Proposed actions and entry points for mainstreaming climate change interventions into urban sector development are presented in the following sub-sections.

6.1 POLICY, PLANNING AND THE LEGAL FRAMEWORK

At the policy, planning and legal framework level, the following reform entry points have been identified where threats of climate change can be addressed.

6.1.1 DUDBC Vision Paper 2007 – 2027

The DUDBC Vision Paper 2007 – 2027 has set forth strategies and objectives for urban development. The following are the long term objectives of the Vision Paper where climate change reforms can be most readily introduced in future policy revisions:

- Physical Development Plan of the entire country based on national model will be prepared and implemented; and
- Planned urban development programmes will be launched in small towns and market centers.

The first mentioned objective of the Vision Paper spells out the need for a national model for urban Physical Development Plan for application across Nepal. The climate change vulnerability assessment and adaptation planning (VA & AP) tool could be integrated into the national model. Also, the national Physical Development Plan model could specify that land use zoning, established through the use of GIS mapping of hazardous and climate change hot spot areas, should be a required part of the planning process. Land use zoning will also need to be support by bye-laws to provide the necessary safeguards to make urban assets resilient to climate change impacts according to land use and location.

For urban developments in small towns and market centers, the Vision Paper envisions planned urban development programmes. As many types of these towns are often located in unstable hilly areas and near river banks, it is essential that climate change resiliency is an integral part of the urban development programmes, and elements of the proposed Physical Development Plan model outlined in Section 4 of this report are used in small town development. Of particular importance to small towns are the implementation of land use restrictions, zoning, and strict compliance with National Building Codes.

The national model for an urban Physical Development Plan and plan for development of small towns and market centers can be institutionalized in the formulation of the Physical Development Act and Guidelines which is mentioned as a priority area in the DUDBC Business Plan 2014. Otherwise, these initiatives can be included in amendments of the

Town Development Committee Act, a future action also mentioned in the DUDBC Business Plan 2014.

6.1.2 Building Act 2055 B.S (1998)

The Building Act promulgated in 1998, along with first Amendment in 2007, is a landmark piece of legislation to streamline and regulate the building activities in the country. The main purpose of the Building Act was to provide a legal framework for implementation of National Building Code. The Act envisages the formation of 'Building Construction and Management Consolidation Committee' entrusted with the following roles and responsibilities that offer possibilities for including climate change impacts:

- a) Minimisation of adverse impacts and loss in the buildings from natural disasters like earthquakes, fire and others.
- b) Initiation of R & D activities for updating the building code, and for developing building construction processes and technologies.
- c) Public dissemination about the utility of the building code.

With regards to the Building Act, Item a) appears to allow flexibility in introducing climate change into the design and construction of buildings. Particularly item a) recognizes the threats to buildings due to natural disasters which are expected to occur with more frequency and magnitude as a result of climate change impacts. In future Building Act amendments, climate change can be specifically mentioned as a threat to the resilience of buildings.

To adapt to climate change through the designation of more robust building codes appears possible through item b) where research could identify building techniques and building materials more resilient to climate change impacts. Widespread dissemination of the threats of climate change and the need for strengthened building codes can be supported by item c) through greater public awareness for the need of complying with my strict building codes in areas vulnerable to climate change.

These reforms can be considered in future revisions of the Building Act, or in regulations or guidance on implementation of the Act.

6.1.3 Town Development Act 1998 and Amendments

The Town Development Act covers the following aspects concerned with town planning and development:

- Formation of town development committees (TDC) at central and district levels and provisions for operations, duties and authority,
- Town plan formulation and approval,
- Launching of land development programs, including operation and execution of Physical Development Plans.

The Town Development Act, Clause 11, empowers the TDCs to formulate a town plan with any or all of the following objectives:

- a) To sub-divide town development areas into the various land use zones;
- b) To delineate the necessary conditions and standards for physical development in the land use zones along with land classification, and to provide guidance to the local bodies and the related agencies for land development along with the stipulated rules and regulations;

- c) To undertake construction and development activities so as to protect nature and promote environment conservation in a designated land use zone;
- d) To restrict over exploitation of natural resources to minimise negative impacts.

A key climate adaptation measure for the urban sector is strict application and enforcement of flood plain and land use zoning guidelines that specify areas that are vulnerable to climate change threats. Items a) and b) give the TDCs authority to classify various urban areas suitable for different types of development. With this authority, TDCs can restrict urban development in areas highly vulnerable to climate change threats such as flood plains, steep slopes and unstable ground areas. These types of vulnerable areas should be identified through a hazard mapping process conducted in consultation with planning authorities and local citizens. Further items c) and d) allow the TDCs to establish green zones and to protect natural ecosystems in and around urban areas which serve as natural climate change adaptation systems by providing rain retention and flood control services. Identification of green areas or natural ecosystems can also be made through a consultative mapping process.

All these reforms can be clearly stated in future revisions of the Town Development Act, or in implementing regulations or guidance documents.

6.1.4 National Urban Policy (NUP) 2007

The purpose of the NUP is to address problems arising from increased urban population growth resulting from accelerating rural to urban migration, and the resulting problems such as deficiencies in basic infrastructure services and deteriorating environmental quality. A key objective of the NUP is pursuing an integrated approach towards all aspects related to urban development including environmental improvement schemes.

As part of the integrated approach to urban development, the NUP has developed and implemented a framework for disaster management planning to be conducted by the local bodies to minimize the loss of life and property due to likely natural disaster events. The disaster management planning framework includes the following initiatives:

- a. Develop a building construction system that is safe, environmentally suitable and accessible to the public.
- b. Promote research, development and application, in the context of developing alternative building materials and construction technologies, by giving special emphasis to locally available traditional skill and knowledge.
- c. Initiate timely reform of National Building Code and enforce it in the government, private and public buildings.
- d. Prohibit building construction in the natural disaster prone or environmentally hazardous areas.
- e. Encourage and provide directives to all local bodies to formulate the 'action plan'_for natural disaster mitigation and management that relates to probable disasters like fire, earthquake and flooding.
- f. Mobilize the community through the local bodies for natural disaster mitigation and management, and enhance public awareness for natural disaster management.

The NUP appears to strongly support land use zoning provisions of the Town Development Act through item d) which prohibits building construction in natural disaster prone or environmentally hazardous areas that can be considered to be flood plains and steep topographical areas. Both of these types of urban areas will be seriously impacted by climate change threats such as increasing intense rainfall, higher river flows, and river flooding. To identify the natural disaster prone areas, the consultative hazards mapping tool can be used to delineate restriction zones and zones for various types of land use. To increase resilience to climate change threats, item e) provides for the formulation and implementation of action plans to combat the natural disaster events, many of which will be associated with climate change. Community awareness and support are required for successful implementation of the natural disaster and climate change adaptation action plans, and item f) provides this opportunity.

Climate change adaptation measures are already inherently built into the NUP. However, future revision of the NUP should specifically call attention to climate change threats, and make reference to key climate change adaptation tools such as hazards mapping, land use zoning, and safeguards bye-laws for each type of land use zones.

6.2 INSTITUTIONAL AND MANAGEMENT STRENGTHENING

The DUDBC has three main divisions and two ancillary divisions. The main divisions consist of the Urban Development Division, the Housing Division and the Building Construction Division. There are 24 DUDBC field division offices covering all 75 districts.

The Urban Development Division is concerned with formulating and executing Physical Development Plans for major urban centres already designated as municipalities, and for emerging urban centres and for small towns.

The Housing Division is responsible for providing safe and affordable shelter in both the urban and rural areas of the country through development of planned settlements. The Building Division is entrusted with design, construction, repair, and maintenance of government buildings. The guiding principles are the promotion, construction and development of safe, economical, and environmentally friendly buildings with emphasis on utilizing local architecture.

The DUDBC field division offices are the main implementing agencies and are responsible for executing in the districts the main DUDBC components: Urban Development; Housing; and Building Construction. DUDBC at the central level directly manages projects which are complex in nature or are of national importance such as the Mid-Hill Town Development Project.

6.2.1 Potential Organizational and Staffing Changes

The Urban Development Division currently has an Urban Environment Section headed by a gazetted second class officer. Climate change concerns are now being added to the responsibilities of the Urban Environment Section. The main challenges lie in bringing about needed changes in DUDBC's organisational structure to address the impacts of climate change at both the central and field offices levels, and securing adequate human and financial resources for this task.

In the future, the threats and opportunities regarding climate change can have a significant impact on urban development. For this reason, DUDBC should consider instituting a new section under the Urban Development Division, with a focus on both Disaster Management and Climate Change. Among the required technical personnel, the new section should include at least one GIS expert with expertise hazards mapping and land use zoning as depicted in Figure 6.1.

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Figure 6.1 Proposed Organization Change for Urban Development Division

Currently there are 109 vacancies at the various levels within DUDBC at both the central and in the field division offices. To build capacity for adapting to climate change, the DUDBC could staff several vacancies at the central and field offices to provide the sufficient human resource for addressing climate change threats and impacts. More specifically, the Urban Development Division could employ an experienced drainage engineer to assist in preparing guidelines for urban Drainage Master Plans which would include drainage from wastewater, rainwater runoff, and urban roads drainage.

6.2.2 DUDBC Business Plan

The DUDBC has published a Business Plan for 2014. In Table 21 of the Business Plan, DUDBC lists Minimum Physical Infrastructure for Various Levels of Urban Classification. The Table covers Metro City, Sub Metro City, City, Sub City and Market Center urban classifications for the following types of physical urban infrastructure: Road; Water Supply; Water Accessibility; Sanitation Facilities; Solid Waste Management; Electricity; and Tele-communication. Storm water drainage facilities are not mentioned even though urban drainage is a responsibility of DUDBC.

It is highly recommended that storm water drainage be included in future DUDBC Business Plans and that the Planning Norms and Standards 2013 be revised to include more specific design provisions for urban drainage. The Planning Norms 2013 are discussed further in the next sub-section.

The DUDBC Business Plan 2014 also highlights under the Building sector the continuation of the disaster preparedness program which is required to review and update the National Building Code, and to retrofit vulnerable buildings where necessary. Future Business Plans can be more specific in identifying climate change as a major threat to building construction integrity, and to make National Building Code revisions based on climate change impacts.

For the Urban Development Division, the Business Plan 2014 also list priorities for future activities. The priority activities that are related to climate change interventions include the following:

- Formulation of Physical Development Act and Guidelines,
- Completion of Planning Norms and Standards 2013, and
- Updating Periodic Plan Guidelines.

In undertaking these priority activities, DUDBC will have the opportunity to incorporate the VA & AP process, land use zoning, GIS mapping of vulnerable areas, and establishment of safeguard bye-laws in the Physical Development Act, supporting guidelines, and in the Periodic Plan process. Also the Planning Norms and Standards 2013 can be updated to include more specific design provisions for urban drainage and also for providing norms and standards for building new or relocating existing critical physical and social infrastructure with consideration of future climate change projections.

6.2.3 Mid-Hill Town Development Project

DUDBC is in the process of developing and implementing the Mid-Hill Town Development Project. This project is a high priority initiative of national importance. The project involves the rebuilding and upgrading of ten towns along the 1,776 km Mid-Hills Highway corridor. The Mid-Hills Highway links Phidim Municipality in the far east to Patan town in the far western part of the country. The main objective of the Mid-Hill Town Development Project is to develop the ten towns into attractive urban centers with the purpose of preventing out-migration from the mid-hill and mountain regions of the country. It is expected that the project will benefit 7 million people living in the mid-hill region by providing urban areas planned in an integrated and participatory process and with the following urban amenities:

- Complete infrastructure and urban services,
- Industry and employment opportunities,
- Health and education facilities, and
- Food security.

Since the ten towns along the Mid-Hills Highways will undergo a process of redevelopment using land pooling schemes, there is an opportunity to include climate change adaptation tools and methods in the planning of the new towns. It is envisioned that the planning of the new towns could include the following:

- Use of the VA & AP tool,
- Mapping of land use zones,
 - o Identification of flood prone and hazardous areas,
 - o Identification of landslide prone areas,
 - o Identification of natural resource and ecosystem preservation areas,
- Use of GIS overlays to select land uses,
- Downscaling of climate change projection threats to specific town areas.

DUDBC is currently in the process of preparing the Terms of Reference (ToR) for a consultancy to prepare the urban Master Plans for the ten towns. It is highly recommended that the climate change tools mentioned be included in the ToR for the consultancy.

6.3 TECHNICAL GUIDELINES, MANUALS AND TOOLS

6.3.1 Design Standards & Guidelines

The DUDBC Planning Norms and Standards 2013 list the required Norms for various types of physical infrastructure for various urban classifications including Market Centers, Sub City, City, Sub Metro City, and Metro City. For all urban classifications except for Market Centers, there are provisions for providing Sanitation Sewerage Systems and Storm Water Drainage systems. For the storm water and sanitation systems, planning norms and standards are detailed. However, for each city classification the same standard minimum trunk sewer drainage pipe of 200 mm diameter is specified. Instead of listing a standard minimum drainage size for all city classifications, DUDBC should provide some guidance on how to design drainage systems that take into account different city hydrological characteristics and projected rainfall intensities. This is a planning gap that should be addressed and filled, particularly considering the need for a robust urban drainage system to manage for intense and prolonged rainfall events that are projected as a result of climate change.

It is highly recommended that urban drainage guidelines and planning norms be clearly defined also for Market Centers since these areas are often prone to flooding and inundation. Also it is recommended that guidance is given for preparing and implementing Urban Drainage Master Plans requiring the input and cooperation of DoR, DWSS and DUDBC.

The Planning Norms and Standards can also be revised to better climate proof other critical physical and social infrastructure. Physical infrastructure listed in the Planning Norms and Standards include water supply treatment plants and storage reservoirs, sewerage treatment plants and pumping stations, and sanitary landfills and waste collection points. Social infrastructure includes health facilities, schools, and police and fire stations. These infrastructures can become more climate resilient if the Planning Norms and Standards specify safeguards criteria for locating new or relocating existing infrastructure to protect these assets from possible climate events such as extreme flooding, flash flooding and landslides.

Many other design standards and guidelines have been prepared covering areas of DUDBC responsibilities. Table 6.1 lists the documents that have potential for climate change mainstreaming along with possible reform entry points shown in the last column.

SN	Title	Date created	Status	Climate Change Reform Entry Point
1.	Nepal National Building Code	1994, updated 2003	Presently In active use	Further upgrading of the Building Code is in the pipeline, and more robust building standards could be specified for areas vulnerable to climate change threats
2.	National Building Code: Implementation Manual	2008	Presently In active use only in Lalitpur sub- Metropolitan area	Needs to be applied in all towns and municipalities of Nepal, particularly areas vulnerable to climate change threats and where

Table 6.1	Urban Design	Standards	and	Guidelines	Potential	Climate	Change	Reform
	Entry Points							

SN	Title	Date created	Status	Climate Change Reform Entry Point
				more robust building standards are required
3.	Urban Planning Manual	2007	Not in active use	Opportunity for revising the manual with climate change adaptation tools such as land use zoning, consultative hazards mapping, and land use safeguards bye-laws
4.	Town Development Guidelines (Nepali)	2004	Not in active use	Opportunity for revising the guidelines with climate change adaptation tools such as land use zoning, consultative hazards mapping, and land use safeguards bye-laws
5.	Eco-city Guidelines and the concept of Urban Agriculture	2012	Not in active use	Opportunity for revising the guidelines with focus on land use zoning and consultative mapping of natural eco-systems with the purpose of conserving natural systems as a climate adaptation measure
6.	Drainage Guidelines Manual for the Design of Urban Storm Water Management in Nepal	1991	Does not seem to be in use	Guidelines should be updated and revised to include guidance of preparing Urban Drainage Master Plans, which integrate DWSS wastewater drainage and urban road drainage, and designed to consider increased rain runoff from climate change projections
7.	Urban Environmental Management Guidelines	2010	In active usage	Guidelines could be revised to address land use planning, town zoning and conservation of green spaces and agricultural areas as a climate change adaptation measure

6.3.2 Tools and Procedures –Periodic Planning Process

The Periodic Planning process for municipalities requires cooperation between DUDBC and MoFALD. Periodic Plans are usually done for a 5 year timeframe. The Periodic Planning process emerges from two separate legislations: the Local Self-Governance Act 2099 and Regulations (MoFALD) and the TDC Act 2088 (DUDBC). The DUDBC acts as a secretariat to the planning process and provides physical planning inputs to the municipal bodies. Figure 6.2 presents the overall planning process.





There are numerous opportunities for introducing climate change adaptation measures at several stages of the periodic planning process. For example, the conceptualization of the long term strategic vision could include acknowledgement of the requirement for adapting to climate change projections. Further, data collection could include a detailed listing of past climate change extreme events and threats impacting the urban area. The town profile could also address the threats, challenges and opportunities regarding climate change. Among the many implementation plans identified in the overall urban plan design, a climate

change adaptation could be listed separately or integrated into the 6 implementation plans shown.

Finally, the Physical Development Plan could include requirements for inclusion of climate change adaptation tools such as preparing land-use and land development plans based on VA & AP process. Associated tools to adapt to climate change also include land-use zoning, GIS mapping with overlays, hazards mapping, identification of highly vulnerable areas, and preparation of safeguards bye-laws for various types of land use zones.

6.4 SUMMARY OF POTENTIAL REFORMS

In summary, the most viable DUDBC reforms and entry points for climate change adaptation are as follows:

- 1. Prepare national Physical Development Plan model with climate change adaptation, and institutionalize the plan through a new Physical Development Act and Guidelines, or through amendment of the existing Town Development Act.
- 2. Demonstrate the effectiveness of an integrated urban planning process, using climate adaptation tools, during the formulation and implementation of the Mid-Hill Town Development Project.
- 3. Revise the National Building Code to include standards and norms to protect against climate change threats.
- 4. Add a Climate Change / Disaster Management Section within the Urban Development Division at DUDBC.
- 5. Prepare urban drainage master plan guidance in coordination with DWSS and DoR, and revise the Planning Norms and Standards 2013 to include revised drainage design guidance and location criteria for constructing new or relocating critical physical and social infrastructure.

ANNEX I: LIST OF GOVERNMENT OFFICIALS PARTICIPATING IN TIFFIN TALK & ROUND TABLE MEETINGS

No.	Name	Position/Organization
1	Mr. G.P Gorkhali	Joint Secretary, MoUD
2	Er. Shambhu K. C	Director General, DUDBC
3	Mr. Ramesh Singh	Deputy Direcor General, DUDBC
4	Er. Shiva Hari Sharma	Deputy Direcor General, DUDBC
5	Er. Amrit S. Bajracharya	Deputy Direcor General, DUDBC
6	Mr. Sunil Kumar Karna	Deputy Director General, DUDBC
7	Mr. Thumba Raj Shrestha	Senior Divisional Engineer, DUDBC
8	Ms. Uma Devi Sangache	Senior Divisional Engineer, DUDBC
9	Ms. Meera Gyawali	Senior Divisional Engineer, DUDBC
10	Mr. Rabi Shah	DUDBC
11	Mr. Yek Raj Adhikari	Engineer, DUDBC
12	Mr. Tika Ram Paudel	Senior Geographer, DUDBC
13	Mr. Pramod K. Karmacharya	Enginner, GIS, DUDBC
14	Mr. Rabindra Bohara	Senior Divisional Engineer, DUDBC
15	Padma K. Mainali	Senior Divisional Engineer, MoUD
16	Mr. Sabin Karmacharya	Architect, DUDBC

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No.	Name	Position/Organization
17	Ms. Sarita Maskey	Senior Divisional Engineer, DUDBC
18	Mr. Prakirna Tuladhar	Senior Divisional Engineer, DUDBC
19	Er. Deepak Shrestha	Senior Divisional Engineer, DUDBC
20	Mr. Dinesh Pote	Engineer, DUDBC
21	Mr. Dwarika Shrestha	Senior Divisional Engineer, DUDBC
22	Mr. Sagar Krishna joshi	Senior Divisional Engineer, DUDBC
23	Mr. Milan Acharya	Senior Divisional Engineer, DUDBC
24	Ms. Ramita Shrestha	Engineer, DUDBC
25	Mr. Raju Man Manandhar	Senior Divisional Engineer, DUDBC
26	Mr. Topendra B. Khadka	Senior Divisional Engineer, DUDBC, Surkhet
27	Mr. Surendra Raj Khatiwada	Computer operator DUDBC
28	Mr. Nava Raj Pyakurel	Senior Divisional Engineer, DUDBC

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