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Mainstreaming Climate Change Risk Management in Development

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International Experiences on Climate Change Adaptation Measures for Urban Development

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1 INTRODUCTION

Cities have always experienced natural hazard events that are not climate related, such as earthquakes and flooding. These hazard events may become major disasters, depending on the magnitude, location, and severity of impact on lives, peoples' livelihoods, and the surrounding environment. Climate change and extreme weather conditions are expected to increase the frequency and severity of climate related hazard events. Furthermore, climate change projections indicate that there will be incremental impacts that are less obvious and immediate resulting from gradual increased in average temperatures and precipitation in wet seasons.

Climate change will most likely exacerbate the many challenges related to urban development including poverty alleviation, the delivery of basic urban services, and provision of adequate infrastructure. Many of these challenges also limit resilience to disasters and existing and projected climate variability and extremes. City authorities develop plans and actions to limit the risks of disaster events in order to protect their citizens and property. As part of this effort, the authorities can similarly address the risks of climate change impacts by mainstreaming climate adaptation measures into plans and guidelines for urban development.

1.1 Content of Report

This report will first make a brief presentation of projected climate change threats and events that could impact urban areas in Nepal, and some impacts that could be result from climate change projections. Then the report will describe some climate change adaptation options applicable to Nepali urban 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 and individual households.

1.2 Climate Change Impact on Urban Infrastructure

The project climate change threats and events will mainly focus on urban infrastructure and services that could be impacted by climate change. In addition, some indirect impacts, mostly socio-economic and health related are listed. The direct and indirect climate change impacts are listed in the table below.

Projected Climate Change Threats or Events	**Potential Impacts on Urban Infrastructure and Services including Indirect Impacts**
Increase rainfalls in wet season, Increased intensity of rainfall events	▪ Flooding and subsequent disruption of urban services such as water supply, sewer systems, roads and utilities ▪ Contamination of groundwater systems due to mixing of flood and sewer waters ▪ Landslides and damage to buildings in low lying areas and located on steep hilly areas ▪ Increased risk of deaths, injuries, and illnesses (especially water-borne diseases) ▪ Disruption of transport, commerce, economic activity, and peoples' livelihoods
Decrease in rainfall in dry	▪ Greater stress on water resources and water supply systems resulting from increased water demand; declining water quality

season Extended dry periods	▪ Stagnation and odors from waste water not flushed from sewer lines due to low water availability ▪ Land degradation with reduced agricultural yields and increased risk of food shortages ▪ Potential temporary migration from rural to urban areas, and conflicts over water use ▪ Water becomes a commodity the poor cannot afford
Increase in river flooding Flash flooding	▪ Damage to drinking water intakes and waste water treatment structures, and other vulnerable infrastructure located near the flood plain ▪ Severe erosion of river banks; increased sedimentation in some areas ▪ Destruction or severe damage to religious temples and cultural sites ▪ Destruction of informal settlements located in flood plain ▪ Loss of life and livelihoods and need for temporary shelters
Increase in average temperatures Increased number of heat wave events	▪ Greater stress on water resources and water supply system, including those that rely on snowmelt, resulting from increased water demand, declining water quality ▪ Increased energy demand for cooling; load shedding extended beyond normal hours ▪ Exacerbation of the urban heat island effect leading to increased risk of heat-related mortality and illness, especially for the elderly, chronically sick, very young, and socially isolated ▪ Declining air quality resulting from higher ozone formation ▪ Wider geographical incidence of vector-borne diseases (for example, malaria spreading to higher-altitude cities)

Some impacts that are representative of events that can be caused directly or indirectly by climate change are presented in the following paragraphs.

Increased flooding events

Ho Chi Minh City in Vietnam is located 15 kilometres from the coastline and is influenced by at least two major river systems. The urban area routinely experiences flooding events during the wet season. Flooding events are even more severe when intensive rain events occur at the same time as high river flows and high tides. Traffic is often in chaos during these events and some parts of the city cannot be accessed.

Flooding and Traffic Problems in Ho Chi Minh City

Land Subsidence

In many urban areas where the surface water supply system is insufficient to meet the demands of all users, ground water resources are overdrawn in an unsustainable manner. Under these circumstances, ground water is extracted at a greater rate than natural replenishment. As a result, land in the area of the depleted ground water can undergo subsidence. During extended heat waves and draught period, demand for fresh water will increase placing more pressures on all water resources including ground water. During these extended dry and hot climate events, further land subsidence can occur.

Land Subsidence around a Tube Well in Ho Chi Minh City

Severe Erosion

High river flows or flash flooding caused by intense precipitation events, or compounded by landslides, can create high velocity flows that can severely damage river banks. Such events may occur more frequently with greater intensity in the future due to climate change. In May 2012, a flash flood occurred in the Seti river basin impacting many riverside settlements including the

downstream urban area of Pokhara. At some locations, river water crests were reported to be 30 meters above normal.

Seti River Bank Scouring near Pokhara, May 2012

Sedimentation

In the same flash flooding event affecting the Seti river in May 2012, many riverside settlements were buried under vast quantities of debris and sediments washed from the upper watershed. Some areas were buried under about 20 meters debris and sediment deposits.

Buried Settlements along Seti River

2 POTENTIAL CLIMATE CHANGE ADAPTATION MEASURES FOR URBAN SECTOR

From an international perspective, there are a wide range of climate change adaptation measures applicable to urban areas that have already been implemented or are planned for the future to respond to climate change projections. For this paper, the scope of adaptation measures will be targeted towards interventions that are deemed feasible within the Nepali urban context. Furthermore, the climate change adaptation measures presented will focus on measures that can be mainstreamed within the Nepal Department of Urban Development and Building Construction (DUDBC). The main functional areas of DUDBC include the following: urban drainage, water retention, building code guidelines, flood plain and land zoning guidelines, and rainwater harvesting guidelines.

2.1 Flood Control and Drainage

Management of urban flood control and drainage requires the implementation and coordination of several types of adaptation measures. This section presents several adaptation measures applicable to DUDBC. The following section (2.2) addresses the need for proper solid waste management to support some of the adaptation measures mentioned in this sector. To effectively mainstream the flood control and drainage adaptation measures in DUDBC plans and guidelines, there must be close coordination with authorities in charge of solid waste management, -- mainly the Ministry of Urban Development and city municipal authorities.

Undertake Responsible Integrated Urban Planning

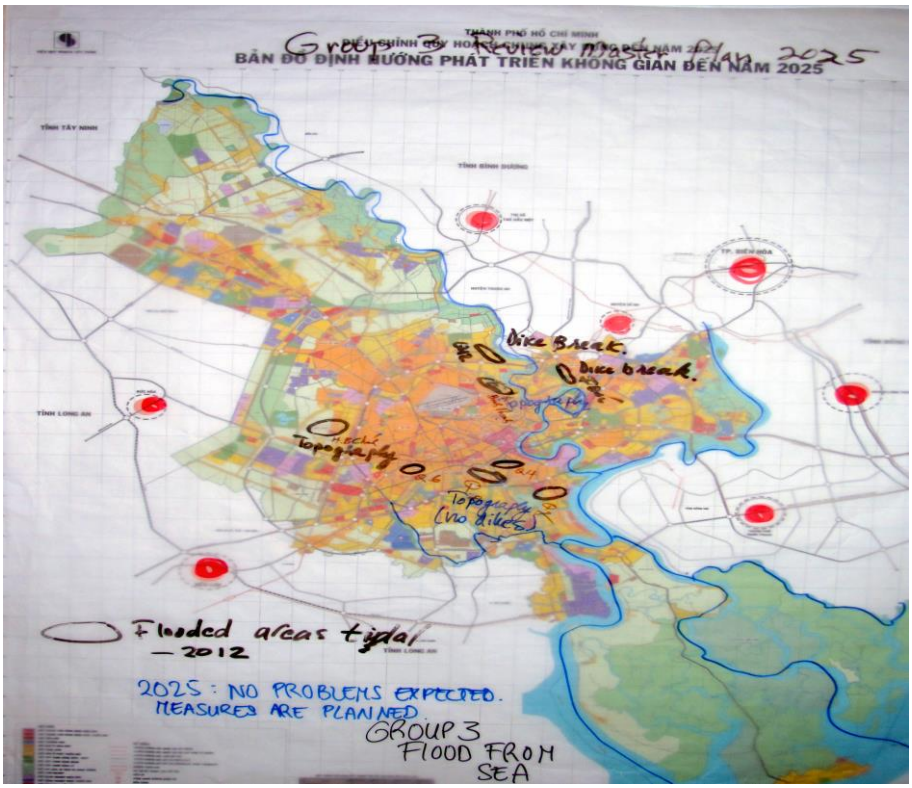
Urban planning and development should respect the city's natural water network including existing flood plain boundaries. These areas should be preserved in their natural state to regulate and store rainwater as well as to absorb high river flows coming from upstream. Sufficient land space should be given for the water to flow naturally. Urban development in all low-lying areas must be carefully examined in light of flooding and possible pooling of rainwater. More attention should be given to concentrating urban development in higher elevations of urban areas.

Since climate change impacts all parts of urban life, an integrated approach is required for urban planning. Urban planners must develop their plans in a broader framework relying on active inputs from all sectors including the local communities and the private sector.

Prepare Flood Risk Map

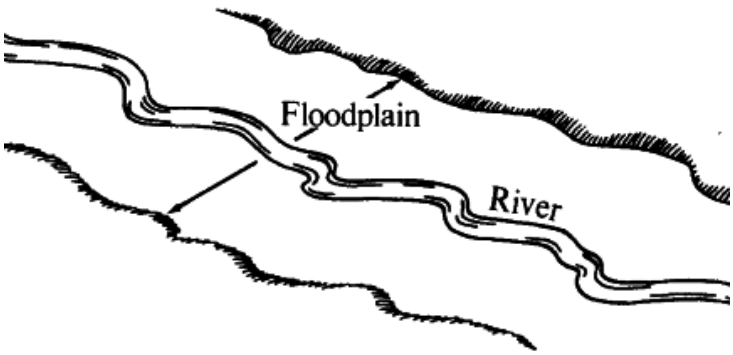
As part of the integrated sector approach to urban land use planning, relevant stakeholders from several city departments should jointly prepare a flood risk map for the city. The risk map should be based on a review of past flooding events, hydrologic modelling, and experiences from respective

departments. Once the flood risk map is prepared and hazardous areas identified, then development in the flood plain areas should be restricted to only certain types of land uses. Ideally the flood plain areas should be allowed to maintain natural vegetation for flood protection measures.



Flood Risk Map Using Coordinated Sector Approach

Under natural conditions, rivers expand during wet seasons and become narrower and more confined during dry seasons. This seasonal widening and contraction of rivers should be used as a natural flood protection mechanism, allowing waters to expand into the flood plain without being restricted by urban development. Planting of high water requirement vegetation in and near the flood plain or low lying areas can be an effective measure to minimize water logging occurring as an aftermath of floods.



Allow Room for River

Plan Urban Space by Valuing Natural Ecosystem Services

Urban infrastructure, such as impervious pavements and alteration of natural landscapes, can create undesirable conditions such as the Heat Island Effect, flooding, and pooling of rainwater. It is however possible to rebuild urban resilience by leveraging the climate adaptation services of natural ecosystems. Ecosystem services are the benefits that people derive from natural systems such as the buffer effect that wetlands and natural green areas provide from storms and flooding, as well as air filtration and cooling effect from the greenery.

Natural Wetland Ecosystem for Flood Control

Control Land Use in Upstream Watershed

Flooding in urban areas often results from degraded land use in upstream watershed areas. When watersheds are disrupted and natural landscapes are stripped of natural vegetation, then the rainwater absorbing capacities of the land are diminished resulting in increased water runoff and sedimentation in receiving rivers. The increased runoff and sedimentation will eventually reach urban areas resulting in increased flooding events. Sedimentation will also decrease the drainage and flow capacity of rivers, thus increasing the magnitude of flooding events.

Degraded Forest in Watershed

Improved Rainwater Management and Harvesting

To improve the management of rainwater, the city can construct multi-functional public areas that can serve as recreational areas during dry periods and as water storage facilities during high rainfall events. The city's streams, canals and drainage systems can also be upgraded, dredged or restored to increase the natural drainage and reduce flooding. Parking lot and other urban paved surfaces can be converted to new highly porous structural materials that allow infiltration of rainwater.

Pervious Pavement Surface

For some apartment complexes and neighbourhoods in urban areas, it may be possible to intercept the storm water drains and build ground water recharging wells of appropriate depths. Recharging structures should be accompanied with suitable filtering systems to prevent ground water contamination. However, adequate study of sub-soil conditions is essential before designing recharging schemes.

Besides capturing rainwater from roof tops, rainwater runoff can also be managed in terraced water collection systems and connected to a sump or the well in group housing schemes or apartment complexes. With respect to the location of recharge points for rainwater harvesting, a detailed

assessment should be conducted for locating recharge points in order to avoid locations with water logging problems and high sub soil water.

Plant trees and increase number and size of city parks.

More green areas in the city will improve the infiltration of rainwater therefore reducing water runoff and flooding, while at the same time natural infiltration will recharge groundwater. Green areas also reduce the Heat Island Effect through increased evapo-transpiration and shading.

City Park in Ho Chi Minh City

2.2 Solid Waste Management

In many developing cities, a key element in adequate flood control and drainage management is to improve the collection and management of solid waste. Wastes not properly managed usually end up in drainage channels and canals and river systems, thereby blocking the normal drainage functions of these systems. A high priority climate adaptation measure should be the expansion of solid waste collections systems and the promotion of waste reuse and recycling through source separation. In particular, solid waste collection should extended to informal settlements that are usually located near rivers and natural drainage channels.

In Nepal it is reported that most solid wastes are organic and can be treated through composting. The plastic content can be recycled, and the remaining residual waste (estimated at 20%) should be sent to a sanitary landfill.

Wastes Block Natural Drain Channel in Ho Chi Minh City

2.3 Water Supply

The most effective climate change adaptation option for an urban water supply system is locate critical assets – such as treatment plants, reservoirs, and major transmission pipelines – away from the flood plain. However, water intake structures must be located near a stream or other type of water source. Water intakes may require some type of protection works such as river training and embankment walls to divert high river flows during extreme events and flooding.

Water supply systems can also adapt to climate change by increasing their resilience and efficiency. For example, water utilities can reduce water consumption that does not generate revenue through stricter surveillance to reduce illegal connections. The water supply system can be made more efficient by reducing the amount of non-revenue water through reduction in water line leakage. Increased resilience can be further realized through either strengthening the supply-side and / or reducing demand for water from the system. Through the supply-side, water supplies can be increased through the following measures: expansion of rainwater storage systems; and wastewater reuse for watering parks and cleaning streets, and potentially for irrigation. Also, demand for water can be reduced through expanded use of economic incentives including metering and pricing to encourage water conservation and awareness raising about water conservation and benefits of using reclaimed water.

Reduce Groundwater Use

In some areas, groundwater extractions should be restricted or not allowed. In areas where groundwater has historically been pumped at a rate faster than natural recharge of the aquifers, groundwater levels have declined often resulting in land subsidence. Areas the have subsided will be more vulnerable to climate change events through increased flooding and pooling and will be more structurally unstable.

House Foundation Failure due to Land Subsidence

3 COMMUNITY BASED ADAPTATION MEASURES

Community-based adaptation (CBA) strategies can build long-term climate change adaptive capacity at the local level. Approaches that draw on local sources of adaptive capacity, such as women's knowledge of natural resources or the ingenuity of a homeowner committed to staying in his house, can be more sustainable than top-down prescriptions from a city or government official. Local communities know their area very well as they have the ability to assess the local impacts of climate change on a day-to-day basis and to find individual and often innovative solutions to respond.

Not all CBA strategies will be effective in the long term. For example, moving household valuables to the top shelf of a cabinet to protect from flooding or building a second floor of a house to allow temporary escape in a flood-prone location may alleviate short term concerns about property loss. However, if flooding continues to increase in frequency and intensity, these strategies may actually increase the vulnerability of people, delaying the full impact of future flooding, rather than avoidance altogether.

CBA enables local communities to strengthen their own existing adaptive capacity and to build resilient livelihoods, to reduce their individual vulnerability. In order to implement more appropriate adaptation measures, they often need to be provided with further information on climate change impacts and on existing larger scale or wider ranging adaptation plans. In this regard, local communities can be assisted significantly by civil society organizations and sometimes local government, who can provide information, capacity-building, adaptation and community mobilization services.

The following are examples of CBA that have been successfully implemented in other locations.

3.1 Green Housing, Green and Blue Roofs

Individual houses, apartment complexes or even government or commercial buildings can construct green or blue roofs. Plants, shrubbery or gardens can be planted on green roof tops for the cooling effect and to trap rainwater. Further, roof top gardening can assist in securing a sustainable food source during emergency flooding situations when it is not feasible to travel to local markets.

A blue roof is designed to temporarily store rainfall with the benefits of mitigating runoff impacts, preventing local flooding, storage of collected rainwater for reuse, or cooling effect through evaporation.

Example of a Green Roof

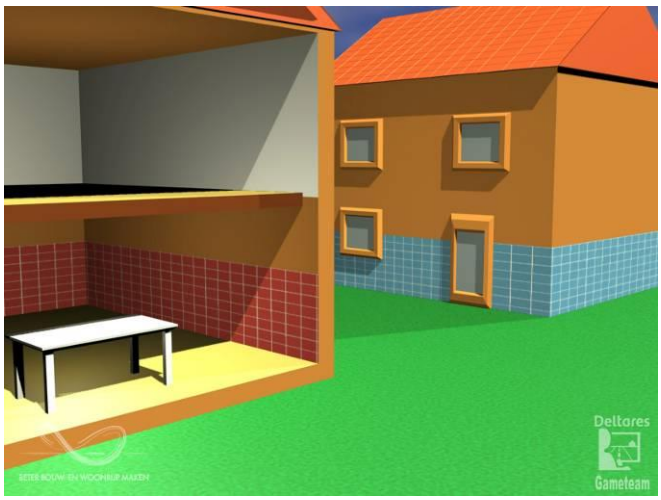
Example of a Blue Roof

Planting greenery around homes and on walls can also help to maintain cooler temperatures during extended periods of heat. The greenery can also assist in alleviating local flooding by absorbing rainwater.

Green Household Facade

3.2 Household Flood Proofing

As an immediate and short term projection method to prevent flooding, the foundation level of individual households in flood prone areas can be raised, or ground floors can be made flood proof though various types of water protection methods using ceramic or other water proof materials.



Flood Proofing of Ground Floor

Flooded Ground Floor in Ho Chi Minh City

Raised Elevation of Ground Floor

ANNEX A - REFERENCES

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Asian Cities Climate Change Resilience Network, http://acccrn.org/

ICLEI Local Governments for Sustainability, http://iclei.org/

ADAPT Asia-Pacific, http://adaptasiapacific.org/