



Cities^{and} Climate Change Initiative

ABRIDGED REPORT
Kathmandu Valley
Nepal
Climate Change
Vulnerability Assessment

UNHABITAT
FOR A BETTER URBAN FUTURE

Cities_{and} Climate Change Initiative

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Nepal

Climate Change
Vulnerability Assessment

Kathmandu Valley, Nepal - Climate Change Vulnerability Assessment

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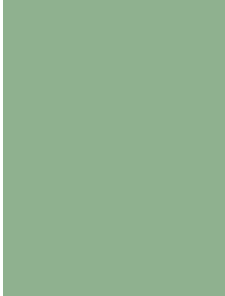
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Introduction

The climate on our planet is changing and in recent years there has been growing concern about how the impacts of climate change will affect cities and urban populations around the world. Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties that persist for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity.¹ Climate change is already affecting millions of people worldwide. In urban areas, which usually have significantly higher population density, climate change has been exacerbating and compounding existing vulnerabilities, especially for the urban poor. Urban areas are one of the largest contributors of climate change, producing more than 60 per cent of all carbon dioxide and significant amounts of other greenhouse gas emissions, mainly through energy generation, vehicles, industry and biomass use. This means that cities must be the centre of any future actions to both mitigate the causes of climate change, and to adapt to their anticipated effects.

Since the late 1800s there has been a profound increase in the average temperature of the earth's surface which has risen by 0.74° C, with the last decade being the hottest of all. It is expected to increase by another 1.8° C to 4° C by the end of 21st century if necessary actions to mitigate are not taken.² There is strong evidence that most of the warming observed over the last 50 years is attributable to human activities.³ A century and a half of industrialisation: the burning of ever-greater quantities of oil, gas and coal, deforestation, and intensive farming methods have

contributed to the variations in climate observed at the present time.

As a result of climate change, it is expected that storm frequency and intensity will increase, flooding will become more serious and droughts will affect food production in rural areas, which will have damaging effects in urban areas. Mountain areas, such as those found throughout Nepal, will suffer from a decrease in glacial cover and higher snowlines. Existing urban development challenges, such as poor health and inadequate housing will be substantially exacerbated by the effects of climate change. In the Kathmandu Valley, the urban population is growing very rapidly, with an influx of poor migrants from rural areas. These people are moving into settlement areas that are unplanned, lack basic services such as water supplies and solid waste management and are located on marginal lands in areas prone to landslides or flooding. Amid all this, the poorest are almost always the most vulnerable, as they have less access to infrastructure, basic services and social safety nets in the event of a disaster.

1.1 UN-Habitat's Cities and Climate Change Initiative

In this context the United Nations Human Settlements Programme (UN-Habitat) established the Cities and Climate Change Initiative (CCCI) in 2008. The CCCI

¹ IPCC (2007). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change S. [Solomon, D. Qin, M. Manning Intergovernmental Panel on Climate Change.

² IPCC (2007). 4th Assessment Report, Intergovernmental Panel on Climate Change.

³ IPCC, I. P. o. C. C. (2001). Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the IPCC. Intergovernmental Panel on Climate Change. UK, Cambridge University Press.

was developed to promote the mitigation of, and adaptation to, climate change in developing countries and to encourage shelter for all and sustainable human settlements development focusing on urban governance, decentralisation and strengthening local authorities, environmental planning and management, and mitigation and adaptation to climate change impacts on human settlements.

The UN-Habitat Asia-Pacific Strategy 2011-2015 has identified three key objectives for the CCCI in the Asia-Pacific region:

- 1) To build the capacities of at least 50 cities in at least 15 countries to prepare and implement comprehensive climate change strategies and action plans.
- 2) To integrate good climate responsive urban development practices into national policies, strategies and legislative reforms.
- 3) To establish a CCCI regional partners' advocacy, knowledge management, capacity building and networking platform.

A vulnerability assessment of the impacts of climate change on the Kathmandu Valley was conducted under the Cities and Climate Change Initiative. This study was part of the National Adaptation Programme of Action of Nepal and Local Adaptation Programme of Action. The research was initiated to understand, enhance knowledge and sensitise local government to the impacts of climate change and their capacity to adapt to such changes.

This study presents a desktop review of the state of climate change research and policy in Kathmandu, Nepal. It identifies important challenges, knowledge gaps, as well as promising practices, with specific focus on urban planning interventions that will be relevant for future urban policy and research priorities in Nepalese cities.

1.2 Objectives

The overall objective of the study was to sensitise and strengthen the response and capacity of governments and stakeholders in the Kathmandu Valley to the impacts of climate change.

The specific objectives were to:

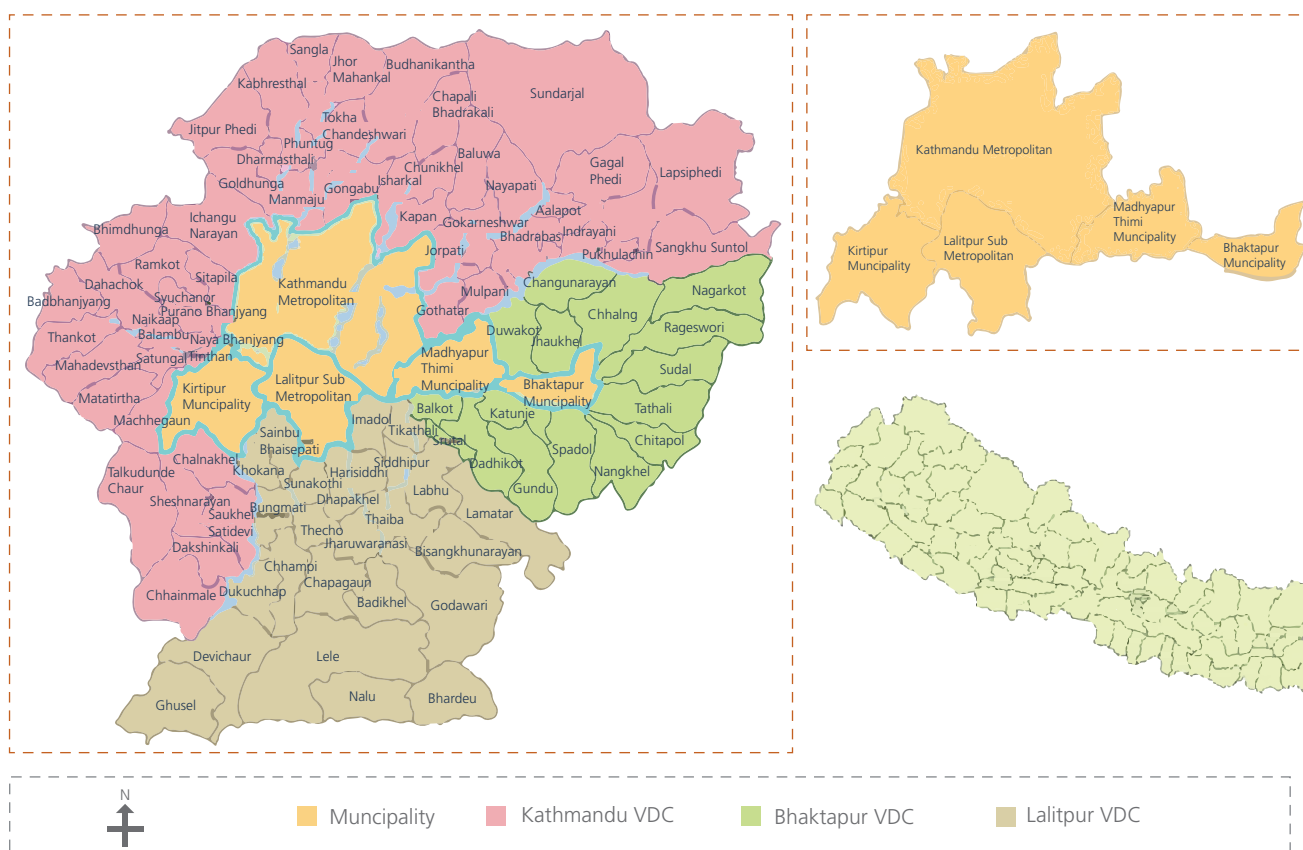
- (i) To sensitise urban government and stakeholders on the linkages between climate change and urbanisation;
- (ii) To strengthen the response and enhance the capacity of government officials and related stakeholders to climate change;
- (iii) To promote the active collaboration of urban governments and local stakeholders to combat climate change;
- (iv) To establish a basis of evidence on which local and national governments can develop and implement climate change response measures; and
- (v) To conduct an urban-based climate change vulnerability assessment and related adaptation plans.

Overview of the Kathmandu Valley

The Kathmandu Valley consists of three districts, five municipalities and 99 village development committees. The study area comprises the three districts of the City of Kathmandu, Lalitpur and Bhaktapur, which contain five municipalities; Kathmandu metropolitan, Lalitpur sub-metropolitan, Kirtipur, Bhaktapur and Madyapur Thimi and 99 village development commit-

tees, as shown in Figure 1. Village development committees are predominantly located in rural areas while municipalities are predominantly in urban areas. However, due to rapid urbanisation many of these rural village development committees are now characterised by urban expansion.

Figure 1. Maps of the Kathmandu Valley.



Source: KVTDC (Kathmandu Valley town development committee), 2008. Preparation of Detail Digital land use map of Municipalities of Kathmandu Valley. Ministry of Physical planning & works, Government of Nepal.

2.1 Geography and Culture

Kathmandu Valley is the administrative center of Nepal and home to the capital city of Kathmandu. The country borders India in the south and China to the north. The city of Kathmandu has experienced a high urbanisation rate in recent years and is famous around the world for its rich cultural heritage. The Kathmandu Valley lies between latitudes 27°32'13" and 27°49'10" north and longitudes 85°11'31" and 85°31'38" east. It is surrounded by the hills of the Mahabharat range forming a bowl-shaped valley floor. The major rivers of the Valley are the Bagmati, Bishnumati, Dhobi Khola, Hanumante, Manahara, Tuku-cha, Balkhu, and Nakhu Khola and remain an important part of this culture and heritage. The majority of temples and ghats lie along the river bank. Kings and commoners alike built pati, pauwa, stone spouts, temples, etc. Most of the revered temples in Nepal such as Bajrayogini, Gokarna, Budhanikantha, Tika Bhairab, Shobhabhagwati, Changu Narayan, Pashupatinath, Swambhu are also located in the valley.

2.2 Demographics

The total population of the Kathmandu Valley was 2,517,023 at the time of the 2011 census, of which 1,465,254 were considered to be living in urban areas (the five municipalities) in 2011.⁴ During the 1990s, the rate of urbanisation was 6.6 per cent per annum which was among the highest in the Asia Pacific region.⁵ This was due to a variety of causes such as natural growth, migration, the designation of additional municipal towns, and the expansion of municipal towns amalgamating with previously rural areas.

At the 2011 census Kathmandu accommodated 32.4 per cent of the total urban population of the country. Of this total, 58.2 per cent of the valley's population was considered to be living in urban areas but urbanising village development committees outside the five municipalities were not considered. Among the

Kathmandu Valley districts, Kathmandu had the highest annual growth rate per annum of 4.71 per cent in 2001 and 4.78 per cent in 2011.

2.3 Governance

The Kathmandu Valley consists of three districts, Kathmandu, Lalitpur and Bhaktapur. These districts comprise five municipalities and 99 Village Development Committees. Municipalities are the same administrative level as Village Development Committees, but are considered urban, whereas VDCs are rural. In addition, in 2011 the Government of Nepal formed the Kathmandu Valley Development Authority (KVDA) with the objectives of re-constructing, expanding and developing the cities in a planned way to provide necessary services and facilities to the people.

Districts are governed by District Councils that oversee District Development Committees. The Council also adopts resolutions relating to taxes, charges, fees, tariffs, loans or borrowings and internal resources submitted by the District Development Committee. The Committee formulates and implements plans and programmes related to agriculture development, water and habitation development, hydropower, infrastructure and transport, land reforms and management, forests and environment, irrigation, soil erosion and river control and natural disasters. Municipalities function as per the Local Self-Governance Act, 1999 which was enacted to promote governance by way of decentralisation and constituted local bodies for the development of the local self-governance system. The Act provides provisions for constituting the Municipal Council which is responsible for approving the budget, plans and programmes. A Village Development Committee is the smallest administrative unit, which is further divided into nine wards, each of which elects a representative to the Committee. Each Committee must formulate and implement plans, programmes and projects relating to agriculture, rural drinking water, works and transport, irrigation, soil erosion and river control, physical development, and health services, etc.

⁴ http://unstats.un.org/unsd/demographic/sources/census/2010_phc/Nepal/Nepal-Census-2011-Vol1.pdf

⁵ ADB/CIMOD, 2006

Vulnerability Assessment - Scoping Exposure, Sensitivity and Adaptive Capacity

3.1 Methodology

The climate change vulnerability assessment of the Kathmandu Valley was analysed through three main pillars: exposure, sensitivity and adaptive capacity to change. The relationships and interactions between the three pillars are illustrated in Figure 2. The study methodology was both qualitative and quantitative and was conducted with the participation of local communities, local government authorities, central government officials and other relevant stakeholders.

Exposure: Exposure is defined as what is at risk from climate change (e.g. population, resources, property) and the change in the climate itself (e.g. sea level rise, temperature, precipitation, extreme events, etc.).

Sensitivity: Sensitivity is the degree to which a system is affected by the biophysical impact of climate change. In particular it takes into consideration the socio-economic context of the system being assessed and the degree to which they could be impacted the future.

Adaptive capacity: The degree to which people, places, institutions, and sectors are able to adapt and become more resilient to climate change impacts.

3.1.1. The Study Process

The study process consisted of seven main steps:

Step 1. Orientation of stakeholders: A consultative meeting was held in Kathmandu with international

Figure 2. Vulnerability assessment framework



Source: UN-Habitat

experts and relevant stakeholders.

Step 2. Formation of the working group: A task force was formed to guide the research team.

Step 3. Data collection and research: The data and information for the study was collected from secondary sources, focus group discussions, key informant interviews and consultative meetings.

Step 4. Technical workshop: A workshop was conducted and experts gave their views on the information collected.

Step 5. Community consultations: A total of 5 focus group discussions were conducted in different parts of Kathmandu to qualitatively assess climate change vulnerability.

Step 6. Visualisation and mapping (hotspots): Visualisation and mapping was performed with GIS where layers were prepared for different sensitivity and adaptive capacity. The hotspots were identified by overlapping the sensitivity layer and adaptive capacity layer.

Step 7. Writing the vulnerability assessment: After completion of the previous steps, a write up on the vulnerability assessment was completed.

3.1.2. Scope and limitations

Several impacts described by the communities are not only attributed to climate change but also other factors such as population growth and haphazard urbanisation. Hence, due to such confounding factors, it was difficult to wholly attribute certain impacts to climate change.

Inadequacy of time was another limitation for the study as the timing of the year for the research study (July, August and September, 2011) which is a period in which Kathmandu received a lot of rainfall could in part be the reason for frequent mentions of flooding, erratic and heavy precipitation and relatively infrequent mention of drought.

3.2 Climate Change Exposure

3.2.1. Temperature

Nepal has a broad range of temperatures from north to south. In the Terai – the southern plain along the border with India, the mean daily temperatures even in winter can be up to 27°C, reaching 37°C in summer, while in the mid-hills around the Kathmandu Valley, temperatures range widely, from around 0°C in winter up to 35°C in summer. Average temperatures generally decrease by about 6°C for every 1000 metres of elevation. Mean average temperatures in the Kathmandu Valley range from about 9°C in January to around 22°C in July and August.

Previous trends

The temperature trend of Nepal shows an increase in temperature over the years. A study by Shrestha et al. (1999) based on the data from 49 stations in Nepal for the period of 1977 to 1994 indicate a consistent and continuous warming at an annual rate of 0.06°C.⁶ Similarly, a study by ICIMOD (2007) for the period of 1977 to 2000 also showed the increase of temperature at the same rate and showed that the regional temperature trend varies from the Himalayas to Terai where the middle mountain has the increasing trend of 0.08°C per year while Terai has 0.04°C per year.⁷ Temperature trends in the Kathmandu Valley were based on data gathered from five weather stations from 1971-2011. The data indicates a continuous mean warming rate of 0.033°C per year, with the average maximum temperature increasing at 0.043°C per year and the minimum increasing at 0.02°C per year.

Projections

An Organization for Economic Co-operation and Development study in 2003 used general circulation models run with the SRES B2 scenario and projected mean annual temperatures to increase by an average of 1.2°C by 2030, 1.7°C by 2050 and 3°C by 2100 compared to a pre-2000 baseline.⁸ This was higher

⁶ Shrestha, A. B., C. P. Wake, et al. (1999). "Maximum temperature trends in the Himalaya and its vicinity: An analysis based on temperature records from Nepal for the period 1971-94." *Journal of climate* 12(9): 2775-2786.

⁷ Jianchu, X., A. Shrestha, et al. (2007). The melting Himalayas: regional challenges and local impacts of climate change on mountain ecosystems and livelihoods, International Centre for Integrated Mountain Development (ICIMOD).

⁸ Agrawala, S., V. Raksakulthai, et al. (2003). "Development and climate change in Nepal: Focus on water resources and hydropower." Organization for Economic Cooperation and Development, Paris: 64.

than the mean global temperature increase of 0.8 °C by 2030, 1.2 °C by 2050, and 2 °C by 2100 for the B2 scenario.

The Nepal Climate Vulnerability Study Team conducted a similar study in 2009 using a General Circulation Model and a Regional Circulation Model, which projected that the mean annual temperature will increase by 1.4°C by 2030, 2.8°C by 2060 and 4.7°C by 2090.⁹ It suggested that extremely hot days (the hottest 5 per cent of days in the period from 1970 to 1999) are projected to increase by up to 55 per cent by the 2060s and up to 70 per cent by the 2090s and extremely hot nights are projected to increase by up to 77 per cent by the 2060s and 93 per cent by the 2090s. The models projected higher temperature increments for winter compared to the summer and monsoon seasons.

Community perceptions

Consultations were conducted in five communities representing traditional settlements, squatter settlements, slum areas and peri-urban agricultural settlements. Likewise, one group discussion was conducted with youths representing different clubs, organizations, colleges and networks. The general perception of communities is that there has been an increase in mean temperature. In general, minimum winter temperatures and maximum summer temperatures are increasing. The summer season is now considerably warmer and the winter has become milder and shorter.

The communities have reported that the warmer days have increased by one to two months and the winter days have decreased by more than two months. Even the coldest months have reduced severe chills in recent years compared to the past. Furthermore, the occurrence of frost has reduced substantially in the valley.

3.2.2. Precipitation

The average annual rainfall in the Kathmandu Valley was 1,563 millimetres, measured across 9 stations

from 1971-2011. There are substantial variations in the amount of rainfall recorded; the maximum precipitation was observed at Sakhu station where the average was 1,980 millimetres, whereas the minimum was recorded in Khumaltar with 1,169 millimeters. This means that the total difference between the highest and lowest rainfall in the valley is around 800 millimetres per year. Around 78 per cent of precipitation falls in the monsoon season between June and September. The wettest month of the year is July followed by August and the driest month November followed by December.

Previous trends

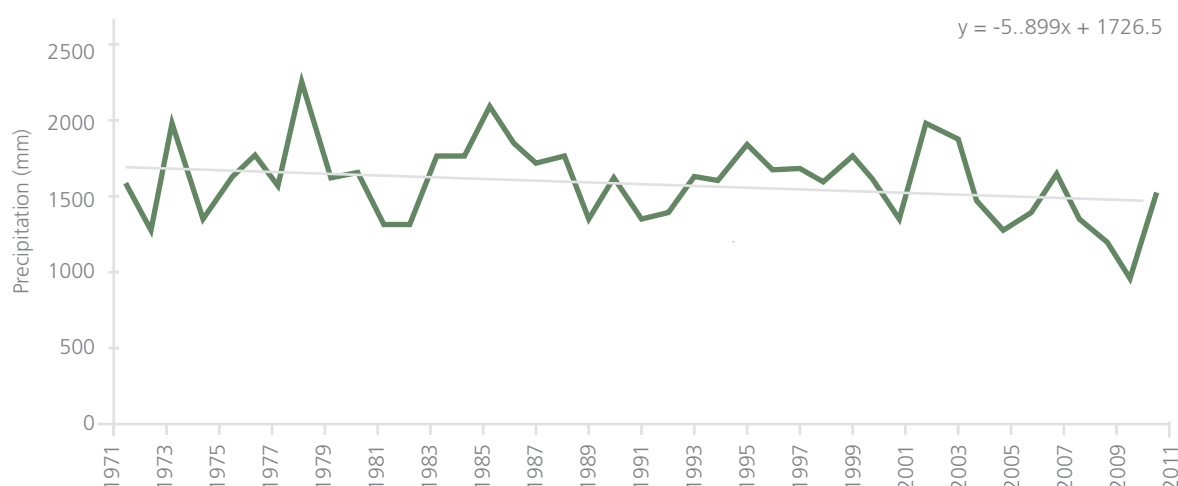
The Fourth Assessment Report of the Intergovernmental Panel on Climate Change revealed a significant increase in precipitation in northern and central Asia and an overall decrease by up to 15 days in the annual number of rainy days over a large part of the South Asia.¹⁰ A study by Practical Action shows that annual rainfall has been increasing in eastern, central, western and far western regions, while the mid-western region showed a decline, and no positive or negative trend for the Kathmandu Valley.¹¹ The total annual rainfall in the Kathmandu Valley considering the data from 1971-2011 in Figure 2. shows a slightly decreasing trend of -5.9 mm/year. Decreasing trend is statistically insignificant. The trend has been decreasing in all the seasons and is highest (-9.5 mm/year) during the monsoon season followed by post-monsoon (-3.8 mm/ year), pre-monsoon (-2.4) and winter (-0.02/ year).

⁹ NCVST (2009). *Vulnerability Through the Eyes of Vulnerable: Climate Change Induced Uncertainties and Nepal's Development Predicaments*. Kathmandu, Institute for Social and Environmental Transition-Nepal (ISET-N, Kathmandu) and Institute for Social and Environmental Transition (ISET, Boulder, Colorado) for Nepal Climate Vulnerability Study Team (NCVST) Kathmandu.

¹⁰ IPCC (2007). *Summary for Policymakers*. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK, 7-22, Cambridge University Press.

¹¹ Action, P. (2009). "Temporal and spatial variability of climate change over Nepal (1976-2005)." Practical Action Nepal Office, Kathmandu, available online: http://practicalaction.org/file/region_nepal/ClimateChange1976-2005.pdf (accessed on 04/04/2013).

Figure 3. Precipitation trend in the Kathmandu Valley from 1971 – 2011



Source: DHM (Department of Hydrology and Meteorology), 2013. Ministry of Environment, Government of Nepal.

Projections

A Nepal Climate Vulnerability Study Team project found no clear trend in precipitation, with both increases and decreases possible.¹² The study projected an increase in monsoon rainfall by the 2090s of 16 per cent in eastern and central Nepal, compared to western Nepal where there is a tendency towards a decline, despite several months showing an increase. Heavy rain is projected to increase slightly in the monsoon and post-monsoon seasons and decrease slightly in the winter. In addition, heavy rain events will change by 21 per cent to 34 per cent with a multi-modal mean of 7 per cent, thus showing a slight increase by the 2060s.

Extremes

The computation of the extreme indices for precipitation for all stations showed that the simple daily intensity index and rainfall in 24 hours greater than 20 mm index have a positive trend overall. Around 60 per cent of the stations from where the data is gathered show negative trends for both indices. However there has been an increasing trend in consecutive dry days in almost all stations with an overall 1.09 days increase. Community Perceptions.

People have observed that the precipitation trend in the Kathmandu Valley has drastically changed in recent years, with rainfall becoming increasingly erratic and unpredictable. There are instances of heavy rainfall in a short period of time with long spells of

dry days even during the monsoon season. In previous years the monsoon would start in early June but it now typically starts in late July. However, there are still exceptions to this – in 2011 the monsoon started early and the valley witnessed a substantial amount of rainfall. According to community members, winter rainfall has sharply reduced, with no rainfall in some years and very little in others.

3.2.3. Flooding

Nepal has a dense network of more than 6,000 rivers that flow through high-angle slopes and complex geology from north to south. The Kathmandu Valley is an intermountain valley that occupies an approximate catchment area of 625 km². The major rivers traversing the valley are the Bagmati, Bishnumati and Manohara rivers. The drainage pattern inside the Kathmandu Valley is such that all the rivers flow towards the valley center to join with the Bagmati River that eventually drains out of the study area through the Chovar gorge. Floods in Nepal occur each year during the latter stages of the summer monsoon when the land is saturated and surface runoff increases. The number of people affected by floods is the highest among all the disasters i.e. around 62 per cent of the total affected people from disasters in Nepal. In recent years, the number of floods has increased in Nepal due to high intensity precipitation like in Tinao Basin in 1978, Koshi River in 1980, Lele (Lalitpur district) in 1981,

¹² NCVST (2009). Vulnerability Through the Eyes of Vulnerable: Climate Change Induced Uncertainties and Nepal's Development Predicaments. Kathmandu, Institute for Social and Environmental Transition-Nepal (ISET-N, Kathmandu) and Institute for Social and Environmental Transition (ISET, Boulder, Colorado) for Nepal Climate Vulnerability Study Team (NCVST) Kathmandu.



Vulnerable community near the river
Photo © Ilija Gubic

Kulekhani-Sindhuli in 1993, and in Syangja district in 1998.¹³

Previous occurrences

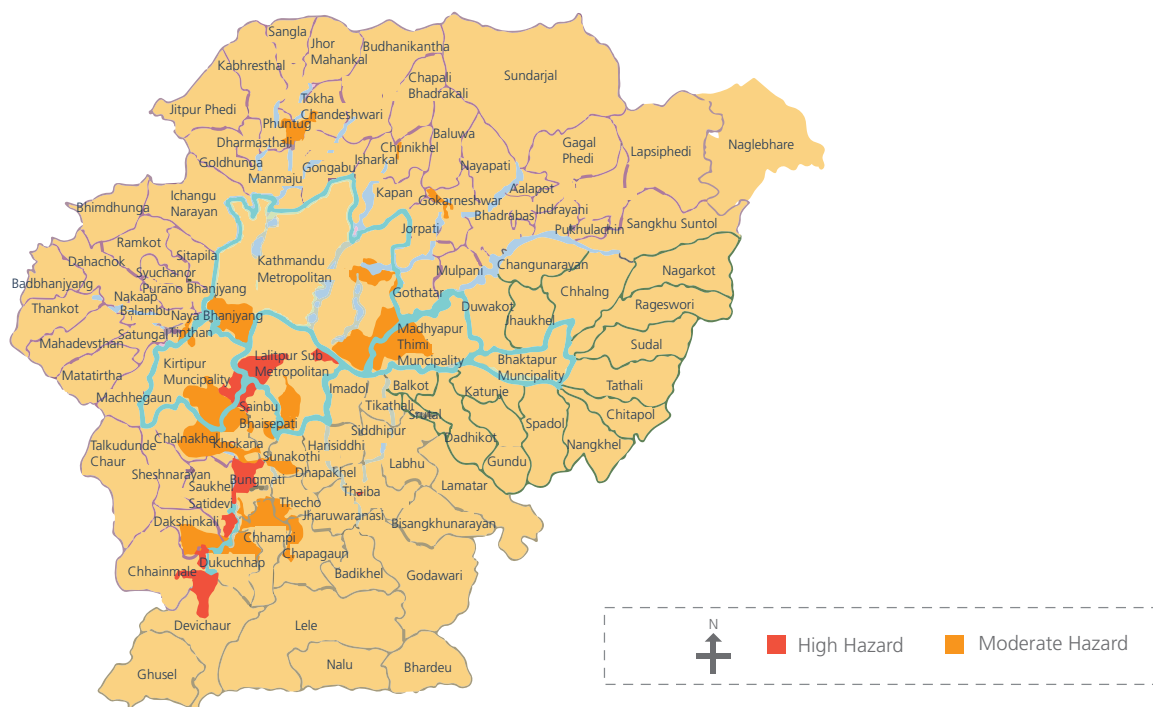
The high intensity and long duration precipitation within the valley causes frequent flooding almost every monsoon, especially in the areas close to the rivers. The flooding trend in the Kathmandu Valley is increasing. However, the number of deaths due to flooding shows a decreasing trend of 0.079. An analysis of the flood events of the decades shows that the number of

flood events has increased with 0.87 events per year. An extreme event occurred in July 2002 when 26 flood occurred in the Kathmandu Valley taking the lives of 28 people, leaving 283 people affected and property losses of 54,455,000 Nepalese Rupees (USD 545,550). In Kathmandu District for example, wards and areas such as Baghauda, Baneshwor, Samakhu-chi, Dhobikhola and Kirtipur municipality are situated along the river basin and have experienced frequent flooding throughout the study period. There have been 34 deaths as a result of flooding in the district since 1971 and 201 houses have been severely damaged or destroyed¹⁴.

Future projections

Based on the previous precipitation, the 50 years return period showed that the flooding occurs in the areas along the Bagmati, Nakhu and Manahara Rivers. According to the Department of Water, high flood hazard probability areas are located downstream from the Bishnumati confluence with the Bagmati River, the confluence of the Manohara and Kodku Rivers, the Gwarko area of Kodku Khola, upstream of Nakhu Dovan along the Nakhu River and the Balkhu area of the Balkhu River.

Figure 4. Comprehensive study of urban growth trend and forecasting of land use in Kathmandu Valley



Source: KVDA (Kathmandu Valley Development Authority), 2013. "Comprehensive study of urban growth trend and forecasting of land use in Kathmandu Valley". Ministry of Urban Development, Government of Nepal.

¹³ Pradhan, B. K. (2007). Disaster preparedness for natural hazards: current status in Nepal, International Centre for Integrated Mountain Development (ICIMOD).

¹⁴ Desinventar (2012). "Desinventar." from <http://www.desinventar.net/Desinventar/statistics.jsp>

Floods and inundation were ranked as the most significant climatic hazards faced by the communities. Some observed that flooding incidents in recent years have decreased but all the communities were equivocal that the inundation events have dramatically increased. Further, they reported that the loss of property and lives is increasing due to flood events.



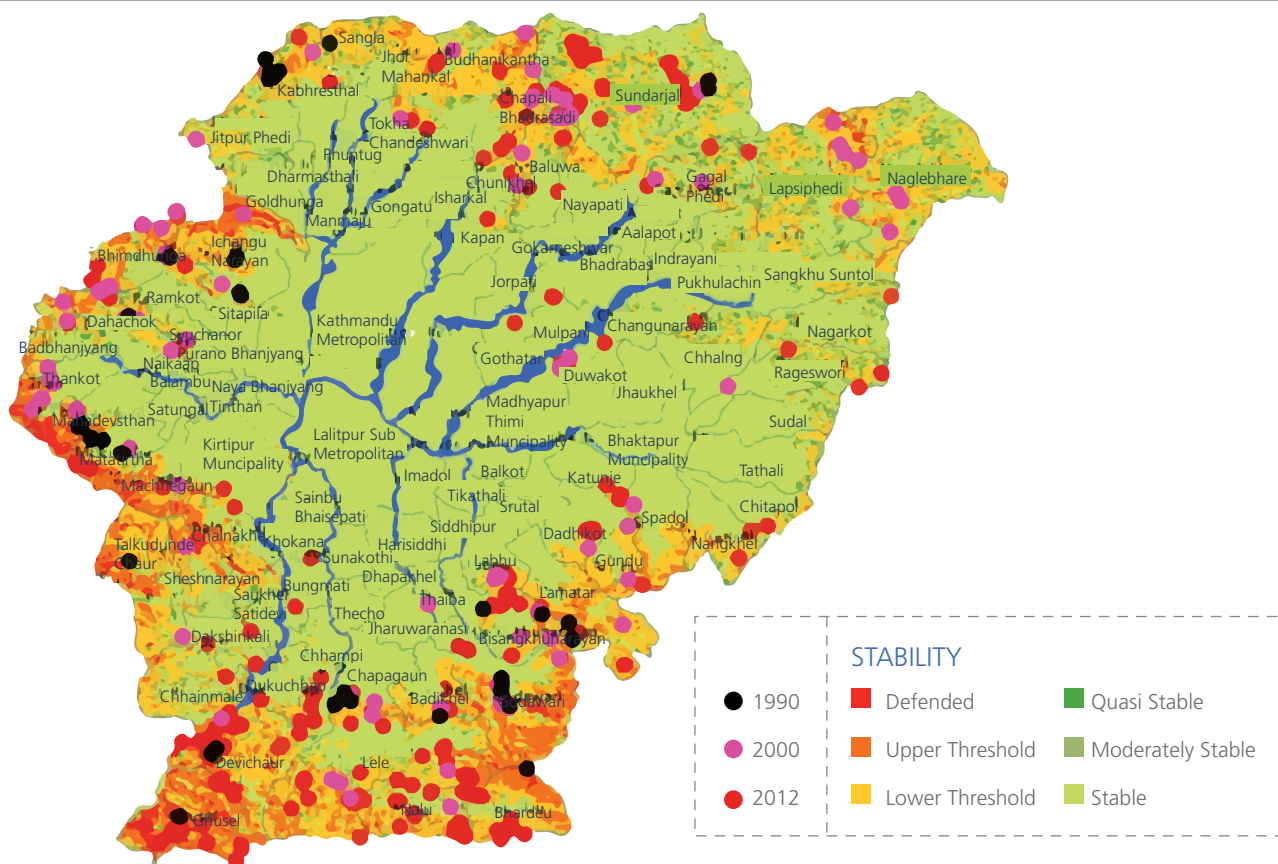
Urban poor along the river
Photo © Ilija Gubic

3.2.4. Landslides and Erosion

Landslides are common in Nepal, where 80 per cent of the total area is mountainous. 75 per cent of landslides in Nepal are triggered by natural phenomena like heavy rainfall, fragile geology, steep and rugged topography, deforestation and disturbance of hill slopes while 25 per cent have an anthropogenic cause.¹⁵ Annual loss of life as a result of landslides is high in Nepal; in fact landslides are second highest after flooding in terms of number of deaths caused by natural disasters.

The Kathmandu Valley is surrounded by high mountain ranges, with peaks including Shivapuri (2,732 m) in the north and Phulchauki (2,762 m) in the south east and Chandragiri in the south west. This area of the valley is also prone to landslides, especially during the monsoon season due to the geology and slopes surrounding the valley.

Figure 5. Landslide events in the Kathmandu Valley from 1971 – 2011



Source: KVDA(Kathmandu Valley Development Authority), 2013. "Comprehensive study of urban growth trend and forecasting of land use in Kathmandu Valley". Ministry of Urban Development, Government of Nepal.

¹⁵ MOPE (1998). State of the Environment of Nepal. Kathmandu, Nepal, Ministry of Population and Environment, Government of Nepal.

Previous occurrences

The occurrence of landslides in the valley is mostly near the foot hills of the valley. Considering the data from 1971 to 2011, an increasing trend can be seen in the number of landslides and also in the number of deaths and affected people with 0.11 and 1.44 respectively in the valley demonstrating an increasing trend.

A study by Genisis for the United Nations Development Programme showed that around 61 per cent of landslides occurred in unstable zones, among which the highest was in the lower threshold range of a stability index of 38.6 per cent. Interestingly, 21.3 per cent of total landslide events have occurred in stable zones. This means that even though the land is stable, anthropogenic works like road construction and river bank cutting act as significant destabilizing factors to the hill sides. The observation of past events indicates that there were 83 landslides in the Kathmandu Valley from 1971-2011 where 104 people have lost their lives, 890 people were affected and property losses were incurred totaling 37,309,070 Nepalese Rupees (USD 373,090).

Landslides have also damaged important infrastructures such as water supply pipelines, roads and drainage systems which has further affected the people of the valley. An important point is that the landslides outside the valley also have an impact, for example in 1993 a landslide on a major road blocked the transportation of commodities to the valley for more than a month.

3.2.5. Drought

Previous occurrences

A study in the Journal of Hydrology and Meteorology in 2010 in which winter and summer indices were separated by averaging precipitation data over Nepal and converting them to standardised precipitation index values for respective years identified out of 31 cases, six years had drought for winter (1974, 1977, 1985, 1993, 1999, 2001) and for four years (1977, 1982, 1991, 1992) for summer.¹⁶ The study highlighted that climatic phenomenon cannot be the sole driver for drought progression and other factors, such as local geography, soil parameters and vegetation may also

be important for drought evolution and severity on a local scale. The valley had seven drought years i.e. in 1981, 1982, 1989, 1991, 2005, 2009 and 2010 considering data from 1971-2011.

3.3 Climate Change Sensitivity

The main climate change related hazards the Kathmandu Valley is exposed to are floods, droughts and landslides. Sensitivity has been analysed through a sectoral approach in line with the National Adaptation Programme of Action of Nepal. The six sectors for analysis were:

- Agriculture and food security;
- Water resources and energy;
- Climate-induced disasters;
- Forest and biodiversity;
- Public health;
- Urban settlement and infrastructure; and
- Cross cutting issues

3.3.1. Agriculture and Food Security

The agricultural land in the Kathmandu Valley has been decreasing since 1984. About 6,300 hectares of fertile and productive agricultural land were lost to urbanisation, industrialisation, and quarrying of sand, soil, and stone between 1984 and 1998.¹⁷ Currently, the built-up areas cover 16 per cent of the total area of the valley, agricultural areas cover 47 per cent and forests/vegetation covers 35 per cent. The total cultivated land in the Kathmandu Valley in 2011 was 44,573.6 hectares, comprising 21,200 hectares in Kathmandu District, 14,000 hectares in Lalitpur District and 8,077.61 hectares in Bhaktapur District. The number of farming families in the valley was around 98,727.4.

The increase in temperature with annual rainfall below the standard causing drought in the area would affect the agricultural lands. In the Kathmandu district

¹⁶ M Sigdel, I. M. (2010). "Spatial and Temporal Analysis of Drought in Nepal using Standardized Precipitation Index and its Relationship with Climate Indices." Journal of Hydrology and Meteorology, Vol. 7, No. 1 SOHAM-Nepal.

¹⁷ ICIMOD, I. C. f. I. M. D. (2007). Kathmandu valley environmental outlook. A. B. M. Greta Rana, Dharma R. Maharjan, Asha K. Thaku Kathmandu, Hill Side Press (P) Ltd. Kathmandu.

unskilled and skilled urban labourers depend on daily wages from the construction sector etc., and are often food insecure. More than 60 per cent of the street children in the valley who depend on picking reusable materials (rags, plastic, etc.) and begging are food insecure.

3.3.2. Water Resources and Energy

The Kathmandu Valley is in the Bagmati River basin. The only agency responsible for distributing piped water to the inhabitants of urban and many rural areas is Kathmandu Upatyka Khanepani Limited which collects surface water and ground water. The main source of water is the Sundarijal and the other are Balaju, Bansbari, Pharping, Chapagaon, Kirtipur, Nakhu, Bhaktapur and Bode. Nearly half of the total water supply during the wet season and 60-70 per cent during dry season comes from groundwater.

Kathmandu Valley has been facing problems of water scarcity. The valley's water demand is about 350 million liters per day but Kathmandu Upatyka Khanepani Limited has been able to provide only 90 million liters per day during the dry season and 105 million liters during the wet season.

The Melamchi Water Supply Project plans to deliver 510 million liters per day of water in three phases to the valley from off valley sources via a 26 kilometre tunnel and a new water treatment plant at Sundarijal. The shortfall will be fulfilled through other sources such as stone spouts, private water tanks, supplies from springs and rivers located far from Kathmandu



Country capital has problems with running water
Photo © Ilija Gubic

Valley, private ground water extraction (boring), wells, and hand pumps, etc. About 50 per cent of the water supply in the valley is from groundwater systems with a total volume of 7,260 million-cubic-meters and deep aquifers with 56,813 million-cubic-meters.¹⁸ The annual recharging of ground water is 9.6 million cubic metres per year but the rate of extraction is continuously rising. The rate of extraction is not balanced as the extraction from the deep aquifers is 20 times more than the recharge rate.¹⁹ The annual drawdown of the deep aquifer water table is consistently reducing by 2.5m every year. If groundwater extraction is continued at the same rate as in 2001 (i.e. 59.06 million liters per day or 21.56 MCM/year) both the shallow and deep aquifers will be emptied in less than 100 years.



Waste along the river, close to the community market
Photo © Ilija Gubic

The traditional spout which was one of the main sources of water supply in earlier times is still in use in some parts of the valley, catering to 10 per cent of the population. However, the old spout has been impacted by increasing urban cover and built up space, decreasing the open space for the recharge. Further, the ponds which were constructed to feed the sub-surface aquifers of most of the stone spouts and wells and used as a place for washing and cleaning has been threatened by the encroachment and lack of maintenance. A study conducted in these settlements showed that half of the households in such settlements use untreated water from these sources which shows their increased vulnerability towards inflicting water borne disease especially among the children and elderly people.²⁰

¹⁸ Panday, V. P. K., F. (2011). "Hydrogeologic characteristics of groundwater aquifers in Kathmandu Valley." *Environmental Earth Science* 62(8): 1723.

¹⁹ Creswell, R. G., J. Bauld, G. Jacobson, M.S. Khadka, and M. P. S. a. S. R. M.G. Jha (2001). A first estimate of groundwater ages for the deep aquifer of the Kathmandu Basin, Nepal, using the radioisotope chlorine-36.

²⁰ Nepal, C. (2008). Health problems among urban poor in selected slums along Bishnumati River in Kathmandu. Kathmandu, Care Nepal.

3.3.3. Quality

Besides the inadequacies of water supply, the piped water supply system in Kathmandu Valley suffers from several problems that make it unreliable and unsafe. These include: a high degree of leakage, lack of treatment of waste water, combined system of sewerages and storm water and poor water quality.

Moreover, the quality of jar water, tanker water and water from stone spouts were found to be low which was tested and affirmed in various studies within Kathmandu aggravating the vulnerability.²¹ Total plate count analysis shows that 82.4 per cent of the samples (total 17 samples) of tap water exceeded the guideline values of the World Health Organization (>10 cfu/ml colony-forming units per milliliter).²²

The physical, chemical and bacteriological properties of ground water have also been seriously affected. Presence of coli bacteria as well as iron and arsenic way above the World Health Organization's benchmarks have been observed. The amount of iron in ground water exceeded the World Health Organization guideline value (1.9 mg/L milliliter per liter) whereas the coli (form count (267 CFU/100 millilitres) in shallow wells exceeded significantly the standard value shown by a previous study.²³ The deep wells studied in 2007 revealed that variables such as ammonium, iron, lead, arsenic and cadmium also exceeded the World Health Organization drinking water standards at most of the sites.

3.3.4. Energy

53.4 per cent of Nepal's electricity comes from hydro-electric sources. This is likely to be affected by both prolonged dry spells and extreme precipitation events. As a result of temperature increases Nepal's hydro energy potential will increase at the beginning but will decrease after the glaciers disappear. It will further decrease due to increased evaporation losses.²⁴

The domestic households and industry would be most affected in a power crisis. Changes in lifestyles and increases in incomes increase demand for electricity and fossil fuels. This has resulted in extended periods of load-shedding in the Kathmandu Valley. Imports of diesel have also increased rapidly. In fiscal year 2007-2008, the Nepal Oil Corporation imported 300,000,000 litres of diesel to run motors and generators. However, this figure had doubled by fiscal year 2012-13, and this rise is likely to continue for the foreseeable future.²⁵ Demand for electricity will further increase as increased temperatures lead to an increase in demand for air cooling systems.

3.3.5. Urban Settlements and Infrastructure

Until 1990, the area inside the ring road was limited to urban areas due to its accessibility to different activities. But, the increase in the population followed by the increase in built-up space, congestion in the core city area and increasing land prices have encouraged the expansion outside the ring road especially towards the northern part of the valley. Increasing urbanisation and land prices have spurred the development along the river banks and other hazardous areas of the valley. The change in the precipitation would increase the occurrence of floods affecting the residential areas situated along the river bank. In addition, the recent construction of institutions like hospitals and education centres along the river bank has increased because of comparatively low land prices. These institutional structures might suffer from the extreme events, due to their proximity to the river.

The Kathmandu Valley also has a growing number of informal settlers and settlements. The number of settlements has grown from 17 to 40 since 1985 to 2008.²⁶ However, a study by the Ministry of Physical Planning and Construction suggested the number to be 70 for the same year. The population of the squatter settlements has increased from 7,791 to 16,953 within 10 years from 2000. If the current trend of the increase of squatters remains the same, the population

²¹ Shrestha, D., & Shukla, A. (2010). Private water Tanker Operators in Kathmandu: Analysis of Water Services and Regulatory Provisions; Research Report. Kathmandu, CREEW.

²² Prasai, T., Lekhak, B., Joshi, D. R., & Baral, M. P. (2007). "Microbiological Analysis of the Drinking Water of Kathmandu Valley." Scientific World 112.

²³ Pant, B. R. (2010). Groundwater Quality in the Kathmandu Valley.

²⁴ Chaulagain, N. P. (2006). Impacts of Climate Change on Water Resources of Nepal, The Physical and Socioeconomic Dimensions. International Institute of Management, Energy and Environment Management. Flensburg, University of Flensburg. PhD.

²⁵ RAI, O. A. (2014). The cost of relying on diesel. Republica, Republica.

²⁶ Lumanti (2008). Status of Squatter Communities Along Bagmati River and its Tributaries in Kathmandu Valley. Kathmandu, Lumanti.



Squatter settlements flooded during the wet season
Photo © Inu Pradhan-Salike

will be 22,510 in 2016 and 38,262 in 2024. According to Lumanti, 7 per cent of the people who migrated to different squatter settlements were due to disasters like floods and landslides in the hometowns.

Out of 16,953 people from 73 settlements, 85 per cent of them reside along or in close proximity to the river and some even on the flood plain area. The squatter settlements of Pachali, Bansighat, Tripureshwar, Kalmochan, Thapathali, sankhamul, Manohara, ShantiNagar Nayabasti, Shanti Nagar, Bijaya Nagar, Gairi Gaun, Jagriti Nagar, Shantinagar Jagriti tole, Chadani tole, Sinamangal, Pashupati Nahar Marga, Shanti Binayak, Devi Nagar, Kalopul, Bhim Mukteshwar, Kohiti, Ramghat, Inatole, Lakhatritha, Khusibu, Balaju Jagriti Tole, Buddha Joti Marga are vulnerable to floods during the rainy season. The material used for the construction of the shelters in the squatter set-

tlements are mostly too fragile such as bamboo, cardboard, galvanized iron sheets, used wooden boxes, mandro, khar, tripal, and mud.

Kathmandu Valley has more than 31,000 people in these urban slum areas and include children and aged people who are the most vulnerable to impacts of climate change due to their under-developed or reduced resilience. The vulnerability of these areas has increased with increases in precipitation and temperature.

3.3.6. Sanitation

The sanitation coverage for Kathmandu city is 93.77 per cent, Bhaktapur has 87.1 per cent and Lalitpur has 83.69 per cent.²⁷ And is much higher than the national average of 43.04 per cent. Access to toilet facilities is currently 93.2 per cent in Kathmandu district, 91.4 per cent in Bhaktapur and 81.7 per cent in Lalitpur.²⁸

However, the lack of proper solid waste and waste water management in the Kathmandu Valley remains a challenge. Almost all domestic and industrial wastewater is discharged directly into the rivers without treatment which have turned Kathmandu Valley into open sewers.²⁹ The sewerage system in the Kathmandu Valley is not well developed and is hazardous with rivers and drains heavily polluted with sewage. The wastewater system in the valley comprises of piped sewers and treatment plants. However, most of the piped sewers discharge sewage directly into the rivers untreated. The existing aging sewerage system is a partially combined and partially separate system. In the combined system, storm water and foul sewage pass through the same sewers. When the storm water flow is connected to the foul sewage sewer, overloading with the sewage treatment plant occurs during the wet season. In addition, the storm water carries a lot of garbage from the streets to the sewers which are easily blocked, resulting in an overflow of foul sewage and storm water on to the streets.

3.3.7. Solid Waste

The piling of solid waste on the streets and at open spaces of the valley has become a common practice.

²⁷ NMIP/DWSS. (2010). A Survey Report on Nation-Wide Coverage and Functionality Status of Water Supply and Sanitation Kathmandu.

²⁸ Nepal, G. o. (2010). District Development profile of Nepal 2010/11. Kathmandu, Mega Publication.

²⁹ GoN-NPC, U. (2006). MDG Needs Assessments for Nepal. United Nations Development Programme. Kathmandu.

The decomposition of such wastes leads to the production of methane, a harmful greenhouse gas which holds 21 times more heat retaining capacity compared to carbon dioxide gas. For a place like Kathmandu, where piles of waste can be seen in almost every other corner, such an effect can be significant.

The waste generation of Kathmandu Valley is ever increasing as the population expands. Composed of mostly of organic materials the municipal per capita solid waste generation ranges from 0.266 to 0.416 kg/d-capita Kilogram per day per capita and is projected to increase to between the ranges of 0.332 to 0.519 kg/d-capita by 2015.³⁰ Among the five municipalities, Kathmandu Metropolitan City generates more than 70 per cent of the total amount of solid waste.

3.3.8. Vector and Air Borne Diseases

Changing temperatures and precipitation patterns linked to climate change will affect human health by changing the ecology of various vector-borne diseases, such as malaria, dengue fever, Japanese encephalitis, kala-azar, and filariasis. The incidents of vector-borne diseases are expected to increase directly through its effects on insect development, and indirectly through effects on host plants and animals.³¹ Climate influences the spatial distribution, intensity of transmission, and seasonality of diseases transmitted by vectors (e.g., malaria).³² Other vector borne diseases like Japanese encephalitis and lymphatic filariasis are found in the valley. The cases of Japanese encephalitis had started to increase until the vaccination programme started in 2008 in the valley. New cases of diseases that were not found in the valley before had started to be seen as in 2006, four cases of dengue fever and a case of yellow fever in 2009 were detected.

Extreme precipitation events in the valley also increase the likelihood of water borne diseases in the rainy and summer seasons. Bacteria breed more easily in flooded areas and when combined with mismanaged solid and liquid waste there is an increase in cases of disease, particularly acute diarrhea, dysentery and typhoid. Increases in landslides also have a direct relationship with increased incidents of disease because landslides

break water pipes depriving households' access to potable water and as a result increasing incidences of disease such as diarrhea, cholera and typhoid.

The inequitable nature of climate change impacts have differential burdens upon those who are marginalised, poor and minority groups such as people living in squatter settlements and slum areas.³³ Thus, the more well-off populations in the Kathmandu Valley may avoid the health impacts of climate change but thousands of people living in slum conditions lacking adaptive capacity are unable keep themselves aware and away from these dangers.

3.3.9. Climate Induced Disasters

The major climate induced disasters in the Kathmandu Valley are landslides, floods and droughts. The number of people affected by landslides and floods has increased from 1971 to 2011. The increase in the extreme events may increase the occurrence of landslides in the future, especially in the northern part of the valley where population growth is high. The landslides would affect the infrastructure like housing, roads, water supplies, drainage and property.

Landslides can also impact the food supply as rain could trigger landslides and block the highway connecting the valley with other parts of the country increasing the food prices and increasing scarcity of basic food items. The high intensity and long duration of precipitation within the valley causes flooding almost every monsoon, especially in the areas close to the rivers. The flooding in the Kathmandu Valley shows an increasing trend from 1971-2011 which will have impacts on the infrastructure, health and agriculture sectors. The district with the highest numbers of deaths and houses destroyed by floods in the Kathmandu Valley is Lalitpur where 67 people lost their lives, 1,857 people were affected, 255 houses were destroyed, 121 houses were damaged, Rs. 4,655,000 worth of property losses, and 131.32 hectare of crops damaged. In coming years, the existing drainage system of the valley might not be able to cope with the increasing heavy rain fall creating water logging and inundation. Further, the disposed garbage near the

³⁰ CEA, N. (2007). Analysis of Urban Environmental Issues – Final Report (3rd DRAFT), The World Bank and ENPHO.

³¹ Rogers, D. J., Randolph, S., Lindsay, S., & Thomas, C (2002). Vector-borne diseases and climate change. UK, Department of health.

³² Bates, B. C., Kundzewicz, Z. W., Wu, S., & Palutikof, J. P (2008). Climate change and water. Technical Paper of the Intergovernmental Panel on Climate change. Geneva, IPCC Secretariat.

³³ UN-HABITAT (2011). Global Report on Human Settlements 2011, Cities and Climate Change. Kathmandu, United Nations Human Settlements Programme.

banks of the river might accelerate the transmission of waterborne diseases to communities near the river bank.³⁴

3.3.10. Forests and Biodiversity

The Kathmandu Valley is surrounded by forests that provide timber, firewood, fodder, air purification, water supplies, recreation and soil conservation commonly known as eco-system services. It is also one of the main sources of fresh water as the Shivapuri watershed provides 40 per cent of the drinking water to the inhabitants of the valley. With the unsustainable collection of forest products, charcoal making, unregulated stone quarrying, deforestation for agricultural land and encroachment for building infrastructure like housing, public buildings etc. the forest area has been significantly reduced. Further, the change in the precipitation and heavy rain events have accelerated soil erosion and landslides and decreased the water holding capacity affecting urban inhabitants and decreasing numbers of species in the forest. The shift in the monsoon and warming of the days has attracted different diseases to the vegetation which has not been recorded before and also increased the use of insecticides, limiting the benefit of the forest to both urban and rural inhabitants.

3.3.11. Cross-cutting Issues

The existing gender inequalities combined with the new challenges brought by climate change would hit women disproportionately hard and exacerbate the already existing inequalities between the sexes.³⁵ Men and women differ in their livelihoods, family roles, production and consumption patterns and their behaviors, perception of risk, and in some cases are treated differently with respect to planning and relief efforts and after disasters. Responsibilities for women in households are related and highly dependent on natural resources like water management, type of cooking fuel used, fodder collection, etc. The impacts of climate change may affect the availability of natural resources which would create new challenges for women. The management of water and energy for day

to day activities would be more difficult during the dry season and may compel the women of the household to fetch water from distance sources or queue in line for hours resulting in negative impacts on their health. The availability of fodder and forest products may decrease and affect the income of women as their dependence on the forests for livelihood is high. Around 25.19 per cent of the households of Bhaktapur use firewood for cooking which is the highest in the Kathmandu Valley while Kathmandu district has the least. The reduction of forests and fire wood would increase the load of the women especially in Bhaktapur district. The limited access of women to credit, markets, land and agricultural extension services also makes them more vulnerable to adverse climate effects on agriculture.

Nevertheless, women play an important role in the reduction of the vulnerability of climate change, often informally, through participating in disaster management and acting as agents of social change.

3.4 Adaptive Capacity to Climate Change

Adaptive capacity is the ability of systems to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities or to cope with the consequences. It is the ability of society to plan, prepare for, facilitate and implement adaptation measures. Factors that determine adaptive capacity of human systems include wealth, technology, information, skills, infrastructure, institutions, social capital and equity. Countries or cities with limited economic resources, low levels of technology, poor information, skills, infrastructure, institutions, and equity, unstable or weak institutions, and inequitable empowerment and access to resources have little capacity to adapt and are highly vulnerable.³⁶

³⁴ Desinventar (2012). " Desinventar." from <http://www.desinventar.net/Desinventar/statistics.jsp>

³⁵ Brody, A., Demetriades, J. and Esplen, E. (2008). Gender and climate change: mapping the linkages. A scoping study on knowledge and gaps BRIDGE. UK, Institute of Development Studies, University of Sussex

³⁶ IPCC (2007). Summary for Policymakers. In: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK, 7-22, Cambridge University Press.

3.4.1. Wealth

The Human Development Index of Kathmandu, Lalitpur and Bhaktapur are 0.652, 0.588 and 0.595 respectively, while it is 0.471 for Nepal overall. The Human Poverty Index of the Kathmandu, Lalitpur and Bhaktapur districts is 25.8, 25.0 and 29.9 respectively.

ly. Similarly, the Gender-related Development Index of the three districts is also higher than the whole country. Gender-related Development Index values for the Kathmandu, Bhaktapur and Lalitpur districts are 0.635, 0.569, and 0.578 respectively, compared to 0.452 for the country.

Table 1. Comparing HDI, HPI & GDI between three district and country

Districts	Human Development Index (HDI)	Human Poverty Index (HPI)	Gender-related Development Index (GDI)
Bhaktapur	0.60	29.90	0.58
Kathmandu	0.65	25.80	0.64
Lalitpur	0.59	25.00	0.57
Nepal (overall)	0.47	39.6	0.45

Source: UNDP(United Nations Development Programme), 2004. Nepal Human Development Report 2004: Empowerment and Poverty Reduction. Kathmandu, Nepal.

3.4.2. Communication Systems

There is a flood forecasting system for real time data acquisition of 44 stations in major river basins of Nepal. A web-based data acquisition and dissemination system was developed which aids flood forecasting and early warnings. However, the country does not have an effective weather-forecasting radar. The meteorology department has been working on a small-scale early warning system and the rainfall monitoring centers are mostly manual stations. There is lack of co-

ordination of the systems which alerts the concerned authorities about hazards with the change in precipitation. The acquired data from the monitoring stations needs to be translated in to local understandable everyday language by the experts and disseminated quickly to advise the agriculture community. Most of the households of the valley have access to mobiles and access to modern communications is higher in the valley than the country overall.

Radio can play a significant role in disaster manage-

Table 2. Household access to Communication

District	Household	Telephone household	% of telephone household	Mobile household	% of mobile household
Bhaktapur	68 636.00	174 80.00	174 80.00	59 588.00	86.82
Kathmandu	436 344.00	121 513.00	121 513.00	395 183.00	90.57
Lalitpur	109 797.00	33 264.00	33 264.00	944 40.00	86.01

Source: CBS (Central bureau of statistics)2012. National Population and Housing Census 2011. Kathmandu, National Planning Commission Secretariat, Government of Nepal. Volume 01, NPHC 2011.

ment through promoting preparedness, warning and rehabilitation programs before, during and after a disaster. The reach of such facilities help people and enhances their capacity to respond. In the valley the number of households with a television in their household is more than the radio. The percentage of households with a radio is 56.12, 56.05 and 57.24 while television is 82.6, 74.6 and 66.07 in Bhaktapur, Kathmandu and Lalitpur district respectively.

3.4.3. Education

The literacy rate of the Kathmandu Valley is higher than the national average. The literacy rate is highest in Kathmandu district for both males and females, followed by Lalitpur and Bhaktapur. The total literacy rate of Bhaktapur, Kathmandu, Lalitpur district is 83.3, 87.6 and 76.8 per cent respectively. Similarly the male literacy rate is 91.9, 93.5 and 91.6 and female literacy rate is 74.7, 81.58 and 76.8 respectively for the Bhaktapur, Kathmandu and Lalitpur district. The trend of the literacy rate is increasing (CBS, 2011).

Table 3. Compare Literacy, % of household with Radio and TV between district

District	% literacy male	% literacy female	Total literacy rate	% of radio in household	% of TV in household
Bhaktapur	91.93	74.65	83.29	56.12	82.62
Kathmandu	93.52	81.58	87.55	56.05	74.62
Lalitpur	91.56	76.75	84.15	57.24	66.07

Source: CBS (Central bureau of statistics)2012. National Population and Housing Census 2011. Kathmandu, National Planning Commission Secretariat, Government of Nepal. Volume 01, NPHC 2011.

3.4.4. Infrastructure

The strategic road network in the Bhaktapur, Kathmandu and Lalitpur district is 111.59, 229.99 and 131.39 km. The proportion of the HHs with access to electricity within the Kathmandu Valley is high. Only few percentages of the households have no access to electricity. The number of hospitals and health facilities is high in the valley compared to other districts. Both the government and private sector have been providing health services.

3.4.5. Local Policies for Disaster Risk Reduction

- Natural Disaster Relief Act (1982)
- Nepal Building Act (1998)
- Nepal Building Code (1994)
- National Strategy for Disaster Management
- National Adaptation Programme of Action (NAPA)
- Bagmati Action Plan

3.4.6. Policies that Contribute to Environmental Protection

- Environment Protection Act (1996)
- Forest Act (1993)
- National Sanitation Policy (1994)
- National Urban Policy (2007)
- National Urban Water Supply and Sanitation Sector Policy (2009)
- Government's Three-year Interim Plan (2007-2010)
- Solid Waste Management Act (2011)
- Water Resources Act (1993)
- National Water Resources Strategy (2002)
- National Water Plan (2005)
- Sanitation and Hygiene Master Plan (2011)

Hotspot Identification

4.1 Methodology

Hotspot areas in the Kathmandu Valley have been identified taking into consideration exposure, sensitivity and adaptive capacity. The numeric value of 1 has been given to different sensitivities that have been identified in the study areas. Further, the high hazard and moderate hazard of the sensitivity has been allocated 1 and 0.5 respectively. For example the value of 1 and 0.5 is allocated to high hazard and moderate hazard areas prone to landslides where the urban growth trends have been increasing. The adaptive capacity of the area according to Village Development Committees has also been valued, for example the percentage of poor which is more than 10 per cent of the population is also given a numerical value of 1. A standardised value above zero is used in giving the value for the adaptive capacity parameters like literacy, provision of sanitation, etc. The feedback obtained from government officials and residents was that flooding is the biggest issue for the Kathmandu Valley.

The hotspot analysis shows that the most vulnerable district among the three districts of the valley is Kathmandu district. However, urban areas like Kirtipur municipality and urbanising Village Development Committees like Gokarneshwar and Goldhunga are also in the vulnerable areas of the district. The health issues, housing, sanitation, literacy, etc. are the main parameters for the vulnerability of the area.

Lalitpur district is the second most vulnerable among the districts. Further, it shows that the Village Development Committees near the urban centre like Lalitpur sub metropolitan are less vulnerable than the Village Development Committees away from the centre. The vulnerability in these areas has been due to dependence on rainfall for agriculture, lack of sanitation facilities and lower adaptive capacity due to low literacy rates.

Conclusion

The findings from the Kathmandu Valley vulnerability assessment indicate there is an urgent need for policies and actions to build resilience and to mitigate the impacts of climate change. The main climate change related hazards identified in the Kathmandu Valley were floods, droughts and landslides. The hotspot analysis showed that the most vulnerable district among the three districts of the valley was Kathmandu, followed by Lalitpur and Bhaktapur. The main parameters for the vulnerability of the residents included health issues, housing, sanitation, and literacy.

Floods and inundation were identified as the most significant climatic hazards faced by the communities. Rapid urbanisation caused by population growth and migration are generating pressures on the city's long-term environmental sustainability by damaging natural ecosystems and putting the water supply system under stress. The unplanned urban sprawl is taking over valuable agricultural land, destroying ecosystems, causing critical scarcity in essential resources such as water and electricity and raising the risk of disease. Urban expansion needs to be better planned and managed to prevent communities from moving to areas prone to flooding and inundation, particularly as climate change exacerbates the effects in coming years. Better planning would also help to counter the city's vulnerability to river bank instabilities caused by encroaching on the natural river channels.

Another significant hazard in the valley is the threat of landslides often triggered by heavy rainfall. Landslides may increase in the valley as precipitation rates increase. The number of people affected by landslides and floods in the valley has increased from 1971 to 2011. The increase in extreme events may increase the occurrence of landslides in the future, especially in the northern part of the valley where population growth is high. The landslides would endanger people's lives and affect the infrastructure like housing, roads, water supplies, drainage and property.

The Ministry of Urban Development has the overall responsibility for formulating, implementing, monitoring, regulating and evaluating policies, plans and programmes related to urban and infrastructure development in the country and should lead efforts in collaboration with the Kathmandu Valley Development Authority in designing and implementing plans to improve the climate resilience of the valley. Actions that are directed at reducing vulnerability at the city level (such as addressing systemic issues such as water shortage and drainage, and increasing the coordination and technical capacity of city agencies) would be beneficial and need to be effectively maintained and managed over the long term. Strengthening physical infrastructure such as flood defences, embankments, flood gates, etc. along the rivers will help vulnerable communities living in hot spot areas to better adapt while creating planted green zones may help to stabilise the natural river banks.

The process of building resilience to climate change can take a long time and requires the engagement of a broad range of stakeholders from both communities and the national to local levels of government. Resilience cannot be built immediately but is rather an ongoing process of mainstreaming actions into all areas of development planning. City government can reduce climate change vulnerability by influencing the sensitivity and adaptive capacity of residents and communities of the city through public awareness campaigns and community-led action. At the village development committee level there is limited knowledge about the causes and effects of climate change. Therefore, officials as well as communities need greater support, capacity building and allocated resources for actions to build climate resilience.

The Kathmandu Valley has also been facing problems of water scarcity. Besides the inadequacies of water supply, the piped water supply system in Kathmandu

Valley suffers from several problems that make it unreliable and unsafe. These include: a high degree of leakage, lack of treatment of waste water, combined system of sewerages and storm water and poor water quality. This will be helped by the construction of the Melamchi Water Supply Project and a new water treatment plant at Sundarijal.

Public health is also a key challenge, as the Kathmandu Valley is host to a variety of water and vector borne diseases and respiratory problems. Health impacts are especially severe after times of flooding as was shown during the community consultations. The lack of proper solid waste and waste water management in the Kathmandu Valley remains a challenge. Almost all domestic and industrial wastewater is discharged directly into the rivers without treatment which have turned them into open sewers. The sewerage system in the Kathmandu Valley is not well developed and is hazardous with rivers and drains heavily polluted with sewage, while flooding can intensify the challenges. An increase in improper and environment-fouling municipal solid waste disposal may exacerbate the spread of diseases, so effective social policies will be vital to protect communities at risk.

UN-Habitat's Cities and Climate Change Initiative promotes enhanced climate change mitigation and adaptation in developing country cities. This document is an initial output of the Cities and Climate Change Initiative activities in the Kathmandu Valley of Nepal. This abridged report is based on the report titled: "Kathmandu Valley, Nepal – Climate Change Vulnerability Assessment".

Starting with a brief background of the Kathmandu Valley, this report addresses the climate change situation from a comprehensive vulnerability perspective that focuses on exposure to climate change hazards, socio-economic sensitivities and the adaptive capacities of the city and its stakeholders. Based on this analysis the report identifies vulnerable people, places and sectors.

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