Kathmandu Valley Environment Outlook

ICIMOD

MoEST/GoN

UNEP

About the Organisations

International Centre for Integrated Mountain Development

The **International Centre for Integrated Mountain Development** (ICIMOD) is an independent 'Mountain Learning and Knowledge Centre' serving the eight countries of the Hindu Kush-Himalayas – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – and the global mountain community. Founded in 1983, ICIMOD is based in Kathmandu, Nepal, and brings together a partnership of regional member countries, partner institutions, and donors with a commitment for development action to secure a better future for the people and environment of the extended Himalayan region. ICIMOD's activities are supported by its core programme donors: the governments of Austria, Denmark, Germany, Netherlands, Norway, Switzerland, and its regional member countries, along with over thirty project co–financing donors. The primary objective of the Centre is to promote the development of an economically and environmentally sound mountain ecosystem and to improve the living standards of mountain populations.

United Nations Environment Programme

Established in 1972 and based in Nairobi, Kenya, the **United Nations Environment Programme** (UNEP) is the voice for the environment within the United Nations system. The Executive Director is Achim Steiner.

UNEP's mission is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations. Acting as a catalyst, advocate, educator and facilitator to promote the wise use and sustainable development of the global environment, UNEP works with numerous partners within the United Nations, as well as with national governments, international and non-governmental organisations, the private sector and civil society. UNEP assesses global, regional and national environmental conditions and trends; develops international and national environmental instruments; helps to strengthen institutions for the wise management of the environment; facilitates the transfer of knowledge and technology for sustainable development, and encourages new partnerships and mind-sets within civil society and the private sector.

To ensure its global effectiveness, UNEP has six regional offices: in Africa; West Asia; Asia and the Pacific; North America; Latin America and the Caribbean; and Europe. UNEP can be reached at www.unep.org

Ministry of Environment, Science, and Technology

The **Ministry of Environment, Science and Technology** (MoEST) was established in 2005, when the environment functions of the previous Ministry of Population and Environment (MoPE) were transferred to the then Ministry of Science and Technology. The Ministry of Population and Environment had been created in 1995, building on the previous Ministry of Forest and Environment, the first environment ministry in Nepal set up in 1991.

The main objectives of MoEST are to promote environmentally sustainable economic development of the country, promote a natural and cultural and environment, to protect life support systems, identify new technologies through the development and promotion of research activities in the field of environment, science and technology, contribute to achieving national objectives related to poverty alleviation by developing appropriate and new technologies through research, develop and promote traditional indigenous technologies, and encourage intellectual groups working in the field of environment, science, and technology by creating appropriate opportunities.

The Ministry works through three divisions – Environment, Science and Information Technology Promotion; Planning Evaluation; and Administration – and one Department (Metrology and Hydrology). Other important organs of the Ministry include the Nepal Institute for Science and Technology, the High Level Commission for Information Technology, and the Alternative Energy Promotion Development Board. The Ministry is also the focal point for various multilateral international conventions. During the short period since its establishment, the Ministry has been successful in making public some important policies and standards related to environment, science and technology.

The Ministry can be reached through its website-www.moest.gov.np and email-info@moest.gov.np.

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Kathmandu Valley Environment Outlook

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and
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January 2007


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SCALE
Source: Topographical Survey Branch
1996
Projection: Geographic
ICIMOD
MENRIS, 2007


KATHMANDU VALLEY
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KATHMANDU
BHAKTAPUR
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Legend
Kathmandu Valley
District Boundary
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Source: Topographical Survey Branch
1996
Projection: Geographic
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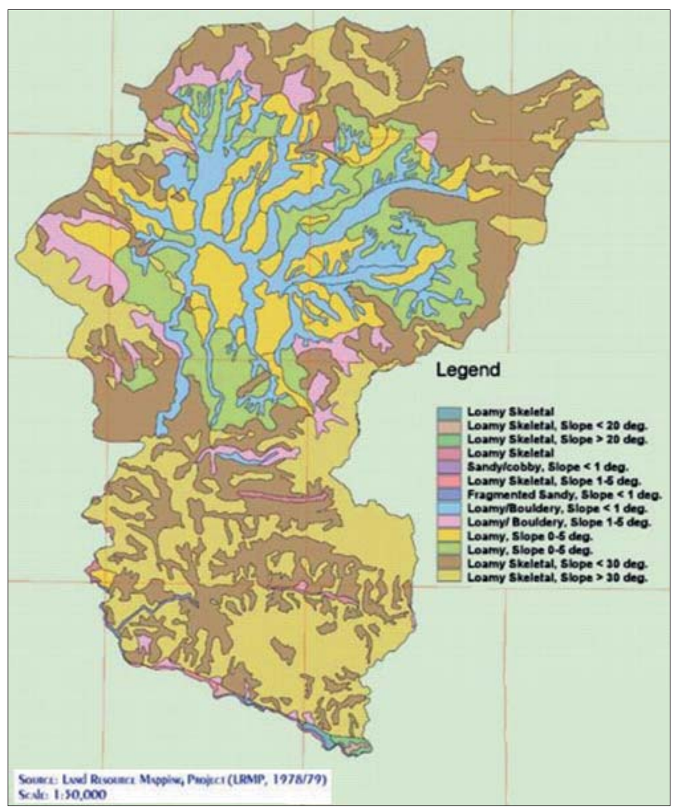
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Loamy Skeletal, Slope < 30 deg.
Loamy Skeletal, Slope > 30 deg.
Source: Land Resource Mapping Project (LRMP, 1978/79)
Scale: 1:50,000

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Foreword

Director General

International Centre for Integrated Mountain Development

Forty or fifty years ago, every pupil in the English-medium education system knew the phrase, "And the wildest dreams of Kew are the facts of Kathmandu" from one of Kipling's poems. The famous phrase gave an impression of a peaceful valley of dreams, a place of great natural and cultural beauty.

The Kathmandu valley is still a place of extraordinary natural and cultural beauty. But for those of us who were here over forty years ago, it is a valley transformed almost beyond recognition. Constantly growing traffic congestion, polluted air from vehicles and brick factories, rapidly expanding urban sprawl, streams and rivers that too often resemble sewers, piles of garbage and shortages of drinking water too often obscure the beauty beneath and beyond – the rice paddies and mustard fields still found reflecting the pagodas and high Himalaya beyond.

The present publication provides a detailed account of the status of the Kathmandu Valley environment. The report highlights the five key environmental issues of air quality, settlement, drinking water, waste management, and natural disaster preparedness, reviews their status, and recommends measures to prevent or minimise the negative impacts. The report provides direct options for management by various levels of government, civil society, the public-private sector and residents. These include improved planning and zoning, land pooling, solid waste management, rainwater harvesting, a variety of infrastructural and technical measures and vastly improved coordination and enforcement. Community mobilisation is critical to achieving these goals. With the potential for catastrophic disaster from earthquakes, many of these measures are not only important for human health, tourism development and the quality of life – but essential to the preservation of life when the inevitable earthquakes occur.

ICIMOD has been pleased to partner with the United Nations Environment Programme (UNEP) and the Ministry of Environment, Science and Technology of the Government of Nepal (MoEST) in preparing this report. It builds on previous collaborations that resulted in the Kathmandu Valley GIS Database published in 2000; the Nepal State of the Environment report, prepared by ICIMOD and published by UNEP in 2001; and the joint ADB/ICIMOD Environment Assessment of Nepal published in 2006. ICIMOD is particularly grateful to Mr. Surendra Shrestha, Regional Director, UNEP Regional Office for Asia and the Pacific for his strong support and close partnership throughout all of these efforts. We also thank Mr. Bal Krishna Prasai, Secretary, Mr. Khum Raj Punjali, Joint Secretary, and Mr. Chhewang Lama, Agricultural Officer, from MoEST and their colleagues for their contributions to the research and preparation of this report. Special thanks go to the numerous thematic experts who developed and contributed to the different chapters.

It is always easier to report on the environment than to act. We need both, and I encourage all of us to take up the concomitant action so desperately needed. Kathmandu is indeed an extraordinarily special place worth all of our effort to keep it a place of both our homes and our dreams.

J. Gabriel Campbell
Director General, ICIMOD
January 2007

Foreword

Executive Director
United Nations Environment Programme

The United Nations Environment Programme (UNEP) is mandated to regularly assess major environment developments and trends. This mandate has been practically implemented through the Global Environment Outlook (GEO) process with global, regional, sub-regional, national and even city-level assements. The GEO process is participatory, consultative and features capacity building at its core. This gives GEO assessments the necessary scientific accuracy, credibility, and authority to provide information for environmental management and policy development to a wide target audience.

The capacity building programme of the GEO process has been highlighted in the Bali Strategic Plan for Technology Support and Capacity Building, an agreed intergovernmental framework to strengthen capacity and provide technology support to developing countries and countries with economies in transition. The implementation of the Bali Strategic Plan is an important opportunity for UNEP to work with partners to strengthen national structures for environmental reporting as a basis for decision making.

Kathmandu Valley Environment Outlook is one of the outputs of UNEP's capacity building programme. The report identifies key environmental issues for Kathmandu Valley, including air quality and traffic management, unplanned settlement, degradation of water resources, waste management, and natural disaster preparedness. These issues have been analyzed by various experts, including national and city officials, scientists, academics, and civil society representatives, to determine their policy making implications. This broad-based participatory process brings national environmental issues to the attention of different stakeholders to the general public.

I hope this report will provide a sound basis for decision-making by the Government of Nepal and Kathmandu Valley Municipalities in addressing environmental issues at the policy level and in advancing the sustainable development agenda of the valley's settlements. UNEP has also been assisting the Government of Nepal to conserve the environment with collaborative activities on environmental monitoring and early warning, capacity building, and raising of environmental awareness. I would like to express my gratitude to the Government of Nepal, International Centre for Integrated Mountain Development (ICIMOD), and associated experts for this fruitful collaboration.

Achim Steiner
United Nations Under-Secretary General and Executive Director
United Nations Environment Programme
January 2007

Foreword

State Minister

Ministry of Environment, Science, and Technology

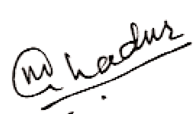
I am delighted to be able to release this report *Kathmandu Valley Environment Outlook* on the occasion of the South Asia Cooperative Environment Programme's (SACEP) 10th Governing Council Meeting 2007, in Kathmandu, Nepal.

I believe that this report has successfully focused on the emerging environmental issues of Kathmandu Valley, particularly in the fields of air pollution, water quality, urban settlement, waste management and natural disaster as well as institutional setting, including social, economic and political context of the valley. The report will serve as an instrument to reflect how, why, when and what factors influenced the transformation of the state of the environment in Kathmandu Valley and how one issue can be addressed.

Over the last decade and a half, Kathmandu Valley has experienced various environmental problems, particular the rapid growth of population, urbanisation, unplanned settlement, inadequate management of waste, increase of vehicles and emissions, traffic congestion and inadequate preservation of water bodies. The Ministry has developed a vision to address the problems across the country and to take major action towards conserving and protecting the country's environmental resources, with the aim of attaining environmentally sustainable development of the state. We have realised that appropriate capacities are essential to deal with the situation to enable a balance to be achieved among the social, economic and ecological systems for the establishment of environmentally sustainable development without creating an adverse impact on environmental services, and still providing an equal opportunity to the coming generations to have access to the environmental resources.

The Ministry has recognized that it is necessary to have partnership arrangements to deal with environmental issues through collective efforts, and has formed a strategic partnership with UNEP to implement various environmental programmes and activities in collaboration with ICIMOD. UNEP has been particularly supportive in implementing a number of programmes and projects in transboundary air pollution, including the Malè Declaration and Atmospheric Brown Cloud, the Nepal Biodiversity Year Book, promotion of environmental education and the current publication on Kathmandu Valley environment.

I strongly believe that this report will provide a significant reference document for all institutions and individuals involved in the field of environment management in the valley. The Ministry greatly acknowledges the contribution of UNEP and especially Mr. Surendra Shrestha, Regional Director, of UNEP ROAP in supporting the preparation of this report and of ICIMOD for facilitating the process especially technical input by Ms. Bidya Banmali Pradhan and Mr. Basanta Shrestha and support by the Publications Unit in bringing out the report. I also extend my thanks to those involved in the preparation of the report including our Joint Secretary, Mr. Khum Raj Punjali and Dr. Chhewang Lama, Agricultural Officer, who were also in the review committee that provided valuable inputs in shaping the report in its present form.



Man Bahadur Biswokarma
Honourable State Minister
Ministry of Environment, Science and Technology
January 2007

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ICIMOD would like to thank the many individuals and institutions who contributed to the preparation of the Kathmandu Valley Environment Outlook, and especially the many institutions and individuals who provided data from their own records.

Our sincere thanks go to the consultants who prepared specific chapters – Amar Manandhar of Seed Nepal (Chapters 1,2 and 4), Bhushan Tuladhar of ENPHO (Chapter 3), Bandana Pradhan (Chapter 4), Drona Ghimire (Chapter 5), Kishore Thapa (Chapter 6), and Gyani Raja Chitrakar and Birendra Piya (Chapter 7) – as well as to Bidya Banmali Pradhan and Amar Manandhar who were responsible for the overall compilation and editing of the report. The overall guidance from Basanta Shrestha and Bidya Banmali Pradhan from ICIMOD, and from Khum Raj Punjali and Chhewang Lama from the Ministry of Environment, Science and Technology, who reviewed the report, is also deeply appreciated.

This study could not have been prepared without the continuing support and encouragement of the United Nations Environment Programme, Regional Resource Centre for Asia and the Pacific in Bangkok, and especially the Regional Director of the Regional Office for Asia and the Pacific, Surendra Shrestha.

A picture speaks a thousand words, we thank the many individuals and organisations who provided photographs illustrating the report. We have tried to credit all sources and apologise if any were overlooked.

This report relied heavily on input from the staff of ICIMOD's MENRIS Division, in particular Pradeep Dangol who compiled the graphs, Govinda Joshi who compiled and/or prepared the maps, and Monica Moktan who provided administrative support and acted as rapporteur during the consultation meeting.

The extensive input from ICIMOD’s Information Management, Communications and Outreach Division is gratefully acknowledged, especially A. Beatrice Murray, Senior Editor, Dharma R. Maharjan, who worked extensively to complete the layout and design on time, Asha Kaji Thaku, cartographer/artist, who helped with the figures, layout, and final proofing, and Anjesh Tuladhar who uploaded the report in Wiki form so that the group could work together more easily after the first draft consultation. The work of the consultant editor, Greta Rana, was crucial in preparing the publication.

Executive Summary

The purpose of the 'Kathmandu Valley Environment Outlook' is to examine the current status of the environment of the Kathmandu Valley and the suburban areas of Kathmandu, Lalitpur, and Bhaktapur districts. The report analyses the emerging environmental problems and promotes specific recommendations for future action. The analysis uses UNEP'S adaptation of OECD's Driver-Pressure-State-Impact-Response (DPSIR) framework.

The two chapters in the first Section provide an overview of the historical factors and set the stage for assessing the key environmental issues in the five chapters of the second section. This analysis presents an alarming picture of a rapidly deteriorating environment. The last section summarises the analyses and identifies a number of measures for amelioration of existing problems and prevention of future deterioration.

In Chapter 1, the Kathmandu valley settlement has been traced back to 900 B.C. A rich cultural heritage has been provided through a succession of farmer kings, the development of Kathmandu as a trade entrepôt between Tibet and the states of the Indian sub continent, and the enrichment of the valley through craftsmanship and architectural monuments. Chapter 2 on social and economic factors provides a demographic profile of the subsequent urban growth and the impact of increases in transient and migrant populations. The growth of employment and education lead to an exponential rise in population and an increase in the numbers of urban poor. Infrastructure is now overloaded and poor service delivery is related to a number of issues including poor coordination.

On the topic of air quality and traffic management, Chapter 3 cites increasing affluence, rapid urbanisation, Kathmandu-centric development, and poor infrastructural capacities as key elements in the rise in air pollution. The main contributor is identified as vehicular emissions. There are increasingly negative impacts on health, especially in the form of chronic obstructive pulmonary disease (COPD). In Chapter 4, the settlement pattern is described as growing haphazardly with the tremendous increase in population. In-migration and the rapid population growth rate are driving factors leading to unprecedented land subdivision and construction in rural areas where there is insufficient infrastructure. Chapter 5 discusses the extensive deterioration in river water quality in urban areas due to excessive pollution loads. Increasing demands for drinking water place a heavy strain on insufficient supplies. Chapter 6 then describes the problems in the management of solid waste, and the negative impacts of waste and pollution on health. Earthquakes and landslides are identified as the two most prominent potential natural disasters in the Kathmandu Valley in Chapter 7. The location of the valley in a seismic zone, lack of public awareness about earthquakes, lack of adequate planning, and lack of coordination are the main factors that impact negatively on disaster preparedness. Excavation of slopes, deposition of loads on slopes, deforestation, irrigation, mining, and water leakage are the main human activities causing landslides.

In the last section, Chapter 8 provides recommendations for policies related to the five issues under analysis. These include incentives for electric vehicles and improved emission testing; effective urban planning; and air quality governance. An urban land-use and management policy for the Kathmandu Valley, along with land zoning and encouragement of infrastructural planning and construction through land-pooling projects, is seen as a sine qua non for the future of the valley. Among the many recommendations for water quality and drinking water resources are the involvement of communities in water resource planning and the biological treatment of water. Rainwater harvesting should be encouraged and water-saving practices promoted. Waste management recommendations start with the need for a basic clarification in the roles of all the agencies involved; promotion of composting, reuse, and recycling; improvement in facilities and wastewater treatment plants; and strong compliance monitoring. Finally, recommendations related to natural disaster preparedness include strengthening the existing institutions, enforcing building codes, and promoting awareness and emergency planning.

All of the recommendations are well within Nepal's means at this point in time. The report comes at an important watershed in the nation's history when many changes are being made. The report holds out the hope that with proper concerted planning and implementation of the recommendations, the Kathmandu Valley could still be a Shangri La in the middle of the Himalaya and contribute to meeting the millennium goals for the environment by 2015.

Acronyms and Abbreviations

ADB	Asian Development Bank
AQM	air quality management
BKM	Bhaktapur Municipality
CBD	Convention on Biological Diversity
CBS	Central Bureau of Statistics
CEN	Clean Energy Nepal
CKV	Clean Kathmandu Valley
COPD	chronic obstructive pulmonary disease
CWTP	combined wastewater treatment plant
DDC	district development committee
DMG	Department of Mines and Geology
DoTM	Department of Transport Management
DPSIR	Driver-Pressure-State-Impact-Response
DUDBC	Department of Urban Development and Building Construction
DWSS	Department of Water Supply and Sewerage
ECONSAN	ecological sanitation
EIA	environmental impact assessment
EMP	environment management plan
EMS	environmental management system
ENPHO	Environment and Public Health Organisation
EPA	Environment Protection Act
EPC	Environment Protection Council
EPR	Environment Protection Regulations
ESPS	Environment Sector Programme Support
GPS	global positioning system
GTZ	German Agency for Technical Cooperation
HCI	health care institution
ICIMOD	International Centre for Integrated Mountain Development
IDNDR	International Decade for Natural Disaster Reduction
IUCN	The World Conservation Union
JICA	Japan International Cooperation Agency
KMC	Kathmandu Metropolitan City
KRM	Kirtipur Municipality
KUDP	Kathmandu Urban Development Project
KVEO	Kathmandu Valley Environment Outlook
KVMP	Kathmandu Valley Mapping Programme
KVTDC	Kathmandu Valley Town Development Committee
LSGA	Local Self-Governance Act
LSMC	Lalitpur Sub Metropolitan City
MBT	Main Boundary Thrust
MCT	Main Central Thrust
MDG	Millennium Development Goals
MFT	Main Frontal Thrust
MHPP	Ministry of Housing and Physical Planning
MHT	Main Himalayan Thrust
MoAC	Ministry of Agriculture and Cooperatives
MoEST	Ministry of Environment, Science and Technology
MoF	Ministry of Finance

MoFSC	Ministry of Forest and Soil Conservation
MoI	Ministry of Industry
MoICS	Ministry of Industry, Commerce and Supplies
MoLD	Ministry of Local Development
MoPE	Ministry of Population and Environment
MoWR	Ministry of Water Resources
MPPW	Ministry of Physical Planning and Works
MTM	Madhyapur Thimi Municipality
NBSM	Nepal Bureau of Standards and Metrology
NEPAP	Nepal Environment Policy and Action Plan
NESS	Nepal Environmental and Scientific Services
NHRC	National Health Research Council
NLSS	Nepal Living Standards Survey
NPC	National Planning Commission
NSC	National Seismological Centre
NSET	National Society for Earthquake Technology
NTC	Nepal Telecommunication Corporation
NWP	National Water Plan
NWRS	National Water Resources Strategy
NWSC	Nepal Water Supply Corporation
PEER	Programme for Enhancement of Emergency Response
SDC	Swiss Development Cooperation
SEED Nepal	Society for Environment and Economic Development Nepal
SWC	Social Welfare Council
SWMRMC	Solid Waste Management and Resource Mobilisation Centre
SWNCC	Social Welfare National Coordination Council
TDIC	Town Development Implementation Committee
UEIP	Urban Environment Improvement Project
UEMP	Urban Environment Management Programme
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
VDC	village development committee
WAC	Water for Asian Cities
WECS	Water and Energy Commission Secretariat
WHO GV	World Health Organisation guideline value
WHO	World Health Organisation

Scientific and temporal measurements

μg	microgram (10^{-6} gram)
$\mu g/m^3$	microgram per cubic metre
A.D.	(Anno Domini) of the Christian era
B.C.	before Christ
B.S.	Bikram Sambat (era used in Nepal)
BOD	biological oxygen demand
CNG	compressed natural gas
CO	carbon monoxide
COD	chemical oxygen demand
DO	dissolved oxygen
HC	hydrocarbon
HSU	Hartridge smoke unit

LPG	liquefied petroleum gas
mld	million litres per day
MMI	modified Mercalli intensity
NAAQS	national ambient air quality standards
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
PAH	polycyclic aromatic hydrocarbon
$PM_{2.5}$	particulate matter of diameter 2.5 microns or less
PM_{10}	particulate matter of diameter 10 microns or less
POP_s	persistent organic pollutants
SWQ	saprobic water quality
SODIS	solar disinfection
SOx	sulphur oxides
SO_2	sulphur dioxide
TDS	total dissolved solids
TSP	total suspended particles
TSS	total suspended solids

Currency Equivalent

In this report all references to rupees (Rs) are to Nepalese rupees

Currency Unit – Nepalese rupees (NRs)
$1 = NRs 70.60
(As of 2 January 2007)

Notes

(i) The Nepalese calendar year (B.S.) runs from mid April to mid April. Unless otherwise stated, year ranges written in the form 2005/06 denote a single calendar year.
(ii) The fiscal year (FY) of the Government ends on 15 July. FY before a calendar year denotes the year in which the fiscal year ends. (For example, FY2000 begins on 16 July 1999 and ends on 15 July 2000.)
(iii) In this report, $ refers to US dollars.
(iv) In this report, tons (t) refer to metric tons or tonnes (1,000 kg).
(v) Acts and Regulations are cited under the name of the ministry from which they originate. The official version of Acts and Regulations is published in the Nepal Gazette (in Nepali). Some Acts and Regulations are published by other Government agencies in English (unofficial translations).

Section 1

Background

1 Introduction

History of the Kathmandu Valley

Legends concerning the origins of Kathmandu Valley (referred to also as the valley in this document), from both religious texts and oral tradition, describe it as a lake surrounded by hills and forests. The lake, Nag-hrada, the abode of serpents, so the legend has it, was drained by a Chinese Saint, Manjushree, so that he could worship at Swayambhunath and Guheswori. Once the waters were drained away, the valley was settled (Jha 1996). The formation of Chobhar Gorge, the drainage conduit for the inner valley, is given as an example of the veracity of the legend. Kathmandu Valley used to be known as Nepal and any early history of Nepal is actually the history of the Kathmandu Valley (Regmi 1999).


Source: A.B. Manandhar, SEED Nepal

Chobhar Gorge

The 'Vanshavalis' (historical documents) record that initially Kathmandu Valley was ruled by 'Gopal Bansi' (cow herders) from 900 to 700 B.C.; by 'Mahisapalas' (buffalo herders) from 700 to 625 B.C.; and by 'Kirat' Kings from 625 B.C. to 100 A.D. The first Kirat king was Yalamber. Gautam Buddha visited Nepal during the rule of Jitedasti, the seventh ruler of the Kirantas, and Buddhist culture and art were adopted in the valley. The 'Lichhavis', from Northern Bihar, invaded at the end of the 5th century. The Lichhavi era is known as a golden period, and it is from this time that the recorded history of Nepal really begins with the inscription of King Manadeva I (464–505 A.D.) at the temple of Changu Narayan. At the beginning of the seventh century, Amshuvarma, a 'Thakuri' officer, became king. An able administrator, he opened up a trade route to Tibet. After Amshuvarma, the Gupta nobles came to power and ruled for twenty-two years until Narendradev of the Lichhavi dynasty took over again. The Lichhavi period was prolific in terms of cultural activities.

In the 13th century, the 'Mallas' from far west Nepal took over the Kathmandu Valley. Arimalla, the first Malla King, ruled from 1201 to 1216 A.D. King Jayasthiti Malla was the most noted among this dynasty (1380 to 1395 A.D.). He was a great politician, reformer, and an able administrator. He stratified the society into various castes and sub-castes based on Hindu philosophy. Land too was stratified according to productivity into four types: 'Abbal', 'Doyam', 'Sim' and 'Chahar'. However, Malla rule was weakened in the 15th century following the death of King Yakshya Malla. Kathmandu Valley was divided into three sister kingdoms: Kathmandu, Lalitpur, and Bhaktapur. This led to the weakening and eventual end of Malla rule.

In 1769 A.D., Prithivi Narayan Shah, the king of Gorkha, took over the three kingdoms of Kathmandu Valley. He unified the many small kingdoms and principalities into a single nation, Nepal, with Kathmandu as its capital. In 1846, Jung Bahadur Kunwar came to power and founded a Rana Dynasty as hereditary prime ministers with Prithivi Narayan's descendants as puppet kings. During the time of King Tribhuvan, a democratic movement emerged and Rana rule came to an end.

King Mahendra, Tribhuvan's son, dissolved the elected parliament in 1960 and replaced multiparty democracy with a partyless 'Panchayat' system of government under the direct rule of the king. During the reign of Mahendra's son, Birendra, a people's movement emerged and this led to the establishment in 1990 of multiparty democracy with a constitutional monarchy. There were frequent changes in government and from 1995 onwards a political faction from the Communist Party of Nepal/Maoist took up arms.

After the massacre of almost all Birendra's family at the Royal Palace in 2001, Birendra's brother, Gyanendra, became king. Parliament was dissolved under the constitution, but elections could not be held due to the lack of security nationwide. After five years of turmoil, leading to dissolution of parliament and a succession of prime ministers without parliaments, King Gyanendra took over the government. The continuing disatisfaction of political factions led to a series of demonstrations in early 2006 that ended the king's government. Since that time, continuing negotiations have been taking place between all political factions in an effort to re-establish peace and democracy.

Physical and Political Features

Kathmandu Valley lies at 1,300 masl and is located between latitudes 27°32'13" and 27°49'10" north and longitudes 85°11'31" and 85°31'38" east. Its three districts, Kathmandu, Lalitpur, and Bhaktapur, cover an area of 899 square kilometres, whereas the area of the valley as a whole is 665 square kilometres. The valley encloses the entire area of Bhaktapur district, 85% of Kathmandu district and 50% of Lalitpur district.

The valley is bowl shaped and surrounded by the Mahabharat mountain range on all sides. There are four hills acting as forts of the valley, Phulchowki in the South East, Chandragiri/Champa Devi in the South West, Shivapuri in the North West, and Nagarkot in the North East. The highest altitudes are 2,166m (in Bhaktapur), 2,732m (in Kathmandu), and 2,831m (in Lalitpur).

The climate is good, the soil fertile, and it is endowed with rich forests and scenic beauty. The three major river systems in the Valley are the Bagmati, Bishnumati, and Manohara. There are lakes and ponds in all three districts–Taudaha and Indra daha in Kathmandu; Gunaldaha, Katuwaldaha, Godavari, Nagdaha, Bojho Pokhari, and Saraswatidaha in Lalitpur; and Siddhapokhari, Bhajupokhari, and Kamalpokhari in Bhaktapur. Kathmandu Valley has waterfalls at Sundarijal, Chobhar, and Matatirtha. The climate is sub-tropical, temperate, and cool-temperate, with four distinct seasons: spring from March to May; summer from June to August; autumn from September to November; and winter from December to February.

In general, the annual maximum and minimum temperatures are between 29°C in June and 1°C in January. The comparative monthly maximum and minimum temperatures for 1985, 1999, and 2004 are given in Annex 1. The average wind speed recorded by the Hydrology and Meteorology department's station at Tribhuvan International Airport in 1998 was highest in March (2.1 km/hour) and lowest in December (0.8 km/hour). The annual rainfall records for Kathmandu from 1995 to 2003 show fluctuations between 1,171 to 1,868 mm. Figure 1 shows the Kathmandu Valley districts, municipalities, and VDCs and Table 1.1 shows the distribution of municipalities. Kathmandu Valley has five municipalities and ninety-eight VDCs and 14 VDCs of the three districts fall outside the valley (Figure 1).

Human Settlement

Early settlements were around the Bagmati River near Pashupati Deo-Patan and on the banks of the Dhobi Khola at Hadigaon. Townships developed and flourished through Indo-Nepal-Tibet trade. Though many small towns were established by the second century A.D. and urban centres by the 11th century, according to the records, urbanisation of the valley commenced in the late 1950s, accelerating during the 1970s. According to the population census of 2001, Kathmandu district has the biggest urban population and the highest number of households.

Between 1984 and 1998, circa 6,300 hectares (ha) of fertile and productive agricultural land were lost to urbanisation, industrialisation, and quarrying of sand, soil, and stone. Between 1984 and 1994, the valley's urban area increased from 3,096 to 8,378 ha and 5,282 ha of fertile agricultural land were lost to urbanisation (MoPE 1999). It is estimated that more than half of the valley's 'A' grade land; i.e., 43% of the existing agricultural land, will be lost to urban sprawl by 2010 (HFA 1991, MoPE 1999).

Squatter settlements are another aspect of urban settlement. In 1985, there were 17 squatter settlements in the valley with a total population of 3,000 (MoPE 1999). In 1994, there were 33 squatter settlements with a total population of 15,000 (Thapa 1994). Sixty per cent of these squatter settlements are on public land and 40%

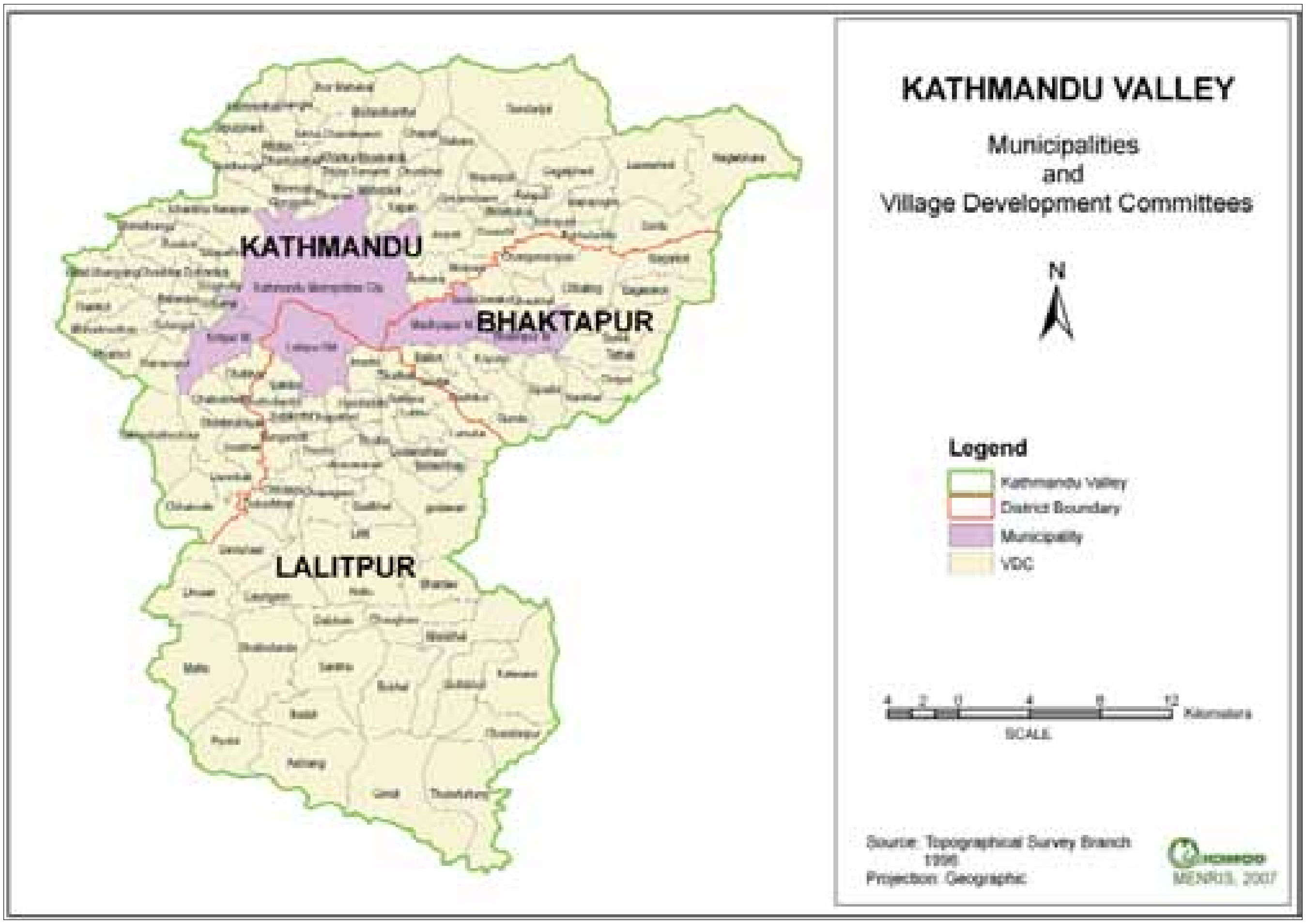


Figure 1: Kathmandu Valley: districts, municipalities, and village development committees (VDCs)

Table 1.1: **Kathmandu Valley boundary**

Districts & Municipalities		Area (km^2)
1.	**Bhaktapur district**	**119**
	1. Bhaktapur Municipality	6.88
	2. Madhyapur-Thimi	5.56
2.	**Kathmandu district**	**395**
	3. Kathmandu Metropolitan	48.29
	4. Kirtipur Municipality	5.70
3.	**Lalitpur district**	**385**
	5. Lalitpur Sub Metropolitan	16.10
Valley urban areas total		82.53
Valley districts total		899

Source:NIDI 2006 and compiled from municipality records

are in public buildings such as temples and traditional free shelters provided by the community called 'patis' (Rabenau 1990). A survey of 24 squatter settlements carried out by students from Trondheim university in 1988 revealed that 54% of the settlements were located in urban areas and 46% on river banks; 66% of the houses had permanent structures and 52% were without tap water; and 63% had no electricity and 66% had no toilet facilities.

Traditional Water Supplies

Kathmandu Valley has a number of traditional, stone water-spouts: 237 in Kathmandu, 77 in Lalitpur, and 53 in Bhaktapur (Amatya 2006). These waterspouts are evidence of the engineering skills of the past. The spouts are located within rectilinear pits built into the ground and supplied through 'Raj Kulos' (state canals), which met irrigation needs using local water sources. Even though they received state sanctions, they were decentralised in operation. Modern construction and the falling water level in the valley have led to the drying up of many of these stone water spouts.

Distribution of improved drinking water started around 100 years ago during the period of the Rana Prime Minister, Bir Shamsher. Kathmandu's first drinking water system, 'Bir Dhara', was built at that time. The Bagmati River and its tributaries are the valley's principal river system and its springs are the main source of drinking water for residents, particularly for greater Kathmandu – the urban core of the valley.

Source: G. K. Shrestha, SEED Nepal

A typical stone spout

Traditional Agricultural Practices and the Housing System

Traditional agricultural practices

The prosperity of Kathmandu Valley has been attributed to indigenous agricultural practices and good crop yield. The valley farming community are known collectively as 'Jyapoos'. The community produces the greatest share of fresh vegetables for the Kathmandu market, and is known for its good practical skills and expertise in intensive traditional agriculture, especially for vegetable production (FAO 1994). Traditional methods included keeping and maintaining quality seeds, using local compost and organic manure, and maintaining soil and crops by indigenous methods.

The Jyapoos cultivate around 1,000 to 2,500 square metres of land per family. They do not use oxen or bulls for ploughing, but simple tools. Every bit of land is used efficiently. Black clay, compost, and human excrement are traditional sources of manure. They rarely keep cattle as other farmers do and transport goods with a piece of equipment like a balance called 'kharpan'. They are skilled at intercropping (which helps control crop diseases and pests) as well as crop rotation, and harvest three crops annually.

Source: G.K. Shrestha, SEED Nepal

A typical traditional house

The traditional housing system

Traditional housing in the valley is constructed with local materials. Thick load-bearing walls are made of mainly green or unfired bricks held together with mud mortar. This ensures low heat transfer to render houses cool in summer and warm in winter. The timber used is mainly hard wood for beams, doors, windows, staircases, and purlins.

Normally, traditional houses have four stories. The kitchen and 'puja room' (prayer room) are on the top floor and have sloping roofs made of fired clay or ceramic tiles. The bedrooms are on the second floor and the living room is on the first floor. The ground floor of the house has a stone 'dhiki' for milling paddy.

The floors of the houses are plastered with mud supported by wooden planks. Windows on the first floor, called 'aankhejhyals', are often decorated with wood carving and on the second floor it is customary to build three joined windows called 'sanjhya.'

Unlike in the villages, where the houses are scattered and separated, Kathmandu Valley houses are joined together. The line of houses near New Road, called 'Jhochhen' (meaning 'lined houses'), is a good example. This type of construction provided stability. Groups of houses were arranged around a courtyard, which was also used for the management of solid waste.

Cultural Heritage of the Kathmandu Valley

Kathmandu Valley is known for its ancient art, culture, craftsmanship, and numerous monuments of historic and archaeological importance. UNESCO has described Kathmandu as a 'living heritage site'. The valley has a number of temples, palaces, monasteries, and Buddhist stupas that are centuries' old. A unique feature is the religious co-existence of Hindus and Buddhists, as they worship at the same religious sites. There are many interesting sites within a radius of 20 km, and it used to be said that there were as many temples as houses and as many festivals as there are days on the calendar.

There are seven sites classified as World Heritage Sites by UNESCO. Urbanisation and construction of concrete structures with little architectural merit threaten these sites and they have been placed on the 'World Heritage in Danger' list. However, preservation activities are taking place on these sites, and it is expected that they will be off the 'danger list' next year (THT 2006, 27 July). The seven sites are as follows.

1. Kathmandu Durbar Square
2. Patan Durbar Square
3. Bhaktapur Durbar Square
4. Swayambhunath Stupa
5. Pashupatinath Temple
6. Boudhanath
7. Changunarayan Temple

Recent photographs of the heritage sites are presented overleaf and details of them are given in Annex 2.

In the Kathmandu Durbar Square, some of the houses built in contravention of the prescribed code have been demolished. Many important temples, including Kasthamandap, have been renovated. Presently, Jagannath Temple is being renovated. Similarly, the fifty-five windowed palace, known as 'Pachpanna Jhyale Durbar', in Bhaktapur Durbar Square is being renovated. Around Swayambhunath, a number of statues and monasteries are being built in and around the hillock. Swayambhu hill has been stabilised. Many new statues, including a large statue of Buddha, and monasteries have been built on the western side of the hill. Pashupati Development Trust has been more active in demolishing buildings encroaching on the area and also in constructing new monuments and service areas, along with providing green areas.

Besides the above UNESCO world heritage sites, there are numerous important cultural sites in the valley. There are more than 360 'vihars', 'chaityas', and 'monasteries'. There are also many important religious and cultural sites on the river banks such as the Teku – Thapathali Riverine Heritage Site, Gokarneswor Mahadev Temple at Gokarna, Jagat Narayan Temple, and the shrines at Sankhamul, Patan; Shova Bhagwati, the Vijeswori temple and Kankeswari temple in Kathmandu; and the temples and shrines of Ramghat and Hanumanghat in Bhaktapur. Even in rural areas, every village has religious and cultural monuments such as temples, vihars, stupas, or monasteries. The important ones among them are as follows.

- Mahalaxmi Temple in Thankot,
- Bishnudevi Temple in Satungal,
- Kalika Temple, Kisipidi
- Mahalaxmi Temple, Balambu
- Rudrayani Temple, Khokana
- Bramhayani Temple, Thaiba
- Bringareshwor Mahadev Temple, Sunakothi
- Aadhinath Temple, Chobhar
- Chilanchu Mahavihar Temple, Bagh Bhairab Temple, and Umamaheswor Temple in Kirtipur
- Bajrabarahi Temple in Chapagaon
- Shikara Temple of Rato Machhendranath in Bungamati

There are also numerous wayside settlements and resting places, called 'pati', and stone water spouts. There are also important ponds as it was believed that bathing in these ponds washed away sins. Examples are Rani Pokhari, Kamal Pokhari, and Nag Pokhari in Kathmandu and Godawari and Kumbheswor in Patan.

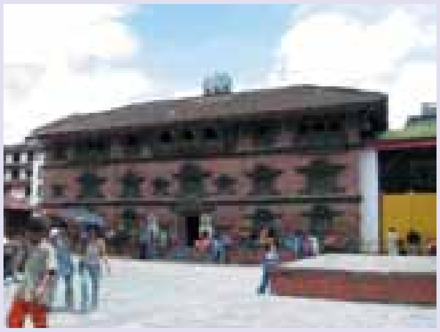
Festivals Contributing to the Environment

Many festivals are linked with nature. About 76% of the population of Kathmandu Valley are Hindus and 20% are Buddhists. Other religious groups found in the valley are Christians, Muslims, Kirats, and Jains and a very small number of Sikhs and Bahais. Hinduism and Buddhism have close links. The whole mechanisms of worshipping, temple architecture, features of gods and goddesses, and myths are highly influenced by nature. For example, Hindus worship the sun, moon, rivers, land, stones, trees, and animals. Religious texts like the 'Puranas', 'Gita', 'Ramayan', and 'Upanishads' explain about the vehicles, or 'bahans', of each god or goddess. For example, the lion is associated with Durga, the elephant with Indra (the god of rain), the snake with Lord Shiva, and so on. Moreover, there are certain plants that are worshipped. For example, 'pipal' (*Ficus religiosa*), bur (*Ficus bengalensis*), 'kush' (kush grass), and 'tulsi' (basil). This helps in preservation of such plants. The 'pipal' and 'bur' trees are never cut. They are planted at important locations along the route to provide shade for travellers and trekkers. 'Tulsi' is an important plant with medicinal values. This also has insect repellent characteristics and is generally planted in the middle of the courtyard.

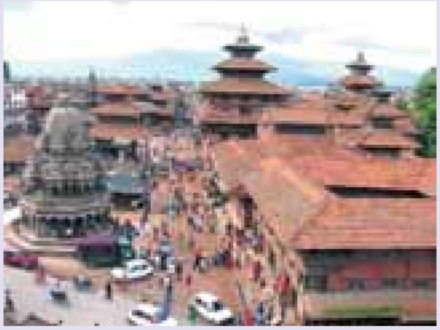
In some areas, certain parts of the forests remain untouched because they are considered to be sacred. These sacred places are protected and conserved because of faith in or fear of deities. It is believed that the sacred portion of a forest belongs to the 'Ban Devi' (goddess of the forest), or other deities whose temples and shrines are built there. It is considered an ill omen for the village or locality if anything is taken from this forest. This belief has helped to protect forest resources. The forest of Bajrabarahi is one example of this practice.

Kathmandu Valley Heritage Sites


Kathmandu Durbar Square with Jagannath Temple being renovated


'Kumari Ghar' (Home of the Living Goddess) at Kathmandu Durbar Square


Swayambhunath Stupa


Patan Durbar Square


Bhaktapur Durbar Square with the fifty-five windows' palace being renovated


Temple of Pashupatinath on the bank of Bagmati River


Landscaping of Pashupatinath Area


New statues and stupa being constructed on the western side of Swayambhu hill


Boudhanath Stupa


Temple of Changunarayan


Improvement of Pashupatinath Area

Source: All photos by A.B. Manandhar and G.K. Shrestha, SEED Nepal

There are certain cultural activities such as 'Bhumi Puja' (worshiping of land), dances, fasting, and cremation activities that are closely related to the environment. These practices, festivals, and beliefs have both positive and negative impacts on the environment. Linkages of other festivals to the environment are presented below.

- **'Sithinakha'** is celebrated on the sixth day of the waxing moon of Jestha (around the last week of May) among Newar communities in the valley. People clean the surroundings of water sources and repair and maintain the canals, wells, deep stone taps, ponds, and rainwater drainage systems. This festival highlights the importance of preserving water sources.
- On the fifth day of the waxing moon of 'Shrawan' (around the third week of July) **'Naag Panchami'** is celebrated by worshipping the 'Naag' (snake), believed to be the source of water. It is believed that people will suffer from skin diseases and infections if they agitate the Naag by polluting water sources. This helps to keep pollutants away from water sources.
- On the full moon day of 'Shrawan' (last week of July), **'Janai Purnima'** is celebrated. Farmers offer food to frogs in the rice fields for their contribution to eradicating insects protecting their crops.
- **'Deepmalika'** is celebrated for one month from the full moon of 'Aswin' to the full moon of 'Kartik' (the first week of October to the first week of November) by lighting oil lamps on high bamboo poles. These lamps attract and kill harmful insects which would otherwise destroy the almost ripe crops.
- **'Tihar'** is celebrated for five days in the month of 'Kartik' (around the end of October). The crow is worshipped on the first day, the dog on the second day, the cow on the third day, and bulls on the fourth day for their contributions to the environment.
- One day before the waxing moon of Mangsir, **'Balachaturdashi'** is celebrated by spreading the seeds of seven different grains – maize, wheat, lentils, cereals, and mustard seeds — all over the forest of Sleshmantak (around the Pasupatinath area) in the name of deceased family members. These produce food grains that eventually support animals and birds in the area.

Forests and Biodiversity

The forests in and around the valley of Kathmandu provide basic needs to rural communities, clean water for valley residents, and recreational sites for tourism; and they also help in situ conservation of biological diversity.

The valley has 20,945 ha of forests, about 32.7% of the total area of the valley. The natural vegetation, except in a few conservation areas, has been under intense pressure. The area under natural forest cover, excluding shrubs, is 9,580 ha (45.7% of the total forest land), of which only about 22% has good forest cover with more than 50% of crown coverage. Mature hardwood forests are now confined to parks and sacred areas such as Nagarjun (Raniban), Gokarna and Shivapuri watershed and Wildlife Conservation forest, and Bajrabarahi forest. Shrubland occupies nearly 34% of the total forest area. Quarries cover 84 ha of forest land in the valley (MoPE 1999).

The main vegetation groups in the valley are the following.

- *Schima-Castanopsis* associations on the valley floor and hill slopes
- *Pinus roxburghii* on the lower hill slopes and on the southern sides of Chobhar, Nagarjun, Bisankhu Narayan, and Badikhel
- *Quercus lanata* dominating the upper hill slopes of Phulchowki, Shivapuri, and Chandragiri.
- *Quercus lanata – Pinus willichaina* generally found in Manichur Lekh and Nagarkot.
- *Quercus lamellosa – Laurus* (laurels) in the middle of Phulchowki
- *Quercus semecarpifolia* is abundant on the hill slopes of Shivapuri and Phulchowki.
- *Rhododendron arboreum* on the reaches of the valley hills, e.g., Phulchowki, Nagarjun, and Chandragiri

The forests in the valley are not in good condition. Most of the forests in the valley are in the regenerating stage. The crown coverage of *Rhododendron* and *Quercus* is more than 70% and the crown coverage of *Pinus roxburghii,* and *Schima-Castonopsis* is less than 40%. About 1,312 plant species belonging to 162 vascular families are found in the valley, representing 26% of the total of plants recorded in Nepal. About seven species of Gymnosperms, 170 species of Fern, and 97 species of Orchid are found in the valley. About 256 species of birds have been reported from the Phulchowki area and many birds are found in Nagarjun, Shivpuri, Tuadaha, Tokha, and Bajrabarahi. Many migratory birds are found at Taudaha pond. About 33 bird species have disappeared from the valley due to habitat destruction. Marble and stone quarrying are among the causes of habitat destruction and genetic resource loss.

Some patches of forest exist in Bajrabarahi, Hattiban, Balkumari, Karya Binayak, Mhaipi, Pashupatinath, Raniban, and Bansbari. These are mostly of *Eucalyptus, Protea* sp, *Jacaranda* sp, and *Camphor*. Green belts are found in some city areas. *Populus* sp and *Eucalyptus* sp are found along the Ring Road, Kathmandu-Bhaktapur Highway, and Lagankhel-Godawari way. Among the trees planted around the Tudikhel are *Gravelia* sp, *Salix* sp, *Albizia* sp, *Gingo* sp, *Elaeocarpous* sp, and *Callistimon* sp.

Besides urban forests there are parks and gardens in and around the valley. These are given below.

- Tribhuvan Park with an area of around eight hectares consisting of mostly ornamental plants.

- Balaju Park which is a very attractive park for local residents and well managed: it also has a small forest.

- Sankha Park and Ratna Park also contribute greenery to the valley.

Besides parks, the valley also has many gardens. The Botanical Gardens in Godavari cover an area of 26 ha and have ornamentals, shrubs, and many natural trees. This garden provides an outdoor laboratory for students and also facilitates the in situ as well as ex situ conservation of plants. In addition to these gardens are the Zakir Hussain Rose Garden, Coronation Garden, and Bhrikuti Mandap Exhibition ground with many beautiful ornamentals and fruit trees. These gardens give the valley green spaces. A United Nations Park is also being promoted to establish greenery and bird habitats in Lalitpur district.

Pull Factors

Kathmandu Valley has exceptional scenic beauty. The fertile valley with terraced fields is surrounded by green hills. Snow-capped mountains can be seen behind the hills to the north. It is said that when King Prithvinarayan Shah of Gorkha saw the beautiful valley from Chandragiri hill during a trip to the then kingdom of Makawanpur, he was so taken by the site that he made up his mind to conquer the valley. Phulchowki hill at 2,765m is the highest point in the valley; and this hill provides a spectacular view of the Himalayas as well as a part of the Terai plains. Similarly, Nagarkot, at an altitude of 2,195m, provides a magnificent view of the sun rising over the Himalayas.

The unique combination of monuments, art, and architecture together with mountains and lakes or ponds is attractive to tourists, and many return, time and again. Historically, the valley was known as Nepal. Ironically, it seems to be so even today from the point of view of physical infrastructure and institutional centralisation. The valley houses all the major amenities and institutions, both governmental and non-governmental.

Basic amenities like water supplies, electricity, gas, telecommunications, roads, sanitation, education, security, and transportation are well developed in the valley in comparison to the rest of Nepal. New products and services are first launched in the valley; and its inhabitants have access to modern equipment and technology. New technologies and interventions come to the valley first, and this technological sophistication is an important pull factor.

There are all kinds of institutions – services and financial institutions, good academic institutions, renowned health care units, research centres, and the entertainment industry all clustered in the valley of Kathmandu. This means there are better job opportunities in Kathmandu than elsewhere in Nepal, resulting in excessive migration and inflow of people from other parts of the country.

2

Social and Economic Context

This chapter presents those social and economic factors that have an impact on environmental conditions.

Demographic Profile

Population, population density, and growth

The population of the three districts of Kathmandu Valley increased from 1,107,370 in 1991 to 1,647,092 in 2001. The annual population growth rate in Kathmandu district was 4.71%. The population of Kathmandu district was 675,341 in 1991 (3.6% of Nepal's population) and 1,081,845 in 2001 (4.6% of Nepal's population). The population density[1] of Kathmandu district was 1,069 in 1981; 1,710 in 1991, and 2,739 in 2001 (Tables 2.1 and 2.2). The sex ratios[2] for the three districts of Kathmandu Valley are presented in Table 2.3.

Table 2.3 shows that the male population is higher than the female population. The sex ratio is higher for Kathmandu district. In the national context also, the sex ratio of Kathmandu district is the highest. This record differs from the rest of the hills because in other hill districts females are dominant.

The three districts of Kathmandu Valley consist of five municipalities and 114 VDCs. According to the Local Self Governance Act, 1999, urban areas are classified into Metropolitan Cities, Sub-Metropolitan Cities, and Municipalities. As per this Act, there are three municipalities (Bhaktapur, Madhyapur, and Kirtipur), one sub-metropolitan city (Lalitpur), and one metropolitan city (Kathmandu) in the valley. The population in designated urban areas of Kathmandu Valley has increased considerably (Table 2.4).

Urbanisation has not been uniform throughout the country. Most urbanised areas are in Kathmandu Valley,

able 2.1: **Distribution of population by district, 1991-2001**

District	1991	% of total popula-tion	2001	% of total popula-tion	Annual growth rate
Lalitpur	257,086	1.39	337,785	1.46	2.73
Bhaktapur	172,95	0.94	225,461	0.97	2.65
Kathmandu	675,341	3.65	1,081,845	4.67	4.71
KVD*	1,105,379	5.98	1,645,091	7.10	4.06

Source: CBS 2003 b
* Kathmandu Valley districts

Table 2.2: **Population density by district, 1981-2001 (person/sq. km.)**

District	Area in sq. km	1981	1991	2001
Lalitpur	385	479	670	877
Bhaktapur	119	1,343	1,453	1,895
Kathmandu	395	1,069	1,710	2,739
KVD	899	852	1,230	1,830

Source: CBS 2003b

Table 2.3: **Sex ratio by district, 1981-2001**

District	1981	1991	2001
Lalitpur	113	103	104
Bhaktapur	105	100	104
Kathmandu	117	108	114

Source: CBS 2003b

which contributes significantly to the overall urbanisation status of the country. The urban population density of Kathmandu Valley is 10,265 (the population is 995,966 and the area 97 sq.km.) (CBS 2003b). On the other hand, the rural population is also increasing slowly in the valley. The average annual growth of the rural population is comparatively higher than for Nepal as a whole (Table 2.5).

[1] Number of persons per square kilometre
[2] Ratio of males to females x 100 (also referred to as the masculinity ratio.)

Table 2.4: **Urban growth and urban population growth trend, 1952/54 – 2001[3]**

Region	1952/54	1961	1971	1981	1991	2001
Kathmandu Valley	196,777	218,092	249,563	363,507	598,528	995,966
Nepal	238,275	336,222	461,938	956,721	1,695,719	3,227,879
Percentage distribution of urban population						
Kathmandu Valley	82.6	64.9	54.0	38.0	35.3	30.9
Level of urbanisation (in %)						
Kathmandu Valley				47.4	54.1	60.5
Nepal				6.4	9.2	13.9

Source: CBS 2003b

Table 2.5: **Average annual growth rates of urban and rural population, 1952/54 – 2001**

Region	1952/54		1961 -71		1981		1991		2001	
	U	R	U	R	U	R	U	R	U	R
Kathmandu Valley	1.29	1.53	1.36	4.32	3.83	0.87	5.11	2.32	5.22	2.50
Nepal	4.40	1.56	3.23	2.03	7.55	2.40	5.89	1.79	6.65	1.72

Key: U = urban; R = rural
Source: CBS 2003b

Transient population

Kathmandu Valley is like a hub for the wider population. The enactment of the Local Self Governing Act (LSGA) 1999 is expected to decrease the flow of the transient population to some extent. Large pockets of the population move in and out of the valley for different purposes, mainly seeking services and institutional activities. Uneven allocation of resources for development and institutionalisation in the valley has given rise to this movement of population.

The transient population is distributed sporadically throughout the valley, determined by the objectives of their visits. The main reasons for coming to the valley are higher education, medical check-ups, pilgrimages, bureaucratic formalities, visiting relatives, internal tourism, and official visits. A large proportion of this population lives in Kirtipur municipality because they are students at Tribhuvan University; in *dharmashalas* of different pilgrimage sites or temples like Pashupatinath, Sankhu, and Mata Tirtha; and in hotels and lodges in urban areas, near bus stations, and hospitals.

In the last five years, people seeking jobs overseas have constituted a large proportion of transient population. The nature and flow of population depends upon the time of year and festivals as well. Such a population flow exerts pressure on the environment and natural resources because it adds to the consumption of petroleum products for commuting and for cooking; and it also adds to solid waste and sewage which has a negative impact on the environment.

Migration

The total population of the Kathmandu Valley is the sum of local inhabitants, migrant population[4], and transient population. The migrant population accounted for 11.1% of the total urban population in 1981. This proportion has increased in the past decade because of the conflict. A study carried out by ICIMOD in 1993 (MOPE 1999) revealed that migration contributed to less than 10% of the urban population of Kathmandu between 1952 and 1961, about 6% between 1961 and 1971, about 42% between 1971 and 1981, and over 64% between 1981 and 1991. The percentage of migrant population is comparatively less in Lalitpur (47% between 1981 and 1991) and Bhaktapur districts (12% between 1981 and 1991).

Internal migrants comprised of 10.2% of the population, while foreign-born external migrants comprised of 0.9% in 1981, increasing in 1991 to 19.4 and 2.7% respectively. Earlier most migrants were from the hills (56%) compared to the mountains (32%) and Terai (12%). In the last three decades, the trend has shifted; migrants from the Terai (36%) and from the hills (25%) have increased. This shift is directly linked to the flourishing garment and brick industries in Kathmandu between 1981 and 2001. The larger proportion of migrants are workers in manufacturing and textile industries such as brick industries, garment industries, carpet weaving, and dyeing industries. According to a study carried out by The World Conservation Union (IUCN) and the National Planning Commission (NPC) in 1994 (MoPE 1999), approximately 74% of the workers in the different industries in the valley are migrants.

According to the 'National Living Standards Survey (NLSS)-II', carried out by the Central Bureau of Statistics in 2003/2004 (CBS 2004) among migrants, an overwhelming majority (54%) gave 'family reasons' for migration, followed by 'looking for a job' (18%), 'easier life style' (14%), and education/training (9%).

The percentage of the population migrating has increased considerably because of the conflict. The displaced population migrates to the district

[3] The data for Madhaypur and Kirtipur municipalities are not available in the censuses of 1971, 1981, 1991.
[4] Migrant population refers to internal and external migrants.

headquarters and ultimately to the valley in search of employment, government aid, security, and shelter. This has already had an adverse impact on the urban environment. However, hopefully with the peace talks, many may return home.

Education

According to data from the Department of Education (2001), the enrollment of children in primary schools in the valley is around six per cent of the total primary enrollment in Nepal. The enrollment of girls in primary school is 47.7%. The data also reveal that the net enrollment ratio (NER)[5] is 90.5%; the NER for boys is 91.4% and it is 89.5% for girls.

Table 2.6: **Literacy rate in the districts of Kathmandu Valley (6 years and above in %)**

Region	1981	1991			2001		
	Total	Total	Male	Female	Total	Male	Female
Lalitpur	37.1	62.4	76.5	48.0	70.9	81.0	60.4
Bhaktapur	32.4	58.8	74.8	42.7	70.6	81.1	59.6
Kathmandu	50.0	70.1	82.2	57.0	77.2	86.5	66.6
Nepal	23.3	39.6	54.5	25.0	54.1	65.5	42.8

Source: CBS 2003b

The literacy rate of 77.2% for Kathmandu district is the highest in the country. The literacy rate increased from 50% in 1981, to 70.1% in 1991, and 77.2% in 2001. The literacy rate for boys was 86.5% whereas it was 66.6% for girls in 2001. Table 2.6 presents the literacy rates for the three districts and can be compared with those for the country as a whole. The literacy rate for the valley is higher than 70% compared to 54.1% for the country as a whole.

The urban poor

Data from the 1995/96 and 2003/04 Nepal Living Standards surveys (NLSS-I and II) carried out by the Central Bureau of Statistics (CBS) reveal that poverty dramatically declined in Nepal between 1995-96 and 2003-04 by about 26% over a period of eight years (CBS 2004).

Between 1995-96 and 2003-04, poverty declined in Kathmandu Valley by 23%, while in other urban areas it declined by 59% (CBS 2005). The lower rate of decline may be attributed to an increase in the urban poor and also to the higher rate of migration of poor people to the valley.

Table 2.7: **Poverty measurement: Kathmandu Valley vs. other urban areas and Nepal**

	Poverty Head Count Rate			Distribution of the Poor			Distribution of Population		
	95/96	03/04	Change %	95/96	03/04	Change %	95/96	03/04	Change %
Kathmandu Valley	4.3	3.3	-23	0.3	0.6	118	2.6	5.4	110
Other Urban	31.6	13.0	-59	3.3	4.1	23	4.4	9.7	121
Nepal				100	100	-	100	100	-

Source: CBS 2005

Table 2.7 shows the distribution of the population, distribution of the poor, and the poverty head count rate for the valley, other urban areas, and Nepal as a whole. The figures from the table show that the distribution of the population for Kathmandu as well as other urban areas has increased more than 100% between 1995-96 and 2003/04. The distribution of the poor has also increased in the valley and in other urban areas, but the figures for the valley have more than doubled whereas those for other urban areas have only increased by 23%. Similarly, the decrease in the poverty head count rate for the valley is 23% only compared to 59% for other urban areas.

Infrastructural Services

Administrative institutions

Government institutions

There are 21 ministries; most of them have a network of regional and district offices established throughout the country. The central organisation in the valley is not only limited to the executive branch of the government but also includes the legislative and judicial branches.

The Royal Palace, both Houses of Parliament, and the Supreme Court are also situated in the valley. Besides the Supreme Court there are six other courts, including the Appellate Court, the Administrative Court, the Revenue Jurisdiction Court, and three districts courts in Kathmandu, Lalitpur, and Bhaktapur.

Commissions, councils, and committees. Election Commission, the Commission for Investigation into Abuse of Authority, the Office of the Auditor General, the Office of the Attorney General, the Parliamentry Secretariat, and the Public Service Commission.

[5] Number of students in the officially defined age group for a given level of education expressed as a percentage of the population in the corresponding age group.

There are also the NPC, the Judicial Service Commission, the Water and Energy Commission, and the Commission for Information Technology.

Regional institutions, valley-level institutions. Several ministries have established regional offices in the valley. Valley-level institutions include three types of organisation: a) those concerned with the valley; b) those concerned with individual districts within the valley; and c) local governments.

Kathmandu Valley Town Development Committee (KVTDC) has been established under the Chairmanship of the Minister / State Minister of Physical Planning and Works and is represented by the Secretaries of the Ministry of Physical Planning and Works (MoPPW); Ministry of Home Affairs (MoHA); Ministry of Water Resources (MoWR); Ministry of Information and Communications (MoIC); Ministry of Finance (MoF); Ministry of Forest and Soil Conservation (MoFSC); and Ministry of Law, Justice and Parliamentary Affairs (MoLJPA). Vice Chairman of the National Planning Commission (NPC) is the Vice Chairman for the committee. The Director General of the Department of Urban Development and Building Construction (DUDBC), the Chairpersons for the three district committees of the valley, and the Mayors of the five Municipalities in the valley are also members of the committee. The Chief for the KVTDC Office serves as the Member-Secretary to the Committee. Under KVTDC, there are three district-level Town Development Implementation Committees (TDICs) for Kathmandu, Lalitpur, and Bhaktapur. The main responsibility of KVTDC is to approve and coordinate the plans prepared by the three TDICs.

The administrative section of all three districts is headed by the Chief District Officer appointed by the Ministry of Home Affairs. There are three district development committees (DDCs) in the valley. Each DDC is made up of elected representatives from the village development committees (VDCs) and Municipalities of the corresponding Districts.

Local governments. There are five municipalities in the valley; namely, Kathmandu Metropolis, Lalitpur Sub-Metropolis, Bhaktapur, Madhyapur (Thimi), and Kirtipur. There are 41 VDCs in Lalitpur, 13 VDCs in Bhaktapur, and 57 VDCs in Kathmandu (CBS 2002).

Other Institutions. Besides the above-mentioned government institutions, three other government institutions are situated in Kathmandu Valley: i) the Employee Provident Fund alone employs about 779 persons and is responsible for managing the deposits of different government, semi-government, and private sector agencies, ii) National Cooperative Development Board employs about 60 persons and is responsible for developing the cooperatives in the country, and iii) Kathmandu Urban Development Project (KUDP).

Other independent donor-funded projects and government organisations are involved in the development of Kathmandu Valley, among these projects are the Urban Environment Improvement Project (UEIP), the Kathmandu Valley Watershed Management Project (KVWMP), the Metropolitan Environment Improvement Programme (MEIP), the Urban Environment Management Programme (UEMP), and The Water Supply and Sanitation Board.

Semi-government institutions

Corporations and government companies/centres. The corporations in the valley include the Agricultural Inputs' Corporation, the Dairy Development Corporation, Nepal Food Corporation, Nepal Oil Corporation, and Nepal Water Supply Corporation (NWSC). In addition there are 20 more corporations and related organisations such as the Agriculture Lime Industry Ltd., Bhaktapur Brick Factory, Credit Guarantee Corporation Ltd., Gorkhapatra Sansthan, Industrial District Management Ltd., Janak Education Materials' Centre Ltd., National Construction Company of Nepal, National Productivity and Economic Development Centre, National Trading Ltd., Nepal Metal Co. Ltd., Nepal Rosin and Turpentine Ltd., Nepal Telecommunications' Corporation Ltd., Nepal Transit and Warehousing Company Ltd., Nepal Transport Company, Nepal Drug Ltd., Guthi Sansthan, and Salt Trading Corporation Ltd.

Authorities. Nepal Electricity Authority regulates electricity development, production, use, and management in the valley and throughout the country. Similarly, Nepal Telecommunications' Authority and the Civil Aviation Authority of Nepal are responsible for the management of telecommunications and air traffic management throughout the country. The Tourism Development Authority is responsible for promotion and development of tourism in the country.

Trusts. National Trust for Nature Conservation, Lumbini Development Trust, and Pashupati Area Development Trust are the major trust offices located in the Kathmandu Valley.

Non-government organisations (NGOs)

The Social Services' National Coordination Council regulates and supervises NGOs, whereas the Social Welfare National Coordination Council (SWNCC) handles most of the funding agencies. According to the Social Welfare Council (SWC), there are altogether 7,004 NGOs registered with SWC operational in the Kathmandu Valley. Kathmandu has 5,969, Lalitpur 856, and Bhaktapur 179 NGOs.

International non-government organisations (INGOs)

According to SWC, there are 157 international non-government organisations (INGOs) across the country: of these almost all have head offices in Kathmandu Valley and more than 80% are working in the valley.

Residential diplomatic missions in Kathmandu Valley

Altogether there are 25 residential diplomatic missions in Kathmandu Valley. There are also 17 multilateral donor agencies in Nepal and all have offices in the valley (MoPE 1999). There are 15 bilateral donor agencies in the valley.

The Secretariat of the South Asian Association for Regional Cooperation (SAARC) initiated by seven countries; namely, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka – and at present with Afghanistan added as a new member; is also located in Kathmandu. The secretariat complex was established in January 1987. The role of the secretariat is to coordinate and monitor the implementation of SAARC activities, service the meetings of the Association, and serve as the channel of communication between SAARC and other international organisations. The Secretariat has also been increasingly utilised as the venue for SAARC meetings. The Secretariat is comprised of the Secretary General, seven Directors, and the General Services' Staff.

Transport network

The Kathmandu Valley air and ground transport networks are described below.

Air transport

Tribhuvan International Airport (TIA) in Kathmandu is the only international airport in Nepal. There are 12 international airlines operating at present. There are 43 domestic airports connected to TIA and eight private, domestic airlines. There is only one government-owned airline, i.e., Nepal Airlines' Corporation, and it has a limited network within and outside the country.

Ground transport

The road network within the valley is inadequate. Roads are not classified according to vehicle types. With increased vehicular traffic and common tracks for all types of vehicles in the valley, traffic congestion is increasing and contributing to excessive vehicular emissions.

Sajha Bus Service, as a public limited company, carries passengers from and outside the valley to other parts of the country. There is a trolley bus service (electrically operated) but it is limited to a small section of one route in the valley.

Private transport includes buses, microbuses, vans, cars, jeeps, and three wheelers, operated by petroleum, liquid petroleum gas (LPG), and batteries.

According to the Department of Transport Management (DoTM), the total number of vehicles registered in Bagmati Zone was 224,098 up to 2003-04 (2060B.S). The total number of vehicles registered in 2005-06 (2062/63) was 26,781: 801 buses; 245 minibuses; 614 trucks, tractors, dozers, cranes, tippers; 3,493 cars, jeeps, and vans; and 21,628 motorcycles.

Assuming that the annual addition of vehicles in the year 2004-05 is equal to the previous year, the present trend in addition of vehicles in Kathmandu Valley is estimated to be around 12% per annum.

According to the latest statistics available from the Department of Roads in 2002, district-wise road length, population influenced, and area are presented in Table 2.8. Also, from the same publication, category-wise road lengths are presented in Table 2.9.

The main institutions looking after transport systems in the Kathmandu Valley are The Department of Roads, Department of Transportation Management, Department of Civil Aviation, and Tribhuvan International Airport Authority. These Departments are functioning in coordination with the Ministry of Physical Planning and Works, Ministry of Labour and Transport Management, Ministry of Local Development, and the Ministry of Tourism and Civil Aviation.

Communication facilities

Postal services. The postal service is the oldest means of communication and it reaches all the villages. Currently the postal service network includes the

Table 2.8: **Road length, population influenced, and area in the districts of Kathmandu Valley**

District	Total population in 2001	Total area in km²	Total length of roads, km	Population influenced per km of road	Road density, km/100 Km²
Kathmandu	1,081,845	395	813	1,331	206
Lalitpur	337,785	385	337	1,002	88
Bhaktapur	225,461	119	181	1,245	152
KVD	1,645,091	899	1,331	1,236	148

Source: DoR 2004

Table 2.9: **Total road length in Kathmandu Valley category-wise**

Class	Black top			Gravel road			Earthen road			Total
	Kath	Ltp	Bkt	Kath	Ltp	Bkt	Kath	Ltp	Bkt	
NH	18.85	0.00	14.12	0.00	0.00	0.00	0.00	0.00	0.00	33
FRN	17.05	0.00	23.00	0.00	0.00	0.00	0.00	0.00	0.00	40
FRO	41.19	25.00	00.00	0.00	8.57	0.00	0.00	0.24	0.00	75
DR	82.70	34.00	25.50	104.96	39.90	42.50	105.93	121.40	46.00	603
UR	339.50	84.00	20.00	70.65	16.00	8.00	32.00	8.00	2.00	580
District wise	499.29	14	82.62	175.61	64.47	50.5	137.93	129.64	48	
Total in Valley	**725**			**290**			**316**			**1,331**

Key: NH = national highway; FRN = feather road (major); FRO = feather road (minor); DR = district road; UR = urban road; Kath = Kathmandu; Ltp = Lalitpur; Bkt = Bhaktapur
Source: DoR 2004

general post office, regional postal directorates, district post offices, area (*ilaka*) post offices, and additional post offices; and their total number is 3,991. There are 142 (NIDI 2006) for the three valley districts. Besides these, a number of private postal care companies provide a wide range of postal services (MoF 2006).

Nepal Telecommunications' Authority. This authority is the regulatory body for telecommunications in Nepal. It is an autonomous body established in 1998 in accordance with the Telecommunications' Act 1997 and Telecommunications' Regulations 1998. Its objective is to foster a favourable and competitive environment for the development, expansion, and operation of telecommunications' services with private sector participation in Nepal.

Nepal Telecommunications' Authority, as of 2005/06 has issued basic telephone service licenses to two agencies, cellular mobile service licenses to two agencies, and internet (including email) licenses to 38 agencies (more than 50,000 customers). Other licenses are given in the following table (Table 2.10).

Extension of telephone services in 58 urban areas,on the basis of the National Population Census 2058 (CBS 2002) and data given in GoN/MoF, July 2006, Economic Survey (2005/06), was found to have reached to 25.40 thousand lines distributed from the 17.64 per thousand lines distributed in 2003/04. International circuit capacity, which enables worldwide telephone links, is 2,990.

Educational institutions

Modern education in Nepal is said to have been introduced after the visit of Prime Minister Jung Bahadur to England in 1850. Impressed with the system of education there, he established a private English school at the Thapathali Palace to teach his sons. In 1853, Durbar High School was established to provide formal education to the sons of Ranas. During the time of Prime Minister Chandra Shumshere, the school was opened for common people as well. However, the Ranas were not interested in promoting education. During the Rana regime (1846 – 1950), only four high schools and two colleges were established.

After 1950, education has been progressing continuously, specifically in the valley and, as a result, educational institutions, levels of education, and fields of study have been increasing.

Table 2.11 presents the existing number of schools by levels for the three districts and also for the valley.

Table 2.10: **Licensing of communications**

Type of licensee	Number
Basic Telephone Service Providers	2
VSAT Network Service Providers	10
GMPCS Service providers	2
Video Conferencing Service	1
Local Data Network Service	1
Cellular Mobile Service Provid ers	2
Internet Service Providers (ISP)	38
Fax Mail Service Providers	6
Radio Paging Service Providers	5
Rural Telecommunications Service Providers	1

Source: Website of Nepal Telecommunication Authority (NTA), 07/08/2006

Table 2.11: **Total number of schools by grades and levels**

	Primary	Lower Secondary	Secondary	Higher Secondary
Kathmandu	920	671	514	148
Lalitpur	277	147	108	47
Bhaktapur	243	137	85	9
Total in the Valley	**1,440**	**955**	**707**	**204**

Source: Compiled from NIDI 2006.

Tribhuvan University, the national university in Kirtipur, has five institutes (Engineering; Agriculture and Animal Sciences; Medicine; Forestry Science; and Science and Technology) and four faculties (Law, Management, Education, and Humanities and Social Sciences). The university and colleges and campuses affiliated to all the five universities of Nepal are offering almost all the popular disciplines at different academic levels, including Master's and Doctoral levels, in the valley.

There are three medical and more than 12 engineering colleges offering up to master's level education. The Council for Technical Education and Vocational Training is another regulatory body monitoring the curriculums for technical and vocational training as well as diploma courses in different subjects to produce skilled manpower.

Health services

Kathmandu is a centre for all types of health services. Most of the old, well-equipped and specialised health-care facilities are located in the valley. Health-care service centres are classified into the government or private sectors. Health service centres are also classified into central, district, teaching, health centre, primary health care units, health posts, and sub-health posts. A summary of health facilities is given in Table 2.12.

The central hospitals in Kathmandu Valley are Bir Hospital (general medicine and surgery), Teku Hospital, the Maternity Hospital, Sahid Gangalal Heart Centre, Kanti Children's Hospital, and Patan Mental Hospital.

There are also two eye hospitals in Kathmandu district and they are in the non- government sector. All three teaching hospitals are in Kathmandu district: the Institute of Medicine, Maharajgunj (under Tribhuvan University), Nepal Medical College, Jorpati, and Kathmandu Medical College, Sinamangal (both affiliated with Kathmandu University).

Table 2.12: **Health facilities available in Kathmandu Valley**

Category	Kathmandu	Lalitpur	Bhaktapur	Total
Central Hospital	5	1	0	6
District Hospital	0	1	1	2
Teaching Hospital	3	0	0	0
Health Centres	1	0	0	1
Primary Health Care Units	7	3	0	10
Health Posts	5	9	0	14
Sub-health Posts	53	29	0	82
Private Hospitals & Nursing Homes	23	5	2	30
Total	**97**	**48**	**3**	**145**

Source: DOH 2006

Private health facilities are mostly of the polyclinic type. Some of them provide special treatment facilities for heart care, orthopaedic care, gastrointestinal care, kidney care, and dental care. The number of private facilities shown in Table 2.12 does not include the numerous clinics run by individual doctors.

Utilities

The status of utilities, mainly electricity and drinking water, is presented here.

Electricity

Not all households in the valley have electricity. The proportion of households having electricity in the three districts is given in Table 2.13 and is based on data from the Nepal Human Development Report 2001 (UNDP 2002). The overall proportion of households connected to electricity is approximately 95%.

Table 2.13: **Proportion of households with electricity**

S. No.	District	Total households	Proportion of households in %
1	Kathmandu	235,387	96.81
2	Lalitpur	68,922	87.64
3	Bhaktapur	41,253	96.41

Source: NIDI 2006

Drinking water

Not all households and people in the valley receive safe drinking water. The dependency of households for drinking water on a variety of sources can be seen from Table 2.14.

Table 2.14: **Sources of drinking water**

	Kathmandu		Lalitpur		Bhaktapur		Kathmandu Valley	
	HH	%	HH	%	HH	%	HH	%
Tap	197,851	84.1	57,237	83.0	30,755	73.5	285,843	82.6
Well	14,714	6.3	6,745	9.8	4,843	11.6	26,302	7.6
Tube well	13,478	5.7	825	1.2	2,977	7.1	17,280	5.0
Spout	6,082	2.6	3,099	4.5	2,632	6.3	11,813	3.4
River/ stream	195	0.1	113	0.2	29	0.1	337	0.1
Others	1,616	0.7	477	0.7	277	0.7	2,370	0.7
Not stated	1,381	0.6	425	0.6	339	0.8	2,145	0.6
Total	235,317	100	68,921	100	41,852	100	346,090	100

Key: HH = household
Source: NWSC 2005

Table 2.15: **Population receiving drinking water**

Districts	Estimated population 2005	Population benefiting 2005	Percentage benefiting
Kathmandu	1,246,110	947,630	76.05
Lalitpur	366,010	286,250	78.21
Bhaktapur	244,130	152,270	62.37
Total	**1,856,250**	**1,386,150**	**74.67**

Source: NWSC 2005

Based on the data for 2005 given by the Department of Drinking Water and Sewerage, the population and percentage of the population receiving water by districts and also for the valley are given below in Table 2.15. It is seen that less than 75% of the population receives drinking water supplies.

Economic Structure

Trade links (international and bilateral agreements)

Trade links with India and the Tibetan Region of China

Kathmandu Valley developed as an entrepôt, a centre of trade links with India and Tibet. Anshuvarma, the talented and influential officer who became king, ending the Lichhavi dynasty, opened the trade route to Tibet. One of his daughters, Bhrikuti, was married to Songsten Gompo, an influential ruler of Tibet at that time (Regmi 1999).

Although Nepal has developed trade links with other countries, the majority of the trade is still with India: exports in the fiscal year 1965-66 were 98.8% to India and only 1.2% to other countries. In the fiscal year 2003-04, 59.3% went to India and 40.7% to other countries. The major trading partners for exports after India are the United States, Germany, the U.K., Italy, France, Canada, and Japan. The main items of export are readymade garments, woollen carpets, woollen and pashmina goods, and handicrafts: manufacturing of these is mainly in the Kathmandu Valley.

Similarly, imports in the Fiscal Year 1965-66 were 97.6% from India and 2.4% from other countries. These figures changed to 58.7% from India and 41.3% from other countries in 2003-04. The major trading partners for imports after India are Singapore, the People's Republic of China, Thailand, Malaysia, Indonesia, and the Republic of Korea. The majority of imports are handled through the valley.

Institutions working in the trade sector

The Ministry of Industry, Commerce and Supplies (MoICS) is the main government body responsible for trade promotion. This Ministry has a Department of Commerce (DoC) and a Trade Promotion Centre (TPC) to assist in the implementation and promotion of bilateral and multilateral trade.

Trade agreements ratified by Nepal

Nepal signed the South Asian Free Trade Agreement in January 2004 with the other countries of the South Asian Association for Regional Cooperation (SAARC). Nepal was admitted (along with Bhutan) in February 2004 into the Bangladesh, India,Myanmar, Sri Lanka, and Thailand consortium for socioeconomic cooperation (BIMSTEC) which was established in June 1997. Nepal became the 147^{th} member of the World Trade Organisation (WTO) on 23 April 2004, and it will need to improve its competitiveness to benefit from these memberships and agreements.

International trade conventions ratified by Nepal

Nepal has ratified the following conventions on trade and environment (ADB/ICIMOD 2006).

- Plant Protection Agreement for South-East Asia and the Pacific Region 1956
- Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES)
- Montreal Protocol on Substances that Deplete the Ozone Layer 1987 and its amendments
- Basel Convention on the Control of Transboundry Movement of Hazardous Wastes and Disposal

- Convention on Biological Diversity 1992 and the Cartagena Protocol on Biosafety 2000
- United Framework Convention on Climate Change 1992 and the Kyoto Protocol 1997 (accession)
- International Tropical Timber Agreement 1994

Industries (cottage and others)

A 'Udhyog Parishad' (Industrial Development Board) was established in 1935, and promulgation of the Company Act in 1936 paved the way for industrial development.

Kathmandu Valley has many traditional cottage industries. These include textile weaving (handlooms), brick and tiles, pottery, handicrafts (e.g. idol making), precious ornaments, traditional food processing and preservation (such as rice milling, beaten rice, oil milling, sweetmeats, and traditional dairy products), wooden furniture and carving, bamboo crafts, traditional textile printing and dyeing, traditional art and paintings, copper and brass metal utensils, herbal medicines, forges, and cordwaining (leather crafts).

As it is the capital and all the important institutions are located here, particularly the Nepal Industrial Development Corporation, private small and medium-scale industries have developed. Three industrial districts, namely, Balaju Industrial District in Balaju, Kathmandu, Patan Industrial Estate in Lagankhel, Lalitpur, and Bhaktapur Industrial Estate in Byasi, Bhaktapur, were established. Industries flourished during the 1970s and 1980s. Public sector brick factories, leather tanning, and shoe manufacturing and cement industries were also established. Food and beverages, plastic products, construction materials, carpets, and readymade garment industries have flourished. However, the number of industries and employment provided by them have decreased drastically within the last decade. Table 2.16 presents the number of industries and employment provided in the three districts from 1991-92 and 2001-02 (CBS 1994, CBS 2003a) and Table 2.17 presents the existing status of the three industrial districts in the Valley.

Outside the industrial districts, industries are concentrated along the Kathmandu-Bhaktapur and Kalanki-Thankot roads. The carpet industries are established around the Swayambhu and Boudha areas. Handicraft industries, especially metal handicrafts, are mainly concentrated in the Lalitpur area and brick kilns mainly in Bhaktapur and Lalitpur.

Table 2.16: **Number of industries and employment**

Year	1991/92		2001/02	
District	No. of Establish-ments	Employment	No. of Establish-ments	Employment
Lalitpur	628	34,688	236	18,364
Bhaktapur	145	15,155	97	8,171
Kathmandu	1,401	74,825	514	33,883
Total	**2,174**	**124,668**	**847**	**60,418**

Source: CBS 1994, 2003a

Table 2.17: **Status of the industrial districts in the valley**

Description	Balaju Industrial District	Patan Industrial Estate	Bhaktapur Industrial District
Establishment year (B.S.)	2016	2020	2036
Assisting country	USA	India	Germany
Total area in ropani	696	293	71
Developed area	100%	100%	100%
Leased area	521	218	58
Remaining	-	-	-
Service area	173	75	13
Government sector investment (million Rs.)	13.2	14.3	13.6
Private sector investment (million Rs.)	2,000	408.1	280
Total no. of industries	93	106	34
Operational industries (no.)	74	90	28
Under construction (no.)	10	1	2
Closed (no.)	9	15	4
Employment provided to	3,800	1,472	700
Electricity (kVA)	4,000	1,500	900
Water use ('000 litres per day)	412	21	-
Internal road (km)	5.2	5	0.69

Source: IoM 2005

The study carried out by IUCN in 1991 in collaboration with the NPC identified Kathmandu, Lalitpur, and Bhaktapur as three of the 15 industrial pollution hotspots in the country (IUCN 1991). If we look at the types of industry, most of the polluting industries such as cement, textile dyeing, tanning, and distilling have been closed or transferred to places outside the valley. Of the remaining industries, the main polluting industries in the valley are only small scale, and these include brick kilns; wool dyeing and carpet washing; textile dyeing; pottery; polyurethane and rubber foam; beaten rice; dairy products; metal casting; metal craft industries and gold plating; and alcoholic and non-alcoholic beverages.

The public sector industries have been either privatised or closed. Bansbari Leather and Shoe factory was privatised on the condition that it be relocated outside the valley. Himal Cement Factory has been closed.

With the increase in industrial pollution and rising awareness of the general public about the adverse impact of industrial pollution, complaints augmented and measures were taken to address the issue. The Industrial Promotion Board (IPB) formulated an industrial location policy. There have been revisions to the policy and the latest location policy[6] for industries specifies the following.

- The types of industry (List A) that can be established in municipal areas of the valley
- Types of industry (List B)that are not allowed in the valley
- All types of industry that have pollution prevention and safety measures can be established inside any designated industrial district.

The lists of industries (Lists A & B) are given in Annex 3.

Institutional arrangements. The Ministry of Industry, Commerce and Supplies (MoICS) and departments under it; namely, the Department of Industry (DoI), Department of Cottage and Small Industries (DCSI), Nepal Bureau of Standards and Metrology (NBSM), Department of Mines and Geology (DMG), Office of the Company Registrar, and the Cottage and Small Industries' Development Board (CSIDB) are the main organisations for policy formulation and implementation on development of industries in the country. The MoICS, DoI, DCSI, and NBSM are also responsible for approval of Initial Environmental Examinations (IEEs) and they are involved in the approval of Environmental Impact Assessments (EIAs) for establishing new industries and monitoring existing industries.

The National Productivity and Economic Development Centre, Industrial Enterprise Development Institute, and Industrial District Management Limited are promotional organisations in the government sector.

Some notable achievements. The following measures were taken to prevent and control industrial pollution.

- Effluent discharge standards have been promulgated.
- Environment management systems (EMS) have been implemented in more than 20 units in the valley (and more than 70 in Nepal).
- Three industries in the valley have ISO 14001 certification.
- Pollution permits are issued in accordance with the Environment Protection Act (EPA).
- Cleaner production methods have been introduced into more than 100 industries by the Environment Sector Programme Support (ESPS) and six units by the MoICS carried out by Pace Nepal Pvt. Ltd. inside Kathmandu Valley.
- Most polluting industries have been closed or relocated – e.g. Himal Cement Factory, Bansbari Leather and Shoe Factory
- Moving Chimney Bull's trench brick kilns have been banned.
- The DCSI/DoI have laid down stringent conditions for the approval of IEE for industries involved in brick and stone crushing.
- A location policy has been introduced for industries in municipalities both inside and outside Kathmandu Valley

Tourism

Kathmandu Valley is the gateway to Nepal for tourists and their main destination. Ninety per cent of tourists enter through Kathmandu. The valley's rich cultural heritage and its the seven designated world heritage sites have contributed to tourism promotion.

Flow of tourists. Tourists began visiting Nepal only after the late 1950s. In 1960, the total number of tourists, excluding Indians, was only 4,017. In 1970, this figure had reached 45,970 and in 1992 it increased to 334,353. The figures for 2004 and 2005 are 385,297 and 375,398 according to the Ministry of Culture, Tourism and Civil Aviation (MoCTCA 2006). The decrease in tourist flow in 2005 was due to the political situation that led to lack of security in the country. The flow is expected to increase once peace is re-established.

Institutional arrangements. The Ministry of Culture, Tourism and Civil Aviation is responsible for policy whereas the Tourism Development Authority is the overall planning and implementation agency.

The private sector. The private sector is becoming more active in this sector. The following associations are contributing actively to promotion and development of tourism.

- Hotel Association of Nepal
- Nepal Association of Travel Agents
- Trekking Agents' Association of Nepal
- Pacific Asia Travel Association, Nepal Chapter

[6] Based on a decision of the 132nd Meeting of the Industrial Promotion Board (IPB) held on B.S. 2054/1/29 (i.e. 11 May 1997).

Besides these, new sub-sectoral associations have been established. These include Nepal Association of Tour Operators, Tour Guide Association of Nepal, Nepal Association of Rafting Agents, Nepal Mountaineering Association, Non-star Hotel Association, Thamel Tourism Development Committee, Nepal Handicraft Association, Nepal Heritage Society, and Board of Airlines' Representatives of Nepal.

Tourism and environment. If proper consideration is not given, the natural and cultural heritage will continue to deteriorate because of environmental pollution and this will hamper the promotion of tourism. On the other hand, tourist traffic may affect the environment and could also have an adverse impact.The challenge is to strike a balance between environmental protection and tourism development. The collection of entrance fees and their use to improve the environment and preserve and renovate natural and cultural heritage can be effective.

Valley livelihoods

The population census of 2001 recorded 53.6% of the total population of Kathmandu Valley as economically active. Table 2.18 gives the total as well as the economically active population by district and also by gender:

Table 2.19 gives a break down of occupations. Besides agriculture and livestock husbandry, the other activities are manufacturing, trade or business, transport, services, and others.

Table 2.18: **Total and economically active population**

District	Total			Economically active		
	Total	Male	Female	Total	Male	Female
Kathmandu	877,736	464,153	413,578	455,671 (52%)	302,603 (65%)	153,063 (37%)
Lalitpur	278,502	141,264	137,240	154,071 (55%)	94,943 (67%)	59,136 (43%)
Bhaktapur	182,626	92,348	90,277	107,557 (59%)	63,973 (69%)	43,582 (48%)
Total	**1,338,864**	**697,765**	**641,095**	**717,299 (54%)**	**461,519 (66%)**	**255,781 (40%)**

Source: CBS 2002

Table 2.19: **Households by economic activity in Kathmandu Valley**

District	Agriculture & livestock	Manufac-turing	Trade/ business	Transport	Services	Others	Total households
Kathmandu	57,189	6,210	30,896	2,615	24,411	9,694	235,387
Lalitpur	33,839	3,978	8,448	1,149	12,211	2,249	68,922
Bhaktapur	28,183	1,463	4,693	454	4,280	3,302	41,253
Kath. Valley	119,211	11,651	44,037	4,218	40,902	15,245	345,562

Source: NIDI 2006

Under manufacturing activities, notable are carpet and textile weaving, and these include pashmina, readymade garments, handicrafts in metal and wood, and paintings (thanka painting). New types of service units have emerged such as Internet/Cyber parlours, computer services, photocopying, and communication call centres.

Institutional Framework for the Environment

This section discusses environmental governance in Nepal as a whole and in the Kathmandu Valley in particular. It covers environmental policies and plans; development and enforcement of environmental laws and regulations, norms, and standards; and establishment and operation of relevant institutions for supervising, executing, and monitoring programmes.

Nepal has implemented planned development programmes since 1956, and it is now almost at the end of the Tenth Plan (2002/03 – 2006/07). The NPC has attempted to integrate environmental issues into sustainable development and poverty reduction. Protection of natural resources has been emphasised. Natural resource conservation was emphasised in the first three plans. Sectoral policies included environmental concerns from the fourth plan onwards. Environmental considerations have been consistently included in the national development plans from the Eighth Plan (1992/93 – 1996/97) (ADB/ICIMOD 2006).

The National Conservation Strategy 1988, Industrial Policy 1992, Nepal Environmental Policy and Action Plan (NEPAP) 1993, Tourism Policy 1995, Solid Waste Management Policy 1996, National Water Supply Sector Policy 1998, Forest Sector Policy 2000, Hydropower Development Policy 2001, Nepal Biodiversity Conservation Strategy 2002, Leasehold Forestry Policy 2002, Water Resource Strategy Nepal 2002, National Wetland Policy 2003, Irrigation Policy 2003, and the Sustainable Development Agenda for Nepal 2003 have emphasised environmental considerations, minimisation of the adverse impacts of development projects on the environment and biodiversity, and environmental protection.

Legal and legislative framework

Provisions in the Constitution of 1990

Article 26 of the Constitution of Nepal 1990 (Part 4) states the following.

- The state shall pursue a policy of mobilising the natural resources and heritage of the country in a manner useful and beneficial to the interests of the nation.
- The State shall give priority to the protection of the environment and also to the prevention of its further damage by physical development activities by increasing the awareness of the general public about environmental arrangements for the special protection of the rare wildlife, the forests, and vegetation.

Environmental legislation

Environmental considerations taken into account in sectoral policies and provisions were included in related sectoral acts before the promulgation of the Environment Protection Act (EPA) and Environment Protection Regulations (EPR) in 1997 after the formation of the then Ministry of Population and Environment (MoPE). This act and these regulations have given a legal context in which to approach approval of new development activities and prevention as well as control of pollution. Pollution control certificates, inspections by environmental inspectors, establishment of environmental laboratories, establishment and use of environment protection funds, incentives for good work, and compensation for adverse impacts are included in these legislations (MoPE 2000).

The Local Self Governance Act (LSGA) 1999 gives more autonomy to village development committees (VDCs), district development committees (DDCs), and municipalities to manage local natural resources and to integrate environmental resource management and environmental planning. Under the EPA and EPR, environmental standards have been developed and promulgated. These include the following.

- National ambient air quality standards for Nepal
- Nepal vehicle mass emission standards
- Generic standards
  - Tolerance limits to industrial effluent discharge into inland surface waters
  - Tolerance limits to industrial effluent discharge into public sewers
  - Tolerance limits to wastewater discharge into inland surface waters from combined wastewater treatment plants (CWTPs)
- Tolerance limits to the discharge of industrial effluents to inland surface water by nine industrial sectors: tanning, wool processing, fermentation, vegetable ghee and oil, paper and pulp, dairy products, sugar milling, cotton textiles, and soap industries.

Nepal is also party to 21 environment-related international conventions and has obligations to fulfill its commitments at national as well as at global level. Nepal is active in the following conventions.

- Climate Change
- Protection of the Ozone Layer
- Biological Diversity
- Combatting Desertification
- International Trade in Endangered Species of Wild Flora and Fauna
- Wetlands
- Tropical Timber
- Persistent Organic Pollutants

Administrative framework

The following bodies administer the plans and programmes.

- Parliamentary Committee on Natural Resource and Environmental Protection
- National Development Council
- Environmental Protection Council
- National Planning Commission (NPC)
- Ministry of Environment, Science and Technology (MoEST)
- Ministry of Forest and Soil Conservation (MoFSC)
- Ministry of Industry, Commerce and Supplies (MoICS)
- Ministry of Local Development (MoLD)
- Ministry of Agriculture and Cooperatives (MoAC)
- Ministry of Water Resources (MoWR)
- Ministry of Physical Planning and Works (MoPPW)

In addition, the judiciary, which is the guardian of the constitution, is responsible for environmental justice. VDCs, DDCs, and Municipalities also have a role to play in the administration of environmental aspects. Nepal Electricity Authority, Nepal Agricultural Research Council, Nepal Academy of Science and Technology, the Solid Waste Management Resource Mobilisation Centre, and Nepal Water Supply Corporation are also important stakeholders. Besides these, private sector organisations like the Federation of Nepalese Chambers of Commerce and Industry (FNCCI), NGOs, INGOs, Community-based organisations, professional societies, academic institutions, the media, and civil society also contribute to the management of environmental issues.

Section 2

Key Environmental Issues

Section 2 – Introduction

An inception-cum-training programme was organised from 21-23 December 2005 to introduce Integrated Environmental Assessment training tools specifically developed by the Organisation for Economic Cooperation and Development (OECD) and other organisations. This framework has been adopted by the United Nations Environment Programme (UNEP) for the preparation of an integrated environmental assessment report of the Kathmandu Valley's Environment Outlook.

The training workshop identified five key environmental issues in the Kathmandu Valley. These are the following.

- Air quality and traffic management
- Settlement patterns
- Water resources
- Waste management
- Natural disaster preparedness (focused on earthquakes and land subsidence)

A Driver-Pressure-State-Impact-Response (DPSIR) Framework was used to analyse the five issues in the Kathmandu Valley. The Framework is described below and shown diagrammatic form overleaf.

DRIVERS

They are sometimes referred to as indirect or underlying drivers or driving forces and refer to fundamental processes in society which drive activities having a direct impact on the environment.

PRESSURES

They are sometimes referred to as direct drivers as in the millenium ecosystem assessment (MA) framework. They include, in this case, the social and economic sectors of society (also sometimes considered as Drivers). Human interventions may be directed towards causing a desired environmental change and may be subject to feedback in terms of environmental change, or could be an intentional or unintentional by-product of other human activities (i.e., pollution).

STATE

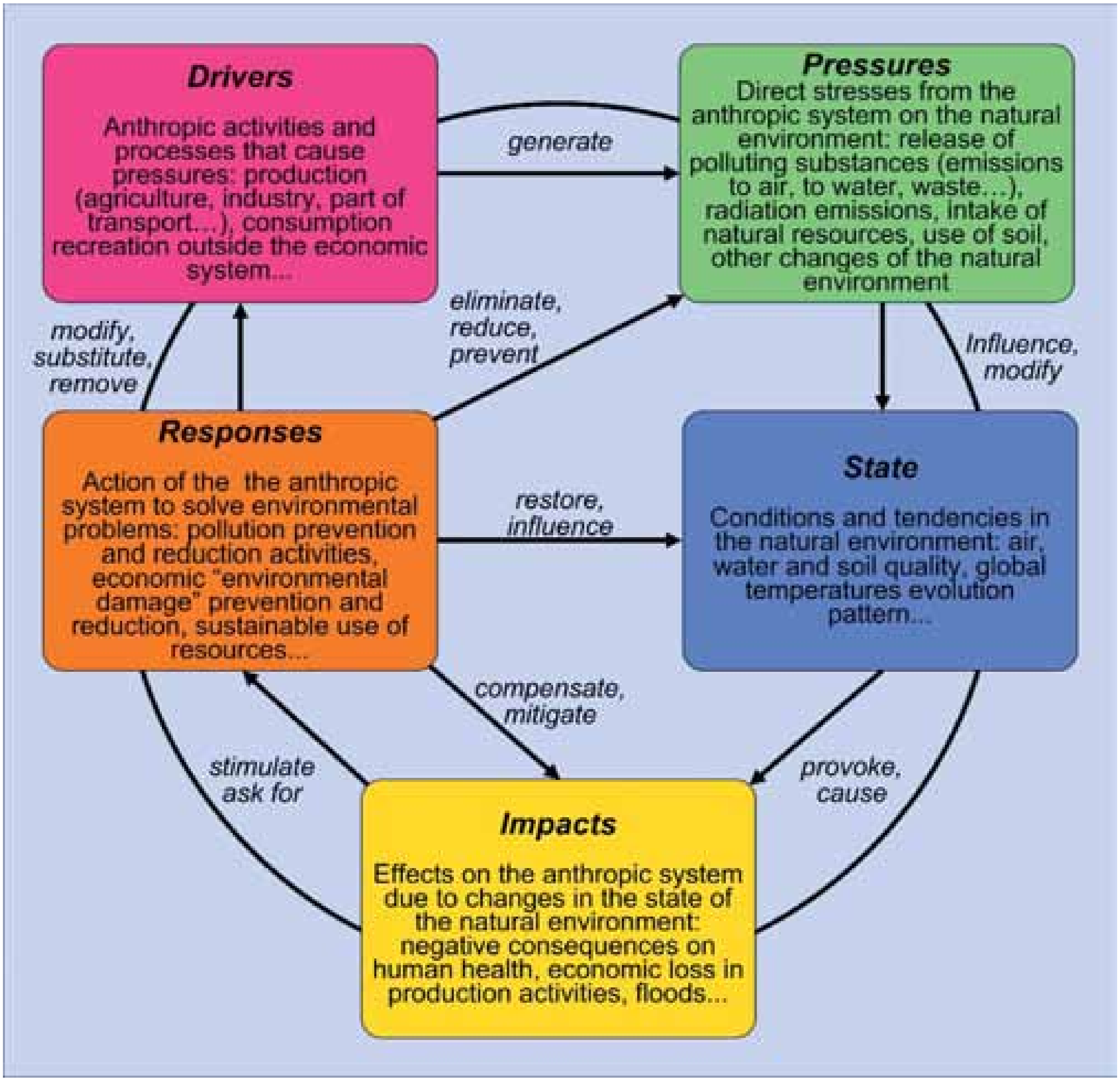
Environmental state also includes trends, often referred to as environmental changes, which could be both natural and human induced. One form of change, such as climate change, (referred to as a direct driver in the MA framework) may lead to other forms of change such as biodiversity loss (a secondary effect of climate gas emissions). Multiple pressures could leave the environment more vulnerable, leading to cumulative change and, in some cases, sudden and disruptive change.

IMPACTS

Environmental change may positively or negatively influence human well-being (as reflected in international goals and targets) through changes in ecological services and environmental stress. Impacts may be environmental, social, and economic, contributing to the vulnerability of people. Vulnerability to change varies between groups of people depending on their geographic, economic, and social location, exposure to change and capacity to mitigate or adapt to change. Human well-being, vulnerability, and coping capacity are dependent on access to social and economic goods and services and exposure to social and economic stress.

RESPONSES

They (interventions in the MA Framework) consist of elements among the drivers, pressures, and impacts that may be used for managing society in order to alter the human-environment interactions. Drivers, pressures, and impacts that can be altered by a decision-maker on a given scale are referred to as endogenous factors, while those that cannot are referred to as exogenous factors. Responses are at different levels, for example, environmental laws and institutions at national level and multilateral environmental agreements and institutions at regional and international levels. Responses address issues of vulnerability of both people and the environment and provide opportunities for enhancing human well-being.



Driver-Pressure-State-Impact-Response (DPSIR) Framework

3

Air Quality and Traffic Management

Air pollution is becoming a significant problem in urban areas in Nepal, particularly in the bigger cities. Kathmandu Valley is particularly vulnerable to air pollution because of its bowl-shaped topography which restricts air movement. The situation is worse during the winter when temperature inversion during the night and early morning traps a layer of cool air under a layer of warmer air, trapping pollutants close to ground level for extended periods. Besides the topography, the relatively high elevation of the valley also results in increased vehicular emissions. The main elements in the DPSIR framework related to air quality in the Kathmandu Valley are in shown Figure 2.

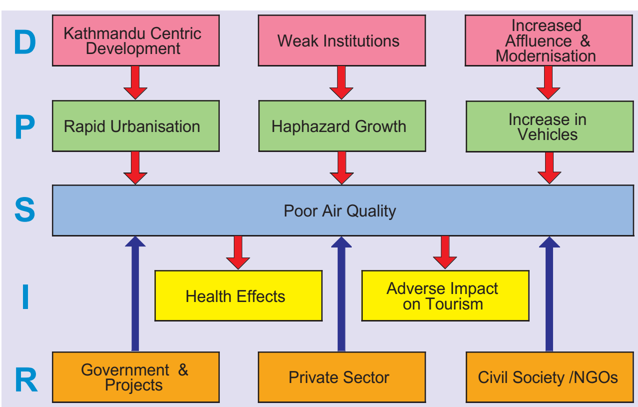


Figure 2: DPSIR framework and urban air quality in Kathmandu Valley

Drivers

In the case of Kathmandu's air quality, the main drivers are Kathmandu-centric development; weak institutional capacities, and increasing affluence and modernisation.

Kathmandu-centric development

Over the years, Kathmandu has become the centre for practically all services and facilities nationally. As the capital city, it is naturally the political and administrative centre of the country. But besides this, it is also the hub for tourism, finance, industry, education, transportation, health care, and sports. Some indicators of this process of centralisation are presented in Table 3.1.

This process of Kathmandu-centric development continues even today. For example, in the national budget for the current fiscal year (2006/07), 35.4% of the fund earmarked for water supply and sanitation is to be spent in Kathmandu Valley. Similarly, the most recent urban development projects, such as the Japan International Cooperation Agency's (JICA) Clean

Table 3.1: **Centralisation of development in Kathmandu Valley**

Function	Indicator
Political	Capital city Due to the insurgency, activities of most political parties have been limited to Kathmandu and other urban centres.
Administrative	Capital city Regional headquarters for various institutions such as SAARC, UNICEF Central Regional Headquarters for various offices District Headquarters for three districts
Finance	Headquarters for all major banks and financial institutions Only share market in the country
Tourism	Major tourist attractions including seven world heritage sites
Industry	Main centre for carpet and garment industries, and these are the largest and most labour-intensive industries Many polluting industries such as brick kilns and stone crushers 14,791 small and cottage industries in Kathmandu Valley
Transportation	The location of the country's only international airport The valley is connected by various highways going north-south & east-west 56 % of the total number of vehicles registered in the country are in Bagmati zone, almost all of which are in Kathmandu Valley
Sports	The only international quality football stadium, covered hall, cricket field and swimming pools in the country are all located in Kathmandu Valley
Education	Largest university and most well-known schools and colleges in the country are located in Kathmandu Valley
Health care	Largest hospitals in the country Specialised health care facilities such as Ganga Lal Heart Centre

Kathmandu Valley (CKV) and Junction Improvement projects and the Asian Development Bank (ADB) funded Kathmandu Valley Development Project have also focused their activities on Kathmandu Valley. Currently, the government is actively seeking funding for the Outer Ring Road project, which many believe will exacerbate urban sprawl. In fact the government's Kathmandu Valley Development Plan, which is the latest plan for managing the valley's urban development, has mentioned that the Outer Ring Road should not be built without considering adverse environmental impacts and the possibility of uncontrolled urban sprawl.

Weak institutional capacity

According to the Local Self Governance Act 1999 municipalities are primarily responsible for urban environmental management. But municipalities have very limited resources, both human and financial, to invest in activities related to urban environmental management. An analysis of the revenue and expenditure of the five municipalities in Kathmandu Valley shows that most municipalities depend on a local development fee provided by the central government for their revenue and most of the revenue is spent on current expenses. Within the current expenses, personnel expenses were the largest component accounting for 27% in Kathmandu Metropolitan City (KMC), 65% in Lalitpur Sub Metropolitan City (LSMC), 18% in Bhaktapur Municipality (BKM), 52% in Madhyapur Thimi Municipality (MTM), and 61% in Kirtipur Municipality (KRM) (Table 3.2) As a result, municipalities have very little money to manage urban growth and environment and the municipalities are often busy in day to day administrative work and crisis management.

Table 3.2: **Actual revenue and expenditure for FY2003/04 (2060/61)**

Items	KMC		LSMC		BKM		MTM		KRM	
	m. Rs	%	m. Rs	%	m. Rs	%	m. Rs	%	m. Rs	%
Revenue	**554**	**100**	**116**	**100**	**128**	**100**	**24**	**100**	**17**	**100**
1) Local Dev. Fee	238	43	52	45	21	16	12	50	12	71
2) Own Revenue	288	52	62	53	106	83	7	29	3	18
3) Grants	28	5	2	2	1	1	5	21	2	11
Expenditure	**580**	**100**	**121**	**100**	**123**	**100**	**21**	**100**	**12**	**100**
1) Current	553	95	68	56	96	78	10	48	7	58
2) Capital	27	5	53	44	25	20	11	52	5	42
3) Debt	0	0	0	0	2	2	0	0	0	0

Key: m. Rs = million Rs; KMC = Kathmandu Metropolitan City; LSMC = Lalitpur Sub Metropolitan City; BKM = Bhaktapur Municipality; MTM = Madhyapur Thimi Mulicipalilty; KRM = Kirtipur Municipality
Note: Opening balance is excluded from revenue.
Source: Compiled from Budget Reports for each municipality, 2004

Although municipalities are spending a large proportion of their income on personnel expenses, they have very little trained manpower. KMC for example has an Environment Department but almost all the staff members in this department are involved only in managing the city's garbage. The Urban Environment Section in the department is responsible for air and water pollution control and greenery, but it has only two staff members. Similarly, other municipalities also do not have any expertise in issues such as transport management and air pollution control.

Other institutions are involved in urban development and urban environmental management, but they have very limited resources and programmes. For example, the Department of Transport Management (DoTM) does not have a transport planner or a transportation management expert. The activities of the DoTM are therefore mostly limited to registering vehicles and issuing route permits for public vehicles.

In many instances, the responsibilities of different organisations involved in various aspects of urban management are not clear, and coordination among different stakeholders to resolve issues and work together is rare. As a result, many problems are ignored and the resources are not used effectively. For example, the seemingly simple issue of digging roads to maintain underground systems, such as water supplies, drainage, or telecommunication cables, often results in converting well-paved roads into patches of dirt and potholes that result in congestion and air pollution. It is estimated that about 25% of the total particles less than 10 microns (PM_{10}) in the air of Kathmandu Valley are from road dust (Gautam 2006).

Most municipalities and other institutions that have responsibilities for urban environmental management do not have plans and programmes to combat pollution. Some plans have been prepared with the support of international agencies, but rarely have these been internalised and implemented.

Another major weakness of institutions is in regular monitoring and enforcing compliance with standards and regulations. Nepal has standards for ambient air quality and vehicle emissions, but these are rarely enforced. Although there is a system for regularly checking the compliance of in-use vehicles, there is no punishment for vehicles that do not comply. Since 2002, the ambient air quality in Kathmandu has been monitored, but the monitoring results have not yet been used to develop plans and programmes.

The organisational culture prevalent in many municipal and government offices prefers the status quo and does not encourage people to take initiative and be creative. Such a culture hampers institutional performance and prevents institutions responsible for urban management from addressing the challenges of a rapidly growing urban centre adequately.

Increasing affluence and modernisation

There is a growing middle class in the valley which is demanding new modern facilities such as houses in the suburbs and vehicles. To cater to these demands, an aggressive market is supplying easy access to financing and a wide choice of vehicles and housing for consumers. According to Tuladhar et al. (2005), the main reasons for the massive growth in demand for vehicles are as follows.

- Availability of a wide range of different automobile models in the market
- Competitive market resulting in aggressive marketing by auto dealers with attractive promotional schemes
- Attractive auto loans offered by financial institutions
- Expanding city boundary forcing people to travel long distances
- Growing population
- Poor public transportation system

Among these reasons, probably the most significant cause in the growth of car ownership is the financing schemes being offered by banks. In recent years, auto loans have become popular in Kathmandu, and this has contributed to an increase in demand for cars and motorcycles. With interest rates as low as 4.5% with a 10% down payment, a car or motorcycle is now within the reach of most middle class families. Because of the lack of investment opportunities in other sectors and inflow of cash from remittances and other sources, many people are taking advantage of offers provided by the numerous banks and auto dealers. Standard Chartered Bank first introduced auto loan schemes in 1992, but the auto loan sector has really taken off in the past five years with interest rates dropping significantly and many commercial banks entering the market with attractive schemes. Several banks have joined hands with car dealers to offer the best deals. Even the traditionally conservative government sector Nepal Bank and Rastriya Banijya Bank have introduced new auto loan programmes. According to local auto dealers, the banks finance 80 to 90% of the cars they sell.

Along with the demand for vehicles, the market for housing in the suburbs has also boomed in recent years. Many real estate dealers and housing companies are offering 'dream houses' just outside the main city and banks are eager to provide the necessary financing. This has resulted in an expansion in urban sprawl and people having to commute longer distances. In fact, the 2001 census indicated that the population in many of the core areas of Kathmandu has actually gone down as people move out of the core areas into the suburbs.

Pressure

Rapid urbanisation

Kathmandu-centric development has resulted in rapid urbanisation in the valley. Kathmandu Valley has five of the 58 municipalities in the country and is home to about 30% of the total urban population. The city of Kathmandu is by far the largest city in the country, with more than 20% of the total urban population, and the second largest city – Biratnagar – has less than one fourth the population of Kathmandu. The population in the valley is increasing at twice the national rate of 2.2% (Table 3.3).

Table 3.3: **Population increase in Kathmandu Valley**

Census Year	Total	Urban	Rural
1920	306,909	-	
1952/54	410,995	196,777	214,218
1961	459,990	218,092	241,898
1971	618,911	249,563	369,348
1981	766,345	363,507	402,838
1991	1,105,379	598,528	506,851
2001	1,581,234	995,966	585,268
2001*	1,581,234	1,210,127	371,107

* Urban population including urbanising VDCs with annual population growth rates >4%
Source: CBS 2002

The rate of urbanisation has increased also due to the migration of people displaced by the insurgency to urban areas and the Kathmandu Valley, as they are considered to be safer. Although reliable figures on the number of internally displaced people are not available, recent data collected in 12 municipalities indicate that the population growth rate has increased from an average of 3.6 to 5.2% per year in these cities.

The rapid urbanisation in Kathmandu is stretching municipal boundaries and converting open spaces and agricultural fields into concrete jungles. Between 1984 and 2000, agricultural land in the valley decreased from 62 to 42%. If this trend continues, by 2025 there will be no agricultural fields left in this once fertile valley. In 1981, three fourths of the residents were involved in agriculture, but, by 1991, this had gone down to one third.

The Municipal Association of Nepal (MuAN) predicts that the Terai region, Kathmandu Valley, and Pokhara will continue to see maximum urbanisation in the foreseeable future (FCM/MuAN 2002). One of the main reasons for the rapid rate of urbanisation is migration from the villages. Extreme poverty, lack of economic opportunities, and, more recently, the insurgency in rural areas, cause many people, especially the young, to migrate to cities in search of opportunities for employment, education, health, and security. According to the 2001 census, over 30% of the people living in cities are migrants. This figure is highest in the large municipalities (populations higher than 100,000), where 37.8% of the people are lifetime migrants, and lowest in the smallest municipalities (populations less than 20,000) where only 12.9% of the people were born elsewhere. Cities with substantial numbers of migrants are Kathmandu (44.1%), Butwal (52.9%), Dharan (46.1%), Bharatpur (45.2%), and Pokhara (33.4%). This indicates that, when people migrate, they tend to migrate to large cities instead of small towns. Thus the large cities will probably continue to grow more rapidly than small towns.

Haphazard growth

Urbanisation itself is not a problem, if it can be managed. In fact, as urban centres are considered to be engines of growth, the process of well-managed urbanisation can result in economic development and increased access to services to more people. In Nepal, however, institutional weaknesses from the perspective of managing urban development have resulted in haphazard growth, manifested in unplanned settlements, increase in vehicular emissions, polluting industries in or near urban areas, traffic congestion, and poor waste management. All of these result in increased air pollution.

Unplanned settlements

The growth of settlements in an unplanned manner tends to reduce population density and increase the need for travel. Similarly, expansion of urban areas without adequate infrastructure and systems for transportation also results in increased congestion and vehicular emissions. Another problem of unplanned growth is the development of incompatible urban forms, such as polluting industries in the middle of residential areas or near environmentally sensitive areas, or establishment of major traffic-generating activities such as long-distance bus parks in city centres. The wholesale fruit market in Kuleshwor, vegetable market in Kalimati, and bus park for Bhaktapur bound busses at Ratna Park are examples of this problem.

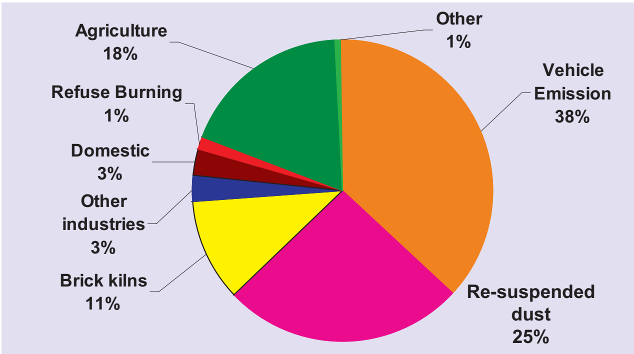
Vehicular emissions

Vehicular emissions have become the main source of air pollution in Kathmandu Valley. An inventory of emission sources by the then Ministry of Population and Environment (MoPE) indicated that exhaust fumes had increased more than four times in the eight years between 1993 and 2001. According to a more recent inventory, vehicular emissions are responsible for 38% of the total PM_{10} emitted in Kathmandu Valley, compared to 18% from the agricultural sector and 11% from brick kilns (Gautam 2006; Figure 3; Table 3.4). Increase in emissions is mainly due to the increase in the number of automobiles, as well as poor transport management and poor vehicle maintenance.

Table 3.4: **Comparison of emission inventories in 1993, 2001, 2005**

Sources	TSP (tons/yr)			PM_{10} (tons/yr)		
	1993	2001	2005	1993	2001	2005
Mobile Sources						
Vehicle exhausts	570	1971	NA	570	3,259	4,708
Road dust re-suspension	1,530	7008	12,239	400	1,822	3,182
Sub-total	*2,100*	*8979*	*12,239*	*970*	*5,081*	*7,890*
Stationary Sources						
Industrial/commercial fuel	582	NA	NA	292	NA	NA
Domestic fuel combustion	2328	NA	630	1,166	NA	347
Brick kilns	5,180	6,676	1,850	1,295	1,688	1,437
Himal Cement	6,000	3,612	0	800	455	0
Stone crushers	NA	NA	1,720	NA	NA	372
Industrial boilers	NA	28	28	NA	15	15
Fugitive Emissions						
Refuse burning	385	687	172	190	339	172
Agricultural sector	NA	NA	NA	NA	NA	2,337
Cremation	NA	NA	158	NA	NA	79
Total	**16,575**	**19,982***	**16,797**	**4,712**	**7,580**	**12,649**

* in original report 19,884
Key: TSP = total suspended particles; NA = not available
Source: Shah and Nagpal 1997; Gautam 2006; MoEST 2005



Source: Gautam 2006

Figure 3: Sources of PM_{10} in Kathmandu Valley

Source: ENPHO

Polluting the environment

Increase in number of vehicles

Out of a total of 472,795 vehicles registered in Nepal by the end of fiscal year 2004/05, 56% (274,805 vehicles) were registered in the Bagmati Zone, most of which covers Kathmandu Valley. In the past five years, the number of vehicles in Kathmandu Valley has been growing at about 12% per year, which is about three times the population growth rate, and this growth is highest in the case of private vehicles such as motorcycles and small cars. The growth in vehicles is shown in Table 3.5. The rapid increase in vehicle numbers, particularly private vehicles, results in traffic congestion and air pollution.

Industrial emissions

About 38% of all industries in Nepal are located in Kathmandu Valley. The records of the Department of Cottage and Small Industries indicate that Kathmandu Valley has 14,791 industries – 10,527 in Kathmandu; 2,933 in Lalitpur; and 13,331 in Bhaktapur. Among these are 111 brick kilns, 89 stone crushers, and 70 industries with boilers (MoEST 2006b). These industries generate stack as well as fugitive emissions directly resulting in air pollution. According to a recent emission inventory, the industrial sector accounts for about 14% of the PM_{10} in the Kathmandu Valley.

Table 3.5: **Vehicles registered in Bagmati Zone**

Types	Bus	Mini bus	Truck/ tanker	Car/ jeep/ van	Pickup	Micro-bus	Tempo	Motorcycle	Tractor	Others	Total vehicles	Growth rate%
1990/91	560	1024	2292	16626	-	-	1854	22359	1156	-	45871	N/A
1991/92	663	1,168	2,631	17,300	-	-	2,186	28,407	1,349	-	53,704	17.1
1992/93	718	1,277	2,950	21,459	-	-	3,844	32,240	1,615	-	64,103	19.4
1993/94	792	1,352	3,343	20,748	-	-	3,844	37,774	1,623	2561	72,037	12.4
1994/95	958	1,388	3,781	22,640	-	-	3,844	43,506	1,635	2678	80,430	11.7
1995/96	1,045	1,430	4,113	22,248	-	-	3,844	49,299	1,670	3,012	86,661	7.7
1996/97	1,163	1,468	4,483	27,153	-	-	3,844	58,029	1,672	3020	100,832	16.4
1997/98	1,298	1,500	4,759	28,915	-	-	3,925	64,142	1,672	3,278	109,489	8.6
1998/99	1,403	1,527	4,811	30,919	-	-	4,262	71,612	1,672	3,311	119,517	9.2
1999/00	1,632	1,610	5,295	35,993	-	-	4,778	94,217	1,672	3,338	148,535	24.3
2000/01	1,744	1,804	5,484	40,674	-	-	4,949	112,000	1,673	3,350	171,678	15.6
2001/02	1,858	2,172	6,274	43,409	-	-	5,073	134,852	1,673	3,356	198,667	15.7
2002/03	2,061	2,378	6,991	45,361	521	232	5,073	156,410	1,677	3,385	224,098	12.8
2003/04	2,214	2,437	7,370	51,541	999	902	5,085	173,646	1,677	3,411	249,282	11.2
2004/05	2,278	2,487	7,607	54,311	999	1,329	5,088	185,593	1,677	3,436	264,805	5.8

Source: Adapted from the Department of Transport Management's records, 2006

Box 1: Burning tyres are injurious to health

Burning tyres is a common form of protest practised by political parties and other groups. Used tyres are readily available and the black smoke released by burning them easily attracts attention and also creates a barrier between the protesters and police. However, most people using this form of protest do not realise the harm they are causing to themselves and others in this process.

Tyres are a consumer product not designed for burning. They are made from natural rubber as well as synthetic rubber consisting of carbon black, extender oils, steel wire, up to 17 heavy metals, other petrochemicals, and chlorine. Burning them emits ultra-fine toxic particles, including metals such as mercury, lead, chromium, beryllium, cadmium, and arsenic, as well as the organic chemicals styrene and 1-3 butadiene. Styrene, a benzene derivative, is a suspected human carcinogen and butadiene also is known to cause cancer in laboratory animals and is a suspected human carcinogen. Studies show a strong association between leukemia and butadiene. Burning tyres also release dioxin which has been recognised by the United States Environment Protection Agency (USEPA) in 1985 as the most potent human-made carcinogen known. Dioxin does not break down in the environment but builds up in the food chain, concentrating in meat and dairy products.

Besides causing immediate air pollution, the fine particles that settle on the ground can pollute groundwater or surface water and can accumulate to toxic quantities in wildlife and degrade the river ecosystem.

Although the Government of Nepal has banned the burning of tyres, this is still a common activity during protests. The public therefore needs to be informed about the health risks associated with the pollution caused by burning tyres, and political parties must take the lead in refraining from burning them.

Emissions from mismanagement of solid waste

Although there has been some improvement in solid waste management in Kathmandu in recent years, waste piles on the streets and burning of waste, both of which cause air pollution, are still fairly common. The situation is especially bad when there is a breakdown in the waste collection system due to strikes or closing of the landfill site.

State

Several studies have shown that Kathmandu's air is densely polluted, particularly in the dry winter months. In the 1990s, projects such as the UNDP-funded Kathmandu Valley Vehicular Emission Control Project (KVVECP), the World Bank-funded Metropolitan Environment Improvement Project (MEIP), and a few NGOs carried out sporadic monitoring at various locations and alerted the government and public to the increasing pollution levels. In 2002, the then Ministry of Population and Environment (MoPE) established six permanent air-quality monitoring stations in Kathmandu Valley (see Table 3.6), and these are monitoring PM_{10} concentrations daily as well as some other key parameters (see Table 3.7).

Table 3.6: **Locations of monitoring stations in Kathmandu**

Location	Classification
Putali Sadak	Urban traffic
Patan Hospital	Urban traffic
Thamel	Urban traffic/residential
Bhaktapur	Urban background
TU, Kirtipur	Urban background
Matsyagaon	Valley background

Table 3.7: **Kathmandu air quality monitoring programme**

Parameter	Methods and Location
PM_{10}	Low volume samplers; 24 hr sampling daily at all 6 stations
$PM_{2.5}$	Since Nov. 2005 at Thamel station, 6 hr campaign performed Nov 05 – Feb 06, since then 24 hr sampling
TSP	High volume sampler at Putalisadak & Patan, one 24 hr sample/ week
CO	Not determined
NO_2	Passive samplers, all stations, monthly sampling
SO_2	Not determined
Benzene	Passive samplers, all stations, monthly sampling
PAH	Campaign monitoring only
Lead	To be determined in 2 samples per station per week

Source: ENPHO

Permanent monitoring station at Tribhuvan University

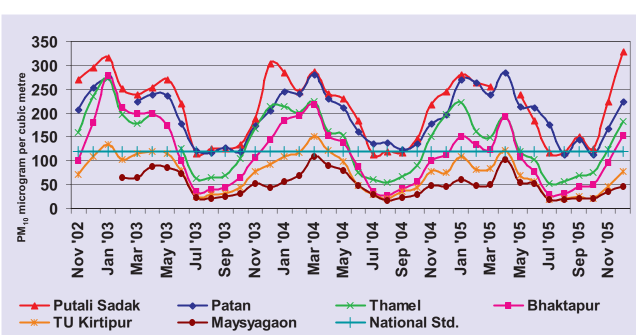
Particulate matter

Air quality data from previous years have shown that a high level of suspended particulate matter (SPM) is a major problem in Kathmandu Valley. Among the particles, the smaller particles such as PM_{10} and $PM_{2.5}$ are of serious concern because they tend to remain in the air for a long time and can enter deep into the respiratory system causing serious health risks to those exposed. Monthly average PM_{10} concentrations measured in the six monitoring stations are shown in Figure 4.

Comparison of 24-hour PM_{10} monitoring data collected by the Environment and Public Health Organisation (ENPHO) from Putali Sadak in 1992 to data collected from the same place ten years later in November 2002 indicates that PM_{10} concentration has tripled over the past decade. Over the past three years, however, the PM_{10} concentration in Kathmandu Valley has stablilised in urban areas of Kathmandu and Lalitpur and has slightly decreased in other areas. The average PM_{10} concentration in Kathmandu Valley went from 132.9 $\mu g/m^3$ in 2003, to 129.2 $\mu g/m^3$ in 2004, and 122.2 $\mu g/m^3$ in 2005 – a decrease of eight per cent in two years (see Figures 4 and 5). This decrease is most significant in the case of Bhaktapur where the average PM_{10} levels fell from 131.0 $\mu g/m^3$ in 2003 to 111.1 $\mu g/m^3$ in 2004 and 96.4 $\mu g/m^3$ in 2005: a decrease of 26.5% in two years. In the roadside stations at Putali Sadak and Patan Hospital, however, the PM_{10} concentration increased by 4.5% over the same period.

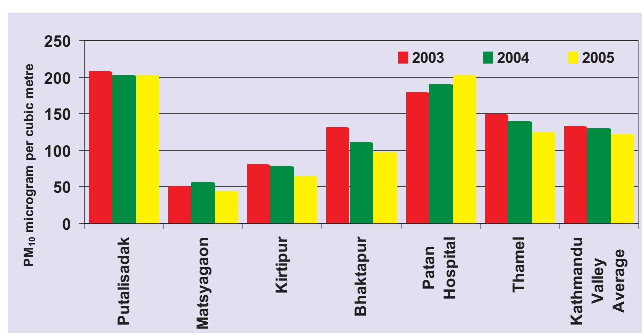
The following conclusions can be drawn from these results.

1. Among the six areas monitored, Putali Sadak is the most polluted. This is mainly because of the dense traffic in this area and the fact that tall buildings on either side of the road tend to have a canyon effect which does not allow pollutants to disperse.
2. In the dry winter months, the PM_{10} levels in Putali Sadak are above the national standard for 99% of the time. With the arrival of monsoon rains in mid-June, the PM_{10} decreases significantly, but is still above national standards on most days.
3. The air is significantly better in Kirtipur (on the west side of the valley) than in Bhaktapur (on the east side of the valley). This is probably due to the westerly winds taking pollutants from Kathmandu over to Bhaktapur.
4. There is significant seasonal variation in the level of PM_{10}. The PM_{10} level is highest in January, which is the peak of the dry winter season, and is lowest in July, the peak of the monsoon season. During the monsoon, rains flush down the particles in the air significantly reducing pollution levels, while, in the winter, temperature inversion causes air pollution to rise. In January 2003, the average PM_{10} concentration in Kathmandu Valley was 255.6 $\mu g/m^3$, but six months later in July 2003 the level had dropped to 64.2 $\mu g/m^3$. An additional factor that keeps the pollution level low during the monsoon is that the polluting brick kilns in



Source: MoEST 2005

Figure 4: Monthly average PM_{10} concentrations in Kathmandu



Source: MoEST 2005

Figure 5: Reduction in annual average PM_{10} in Kathmandu (2003-05)

Kathmandu usually do not operate during the monsoon. The seasonal variation is especially high in Bhaktapur which is surrounded by brick kilns and is located down wind from Kathmandu.

- In Kathmandu, the following data clearly indicate that vehicles are the main source of air pollution.
- Areas with heavy traffic (Putali Sadak and Patan Hospital) are the ones that are most polluted.
- Pollution levels drop on weekends when there are fewer vehicles on the road. The average PM_{10} level on the five weekends (Saturdays and Sundays) in May 2003 on Putali Sadak was 219.4 $\mu g/m^3$. However, in the same month, the average PM_{10} concentration on weekdays (Monday to Friday) was 290.4 $\mu g/m^3$, and this is 32% higher than the concentration on weekends.

5. Pollution levels are very low during 'Nepal Bandh' days (general strikes) when there are almost no vehicles on the road. When there was a Nepal Bandh on April 23, 2003, the PM_{10} level dropped by 30% from 332 to 231 $\mu g/m^3$ and then went up to 284 $\mu g/m^3$ again the next day.
6. Although the number of vehicles in Kathmandu Valley has increased by about 12% a year in the past two years, the PM_{10} concentration in roadside areas has only increased by about 2.2% per year. This may be because the newer vehicles that are coming on the streets of Kathmandu are of EURO I standard and therefore are less polluting than the older vehicles.
7. The 26.5% improvement in air quality in Bhaktapur area between 2003 and 2005 is probably because of the introduction of cleaner brick kiln technology, as most of the brick kilns in Kathmandu Valley are located around Bhaktapur. The fact that much of the improvement has come in the winter months when the brick kilns are in operation also indicates that the government's decision to ban the old bull trench kilns and introduce cleaner fixed chimney kilns and vertical shaft brick kilns has had positive impacts on air quality.

$PM_{2.5}$ is considered to be more hazardous than PM_{10}. Although Nepal does not have any standards for $PM_{2.5}$, some monitoring has been carried out for $PM_{2.5}$ in Kathmandu Valley. $PM_{2.5}$ monitoring in Patan Hospital area and Bhaktapur indicates that more than 60% of the PM_{10} is $PM_{2.5}$. The relatively high $PM_{2.5}$:PM_{10} ratio indicates a significant contribution from combustion sources such as vehicle emissions (Figure 6).

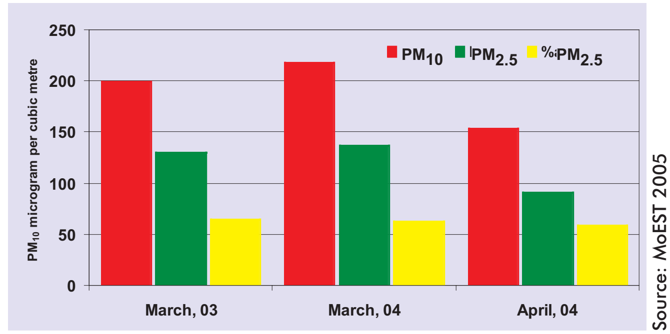


Figure 6: Monthly average PM_{10} and $PM_{2.5}$ in Bhaktapur

Gaseous pollutants

The concentration of NO_2 and SO_2 are generally within the national standards of 40 and 50 $\mu g/m^3$ respectively. NO_2 levels are generally higher in areas with heavy traffic, because vehicles are the main source of NO_2. The SO_2 levels tend to be higher in Bhaktapur, because of the brick kilns in the area which burn high sulphur coal. Data from the winters of 2003/04 and 2004/05 indicate that there has been a slight increase (14.8%) in NO_2 levels in the roadside stations of Putali Sadak and Patan Hospital, while levels have remained constant in urban residential areas (Thamel) and valley background stations (Figures 7,8,9).

Air toxins

Benzene – Benzene is a toxic pollutant of serious concern. The main source of benzene in the air is the benzene mixed in gasoline that is emitted from the fuel and vehicles. Monitoring of benzene in January-February 2002 indicated very high levels of benzene concentration, particularly in roadside areas – up to 77 $\mu g/m^3$ in Putali Sadak. Since then, however, the benzene

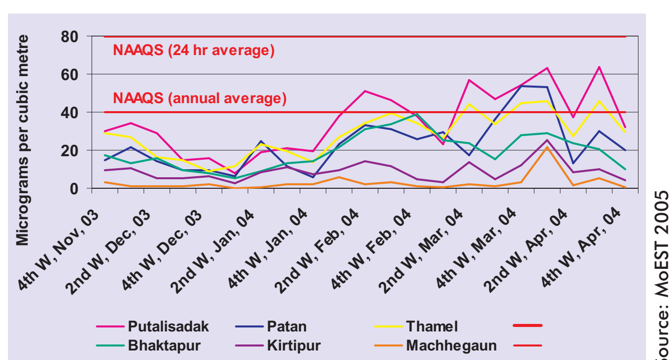


Figure 7: NO_2 concentrations in Kathmandu Valley,weekly averages in 2003/04

level has remained within the national standard of 20 µg/m³. This is probably due to the reduction in benzene concentration in petrol. The average monthly benzene concentrations measured at the six monitoring stations are shown in Figure 10.

Polycyclic Aromatic Hydrocarbons – Polycyclic Aromatic Hydrocarbons (PAH) are toxic compounds that are mainly formed during combustion. The concentrations of PAH at the monitoring stations were measured by MoPE several times in 2003 and the results showed that PAH concentration in Kathmandu may be a concern (see Figure 11). Although Nepal does not have standards for PAH, the concentration in Kathmandu is much higher than European norms. More monitoring of PAH concentration is required to confirm the findings. Diesel exhausts are a major source of PAH.

Impact

Many studies have shown that air pollution has significant impacts on human health. As the most common route for pollutants to enter the human body is by inhalation, the most common health effect of air pollution is damage to the respiratory system. Exposure to air pollutants can overload or break down natural defence mechanisms in the body, causing or contributing to respiratory diseases such as lung cancer, asthma, chronic bronchitis, and emphysema. Recent studies have also indicated that air pollution can also have adverse impacts on other important systems such as the cardiovascular system and central nervous system (Lahiri 2003). Among air pollutants, fine particles are particularly dangerous because they can become embedded in the human body and they are often coated with toxic substances. As the concentration of fine particles in Kathmandu is very high, this is certainly having adverse impacts on public health. Other impacts of air pollution are the economic impacts due to adverse effects on tourism and loss of human productivity because of poor health.

Health impacts from Kathmandu's air pollution

Although there are no long-term epidemiological studies on the impacts of Kathmandu's air pollution, a few studies have carried out preliminary medical examinations of groups of the exposed population or used dose-response relationships that have been developed elsewhere. These indicate that the health impacts of Kathmandu's air pollution can be quite severe.

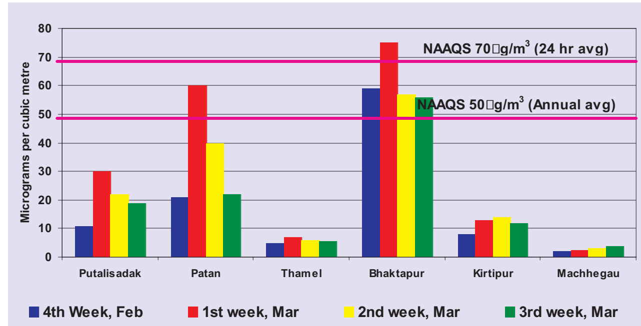


Figure 8: SO_2 concentrations in Kathmandu Valley (Feb-March 2003)

Source: MoEST 2005

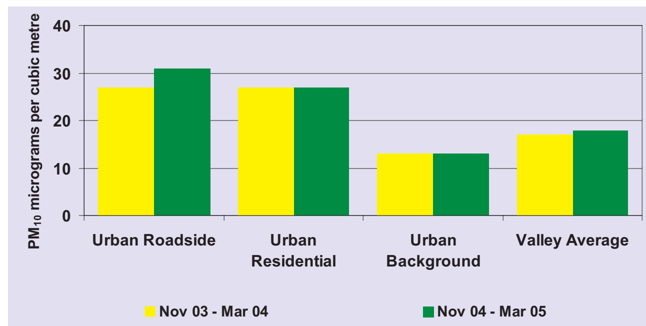


Figure 9: NO_2 concentrations in 2003/04 and 2004/05

Source: MoEST 2005

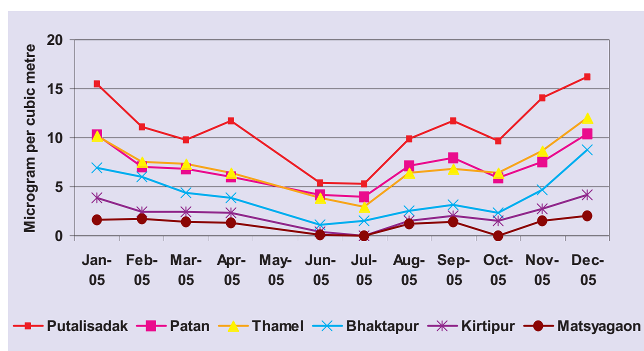


Figure 10: Benzene concentrations in Kathmandu Valley

Source: MoEST 2005

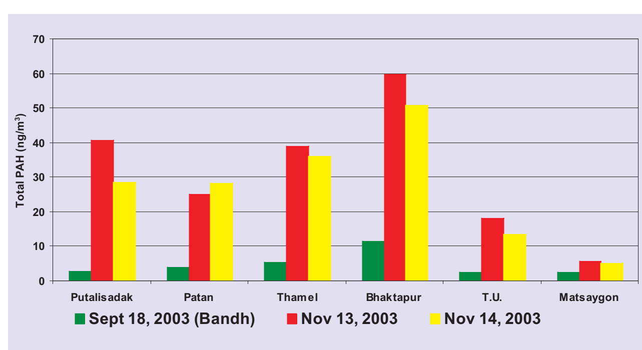


Figure 11: PAH concentrations in Kathmandu Valley, 2003

Source: MoEST 2005

The first study to examine the health effects of Kathmandu's air pollution used dose-response relationships developed from research in the US, and combined it with estimated frequency distribution of PM_{10} exposure in Kathmandu Valley in 1990 to estimate impacts on mortality and morbidity due to PM_{10} (Shah & Nagpal 1997). Although the use of these functions involves many assumptions and the results can only be speculative at best, it does provide some preliminary figures. The findings of the health impact study are presented in Table 3.8.

The study indicated that the PM_{10} in Kathmandu's air has a major impact on respiratory diseases such as bronchitis in children, chronic bronchitis, and asthma attacks. Chronic bronchitis can lead to chronic obstructive pulmonary disease (COPD).

In 1993, an analysis of the records of all patients admitted to Patan Hospital found that in six years (1985 to 1991), the proportion of admissions for COPD as a percentage of the total number of medical patients had tripled. In 1984-85 the proportion of COPD patients was 5.1% but, in 1991, it had increased to 15.2% (Zimmerman 1993).

A few years later a more rigorous analysis of the records of 369 COPD patients and 315 control patients admitted to Patan Hospital from April 1992 to April 1994 found that the odds of having COPD are 1.96 times higher for Kathmandu Valley residents than for residents outside the valley (Zimmerman 2003; personal communication). An unpublished report of the study stated that over the past decade the proportion of COPD patients had increased more than four fold and that COPD was the number one killer of adult patients in the hospital.

Table 3.8: **Health impacts of PM_{10} in Kathmandu Valley in 1990**

Types of Health Impact	No. of Cases	Value (NRs.)	
		Specific	Total (x 10^3)
Excess Mortality	84	340,000	28,644
Chronic Bronchitis	506	83,000	41,988
Restricted Activity Days	475298	56	26,617
Emergency Room Visit	1945	600	1167
Bronchitis in Children	4847	350	1,697
Asthma Attacks	18,863	600	11,318
Respiratory Symptom Days	1,512,689	50	75,634
Respiratory Hospital Admissions	99	4160	415
Total			**187,480**

Source: Shah and Nagpal 1997

In 1997, Child Workers in Nepal surveyed 60 children working as conductors on three-wheelers in Kathmandu and examined the health of 38 of them. The study found that most of the children suffered from eye problems (84%), chest pains (82%), and headaches (58%). Similarly, 66% suffered from coughs, colds, and problems with the upper respiratory tract, and 45% experienced difficulty in breathing (CWIN1997).

Shakya (2001) carried out a questionnaire survey of 90 traffic police and observed them in the field. The study found that most of the policemen suffered from problems with the respiratory and nervous systems.

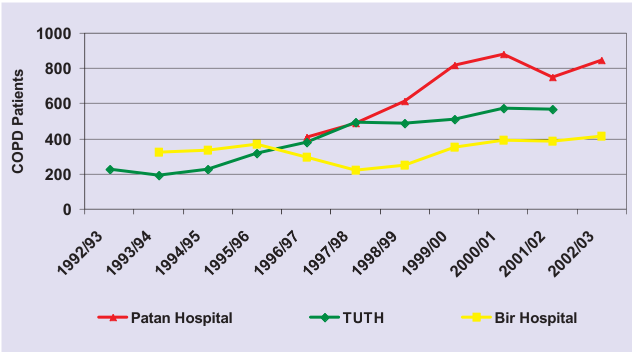
Clean Energy Nepal (CEN) carried out a questionnaire survey of people living near brick kilns and in a control area, and also examined the health of more than 100 children living near brick kilns and in a control area. Out of 290 individuals surveyed, 54% from the area with brick kilns reported symptoms of respiratory disorders compared to 41% in the control area. Similarly, the health examination clearly indicated that young children living in areas with brick kilns suffered from more problems associated with the upper and lower respiratory tracts (Tuladhar and Raut 2002).

Records from major hospitals in Kathmandu Valley also indicate that the number of COPD in-patients in Kathmandu Valley's hospitals has increased significantly over the past 10 years (Figure 12). The increase is most significant in Patan Hospital where the number of COPD patients more than doubled within a period of six years from 407 patients in 1996/97 to 849 patients in 2002/03. In Tribhuvan University Teaching Hospital (TUTH), the number of patients more than doubled from 225 in 1992/93 to 568 in 2001/02.

The records also indicate that COPD patients as a percentage of the total medical patients have also increased over the years (Figure 13). This indicates that the increase in the number of COPD patients is not just because of the overall increase in the number of patients.

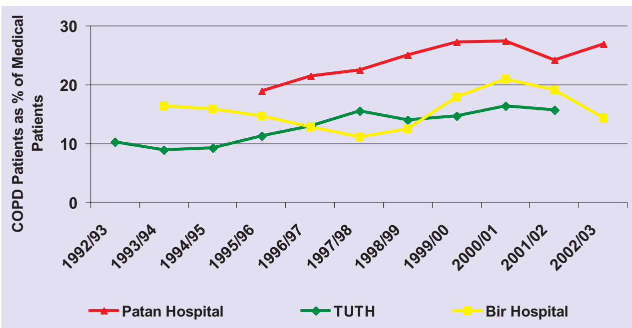
Hospital records and interviews with doctors also clearly indicate that the number of COPD patients admitted to hospitals is highest in the winter season when the air pollution is also at its peak (Figure 14).

Using dose-response functions, CEN/ENPHO (2003) estimated that reducing $PM_{2.5}$ levels in Kathmandu Valley by just half would reduce daily mortality by seven per cent and hospital admissions by 24%. Similarly,



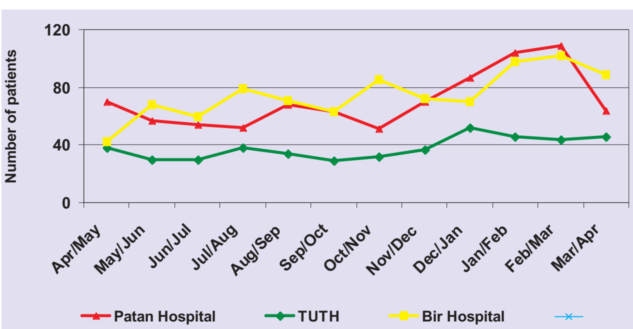
Source: CEN/ENPHO 2003

Figure 12: Number of COPD patients in major Kathmandu hospitals



Source: CEN/ENPHO 2003

Figure 13: COPD Patients as a percentage of total medical patients



Source: CEN/ENPHO 2003

Figure 14: Number of COPD patients admitted to major hospitals in 2002/03 (2059)

reducing the annual average PM_{10} level in Kathmandu to international standards (50 µg/m^3) would avoid over 2,000 hospital admissions, over 40,000 emergency room visits, over 135,000 cases of acute bronchitis in children, over 4,000 cases of chronic bronchitis, and half a million asthma attacks. Overall this means over five million restricted activity days and 32 million days with respiratory problems would be avoided.

A recent study carried out by the Ministry of Environment, Science and Technology (MoEST) estimates that Kathmandu's air pollution results in approximately 1,600 premature deaths per year (MoEST 2005).

Economic impacts

Valuation of health impacts. The first attempt to calculate the value of the health effects of Kathmandu's air pollution was the World Bank study (Shah and Nagpal 1997). The study estimated the health impacts of PM_{10} in Kathmandu and also attempted to calculate the value of these impacts. The study estimated that the total cost of the health impacts of PM_{10} in Kathmandu in 1990 was approximately Rs. 210 million. Since then the number of vehicles has increased six times and the PM_{10} concentration has tripled. Similarly, the number of people exposed to air pollution has also increased significantly due to urbanisation. Therefore the economic value of health impacts must have increased severalfold since then.

CEN/ENPHO (2003) estimated that the avoided cost of hospital treatment by reducing Kathmandu's PM_{10} levels to international standards was about Rs. 30 million. However, this is not the entire cost of the health impacts of Kathmandu's air pollution, because it does not include the cost of emergency room visits, restricted activity days, respiratory symptom days, treatment at home, and excess mortality.

Impacts on tourism. The high level of air pollution can negatively impact tourism as tourists, especially those with respiratory illnesses, do not want to be exposed to high concentrations of pollutants. A survey of 1,702 tourists leaving Kathmandu indicated that air pollution was the number one area in which tourists thought improvement was required (CEN/ENPHO 2003). Even tourism entrepreneurs and local people living in tourist areas feel that the air pollution is having adverse impacts on tourism. A recent survey of 299 Thamel residents found that 94% of the respondents felt that tourists shorten their stay in Thamel because of environmental problems such as air pollution.

The atmospheric data obtained from Kathmandu airport from 1970 onwards show that there has been a substantial decrease in visibility in the valley since 1980: the number of days with good visibility (>8,000m) around noon decreased in the winter months from more than 25 days/month in 1970 to five days/month in 1992 (Shah and Nagpal 1997). As most tourists come to Nepal to see mountains, the reduced visibility will affect tourism. As tourism is a major industry in Nepal, any adverse impact on tourism will affect the economy of Kathmandu as well as the country as a whole.

Source: P. Dangol

Haze masking the mountains

Source: B.B. Pradhan

Clear day showing the mountains

Response

Key stakeholders

Several agencies within the government and several other stakeholders are involved in air quality management. Some of the key agencies and their responsibilities are shown in Table 3.9.

Over the years, various stakeholders have introduced positive steps to control air pollution in the valley (Table 3.10). The government response includes banning the use of polluting vehicles such as diesel three-wheelers and polluting Moving Chimney Bulls' Trench Kilns. The government has also established vehicular emission standards and ambient air quality standards. Private sector initiatives have primarily been limited to operation of public transportation, including electric vehicles.

The Himal Cement Factory, which had been spewing hazardous soot and dust in the air for 25 years, has been closed down. One of the main factors for the closure

Box 2: Environmental improvements in Kathmandu's brick industry

Brick manufacturing is a major source of air pollution in Kathmandu Valley. According to an inventory made in 1993, the industry was responsible for about one third of the PM_{10} in Kathmandu Valley. Since 2004, however, the brick industry has gone through a major transformation as the whole industry switched over from the polluting Moving Chimney Bull Trench Kilns to cleaner Fixed Chimney and Vertical Shaft Kilns. This transformation of Kathmandu's brick industry has resulted in significant improvements in the Valley's air quality. The PM_{10} concentration in Bhaktapur, a town that is surrounded by brick kilns, went down by 26% between 2003 and 2005.

Source: VSBK Programme

The improvement in the brick industry first started with local people, who were the victims of the pollution from brick kilns, raising their voices against the pollution. In the late 1990s, several local groups in areas such as Jhaukhel in Bhaktapur and Tikathali in Lalitpur started raising the issue of pollution from brick kilns with local government authorities as well as with industrialists through letters, meetings, and protests. Later they were supported by local NGOs carrying out more scientific studies to justify their claims. Clean Energy Nepal (CEN),for example, carried out air quality monitoring and health studies among children in areas with and without brick kilns. The studies found that the pollution levels in areas with brick kilns were about three times higher than in control areas and children studying in a school near brick kilns in Tikathali suffered more from respiratory problems than similar children from a control area.

These results of the environmental and public health studies and the persistent and passionate agitation by local communities were highlighted by the local media, which added fuel to the fire. Continuous pressure from the local communities and NGOs finally forced the government to take action against the brick kilns. Initially several illegal kilns were shut down and later the government took the bold decision to completely ban moving chimney bulls' trench kilns. Although the implementation of the decision was delayed by a year, the government went ahead and implemented the decision in spite of pressure from industrialists. At the same time, DANIDA and SDC supported by demonstrating cleaner technologies for brick production. Ultimately the industrialists agreed to shift to a new technology. Thus the combined efforts of local communities, NGOs, government, donor agencies, and industrialists resulted in a drastic change in an entire industry and improved air quality in Kathmandu Valley.

Table 3.9: **Key stakeholders in air quality management**

Stakeholders	Responsibility
Government agencies	
MoEST	Responsible for formulating air quality related policies and programmes Recently implemented a project on Air Quality Management in Kathmandu, one of the components of the DANIDA supported ESPS Currently monitoring air quality in Kathmandu Valley through six monitoring stations that are being managed by the Environment and Public Health Organisation (ENPHO)
MoLTM	Responsible for formulating policies on transport management
MoICS	Responsible for formulating policies related to industrial development
DoTM	Responsible for transport management, including issuing of route permits to public transport vehicles and testing emissions from vehicles
Traffic Police	Responsible for traffic management and on-the-spot emission testing
DSCS	Responsible for promoting and monitoring small and cottage industries, including brick kilns
DoI	Responsible for promotion and monitoring of industries
Municipalities	Responsible for urban environmental management
Nepal Oil Corporation	Responsible for supplying petroleum products and ensuring quality control
Private organisations	
Various Transport Associations	Responsible for operating public transportation and representing the interests of various public transport operators
Electric Vehicle Association of Nepal (EVAN)	An umbrella organisation for EV manufacturers, owners/operators, and charging station managers
Nepal Automobile Dealers Association (NADA)	Represents the interests of vehicle importers
Industrialists	Owners of various industries including limited vehicle manufacturing
Federation of Nepalese Chambers of Commerce and Industry (FNCCI)	Umbrella organisation of the private sector
NESS	Conducts air quality monitoring and environmental studies
Non-government organisations	
Clean Air Network Nepal (CANN)	A network of professionals involved in air quality management. CANN is also the local network for Clean Air Initiatives for Asian Cities (CAI-Asia).
ENPHO	NGO involved in conducting monitoring, research and education campaigns on air quality, solid waste management, pollution control and other aspects of environmental management.
CEN	Involved in research-based education and advocacy campaigns
NEFEJ	Forum for Environmental Journalists
International organisations	
DANIDA (Danish aid)	Implemented ESPS from 2000 to 2005 which included components on air quality improvement, industrial pollution prevention, and control and institutional strengthening.
ICIMOD	Implementing transboundary air pollution projects on Malé Declaration and Project Atmospheric Brown Cloud
SDC (Swiss aid)	Implementing a project to promote clean brick kiln technology
UNEP	Support to Implement Projects on Malé Declaration and Project Atmospheric Brown Cloud
ADB	Implementing a project on Urban and Environmental Improvement in eight towns. Clean Air Initiative for Asian Cities (CAI-Asia), a joint ADB and World Bank programme provides some support for air quality management
Kathmandu Electric Vehicle Association (KEVA)	Promoting electric vehicles

Table 3.10: **Steps taken to improve Kathmandu's air quality**

Year	Action	Year	Action
Government		**Private sector**	
1991	Ban on import of new three-wheelers	Since 1996	Electric vehicle entrepreneurs have invested more than Rs. 450 million in building and operating more than 600 electric three wheelers.
1995	Introduction of in-use vehicle emission standards and emission testing of vehicles	2006	Hulas Motors has developed a proto type for an electric four-wheeler van
1996	Financial incentives for electric vehicles		
1997	Environment Protection Act and Regulations	**Municipalities**	Public awareness and infrastructural development
1999	Import of unleaded fuel		
1999	Removal of over 600 diesel three-wheelers from Kathmandu	**NGOs**	Air quality monitoring and research
1999	Ban on the import of new two-stroke three wheelers		Public awareness and advocacy campaigns
2000	Introduction of EURO I equivalent norms for new vehicles		Development of an electro-bus
2002	Establishment of six permanent monitoring stations in Kathmandu	**International organisations**	
2003	Introduction of National Ambient Air Quality Standards	2000-05	DANIDA assisted ESPS project set up air quality monitoring stations, promoted electric vehicles, and promoted cleaner vehicles in industries.
2004	Two-stroke three wheelers removed from Kathmandu	2002-06	Winrock International, together with other partners of KEVA, promoted electric vehicles through technical support and advocacy.
2004	Moving Chimney Bull Trench Brick Kilns banned from Kathmandu	Since 2003	SDC is promoting Vertical Shaft Brick Kilns.

being the public pressure of the community residing near the factory, environmental groups, and media. This is one example of civil society's involvement in cleaning the air.

However, in spite of the positive steps taken so far, the high level of pollution in the valley clearly indicates the need for more action. One of the problems has been that the actions have not been carried out in a well-planned and coordinated manner and the overall system for managing air quality is still weak. The government, together with all key stakeholders, should therefore develop a time-bound integrated action plan and take bold action to implement the plan. As the government has already banned the highly-polluting Moving Chimney Bull Trench Kiln technology that was predominantly used in the valley's brick industry, the focus of future air quality improvement programmes should be on controlling vehicle emissions.

International support for AQM

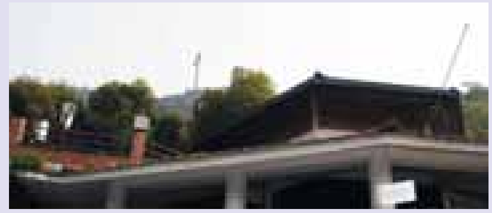
The recently concluded Environment Sector Improvement Programme (ESPS) implemented by MoEST and MoICS with support from Danish International Development Assistance (DANIDA) from 1999 to 2005 has been the main internationally-supported project on air quality improvement in Kathmandu Valley. The project included the following five components.

- Institute of Environmental Management
- Cleaner Production in Industry
- Wastewater Management in Hetauda Industrial District
- Institutional Strengthening of Environmental Authorities
- Air Quality Management in Kathmandu Valley

The component on Air Quality Management in Kathmandu Valley was implemented from 2001 to 2005. Some of the main achievements of the project were establishment of six air quality monitoring stations in Kathmandu Valley and a Vehicle Anti Pollution Programme (VAPP). The challenge now is to continue operating the monitoring stations and VAPP in a sustainable manner and use the results obtained from the monitoring stations for planning and implementing AQM programmes. DANIDA had plans to follow up the Environment Sector Programme Support (ESPS) project with a second phase but that was terminated following the political developments in February 2005. Now in the changed political scenario, although DANIDA has not yet decided to support air quality management once again, if there is strong interest from the government, the support may be forthcoming.

Box 3: Project ABC

The Indian Ocean Experiment (INDOEX) carried out in February 1999, in the islands of the Maldives, revealed that a 3km-thick toxic umbrella of Brown Cloud stretches over Afghanistan, Pakistan, Bangladesh, Bhutan, India, Maldives, Nepal, and Sri Lanka, which are among the most densely populated places in the world. The finding comes from observations gathered by more than 200 scientists supplemented by satellite readings and computer modeling.



The Brown Cloud (haze) puts millions of people at risk not only for various respiratory diseases but also for severe natural disasters as weather patterns are radically altered and become more extreme and unpredictable.

The long-range transport of the haze was an important finding. Cooperation across international boundaries is required to understand the environmental impacts of the haze and for effective mitigation measures.

In response to this, Project ABC was launched with a network of observatories in more than 10 countries. In Nepal, the observatory is in Kathmandu and is known as Nepal Climate Observatory. Radiation measurements are taken at ICIMOD headquarters, Khumaltar, and various aerosol parameters are measured at Godavari. This initiative jointly taken by the Ministry of Environment, Science and Technology (MoEST) and International Centre for Integrated Mountain Development (ICIMOD) with the support of UNEP and Scripps institute of Oceanography provides an excellent example of generating a scientific base to tackle haze and air pollution related problems in a landlocked country with a complex topography of mountains and valleys.

Compiled by B.B. Pradhan

The United Nations Environment Programme's Regional Resource Centre for Asia and the Pacific (UNEP RRC.AP) is supporting two important international projects related to air pollution: The Malé Declaration on Control and Prevention of Air Pollution and Its Likely Transboundary Effects for South Asia and Project Atmospheric Brown Cloud (ABC). The Malé Declaration, now in its third Phase, is looking at the impact due to air pollution on health, crops, and materials. Racks containing various materials of copper, zinc, limestone etc. are placed strategically to study corrosion rates due to air pollution in materials.

Kathmandu Electric Vehicle Alliance (KEVA) was implemented by Winrock International, Padco, City of San Francisco, and Electric Drive Association from 2002 to 2006 with support from the United States Agency for International Development (USAID). The project assisted in policy lobbying and improving technology as well as management of electric vehicles. The project also assisted Hulas Motors in developing a four-wheeler electric van. Although KEVA has been requesting USAID and other potential funding agencies for additional funds to continue the project, these are not yet confirmed.

Swiss Development Cooperation (SDC) is providing technical support to promote Vertical Shaft Brick Kilns (VSBK) because they are energy efficient and environmentally friendly. So far, three such kilns have been established in Kathmandu Valley and a few are being set up outside the valley. Although the project has been promoting VSBK for the past three years, only a few entrepreneurs have invested in the technology because it is more expensive than the Fixed Chimney Kilns which are more popular. The government should therefore support the promotion of VSBKs through tighter emission standards and incentives.

An institutional framework for air quality management

As air quality management is a multidisciplinary issue, it requires the involvement of many organisations from the central government to local government, the private sector, and NGOs. The roles and responsibilities of various organisations need to be clear and there needs to be proper coordination among these organisations. However, one of the main constraints to air quality management in Nepal has been the lack of a clear and effective institutional framework. The current institutional set-up for air quality management is presented in Figure 15. The framework shows that air quality management responsibilities are mainly shared by three ministries – Ministry of Industry, Commerce & Supplies (MoICS); Ministry of Environment, Science, and Technology (MoEST), which is mainly responsible for environmental protection; and the Ministry of Labour and Transport (MoLT) which is mainly responsible for transport management. Besides these ministries and the various departments within these ministries, other institutions such as municipalities, which are under the Ministry of Local Development (MoLD), and the Traffic Police, under the Home Ministry, also have AQM-related functions. Figure 15 shows many boxes but few linkages between these boxes, clearly indicating the lack of coordinating mechanisms within this framework. The Environment Protection Council (EPC), under the chairmanship of the Prime Minister, is a high-level body that could help in coordinating, but the EPC has not met at all in the past eight years. Therefore coordination among key agencies is a challenge for managing Kathmandu's air quality.

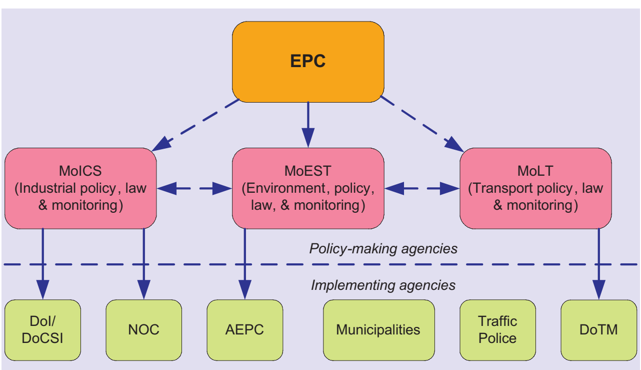


Figure 15: Institutional framework for air quality management in Kathmandu

Policy and legal framework for air quality management

Although Nepal does not have a separate policy on air quality management, some existing policies do address this issue. As these policies are either general policies of the government of Nepal (GoN) or specific policies related to environment, transportation, or industries, they touch upon air quality but do not address it in a comprehensive manner. Some of the key national policies related to air quality management are presented in Table 3.11.

Table 3.11 clearly indicates that several policy documents have touched upon air quality management and some, such as the National Transport Policy, 10th Plan, and the Sustainable Development Agenda, include specific policy statements aimed at ensuring that all citizens have access to clean air. However, there seems to be a clear gap in policy statements and implementation of policies. For example, all Five-Year Plans ever since the 6th Plan have mentioned that the trolley bus system will be expanded. But so far nothing has been done to expand the system; and it has in fact decreased in size. Although the 10th plan has also mentioned expansion of the trolley bus system, this is mentioned as a low priority activity. Similarly, several policy documents clearly mention the need to promote zero emission electric vehicles; but there are no specific plans or programmes to achieve this. Therefore, there is an urgent need to develop and implement plans and programmes to implement these policies.

Legislation

Unlike most other countries, Nepal does not have a separate Act dedicated to managing air quality. However, the Environmental Protection Act and Regulations (1997) have some provisions related to pollution control and the Act also has provisions for the formulation of separate regulations under the Act to deal with specific issues. Some of the key legislative measures are mentioned in Table 3.12.

Table 3.12 shows that legislation related to air quality spread over several Acts and Regulations. Considering the growing problem of air pollution, the complex nature of the problem, and the urgent need for effective action in areas such as Kathmandu Valley, amending some of these legislations and a comprehensive Clean Air Act are essential.

Plans and programmes to combat air pollution in Kathmandu Valley

Plans have been prepared to tackle Kathmandu's air pollution. The World Bank funded URBAIR programme prepared the first action plan for managing Kathmandu's air pollution (Shah and Nagpal 1997). In 2005 IUCN Nepal prepared comprehensive policy guidelines for air quality management (Tuladhar et al. 2005) and a Regional Technical Assistance Programme of ADB prepared a strategy and action plan for air quality management (Giri 2005). Recently, MoEST, through its own efforts, has prepared a draft action plan for air quality management in Kathmandu Valley. The plan aims to meet the National Ambient Air Quality Standards (NAAQS) within five years.

MoEST's latest plan is comprehensive, covering all the main issues such as vehicular emissions, industrial pollution, refuse burning, and land-use planning, and its target of meeting the NAAQS in five years is also reasonable. However, as the plan has a long list of activities covering various sectors, the activities need to be prioritised, and a serious effort made to implement them. Some of the activities mentioned in the plan are quite simple and can be carried out quickly with limited resources, while others require major decisions. The challenge now is to implement the plan in order to improve the air quality in the valley.

Table 3.11: **National policies related to air quality management**

Policy	Description
National Conservation Strategy, 1987	This was the first environment-related policy of the GoN. It mentions the problem of air pollution in urban and industrial areas and highlights the need for Environmental Impact Assessment of proposed projects.
Industrial Policy, 1992	The policy, which aims to promote industrial activities, also mentions the need to minimise adverse environmental effects during establishment, extension, and diversification of industries. The policy also calls for the formulation and implementation of guidelines to control pollution and tax benefits for investments in activities related to pollution control.
Nepal Environmental Policy and Action Plan (NEPAP), 1993	NEPAP recognises the need to address urban and industrial pollution and calls for appropriate legal and institutional mechanisms. It also stresses the need for EIA
National Transport Policy, 2001	The policy has the following provisions related to air quality. ▪ Construction, repair and maintenance of road infrastructure in the context of traffic safety and environmental worthiness ▪ Expand the use of electric vehicles throughout the country. ▪ Make public transport safe, reliable, pollution free and easily accessible to the general public. ▪ Limit the traffic density and movement of vehicles to acceptable levels as per land use and carrying capacity. ▪ Mandatory for vehicles to have appropriate Axle Load Systems (ALS) ▪ Mandatory for vehicles to have roadworthiness certificates ▪ Ban on import of older vehicles ▪ Develop standards for repair and maintenance and road permits. ▪ Tax and customs' rebates for pollution-free vehicles
10th Five Year Plan 2002-07	Strategies, policies, and programmes related to the environment ▪ The responsibility of checking vehicle emissions will be given to municipalities. ▪ Formulate and enforce environmental standards. ▪ Collect pollution fees and establish an Environmental Conservation Trust. ▪ Develop and implement a Sustainable Development Agenda for Nepal ▪ Pollution control and raising public awareness have been identified as priority programmes in the environmental sector. Strategies, policies, and programmes related to transport management ▪ Make transport systems reliable, safe, pollution free, and service-oriented. ▪ Reduce pollution from vehicles in Kathmandu and other urban centres ▪ Enforce Nepal Vehicle Emission Standards, 2056. ▪ Increase public awareness on vehicle emission. ▪ Promote railway and trolley buses through public-private partnerships.
Sustainable Development Agenda for Nepal, 2003	"Every citizen has access to …clean air" is one of the broad goals of Nepal's Sustainable Development Agenda. Section 5.2.5 of the Agenda mentions both indoor and outdoor air pollution. The 15-year objectives include the following. ▪ Setting strictly enforced ambient air quality standards, exceeding which requires immediate cuts in activities responsible for emission. ▪ Encourage shift towards zero-emission vehicles and cleaner fuel in industries. ▪ Create conditions that foster the growth of domestic institutions for research and monitoring local as well as transboundary air pollution. ▪ Promote cleaner stove technology and alternative cooking fuels.
Interim Constitution 2007	Recognises a clean environment as a fundamental right.

Table 3.12: **Legislation related to air quality management**

Legislation	Provisions
Industrial Enterprises Act, 1992	▪ In Section 15, manufacturing industries dealing with energy efficiency and conservation and pollution abatement have been declared 'nationally prioritised' industries and can receive tax rebates of up to 50% of the taxable income
Vehicle and Transport Management Act, 1993	▪ Section 17 makes road worthiness certificatess mandatory, for which vehicles have to comply with the standards prescribed in Section 23 that deal with the following parameters. • Mechanical condition of the vehicle • Emission from the vehicle • Vehicle length, width, height, construction, and appearance • Age of the vehicle ▪ Under Section 23, the government has set standards for emission from in-use vehicles. ▪ Sections 24 and 40 mention the right to refuse registration of a vehicle not complying to standards and certificate provisions. ▪ Section 39 requires prior permission to change specification or fuel types. ▪ Sections 74, 75, 78 and 93 deal with transport management and the public transport system
Environment Protection Rules, 1997	▪ Rule 15 prohibits emission of noise, heat, radioactive material, and waste from any mechanical means, industrial establishment, or any other place in contravention of the standards prescribed by the Ministry. ▪ Rule 16 make it manadatory for 55 different types of industry listed in Annex 7 of the Regulations to obtain Pollution Control Certificates. This has not yet been carried out because of some confusion about how it is to be done.
Environment Protection Act, 1996	▪ Section 7 deals with 'Prevention and Control of Pollution' and restricts people from causing pollution that will have adverse effects on environment and public health. ▪ Section 8 has a provision for the appointment of Environmental Inspectors to carry out inspection and examinations and stop activities that cause pollution. However, Inspectors have not yet been appointed. ▪ Section 15 has a provision to provide additional concessions and facilities to encourage any industry, enterprise, technology, or process that causes positive impacts on environmental protection. ▪ Section 21 allows the ministry to devolve any of its responsibilities to other government agencies. ▪ Section 23 empowers the GoN to frame and implement necessary guidelines under the Act for environmental protection. ▪ Section 24 empowers the GoN to frame necessary rules related to pollution control and standards.
Fiscal Act, 2003/04	▪ Incentives to electrical vehicles ▪ Nepal Vehicle Mass Emission Standard 2056 made compulsory for all imported vehicles. ▪ Ban on import of secondhand and reconditioned vehicles and two-stroke engine vehicles ▪ Pollution tax on diesel and petrol to be sold in Kathmandu Valley

4

Settlement Pattern

Kathmandu Valley is a natural sub-region in the mid hills of Nepal. The whole population of the valley shares the same natural resources, such as watershed, drainage channels, forests, soil, and air. The surface runoff of the entire area of 665 sq.km drains out of a single outlet at Katuwaldaha located on the southern tip of the valley. Air and water pollution occurring in one location easily gets spread to the entire area.

A study carried out by Kathmandu Valley Town Development Committee in 2001 revealed that 32% of the valley was covered with forest, 40% with agriculture, 17% with rural settlements, and 11% with municipal areas. This shows that Kathmandu Valley, in spite of rapid urbanisation and population growth, is still rural and green. However, the same study revealed that, between 1984 and 2000, land covered by urban settlements had increased from 3,096 to 9,193 ha. Similarly, agricultural land had decreased from 40,950 to 27,570 ha. An analysis of settlement patterns using the DPSIR framework is presented below.

Drivers

The population of the valley in 2020 will reach 2.5 million compared to 1.6 million in 2001 (KVTDC 2002). This growth in population includes both natural growth and emigration. Although an additional 300 thousand people can be accommodated by densification of areas within the existing Ring Road, farmland will have to be encroached upon to settle an additional 600 thousand people. Due to the insurgency, there has been a huge influx of internally displaced people in the valley, and this may lead to a much higher population growth than projected by the study.

At present the population growth for the valley has been estimated at more than four per cent per year. The low-density urban sprawl and uncontrolled settlement development in rural areas are the two key issues in urban development. The low density of the existing municipal areas, which is around 120 persons/ha, poses a challenge for urban managers because of the high cost of providing and maintaining municipal services. The optimum density for a medium-sized city like Kathmandu should be at least 200-250 persons/ha. On one hand, huge parcels of land are being underused within the existing Ring Road, and on the other ribbon development as well as leap-frog development are taking place in rural areas.

Pressure

Change in the settlement pattern

The earlier settlements of Kathmandu which date back to the Lichhivi period were normally located on the drier, less fertile elevated land, locally referred to as 'tars'. Kathmandu being the transit point for trade between India and Tibet had a comparative advantage due to the high Himalayas in the north and the malaria-prone tropical forest in the south. The traders had to stay in Kathmandu for three to four months to cross the Himalayas in summer and tropical forests in winter. Agriculture and cottage industries flourished due to the trade and Nepal had substantial influence in Tibet. The surplus revenue earned by the state was used to build civic amenities as well as temples, palaces, and shrines. Until the Malla period, Kathmandu remained a compact settlement surrounded by agricultural land. After the Gorkha conquest, Kathmandu was declared the capital of a unified Nepal. The physical development of the valley was greatly influenced by the construction of new palaces outside the city core. This practice was most prominent during the Rana period when palaces were built to the north, northeast, and east of Kathmandu City. A road network system was developed linking these palaces to the city core and to each other. Over time small settlements grew around these palaces, and the land made accessible by interconnecting roads became the areas to be first developed following the political changes in the country after 1951 (DHPP 1969).

Source: Kishore Thapa

Historic Core Area of Kathmandu built in 13th century A.D.

Modern development due to expansion of the industry and service sectors

Growth of Kathmandu city outside the historic city core area occurred in the 50s and 60s mainly to the east and northeast in Bagbazar, Dilli Bazar, and Putali Sadak in the east and towards Lazimpat and Maharajgunj in the northeast. This development was triggered by the construction of roads to connect Rana palaces. These were generally lower density linear developments along the existing road networks, but without adequate infrastructure. At the time the Physical Development Plan for the Kathmandu Valley was being prepared in 1969, Kathmandu City was confined to the highlands between the Bishnumati River and the Dhobi Khola in the east-west and between Bagmati River and Maharajgunj in the north-south. Low intensity urbanisation had occurred on the periphery, leaving large areas of undeveloped land within the city areas.

In the decade from 1970-80, there was expansion of government machinery, expansion of trade and tourism, and establishment of carpet industries. This led to an increase in employment opportunities in Kathmandu. Urbanisation gained further momentum during this period and low-density urban expansion spread to outlying well-drained 'tars' with easy road access such as Bansbari, Teku-Kalimati, Baneshwore-Battisputali, and so on. These new developments were occurring beyond the Bishnumati River in the west and Dhobi Khola in the east. The Ring Road, which was constructed in the mid 70s, gave further impetus to urban expansion, as more areas were made accessible. Development accelerated at the intersections of the Ring Road and the arterial roads, especially in Balaju, Maharajgunj, and Jawalakhel.

Expansion of the city due to concentration of political and economic power

By the 80s and 90s, the urban growth of greater Kathmandu was taking place generally in a north-south direction. This was mainly due to the fact that much of the easily accessible land had already been consumed and the land bordering on the west was undulating and difficult to develop, whereas the international airport impeded expansion to the east. Although pockets of inaccessible land still remained undeveloped within municipal areas, unregulated ribbon development along the principal arterial roads had extended beyond its borders in the surrounding villages. A major thrust in urban expansion had also been occurring in the east along the Kathmandu-Bhaktapur transport corridor. Bhaktapur had remained a neglected and relatively stagnant city in the past. After the successful completion of the Bhaktapur Development Project, the migration of people from Bhaktapur was checked and the city experienced an increase in tourism activities. The trolley bus service and the Arniko Highway made Bhaktapur easily accessible to Kathmandu. Since the 80s, the space between Kathmandu and Bhaktapur has been filling up with low-density ribbon development. This process has continued unabated until today.

Rapid urbanisation in the valley has been guided by the following factors.

- Concentration of political and economic power resulting in employment opportunities and multiple activities
- Availability of urban basic services such as water, roads, electricity, and telephones
- Proximity to work areas such as administrative centres and industries
- Location of an international airport and tourist centres
- Push factors in rural areas such as natural calamities, unemployment, and social stigma

State

The rural areas of Kathmandu have experienced unprecedented land subdivision and building construction over the past six years. An influx of internally displaced people has suddenly created a demand for housing plots and basic services. Those who cannot afford land in municipal areas prefer to stay on the fringe areas of the cities and in villages.

Difficulties in cultivation of land due to shortage of manpower and a huge demand for housing plots in the land market have motivated rural landowners to sell agricultural land at lucrative prices and search for alternative employment. Besides getting cheaper housing plots, another motivating factor for new migrants to settle in rural areas is that there is no need to get a building permit from the local authorities. People can build anywhere and build anything they like, and there is no government intervention.

One of the vivid manifestations of unplanned settlement in Kathmandu is the emergence of squatter settlements in different parts of the city. A study carried out by Lumanti, a local NGO, in 2000 revealed that there are 64 settlements in Kathmandu and the total population of squatters has been estimated at 14,500 (Lumanti 2003). Most of the settlements are located along river banks and on steep slopes. Squatters have occupied not only public land but also private land, and there have been conflicts between squatters and owners. Although the proportion of squatters in Kathmandu is much less than in other Asian cities, it is increasing at an alarming rate and may create environmental hazards in future (Table 4.1).

Table 4.1: **Growth of squatter settlements in Kathmandu Valley**

Year	No. of settlements	Population
1985	17	2,134
1988	24	3,665
1990	29	4,295
1992	33	6,355
1996	47	8,927
1998	49	10,323
2000	61	11,862
2003	64	14,500

Source: Lumanti 2003

The political power structure in the valley is still dominated by village development committees (VDCs) and the members of parliament raise rural development issues during their election campaigns. All the twelve members of Parliament, irrespective of their political affiliation, get elected on the basis of their influence in rural areas. Even at the local level, whenever a meeting is organised to discuss the development issues of the Kathmandu Valley, ninety-eight persons (chairmen of DDC and VDCs) talk about rural development issues and only five persons (mayors of municipalities) raise urban development issues. Since the existing planning system does not recognise Kathmandu Valley as a single entity, it is virtually impossible to enforce development control tools that can address both rural and urban areas. The development priorities of urban and rural areas are different and in many cases conflict with each other. The issue of landfill sites in the valley is one example of such conflicts.

The growth of settlements in the valley is generally spontaneous, and there is very little planning intervention on the part of the government. Unlike in neighbouring countries, the government does not have financial resources to acquire huge parcels of land where planned urban development can be promoted. The current constitutional provision does not allow the government to impose any kind of restriction on the use of private property. Hence the government has only one legal tool to regulate and use, e.g., provision of infrastructure. However, this tool has been grossly misused in Kathmandu, mainly because of political patronage. As a result of political pressure, basic services such as roads, electricity, and telephones are provided in those areas in which the land-use plan has declared the area unfit for development. This tendency has made all kinds of planning norms redundant or irrelevant and promoted adoption of illegal and irrational practices, rather than following standard practices of urban development.

Whereas the government is unable to acquire land because of financial constraints, private developers face difficulties in assembling land parcels due to land ceiling provisions laid down by the Land Reform Act of 1964. Developers also face difficulties in procuring land parcels from speculative landowners who either demand exorbitant prices or simply refuse to sell the land. There is no legal tool that can be used to acquire isolated land parcels from uncompromising landowners. Notwithstanding, developers cannot buy sufficient land in Kathmandu and other major cities due to the land ceiling.

Kathmandu Valley Town Development Committee (KVTDC), which is responsible for overall planning and regulation of urban development, is operating with a land-use plan adopted in 1976. Several efforts to revise the land-use plan after that were not successful. KVTDC is involved in several land pooling projects and guided land development programmes. It also looks after court cases involved in violation of building byelaws and other issues related to planning. Local bodies like municipalities and village development committees that are authorised by the Local Self Governance Act (LSGA) 1998 are issuing building permits mainly for revenue generation rather than regulating urban development. The technical capability of local authorities to deliver basic urban services is relatively low and people look upon central government agencies for such services. Figures 16 and 17 depict the housing process in unplanned and planned settlements respectively.

People → Land → Building → Infrastructure

Figure 16: Housing process in unplanned settlements (typical case of Nepal)

Land → Infrastructure → Building → People

Figure 17: Housing process in planned settlements

There are some positive trends in the development of Kathmandu Valley. The growth of economic activities in the trade and tourism sectors has created jobs and improved the living standards of valley residents. The pouring in of foreign remittances has also played a key role in the expansion of trade and commerce. The establishment of large shopping malls in the downtown area has boosted commercial activities. Similarly, the boom in academic institutions has attracted students from every nook and corner of the country. The towns of the valley are full of culture and vitality, which is visible in social and political events. The traditional agricultural system is undergoing significant transformation and farmers are increasingly interested in commercial farming, such as floriculture and horticulture, rather than subsistence farming. In urban areas, people have become more sensitive towards conservation of heritage and traditional architecture. The traditional craftsmanship of the valley, which was threatened with extinction a few decades ago, is booming now. The expansion of air transport in the domestic and international sectors is gradually developing Kathmandu as a regional air transport hub. Public transport has improved significantly over the last five years.

Impact

The informal process of settlement development in the last 30 years has created several physical, social, and environmental problems in Kathmandu. The fragile ecosystem is affected severely by ever-expanding built-up areas and incompatible economic activities. Some of the most visible consequences are described below.

River pollution

Lack of proper sanitation and drainage in urban and rural areas has resulted in dumping of sewage and garbage into the rivers. In most cases, the drainage system, which was designed for storm water only, is being used as a sewer; and the sewage directly flows into the river without any treatment. The problem has been aggravated by the growth of settlements along the river banks. Shortage of water in the river, especially during winter, leads to rivers virtually being used as sewers. Illegal mining of sand is causing environmental hazards along the river banks and severely affecting the structural safety of bridges at major arterial roads.

Air pollution

In unplanned settlements, poor road networks and conflicting land uses lead to air pollution caused by emissions from vehicles plying along narrow and winding streets. After the closure of Himal Cement Factory at Chobhar and the banning of Vikram tempos, Kathmandu's air quality has improved.

Dumping of solid waste

Illegal dumping of solid waste is a common sight in unplanned settlements. Those areas are either not served by the municipal solid waste collection system or the community is not well organised to handle the problem.

Loss of agricultural land

Loss of agricultural land in Kathmandu Valley is posing a serious problem in the context of recharging groundwater; and it is also contributing to air pollution and loss of greenery. Kathmandu residents are becoming more reliant on outside supplies of cereals and vegetables.

Traffic congestion

Conflicting land uses and an inadequate road network are creating traffic congestion and transportation facilities are inefficient. Public transport cannot operate in most settlements. Small public vehicles such as tempos and micro-buses have their own limitations in terms of handling passengers at affordable rates. Inefficient networks consume more land for less benefit all round. Table 4.2 shows the increase in vehicle registration in Nepal as a whole from 2004 to 2006.

Table 4.2: **Vehicle registration in Nepal**				
Type	**No. of vehicles in 2004/05**	**Increase in no. of vehicles in 2005/06 (Mar)**	**Total**	**Percentage increase**
Bus	13,331	693	14,024	5.19
Minibus	4,256	261	4,517	6.13
Car/jeep/van	78,255	4,854	83,109	6.2
Tractor	33,230	1,106	34,336	3.3
Motorcycle	302,042	20,125	322,167	6.7
Tempo	7,263	35	7,298	0.5
Microbus	1,700	493	2,193	29.0
Truck/tanker/ dozer/crane/tipper	27,659	1,498	29,157	5.4
Pickup	1,059	352	1,411	33.2
Others	4,000	13	4,013	0.3
Total	**472,795**	**29,430**	**502,225**	**100.0**
Density per km	27		29	

Source: DoTM 2006

Land speculation

Land speculation is a characteristic of urban development in Nepal, particularly in Kathmandu. This trend is detrimental to the organic growth of the city and proper expansion of basic services to the people. There are several areas within the existing Ring Road where developed plots are lying vacant, whereas there is tremendous pressure on housing in suburban areas. Under utilisation of land in the downtown area is a hurdle to planned growth of Kathmandu city. Land speculation is prevalent at both individual and institutional levels. Land brokers and housing development companies hold huge parcels of land in urban fringe areas for speculative purposes.

Loss of cultural heritage

The rich cultural heritage of Kathmandu Valley is gradually eroding because of the excessive pressure of commercial activities. Historic ponds, courtyards, public rest houses, and grazing grounds and playing fields are being converted into private property. Similarly, public lands are being registered as private land for profit and speculation: traditional 'guthis' (trusts), which looked after the management of public lands, have either ceased to exist or are inactive.

Substandard housing conditions

Substandard housing conditions are the most visible effect of unplanned settlements. Lack of natural light and ventilation, overcrowding, inadequate water supplies and sanitation, and air and noise pollution are indicators of substandard housing conditions. This situation causes stress and other deadly diseases.

Gaps in supply of and demand for basic services.

Due to the huge influx of people into Kathmandu Valley, there are gaps in the demand for and supply of housing, water, electricity, drainage, and other utilities. Developed plots are not available at affordable prices and people are forced to buy raw agricultural land cheaply and struggle to acquire appropriate infrastructure afterwards. Ultimately the cost of infrastructure in such cases renders the housing on agricultural land more expensive than on developed land in the long run. Central government agencies are responsible for provision of basic services and these agencies are not in a position to expand their networks due to shortage of funds and lack of proper planning. Local authorities do not have the capacity to provide trunk infrastructure and services and their roles are limited to local-level infrastructure only.

Domination of informal land brokers in the land market

The present supply of housing plots from land pooling projects is insufficient to have a significant influence on demand. The average number of annual building permits issued by Kathmandu City is 3,619 (1999-2001) whereas the total number of developed plots available from the government sector totlled 7,685 over the period from 1977-2002. Since the formal land market is limited to a few land-pooling project areas and developed housing plots are not readily available for prospective buyers, people rely on informal land brokers who operate at local level without license. The relationship between land brokers and employees in the land revenue and survey offices is crucial in land subdivision. There is no restriction on land subdivision except that the minimum size of a plot should be 80 sq.m. Land brokers designate a particular area for land subdivision and advertise it in the newspaper. People are often cheated when the plans shown in the advertisement and the actual on-site situation vary drastically.

Response

Although a historical trading entrepôt between Tibet and British India, Kathmandu Valley was isolated from the influences of modernisation and democratisation until Rana rule ended in 1950. At that time the Kathmandu Valley opened up to international influence after centuries of limited contact. During the coronation of King Mahendra in 1955 and the state visit of Queen Elizabeth in 1962, many beautification activities were undertaken, although these were limited to improvement of aesthetic beauty of some streets and building façades rather than improvement in basic urban services.

Planning initiatives

The government of Nepal with the assistance of the United Nations reviewed the overall situation of Kathmandu Valley and prepared a 'Physical Development Plan for Kathmandu Valley' in 1969. The main objective of this plan was the preservation of historical and cultural heritage, guided urban development through land-use plannng, and densification of fringe areas. The plan was a guiding principle for ordered urban development in the valley and the then government promulgated a Town Development Implementation Act in 1972 to implement it. Kathmandu Valley Town Development Committee (KVTDC) was established under this Act and was entrusted with the overall responsibility of planning and regulating urban growth in Kathmandu Valley. However, between 1970 and 1990, Kathmandu Valley experienced a huge increase in population and in economic activities and KVTDC was unable to cope with the challenges of such rapid urbanisation. Despite deficiencies, the overall planning framework prepared by KVTDC led to the development of a Ring Road and housing schemes at Kuleshwor, Galfutar, Dallu, and in the Sainbu-Bhaisepati area. It also facilitated the introduction of building permits in the municipalities. Later KVTDC launched two programmes, viz., the guided land development and land-pooling schemes; and these were effective in guiding urban development on the fringe areas of Kathmandu and Lalitpur.

Source: Civil Homes (P) Ltd, 2006

A typical housing colony developed by private developers in Kathmandu

In 1984, a Kathmandu Valley Physical Development Concept was prepared by the KVTDC with the objective of enforcing land-use and zoning regulations: the government failed to adopt it.

In 1987, the government, with the assistance of UNDP and the World Bank, prepared a Structural Plan of Kathmandu Valley. The objective of this was to provide guidelines for the physical development of metropolitan Kathmandu for the year 2010 A.D. Zoning was proposed to preserve agricultural lands and environmentally-sensitive areas. Building byelaws for Kathmandu Valley were also drafted, but, because the political situation changed in 1990, this plan was not given recognition by the new government.

In 1988, Kathmandu Valley Development Committee prepared an 'Urban Development and Conservation Scheme' for greater Kathmandu. The scheme emphasised the need for densification of old urban areas from 108 persons/ha to 123 persons/ha and for increasing the built-up area from 3,743 to 4,540 ha. Similarly, it was proposed that fringe areas should also be densified. Strategic re-densification and the role of Kathmandu Valley as a capital were envisaged in the Plan, and it opposed the establishment of major industries or other sources of pollution in the valley. Overlooking the trends and trying to control growth were the main shortcomings of this plan.

In 1991, after the general election, the government launched another study to guide and regulate urban development activities. This study was funded by Asian Development Bank and it examined issues related to land use, financial investment, environmental protection, and institutional re-organisation. Several policy options were recommended, including establishment of a valley-wide development authority and a 10-year infrastructural investment programme.

In 1995, another study carried out by the government with the help of The World Conservation Union (IUCN) examined the possibilities of limiting the growth of Kathmandu and arresting the flow of population coming to Kathmandu through secondary towns adjoining the Kathmandu Valley. The study clearly showed that planning intervention within Kathmandu Valley would not be sufficient unless the issue of secondary towns was addressed.

In 2002, the government approved a Long Term Development Concept for Kathmandu Valley prepared by Kathmandu Valley Town Development Committee.

The concept evolved through extensive consultations with politicians, the private sector, and local authorities. A new legislation was also proposed for establishing a Kathmandu Valley Development Council to replace the Kathmandu Valley Town Development Committee. Although this legislation was widely acclaimed , it has not yet been enacted by parliament because of political instability.

Existing institutional and legal frameworks

The institutions involved in developing settlements and their roles are presented in Table 4.3 and the organisational structure is given in Figure 18. The figure clearly reveals the lack of cooperation and coordination between them.

In 1976, the government adopted a Land-use Plan for Kathmandu Valley and established Town Development Implementation Committees in each of the three districts of Kathmandu Valley. These committees were given the legal authority to enforce land-use regulations and to promote and regulate urban development activities. As a first step towards implementation of the Town Development Plan, KVTDC launched 'sites and services schemes' in Kuleshor, Galfutar, Dallu, and Sainbu Bhaisepati. When the town development plan was launched, the population growth rate was less than three per cent, and most of the land around urban areas was used for agriculture. Between 1981 and 1991, the population grew by more than five per cent, and the government's urban development efforts were inadequate and services could not be delivered to new migrants. The housing projects launched by KVTDC were not completed on time and no new projects could be launched. The huge demand for housing plots was met by the private sector, in particular individual land brokers and real estate agents. Unplanned subdivision and assembly of land posed a serious threat to the planning initiatives of KVTDC. Urban expansion occurred on the fringe areas without any development control and building byelaws were completely ignored.

After promulgation of the Town Development Act 1988, Town Development Committees throughout the country were reorganised and given adequate authority to regulate urban development through enforcement of building byelaws as well as through land development schemes. The efforts of the Kathmandu Valley Town Development Committee to introduce a Guided Land Development (GLD) programme and land-pooling schemes are commendable in the sense that they generated the public interest crucial for the success of the programme. Although, in the initial phases, these programmes did not go head smoothly because of public protests, the obstacles were overcome after extensive consultations with beneficiaries and people's representatives. Under the GLD programme, 475 km of roads were to be developed and the progress to date is

Table 4.3: **Institutions involved in settlement development**

Name	Responsibilities
Department of Land Reform and Management	Land registration, sub-division and transaction
Survey Department	Land survey, production of maps and maintenance of cadastral maps
Department of Urban Development and Building Construction	Regulation of apartments, construction of government buildings, conservation of religious and cultural sites
Kathmandu Valley Town Development Committee	Formulation of building byelaws, implementation of guided and land-pooling programmes
Municipalities	Solid waste management, building permits, revenue collection
Department of Roads	Construction and maintenance of strategic roads
Nepal Water Supply Corporation	Production of water, distribution, and maintenance of the water supply system
Guthi Sansthan	Maintenance and repair of temples and shrines
Village Development Committees	Building permits, construction of rural roads
District Development Committees	Construction of district roads
Nepal Electricity Authority	Generation, transmission and distribution of electricity, provision of street lights

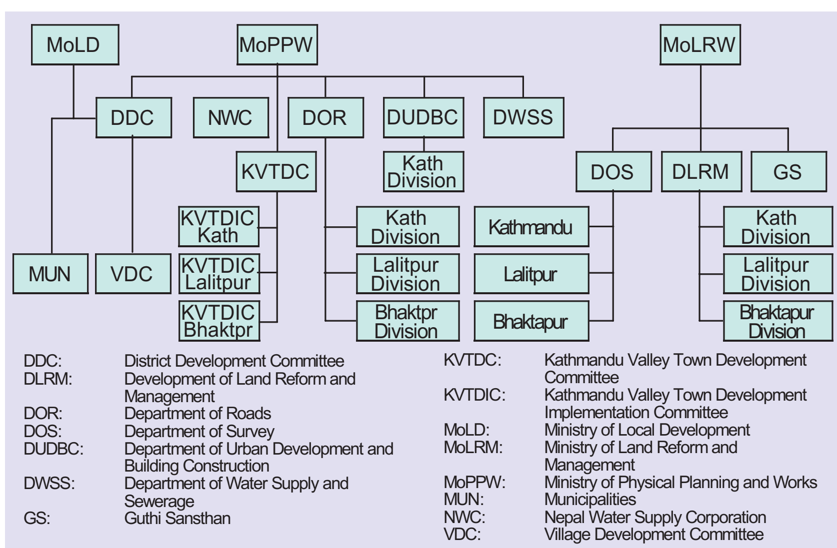


Figure 18: Organisational structure of institutions involved in settlement development

300 km. The beneficiaries have donated 170 ha of land valued at Rs. 2,800 million. The government has invested only Rs.70 million in the scheme (KVTDC 2005): this scheme was limited to a few wards in Kathmandu and Lalitpur, and it could not meet the growing demand for developed plots in the valley. Hence the private sector and individual land brokers benefited from the land market. The conventional role of KVTDC was curtailed after promulgation of the LSGA in 1998. The municipalities have more authority to guide and regulate urban development under the Act and, in certain cases, the functions of the Town Development Committees and municipalities overlap.

The building byelaws enacted in 1976 under the Kathmandu Valley Town Development Plan became obsolete and impractical over time. In order to address the issues emerging in urban planning, in the context of LSGA, KVTDC drafted new planning and building byelaws, and these were approved by the government in 1993. The KVTDC and the municipalities are still operating building and planning permit activities on the basis of these byelaws which rule that planning permits from KVDTC are mandatory for launching land subdivisions or housing development schemes. Furthermore, to regulate land subdivisions, a minimum plot size of 80 sq.m. and a frontage of six metres have been established for the Kathmandu Valley.

At present, KVTDC is concentrating on the implementation of land-pooling schemes, as they have proved to be a promising tool for urban development in Nepal. Considering the holding of land by individuals and problems in land acquisition, the land-pooling concept has been widely supported by members of the public and law-makers. Land pooling is based on the concept of readjusting existing irregular plots into regular and square plots and creating road and drainage networks and open space. The project compensates landowners by providing them with developed plots of higher value but reduced land area. The cost of constructing infrastructure (roads and drainage) is financed by auctioning reserve plots. To date 11 projects have been completed, three projects are nearing completion, and seven projects are being implemented. The land-pooling project in Kathmandu has inspired people in other towns, and several projects are being launched in Pokhara, Dang, Nepalgunj, and Dharan. Despite deficiencies in planning and implementation, land pooling has proved a pragmatic tool for urban development in a country like Nepal where land belongs to the people not the government. Table 4.4 gives information about land development projects completed in Kathmandu Valley and Figure 19 depicts land pooling at Naya Bazar. Figures 20 and 21 also depict different aspects of land pooling in Kathmandu Valley.

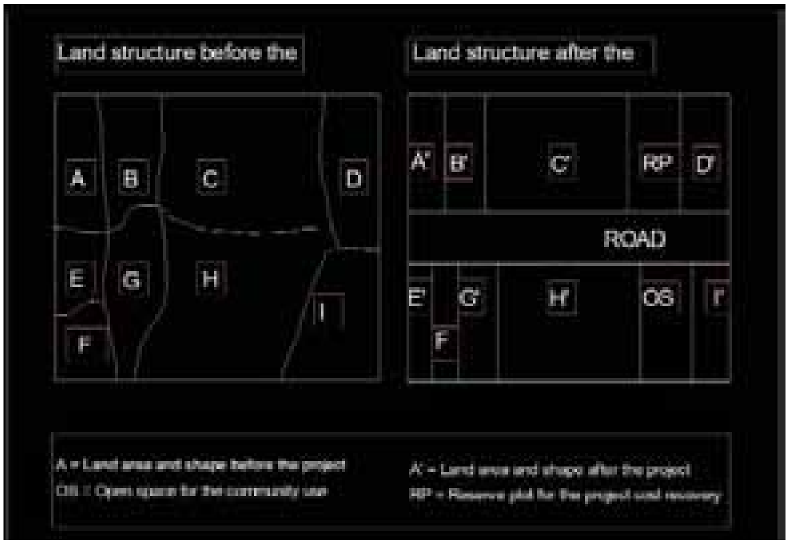
Table 4.4: **Land development projects completed in Kathmandu Valley**

Project name	Area (ha)	Road (km)	Drainage (km)	Open space (ha)	No. of plots	Cost (million Rs.)
Gongabu	14.33	5.94	10.30	0.72	406	69.82
Lubhu	13.50	3.71	6.00	0.58	243	18.16
Kamal Binayak	7.32	3.20	4.90	0.30	205	8.64
Bagmati Phant	9.80	9.41	2.50	-	560	9.59
Liwali	33.45	8.85	9.41	1.17	770	62.32
Sintitar	27.50	8.73	8.85	0.94	920	87.49
Sainbu	24.58	10.25	17.40	3.18	800	296.25
Dallu	20.00	7.00	6.95	1.40	750	107.49
Naya Bazar	44.25	17.20	23.00	1.60	1312	277.79
Gopikrishna	10.88	4.14	4.14	0.42	292	72.46
Sinamangal –I	35.97	11.72	11.72	1.98	1074	109.13
Kirtipur- I	5.18	2.20	2.20	-	300	-
Total	**246.76**	**92.35**	**107.37**	**12.28**	**7632**	**1119.14**

Source: Joshi and Sangachhen 2001

Source: DUDBC 1999

Figure 19: Land pooling at Nayabazar



Source: Kathmandu Urban Development Project, DUDBC1999

Figure 20: Physical improvements in land-pooling project after implementation

Source: KVTDC 2006

Figure 21: Land-pooling project completed in Kathmandu Valley

In 1998, an Apartment Ownership Act was promulgated by the government as a means of promoting apartment living. This act enabled the private sector to construct and sell apartments at affordable prices. The Act was only finalised in 2003 because of legal and administrative hurdles. Although public response to apartment purchasing is quite overwhelming, developers are still finding it difficult to acquire land and provide basic services and access roads.

At the end of the 1990s, the government launched a Kathmandu Urban Development Project. Although Kathmandu Metropolitan City (KMC) was the main beneficiary of the project, other municipalities were included in the institutional development programme. The project's main objective was to redevelop the core city area of Kathmandu. It was also meant to strengthen KMC by undertaking the urban development and management functions outlined in the Local Self Governance Act. The project prepared a digital base map of Kathmandu, and this is used for most of the planning, programming, development, and management activities carried out by government, semi-government, and non-government agencies. Similarly, Kathmandu Metropolitan City carried out a Kathmandu Valley Mapping Programme to improve the management functions of KMC. The most important output of this was the introduction of a Metric Addressing System which not only improved the revenue generation of KMC but also helped service providers such as the post office, police, kennel clubs, newspaper vendors, and garbage collectors to improve their services and collect fees and taxes with greater efficiency.

The government's planning strategy, particularly that of Kathmandu Valley Town Development Committee, is the Land Use Plan (LUP) for greater Kathmandu. Other than that there is no comprehensive land-use plan, no zoning regulations, and no plan for infrastructural expansion. Hence, the municipalities in the valley are also without proper regulatory tools to enforce standards.

Lack of political commitment and unwillingness to approve plans and policies are bottlenecks to proper land-use planning. There are no accepted goals and objectives, and, since rural voters dominate the politics of Kathmandu Valley, senior politicians are not concerned about urban issues.

The future outlook of Kathmandu Valley

Kathmandu will continue to grow in future and, if rational planning and development strategies are not formulated, its growth will become a nightmare in the environmental sense. Policies are required for sustainable development of the Kathmandu Valley at both valley and local levels. Valley-level strategies should address trunk infrastructure such as major arterial roads (ring roads, highways), sewage systems, water supply systems (e.g., the Melamchi Project), and conservation of watershed and management of solid waste. Local-level strategies should address development of city or ward infrastructure such as drainage, open spaces, street lighting, primary collection of solid waste, and maintenance of local roads. Building byelaws and administration of building permit systems should be the functions of local authorities. Furthermore, community development work in which local people can actively participate in developing their neighbourhoods should be among the local-level strategies.

Kathmandu being the national capital means that the roles of central and local bodies are equally important, but their specific roles, responsibilities, authority, and accountability should be clearly defined.

An appropriate land-use and management policy will be required to guide development at both valley and local levels. The traditional land-management system is too obsolete to guide the future physical growth of Kathmandu Valley. No city plan can materialise without a corresponding land-use policy judicious enough to create a healthy living environment. Although local authorities have the authority to exercise self-governance, they need to coordinate with other local authorities through a valley-wide apex body for development endeavours. Such a body is yet to be established.

One of the principal causes of the deteriorating environment is the overlapping functions of different agencies and lack of coordination among them. Without a valley-wide apex body, it is difficult to coordinate three DDCs, 98 VDCs, and five municipalities. Better coordination is also needed among the government and semi-government line agencies.

Major projects to address the deficiency of trunk infrastructure in the Kathmandu Valley are in the pipeline. Table 4.5 lists the issues and interventions proposed for development of the Kathmandu Valley. Box 4 contains policies for the long-term development of the valley.

Table 4.5: **Major issues and interventions proposed for the planned development of Kathmandu Valley**

Major issues	Current Trend	Impact	Proposed intervention
1. Uncontrolled urban Sprawl	People are building houses without planning guidelines	Provision and maintenance of urban infrastructure becomes difficult and costly.	Enforce land-use plan to clearly demarcate the areas suitable for development and those unsuitable for development and provide infrastructure accordingly.
2. Deficiency of water supplies, drainage and sewerage	Existing infrastructure cannot support the population pressure	Quality of life is decreasing and public health is threatened.	More investment in upgrading municipal infrastructure; and increase the involvement of the private sector.
3.Traffic congestion	Inadequate road density and road network	Air pollution and increased travel time	Improvement of the existing road network and expansion to fringe areas
4.Unplanned land subdivision	The land management policy does not comply with urban planning standards and land brokers are more active than planners	Inefficient use of land, overcrowding and increased cost of infrastructure	Introduction of urban land management policy and procedures and regulation of the activities of land brokers through legislation
5.Environmental pollution	Incompatible land use, discharge of solid waste and liquid waste into the rivers.	Loss of eco-system and loss of cultural heritage	Construction of sewage treatment plants and strict enforcement of EIA and IEE in medium- and large-scale projects
6.Loss of agricultural and forest land	Agricultural land converted into built-up areas and forests encroached upon to establish security bases	Less groundwater recharge, loss of recreational area	Delineation of agricultural areas in the land-use plan and restriction on the use of forests for non-compatible activities
7.Poor management of cities	Weak capacity of municipalities and local authorities	The public is not receiving basic services at optimum level.	Improvement in the capacity and efficiency of local authorities to undertake urban management functions

Box 4: Policies for long-term development of the valley

The long-term development concept for the valley approved by the government in 2002 has adopted the following policies. These policies can be taken as the guiding principle for ensuring planned growth.

- A valley-wide apex body to be formed with proportionate representation of local bodies.
- Job opportunities shall be decentralised so that people can settle in any location of the valley.
- Delineation of rural and urban boundaries so that separate planning standards can be enforced in rural and urban areas.
- Investments should be channellised to certain sectors only so that densification, development of new towns, and allocation of future land can be delineated.
- A system of planning permits and environmental impact assessment shall be introduced.
- Tourism-related activities shall be promoted and polluting industries shall be relocated to other towns outside Kathmandu Valley.
- Bhaktapur and other traditional settlements to be declared cultural towns.
- Kathmandu to be declared a single administrative entity.
- Protection of public parks and watershed areas
- Development of cottage industries
- Relocation of security establishments to fringe areas

Proposed outer ring road

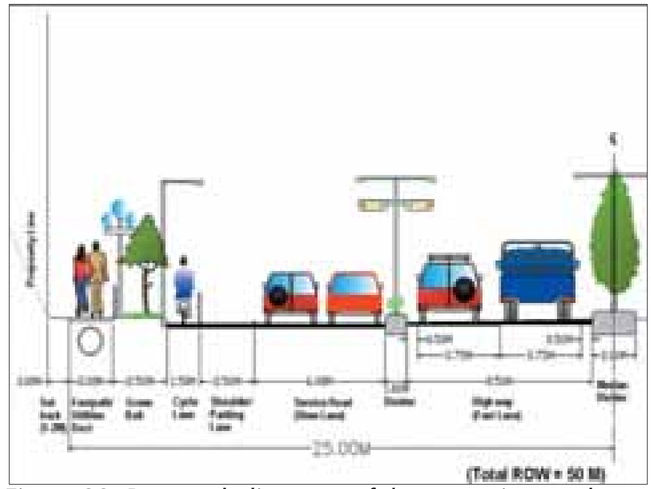
The government has approved an ambitious plan for constructing an Outer Ring Road. It is envisaged as a major arterial road to cater to the needs of the Kathmandu Valley for the next 20 years. The Outer Ring Road will pass through the traditional compact settlements of Kathmandu such as Harisiddhi, Bungamati, Khokana, Bhaktapur, Gokarna, Tokha, and Kirtipur. The 72-km long road will serve not only as the major arterial road but also as the backbone for future urban growth. Considering the mistakes made in planning the existing Ring Road, Nepalese planners have been careful to ensure that the plan encompasses integrated infrastructure, road access, and planned neighbourhoods adjacent to the road. Chinese assistance is expected for construction and the government of Nepal will acquire the land and plan and develop the neighbourhood. The preliminary estimate shows a cost of NRs. eight billion, excluding the cost of land. Land acquisition is to be carried out through a land-pooling concept by which landowners will contribute part of their land for road, drainage, and open space as well as construction of infrastructure. The average contribution of land to the proposed Outer Ring Road will be 40%. In return the people will receive developed plots of much higher value and with better infrastructure than their original landholding. Construction will take about seven years from commencement. Environmentalists and development planners have raised concerns about the negative impacts of the Outer Ring Road. Environmental issues wil have to be addressed through an Environmental Management Plan developed based on the Environmental Impact Assessment. Transportation experts are suggesting improvement of the existing radial road between the existing Ring Road and the proposed Outer Ring Road (Figures 22 and 23).

The Outer Ring Road Project will deliver the following benefits.

- Rural settlements in the valley will have improved access.
- Existing urban areas will grow towards the Outer Ring Road area.
- Land will be available for the utilities and services required for a metropolitan city, e.g., administrative sub centres, commercial sub-centres, intercity bus terminus, and so on.
- Planned neighbourhood and radial roads will be developed.
- The southern and eastern part of the valley will have improved access.

Source: Outer Ring Road Development Project, DUDBC 2006

Figure 22: A view of the outer ring road



Source: Outer Ring Road Development Project, DUDBC2006

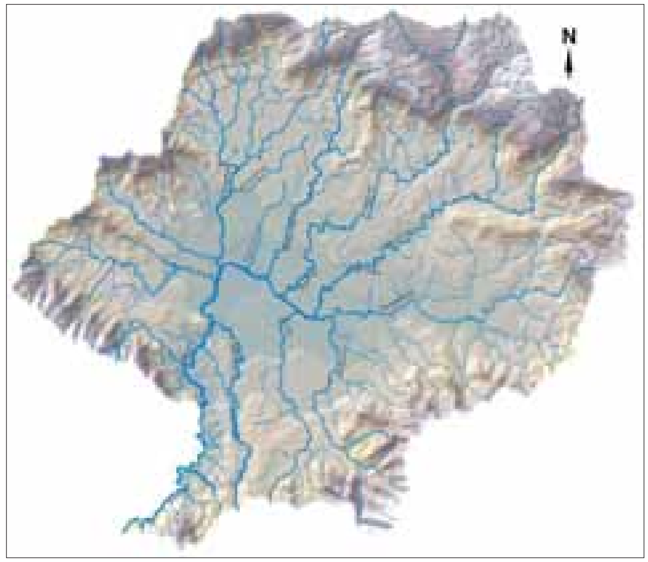
Figure 23: Proposed alignment of the outer ring road

5

Drinking Water Resources

Water in the Kathmandu Valley is derived from two sources: surface water (rivers and ponds) and groundwater. They are basically fed with rainfall. Rivers are important running surface water in terms of water volume and potential development. Over time, requirements for water for drinking and personal hygiene, agriculture, religious activities, industrial production, and recreational activities, such as swimming and fishing, have increased in the valley. Nevertheless, the rivers are also the main repository for the valley's untreated sewage, solid waste, and industrial effluents.

Kathmandu Valley is drained by the multitude of tributaries that feed the main channel of the Bagmati river (Figure 24). So the Bagmati drainage system is the total system of down slope water flow from the point of arrival at the ground surface in the valley. It consists of a branched network of stream channels, as well as the sloping ground surface that contributes overland flow and inter-flow to these channels. There are altogether 20 tributaries of the Bagmati River system within the valley (Table 5.1).



Source: Data: B. Pradhan; Map: ICIMOD

Figure 24: The Bagmati drainage system

Table 5.1: **The Bagmati River and its tributaries: places of origin, elevation, and length**

Name of river	Length (km)	Elevation (m)	Origin	Name of river	Length (km)	Elevation (m)	Origin
Bagmati	35.5	2732	Shivapuri bagdwaar	Manamati	6.1	2000	Bhangari danda
Bishnumati	17.3	2300	Shivapuri tarebhir	Manohara	23.5	2375	Manichur danda
Bosan	6.1	1800	Pokhari bhanjyang	Matatirtha	5.0	2000	Matatirtha danda
Dhobi	18.2	2732	Shivapuri danda	Nagmati	7.9	2443	Shivapuri danda
Godavari	14.8	2200	Phulchoki danda	Nakhu	17.6	2200	Bhardeu ridge
Hanumante	23.5	2000	Mahadevpokhari	Samakhusi	6.4	1350	Dharampur-east
Indrawati	16.8	1700	Dahachok danda	Sangla	10.7	2000	Aale dnada
Indrayani	7.0	2000	Bhangari danda	Syalmati	4.8	2200	Shivapuri danda
Kodku	14.9	2000	Tileswor danda	Tribeni	10.7	1700	Bhirkot
Mahadev	9.2	2000	Aale danda	Tukucha	6.4	1325	Maharajganj

Source: Pradhan 1998

The Bagmati River is the principal river. It originates on Shivapuri lekh (ridge) at an elevation of about 2,650 metres and drops to 1,340m over a distance of about 8 km. The length of the Bagmati river from its origin Shivapuri ridge to the Chobhar gorge is about 35 kilometres. In the upstream region near Sundarijal, two streams, the Nagmati and the Syalmati, come to join this river. The valley basin begins some kilometres below Sundarijal over which it flows to the south, turns to the west and again turns to the south and the west and then finally to the south-west. In the valley basin, the Manohara River with its tributaries the Salinadi, the Manamati, the Indrayani, the Hanumante, and the Kodku join the Bagmati River at Koteswor. Before the Bagmati turns to the south at Teku, other tributaries like the Dhobikhola (Rudramati), the Tukucha (Ichhumati), and the Bishnumati join it. Three other tributaries, the Balkhu, the Nakhu, and the Bosan, join the Bagmati River before leaving Chobhar Gorge.

Because of the relatively flat topography of the valley basin with soft, deep sedimentary deposits, these rivers have meandering courses and, in some areas, wide flood plains. The general slope of the valley area is towards the central part and then to the south-west. The central slope has an average gradient of above 1 in 236, and therefore all the tributaries flow centripetally towards the centre of the valley to meet with the Bagmati River which then emerges into an antecedent transaction valley cutting deeply in the south-west to flow out of the valley. The Chobhar Gorge, through which the Bagmati leaves the valley, has the lowest elevation of about 1,230 masl and it then directs to the south over the Terai plain of Nepal. The common feature of the rivers is that during monsoon season they often get flooded and deposit enormous amounts of sand and fine particles over their banks. In the dry season, their water level is unusually low despite the fact that they are perennial. Table 5.2 shows the discharge of water volume at three sites – head, middle, and end points – within the valley.

In addition to the rivers, there are four 'kunds' (ponds): Gauri, Godavari, Matatirtha, and Naudhara. They are the spring sources and, usually located on a hill slope, feed a continuous supply of water to the rivers in the valley. Kunds are protected sources and maintained as one of the important drinking water supply sources for the local inhabitants as well as for urban dwellers. These spring sources have been used primarily for domestic purposes. This particular aspect is very significant in regards to the location of many village settlements near the sources of springs over the mountain slopes.
The DPSIR analysis for water resources is presented below. Figure 25 presents the overall DPSIR framework schematically.

Table 5.2: **Discharge and catchment areas of the Bagmati River**

Description		Sundarijal	Gaurighat	Chobhar
Discharge (m^3/s)	Minimum	0.03	0.01	0.02
	Maximum	25.5	150	417
	Average	1.06	3.1	15.6
Catchment Area (km^2)		15.0	68.0	585.0

Source: DHM 1998

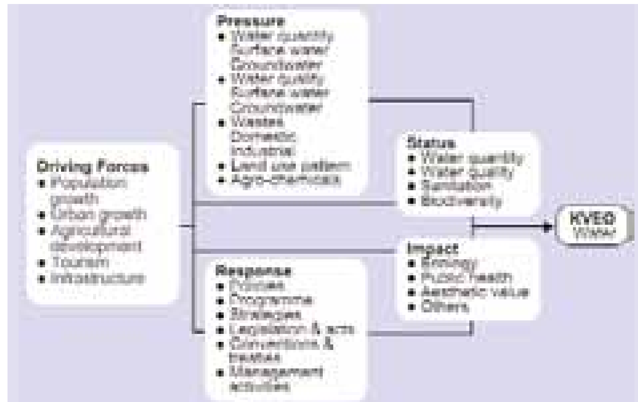


Figure 25: DPSIR framework for drinking water resources

Drivers

Use of water resources can be considered as a measure of development, since it is directly related to agricultural activities, environmental conservation, and human health. With increasing population and development activities, pressure on water resources is increasing. However, the use of water resources is diversified. Since water is a basic element in different types of activities, it is used by tapping most of the available sources and its use is being intensified in order to meet the growing demand for water. Thus water resources have implications on quality and human health, environment and watershed conservation, access to water sources and conflicts, and so on (Pradhan and Pradhan 2006)

The socioeconomic driving forces for describing drinking water resources are made in the following points.

Population growth – population is one of the fundamental driving forces shaping the water environmental base in the Kathmandu Valley. The valley's population increased from 410,995 in 1952/54 to 1,645,091 in 2001. The population density increased from 457 persons/km^2 in 1952-54 to 1830 persons/km^2 in 2001. This has increased the demand for water enormously.

Urban growth and expansion – The valley with its five municipal towns has an urban population of nearly 1 million, constituting slightly over 60% of its total population, accounting for nearly 31% of the country's total urban population. The urban population in the valley increased from 181,082 in the 1950s to 995,966 in 2001. The main contribution to the rapid growth of urban population in the valley is migration. For instance, between 1981 and 1991 the valley's urban population increased by over 82%, in which migration accounted for 59%, the largest ever since the 1950s. The density of population for the urban areas ranges from 139 persons per km^2 (Kathmandu) to 72 persons per km^2 (Kirtipur). The urban areas have expanded in a rapid and haphazard manner. During four and half decades (1955-2000), the valley's urban areas grew from 2,180 to 8,253 ha. Some of the visible consequences of the haphazard urbanisation include the increase in volume of solid wastes and their haphazard disposal, level of pollution of water and air, and squatting on river banks, in open spaces, and on public land.

Agricultural development – The economically active population above 10 years of age constitutes 40.3% of the total population of the valley districts, which is less than the country average. Agriculture in the valley is the secondmost important sector and is characterised by very intensive farming — use of fertilisers, irrigation, human labour, and terracing of farmland.

Tourism – One of the economic and social developments in the valley is tourism. The valley is the first destination for tourists because of its cultural, social, and natural uniqueness. The number of tourist arrivals in the valley has increased each year. Tourism has many facets in terms of employment generation. As a result of increase in tourists, the number of hotels and associated activities like restaurants, travel and communication services, groceries, curio, and others have increased as well.

Infrastructural development – Roads are the most important infrastructure among the driving forces. The total road length in 2001 was 1,319 km compared to 820 km in 1981. Of the total road length of 1,319 km, blacktop accounted for 53.2%, followed by earthen (24.8%), and gravelled (22%).

Regarding health services in the valley, one health service unit (hospital + health post), excluding private clinics, serves an area of 17.4 sq.km and 32,257 persons. It seems that the available public health services in the valley bear the greatest pressure in terms of coverage of population.

Pressure

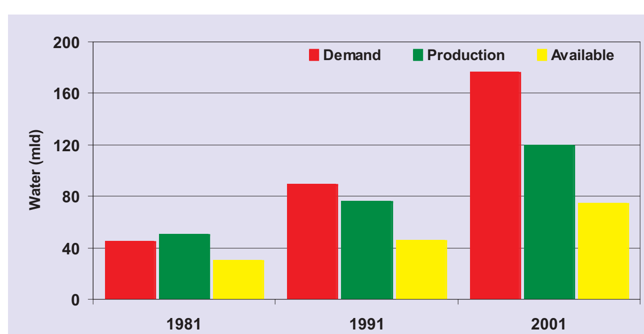
The amount of water required for drinking, domestic, industrial, and recreational uses has increased over time along with the increase in population, quality of life, economic activities and development activities in the valley. In particular, the rivers are not only the main source of water, but also the main repository for untreated sewage, solid waste, and industrial effluents.

Demand for water is always on the increase in the valley. The pressure on water sources is intense due to the limited amount of water available with respect to demand. Over the last few decades, the population has grown rapidly at over two per cent per annum, with migration as the main cause of rapid growth in the valley's urban areas (Pradhan 2004). This additional growth of population leads to demands for more housing. Increase in population obviously puts pressure on the existing water supply. Along with the increase in population, other activities such as industries, irrigation, motor workshops, and so on also require water. Natural factors, such as landslides and floods, also put pressure on water sources by damaging reservoirs, river channels, and irrigation canals. All these activities affect the quality of water.

Water quantity

The valley's surface water sources, such as rivers and kunds, have received tremendous pressure from increasing population and economic activities. The pressure on these water sources has also increased due to use of water for a more and more intensified agricultural system. Almost all major rivers have been tapped at source for drinking water supplies. This supply is only about 120 million litres per day (mld) during the rainy season, 80 mld during dry season of the estimated daily demand of 170 mld (NWSC 2001). In dry season, 60-70% of the water supply comes from groundwater. Only 79% of the total demand for water of the urban population has been met (Figure 26).

Groundwater is an important alternative source of water supply in the valley, and it is under immense pressure, as it is being heavily used for drinking and other



Source: NWSC 1999, 2001

Figure 26: Demand and supply of drinking water

purposes. This has resulted in a decline in groundwater level. A study by Metcalf and Eddy (2000) indicated that the groundwater level had dropped from nine metres to as low as 68m in the valley over a few years and, as a result, there has been a virtual drying up of the traditional dug wells and Dhungedhara (stone spouts). Because of lack of regular monitoring, however, the groundwater depletion rate is uncertain. Unfortunately the recharge areas in the surrounding mountains, which were once densely forested, have been turned into agricultural land, so there is little support from the surrounding watershed areas to replenish the groundwater in the valley. The total sustainable withdrawal of groundwater from the valley's aquifers is approximately 26.3 mld (Stanley 1994), but the total groundwater currently extracted is about 58.6 mld (Metcalf and Eddy 2000). These figures thus mean that the groundwater in the valley is overexploited.

The demand for drinking water in the valley is met by industrial mineral water. Supplies have increased in the last few years. There are 14 mineral water industries, including nine in the valley, supplying about 0.9 mld per day (DoI 2006).

Water quality

The rising demand for water in the valley has put pressure on the quality of water. The quality of both surface and groundwater has deteriorated.

Domestic waste

Domestic waste includes both grey and black water. In Nepal, only the Kathmandu Valley towns have a sewerage network system and the sewerage facility is provided to 15% of the houses only (NWSC 2001). Some households have septic tanks, but the majority of domestic sewers discharge directly into the rivers without treatment. Even so, much domestic wastewater percolates directly into the groundwater or flows as runoff into local streams. It is also seen even in the valley that people defaecate and urinate on open ground, often along the banks of rivers and streams. Based on the study of Tebbutt (1992), it can be estimated that if an average of 50g biological oxygen demand (BOD) per person per day is produced, it will produce 50,000 kg BOD/day from the one million inhabitants in the Kathmandu Valley. An average of 20,846 kg BOD/day has been recorded for the Bagmati River at the outlet, constituting 42% of the total BOD load produced (CEMAT 2000). On the basis of per person per day water use, the wastewater generated per person is estimated to be about 60 litres for the urban area (NPC 1997). About 85% of the total water used ends up as domestic wastewater. Table 5.3 shows the estimated volume of wastewater generated by each of the Kathmandu Valley's municipalities.

Table 5.3: **Estimation of wastewater generation in Kathmandu Valley urban region, 2001**

Municipality	Population 2001	Million litres/day
Bhaktapur	72,543	3.7
Kathmandu	671,846	34.3
Kirtipur	40,835	2.1
Lalitpur	162,991	8.3
Madhyapur Thimi	47,751	2.4
Total	**995,966**	**50.8**

Source: CBS 2001; NWSC 2001

Industrial waste

The Kathmandu Valley hosts more than 72% of the country's water-polluting industries. Many of these industries discharge effluents into local rivers without treatment, spoiling the quality of river water. The study by Devkota and Neupane (1994) indicates that the contribution of industrial effluents to the rivers is about seven per cent of the total effluents (domestic and industrial) in the Kathmandu Valley.

Industrial pollution has been measured in terms of wastewater volume, biological oxygen demand (BOD), and total suspended solid (TSS) loads of the effluents. In terms of relative contribution of BOD load, the major polluting industries are the vegetable oil, distillery, and leather industries.

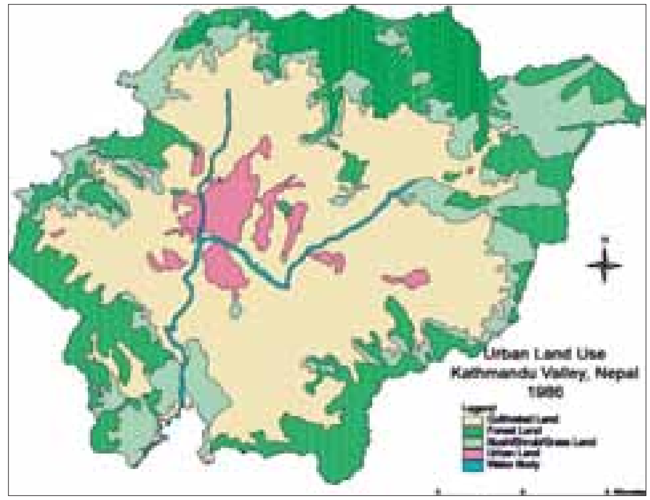
Increase in the use of agro-chemicals

Vegetable farming intensified in the valley due to an increased use of agro-chemicals. Altogether 250 types

Source: ENPHO

Carpet waste

of pesticides were used in Nepal and the average use of pesticide was 0.142 kg/ha in 1995 (Palikhe 1999). Presently, the number of pesticides used has increased to 319 of which 213 are insecticides, 71 fungicides, 23 herbicides, and 12 others. There are altogether 38 importers and 3,450 retailers in Nepal. A total of 177 tons (active ingredient – ai) per year are imported and 142 tons are used (48.3% insecticides, 46.2% fungicides, 4.4% herbicides, 1.1% others). These pesticides are organochlorides, organophosphates, carbamates, herbicides and pest repellents, and disinfectants. Organochlorides are persistent organic pesticides which pass through the food chain through the processes of bioaccumulation and biomagnification, and thus are hazardous to health (Palikhe 2005).

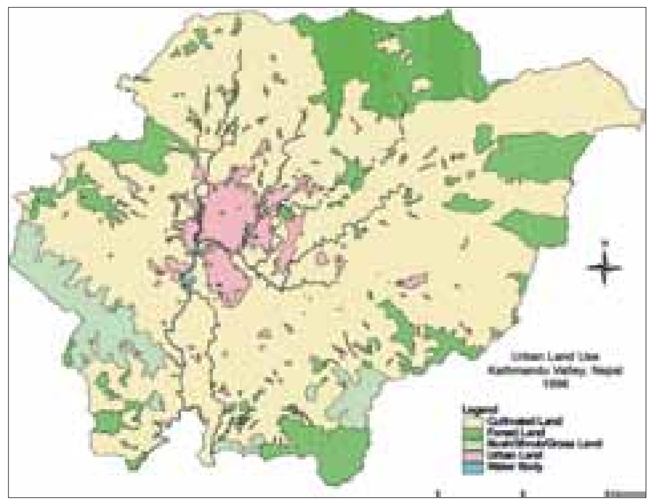


Source: Tuladhar 1998

Figure 27a: Land-use pattern 1986

Change in land-use pattern

The land-use pattern in the valley has changed (Figures 27a and b). As noted in an earlier section, the urban area of the Kathmandu Valley increased from 26% in 1978 to 46.2% in 1996. Likewise, the rural built-up area increased from 11.2 to 24% during the same period (Pradhan 2004). The forest area of the surrounding watersheds decreased by 40% from 1955-1996. As a result, the groundwater recharge area decreased, affecting both the quality and quantity of groundwater sources.



Source: Tuladhar 1998

Figure 27b: Land-use pattern 1996

State

Supply systems for water and sanitation

There are basically three agencies delivering water and sanitation services. The Department of Water Supply and Sewerage is the principal public agency for policy and programme formulations concerning water supply and sewerage, and for water supply in rural areas (Figure 28). Nepal Water Supply Corporation (NWSC) is a semi-government agency that supplies water mainly in the urban areas. However, since the supply of water by the public agency alone is not adequate, the additional requirement of domestic water is being supplied by the private sector. In addition, households also draw water by themselves from groundwater sources.

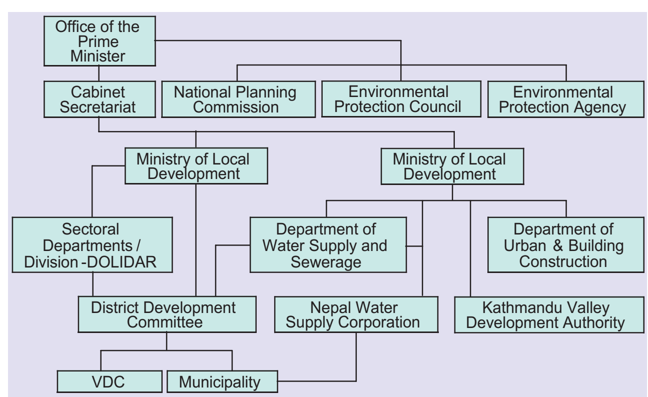


Figure 28: Institutions concerned with drinking water supplies

Water quantity

Two major sources of drinking water in the valley are surface water and groundwater. The surface water source is larger than the groundwater source in terms of volume. Yet, not all households have access to tap water (Table 5.4). On average, nearly 81% of households have access to this safe water source, with Bhaktapur having the least access (74.6%) among the valley districts. The groundwater sources together (well, tube well, and stone spout) are the secondmost important.

Table 5.4: **Access to drinking water by household at district level (%)**

District	Tap	Well	Tubewell	Spout	River	Other
Bhaktapur	74.55	11.74	7.22	4.93	0.07	1.49
Kathmandu	84.05	06.25	5.71	2.63	0.08	1.27
Lalitpur	83.05	09.79	1.20	4.50	0.16	1.31

Source: CBS 2001

Table 5.5: **Drinking water supply and demand, Kathmandu Valley cities**

Description	BKT	KTM	KIR	LAL	MPT
Water supply coverage % by DWSC	70	71	71	70	70
Total city water demand (m^3/day)	7,464	80,622	4,900	19,559	3,836
Total city water supply by DWSS (m^3/day)	3,732	40,311	2,450	9,779	1,918
Total volume of surface water supply (m^3/day)	2,612	28,218	1,715	6,846	1,343
Total volume of groundwater supply (m^3/day)	1,120	12,093	735	2,934	575
Individual extraction of groundwater for domestic purposes (m^3/day)	3,732	40,311	2,450	9,779	1,918

Key: BKT = Bhaktapur; KTM = Kathmandu; KIR = Kirtipur; LAL = Lalitpur; MPT = Madhyapur Thimi
Source: DWSS 2004

Table 5.6: **Status of water supply in Kathmandu Valley**

Description	1999	2001	2002	2003	2004
Production capacity million litres per day (mld)	125.0	132.0	141	144	165
Water demand (mld)	160.0	177.0	281	290	294
Average daily production (mld)	105.0	112.0	120	124	145
Water leakage (waste) in %	38.0	37.0	37	37	36

Source: NWSC 2004

Table 5.7: **Distribution of stone spouts by type of use**

Description	BKT	KTM	KIR	LAL	MPT	Total
No. of naturally operated stone spouts	31	35	8	42	43	159
DWSS operated stone spouts	25	2	0		6	33
Not used	24	34	0	4	9	71
Status not known	3	31	3	7	0	44
Total number of stone spouts	83	102	11	53	58	307

Key: BKT = Bhaktapur; KTM = Kathmandu; KIR = Kirtipur; LAL = Lalitpur; MPT = Madhyaput Thimi
Source: NGO Forum 2005

The only government-led agency, DWSC covers about 70% of the total demand for water in the urban areas (Table 5.5). The remaining needs are met the individual households themselves.

The status of water supply and demand in the Kathmandu Valley is shown in Table 5.6. The production capacity for drinking water in the valley increased from 125 in 1999 to 132 mld in 2001. Likewise the status of other parameters has also improved. The percentage of NWSC household connections is only 47.4% of the total households of 240,000 (NWSC 2001).

The distribution of stone spouts, one of the traditional sources of drinking water in the valley's municipalities, is shown in Table 5.7. One major problem with this source is that the number of stone spouts drying up is increasing due to lack of proper maintenance and management.

There are 37 man-made ponds (16, 4, and 14 in Bhaktapur, Kathmandu and Lalitpur districts respectively), and three natural ponds (one each in three districts), and one reservoir in Lalitpur district (Friends of Bagmati 2006).

Water quality

As stated above, the major sources of drinking water in both rural and urban areas of the valley are surface and groundwater. The water is used for different purposes: drinking, bathing, washing, swimming, irrigation and during cremation. The quality of water, as indicated by faecal coliform, must be zero per 100 ml for drinking purposes according to WHO guideline values.

Table 5.8 shows the bacteriological and chemical quality of drinking water sources. It is found that the values of selected chemical parameters lie within WHO guideline values, whereas the values of selected bacteriological parameters are not within WHO guidelines; they are contaminated either at the source or at the points of consumption.

The groundwater source for drinking water is also contaminated (Figure 29). Arsenic contamination is found in some groundwater, water samples especially in deep tube wells, as shown in Figure 30 (JICA/ENPHO 2005).

The degraded quality of both surface water and groundwater in the valley is due to sewage, industrial effluents, leachate from solid wastes, and infiltration of agricultural residue. In the cities, 20,846 kg of domestic sewage is discharged daily into the Bagmati River, which constitutes 42% of the total BOD load produced. The total industrial BOD load discharged directly into the river is 3,151 kg/day (CEMAT 2000).

Table 5.8: **Bacteriological water quality of different water sources, Kathmandu Valley**

Parameters	Water Sources				WHO GV
	PTW	PUTW	Well	SS	
pH	6.5-8.2	6.5-7.5	7.5	7.5	6.5-8.5
Temp (°C)	13-18	12-15	15-18	15-18	25
Iron (mg/l)	ND-0.2	0.2	0.2	0.3	0.3 -3.0
Chlorine (mg/l)	ND	ND	ND	ND	0.2
Chloride (mg/l)	10-30	22-45	26-27	23-45	250
$N\text{-}NH_4$ (mg/l)	ND-0.2	0.2	0.2	0.2	0.04-0.4
PO_4 – P (mg/l)	0.1	0.1	0.1	0.1	0.4-5.0
Coliform bacteria (source points)	+/-	+	+	+	-
Coliform bacteria (consumption point)	+				-
E. coli cfu/100 ml	10-131	3-20	48-200	58	0

Source: Pradhan et al. 2005
Note: PTW = private tap water, PUTW = public tap water, SS = stone spout, WHO GV = World Health Organisation guideline value

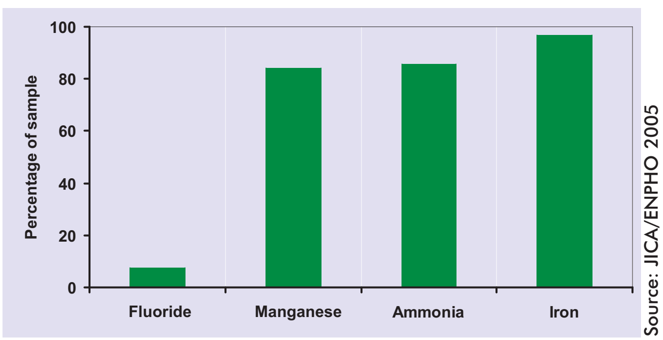


Figure 29: Contamination of groundwater, Kathmandu Valley

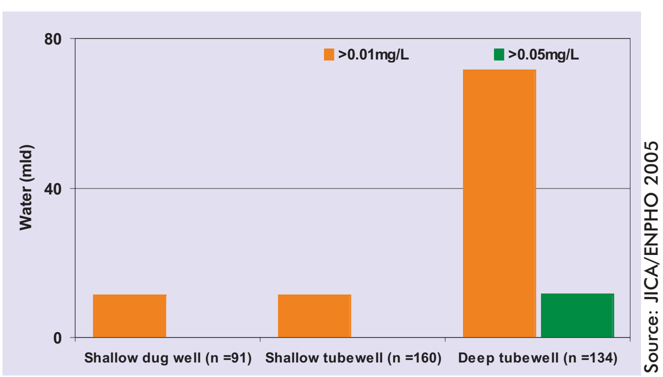


Figure 30: Arsenic concentration in groundwater (pre-monsoon season), Kathmandu Valley

BOD_5 is an indicator of organic pollution which has a direct relationship to the quality of river water. Figure 31 compares the change in concentration of BOD among 7 sites from the headwaters to downstream along the Bagamati River in three different years – 1988, 1998, and 2004 (DSVI/ENPHO 1988; Pradhan 1999; Kayastha 2005).

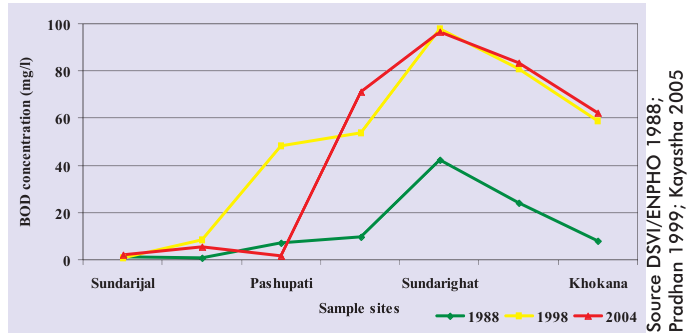


Figure 31: BOD trend of the Bagmati River

BOD concentration increased rapidly in all five downstream sites from 1988 to 2004, except for the Pashupatinath site where BOD concentration decreased considerably between 1998 and 2004. This decrease or improvement in water quality may be due to the treatment plant.

Sanitation

Sanitation generally is defined as activities that improve and sustain hygiene in order to raise the quality of life of an individual. It may include personal hygiene; food hygiene; proper handling, storage, and use of drinking water; human excreta disposal; and solid and liquid waste disposal.

Sanitation here is measured in terms of availability of toilets and sewerage facilities. According to CBS (2001), not all households in the valley districts have toilet facilities. The households with toilets account for 81% in Lalitpur district, 90% in Bhaktapur district, and 92% in Kathmandu district (CBS 2001). The households that do not have toilets practice open defaecation. This is the major reason for the contamination of water sources. In Kathmandu city, however, the municipal government has provided public toilets in its core areas.

Most of the households' toilets do not have septic tanks and they are directly connected to the sewerage lines that also discharge into the nearby river. For the households having septic tanks, a municipal service is available for emptying the septic tanks on a demand basis. But even the municipal authority allows the septage being pumped up from the septic tanks to be dumped on the banks of nearby rivers. There are treatment plants for the municipalities (Table 5.9).

Domestic wastewater makes up approximately 93% of the total wastewater generation by the cities, and the remaining seven per cent is industrial wastewater (Table 5.10).

Table 5.9: **Sewerage coverage in Kathmandu Valley**

Description	1999	2000	2001
Total length of sewers (km)	220	225	232
Interceptors	33.7	38.7	40
Laterals	186.3	186.3	192
Number of treatment plants	4	4	5
Population served	390,000	400,000	420,000
Population coverage (%)	40	40	40

Source: NWSC 2001

Table 5.10: **Wastewater production**

Description	Bhaktapur	Kathmandu	Kirtipur	Lalitpur	Madhyapur-Thimi
Total domestic wastewater generated (mld)	5,971	64,497	3,920	15,647	3,069
Volume of industrial wastewater generated (mld)	418	4,515	274	1,095	215
Total wastewater generated (mld)	6,389	69,012	4,195	16,742	3,284
Volume of wastewater collected (mld)	3,195	34,506	2,097	8,371	1,642

Source: Documents from the municipalities; CBS 2001; and discussions with experts, field observations, and estimations

There is a sewerage system in the cities. Even so, the sewer treatment plants are not functioning, except for the Bagmati treatment plant. An additional sewer line to extend services in urban areas and the actual operations of two new defunct sewerage treatment stations at Dhobighat are being programmed this year for Kathmandu and Lalitpur. There is a problem with the sewer system. Overflow often occurs during the rainy season due to poor maintenance of sewer lines. The problem also occurs due to flooding in the rivers which receive direct discharges of domestic and industrial waste.

The sewer system in the valley's core areas is both a closed and open drain system. The newly expanded residential areas are usually devoid of sewers. In a few cases, however, sewage is channelled through humpipe lines connecting to nearby rivers. The storm water is managed by a combined sewer system. City households do not dispose of kitchen, laundry, and bath wastewater separately.

Due to the direct discharge of sewage and wastewater into the rivers without treatment, all the rivers in the valley have been turned into open sewers. It is estimated that about 50,000 kg of BOD_5 per day is produced in the valley. An average of 20,846 kg BOD/day has been recorded for the Bagmati River at the outlet, constituting 42% of the total BOD load produced (CEMAT 2000).

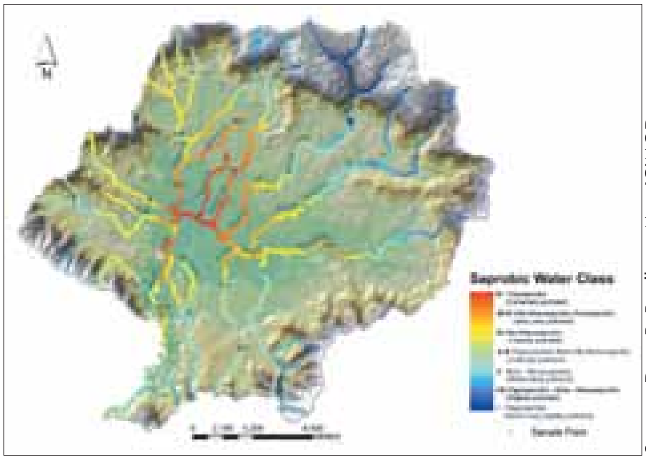
Aquatic biodiversity

The Bagmati River and its tributaries flow through diverse environments in the valley and have varieties of aquatic macro-invertebrate species. Aquatic fauna species include fish, amphibians, and reptiles and all are known as 'vertebrates'. Aquatic flora include benthic, macro, and micro invertebrates. Most of them are pollution indicators and therefore they can be used to determine the quality of river water.

One serious problem with fresh river fish species is that the indigenous fish stocks are declining due to over-fishing, harmful fishing practices (electro-fishing, dynamiting, use of chemicals), pollution and development work. Development work, such as river damming or creation of reservoirs, has affected the river ecology and aquatic flora and fauna. Unlike fish, aquatic insects in the are little known. No information is available about how many aquatic animals are threatened or extinct.

By using the Saprobic method that describes the relationship between riverine ecology and river water quality, the quality of the Bagmati River water can be divided into four major classes ranging from best (pristine) to worst: SWQ Class I (*oligosaprobic* – no to very slight pollution with a variety of species), SWQ Class II (*beta-mesosaprobic* – moderate pollution rich in individuals, biomass, and species' number), SWQ Class III (*alpha-mesosaprobic* – heavy pollution with tolerant macroforms), and SWQ Class IV (*polysaprobic* – extreme pollution with macro benthic life restricted to air-breathing animals). Three intermittent sub-classes of these four major Saprobic Water Qualities (SWQ), viz. I-II, and II-III and III-IV can also be identified. By doing so, the Bagmati River water shows a continuum state of water quality in terms of macro-invertibrates (Figure 32). The description of each water quality class is based on abundance and diversity of macro-zoobenthos present in the river.

Table 5.11 shows that varieties of clean river water species prevail in the headwater region (Classes I and I-II), and only a few tolerant species dominate in the



Source: Data B. Pradhan; Map ICIMOD

Figure 32: Saprobic water quality class, Bagmati River

Table 5.11: **Distribution of macro-invertebrates by SWQ class along the Bagmati River**

Group	Number of families by SWQ class							Total
	I	I-II	II	II-III	III	III-IV	IV	
Tricladida	1	1	1	1	1	0	0	5
Gastropoda	2	1	2	3	2	2	1	13
Oligochaeta	1	1	1	1	1	2	1	8
Hirudinea	1	0	1	1	1	1	0	5
Ephemeroptera	5	6	6	5	4	3	1	30
Odonata	3	2	3	2	2	2	0	14
Plecoptera	2	3	2	1	0	0	0	8
Heteroptera	2	2	3	3	5	3	1	19
Coleoptera	3	3	3	2	2	2	1	16
Megaloptera	1	1	1	1	0	0	0	4
Trichoptera	7	5	4	2	1	1	0	20
Diptera	6	7	4	3	4	5	2	31
Total families	34	32	31	25	23	21	7	173

Source: Pradhan 1998

highly-polluted city core region (Classes III-IV and IV). This indicates that aquatic biodiversity exists in the headwater region, and it is poor in the core areas of the cities because of organic pollution (Pradhan 1998).

Only SWQ Class I with simple physical treatment and disinfection and most of the sample sites of SWQ Classes I-II with normal full physical and chemical treatment with disinfection and SWQ Class II with intensive physical and chemical treatment with disinfection can be used as water for drinking.

Impact

Water ecology

Anthropogenic factors are undoubtedly solely responsible for altering the pristine state of the rivers. As mentioned earlier the rivers in the valley have been major sites for urban solid waste disposal, household effluents and open defaecation, and industrial effluents. Other activities such as dumping debris, agricultural residue, cremation of dead bodies, slaughtering, squatter settlements, animal sheds, washing clothes, and quarrying of pebbles and sand are also water-polluting factors (Tuladhar 2006).

As noted earlier the river water is already mixed with wastewater, which is extracted by pumping or by manual extraction for irrigation. Wastewater is accumulated in shallow ponds to settle for some days before using it for agriculture. Farmers are aware that they should never use wastewater directly in agriculture because it causes a decline in crop yields.

Source: D. Tuladhar

Squatter settlement along the river, Chandani Nagar, Kathmandu Valley

Wetlands

Since wetlands provide habitats for a number of endemic and threatened biological species, human groups rely on wetland resources for their livelihood and they are valuable for ecological maintenance and socioeconomic development. Unfortunately, however, the wetlands of the valley and their rich biological resources are facing threat due to the growing demand for land and a variety of products and services. Among these threats are siltation, eutrophication, over-exploitation and illegal harvesting of wetland resources, pollution, overgrazing, encroachment, development activities in adjoining areas, drainage, and floods. Due to conflicts among the local people over the resources in and around wetlands and absence of an effective mechanism to ensure efficient local-level management of these valuable resources, valuable biological species are gradually becoming extinct.

Eutrophication of most of the valley's water bodies is increasing rapidly due to human interference. For instance, a study of three ponds — Bhinpukhu, Lavapukhu, and Taudah — shows that the nutrient concentration in these ponds increased due to human interference. Water hyacinths in Taudah have increased. Likewise, the nitrogen and phosphorus and chl-a concentration has also increased, showing that the pond's environment is eutrophic. Further, there is a dominance of green algae, *Straustrum tetracerm,* in Taudah and blue green algae, *Microcystes* sp, in Bhinpukhu and Lavapukhu. The dominant animal species are *Copepoda* for Taudah and *Rotifera* for the other two ponds. The water quality in these three ponds is biologically not suitable for domestic purposes due to the presence of faecal coliform (>100cfu/100ml) and high heterotrophic counts (>10000cfu/ml). The productivity of these ponds seems to have increased through autochthonous (inner sources) and allocthonous sources (outside sources) of the water bodies.

Public health

Water pollution is the most serious public health issue in Kathmandu Valley. There is a vital connection between water and health. Solid waste disposal and dumping household and industrial effluents into the rivers and so on are responsible for the deteriorating quality of river water, causing water-borne diseases such as diarrhoea, dysentery, cholera, and skin diseases. Next are the water-washed diseases which occur as a result of poor sanitation.

In addition, when the total treatment capacity for drinking water is lower than the amount of water produced, the quality of drinking water becomes substandard. For instance, in 1998, treated water coverage of the total water supply was over 80% (NWSC 1999). However, most drinking water samples in the valley have residual chlorine levels lower than the WHO standard of 0.2 mg/l (ENPHO 2000). This means that the treatment of drinking water is not effective.


Source: P. Dangol

Bhinpukhu, Kirtipur, Kathmandu, Nepal

A report from Teku Hospital in Kathmandu shows that 16.5% of all deaths had been due to water-borne diseases (Metcalf and Eddy 2000). Table 5.12 summarises the occurrence of diseases caused by poor water quality.

Table 5.12: **Diarrhoeal and worm infestation diseases**

Area	Total OPD visits	Patients with diarrhoea		Patients with worms	
		No.	%	No.	%
Nepal	8,642,852	816,481	9.4	666,362	7.7
Bhaktapur	31,988	2,265	7.1	1,787	5.6
Kathmandu	173,042	15,144	8.8	9,193	5.3
Lalitpur	94,655	7,263	7.7	5,745	6.1

Source: Department of Health Services 2003

Table 5.13 shows the common types of intestinal parasites in stool samples (n=460) tested at the Communicable Diseases Hospital, Kathmandu. The positive samples account for nearly 37% of the total. All parasites in the stool samples are caused by poor hygiene and sanitation.

Table 5.13: **Types of parasites in stool samples**

Parasites	No.	%
Ascaris lumbricoids	48	28.40
Entamoeba histolytica	64	37.87
Hookworm	40	23.67
Giardia lamblia	10	5.92
Trichurus trichura	6	3.55
Hymenolepis nana	1	0.59
Total positive samples	169	100

Source: Teku Hospital, Kathmandu (date: 16 Jul to 16 Aug 2004

The status of health and environmental indicators directly and indirectly related to the quality of water is shown in Table 5.14. In most cases, the valley is better off than the total urban and country average in Kathmandu (worse than both country and urban averages), and access to safe water in Bhaktapur and Lalitpur is poorer than the urban average.

Aesthetic values of water bodies

Public perception is often related to the aesthetic value of river water quality which is generally measured in terms of taste, odour, colour, and clarity. Depending upon these four factors, people decide whether to use water for drinking or other domestic purposes.

Source: D. Tuladhar

Children bathing at a polluted site of the Bagmati River at Gothatar

Source: D. Tuladhar

Sand quarrying activities at Shankhamul

Table 5.14: **Health and environment indicators**

Municipality	Infant mortality/ 1000 live births	Population with access to sanitation (%)	Population without access to safe water %
Bhaktapur	24.01	83.16	19.71
Kathmandu	30.65	92.30	11.05
Lalitpur	40.12	81.42	15.85
Total urban	51.71	77.06	11.46
Nepal	68.51	39.22	20.48

Source: UNDP 2004

In Kathmandu Valley, water bodies like rivers, ponds, and spring sources (kund) are considered to be sacred places for performing religious activities, such as bathing, cremation of the dead, places to worship gods and goddesses, and recreation. The inhabitants now hesitate to perform these activities due to the poor quality of water. The aesthetic values of water bodies have also been greatly affected by the haphazard construction of houses, river bank encroachment, dumping and discharge of household waste and sewage, discharge of industrial effluents into the rivers, and quarrying of sand and stone. These activities, which are associated mostly with urban development, are considered injurious to the preservation of the aesthetic values of water bodies. They are not beneficial from an ecological perspective either.

Box 5: Local people's awareness

The people of Chapagoan have raised their voices against the depletion of water sources caused by the Champapur and Purna Stone quarries, which are located in the Jyaluntaar Community Forest. They are continuously raising public awareness about it through publishing flyers and organising rallies.

Source: Pryawarnya (Nepali magazine), 2006, No. 64, pp 33-35

Others

Other activities can have an adverse impact on the aquatic flora and fauna of streams and ponds. The use of local stream water to sell for domestic supplies, irrigation for vegetables, and sand and stone quarrying is increasing, and as a result, employment generation has also increased. Using local rivers as sources of water for consumption and for irrigating vegetable fields are examples of their economic use. Both relate to urban demand.

Quarrying of sand and stone from rivers is also intensifying because of urban demand. This has caused danger to some of the bridges and they could collapse. Such phenomena seem to have occurred basically in the rivers flowing in and around the valley's cities. These have made the river water turbid and caused an increase in loss of biodiversity and the rivers' aesthetic values. The stone quarried from both the rivers and mines is being supplied to an estimated 89 stone crushers in the valley. The continuous quarrying of stone from mines covered by forest is leading to the drying up of water sources.

Response

Realising the ecological, economic, and social importance of water, attempts have been made by the government to improve the situation of water bodies through adopting different development programmes, organisational adjustments, and research activities. Government, semi-government and non-government organisations have been directly or indirectly involved in development, management, conservation, and planning of water bodies for the valley, either through their own efforts or through economic and/or technical assistance from international and bilateral agencies.

Water resource acts

The Water Resources Act 1993 – This act is of great significance as it vests ownership of all water resources in the State. Private ownership is disregarded. The Act has appropriately recognised drinking water as the priority in terms of order of use, followed by irrigation, farming enterprises such as animal husbandry and fisheries, hydroelectric power, cottage industries, water transport, and others.

The National Water Resources Strategy 2002 – The NWRS aims to develop and manage water resources for sustainable use, ensuring conservation and protection of the environment in a holistic and systematic manner. The following are the major thrusts of the strategy.

- The strategy is to be implemented through adopting three phases of the Water Strategy Formulation Process (WSFP) (WECS 2002): (i) phase 1: 1995-97 – identification of issues, (ii) phase 2: 1998-2001 – formulation of the strategy, and (iii) phase 3: 2002-03 – the National Water Plan (NWP) and Environment Management Plan.
- In the NWRS, drinking water is stated to be the basic minimum need of all human beings. Provision of convenient, safe, and adequate drinking water is the declared commitment of the Government of Nepal. The Tenth Plan document mentions that 85% of the total water demand will be met by the end of the plan period (2008) with gradual improvements in service levels; appropriate sanitation services in rural and urban areas will be provided through community awareness programmes; and infant mortality will be reduced by bringing about a reduction in water-related diseases. To increase the access of the population to drinking water, the following efforts are underway.
  - Rainwater harvesting programmes in feasible areas
  - Community-based water supply and sanitation sector projects, particularly in the mid- and far-western regions
  - Rural water supply projects/water resource management programmes by national and international NGOs in different parts
  - A community-based rural water supply and sanitation programme
  - A small town water supply and sanitation programme
  - A water quality improvement programme
  - A sanitation education and hygiene promotion programme
- The Water Resources Strategy (WRS) formulated in 2005 (WECS 2005) envisaged three types of periodic plans to achieve the national water sector goal, 'living conditions of the Nepali people significantly improved in a sustainable manner'.
  - The three types of plan are short-term (5 years) – for implementing a comprehensive water resource strategy; medium-term (15 years) – for provision of substantial benefits to the people; and long-term (25 years) – to maximise benefits accrued from water resources in a sustainable manner

Table 5.15 summarises the estimated costs of water supply and sanitation.

- An NWP has been formulated for the first time in an integrated manner with different sub-sectors related to water. The NWP, which has been prepared through a series of consultations and workshops, contains several sub-programmes related to the water sector and each sub-programme has targets and action programmes (WECS 2005). The targets are specifically divided into three periodic plans: 2007, 2017, and 2027. The water sector sub-programmes are as follows: (a) Water Induced Disaster, (b) Environmental Action Plan on Management of Watersheds and Aquatic Ecosystems, (c) Drinking Water Supply, Sanitation and Hygiene, (d) Irrigation for Agriculture, (e) Hydropower, (f) Industries, Tourism, Fisheries and Navigational Uses, (g) Water Related Information System and River Basin Management, (h) Regional Cooperation, (i) Legal Frameworks, and (j) Institutional Mechanisms.
- In order to complete the planning process, the NWP has included other activities such as an investment plan, environmental management plan, and a monitoring, evaluation, and updating system.

Table 5.15: **Estimated programme costs for water supply and sanitation (in million Rs. at 2003/04 price levels)**

Programme costs	Short term	Medium term		Long term		NWP Total
	10 th plan	11th Plan	12th Plan	13th Plan	14th Plan	
Kathmandu Valley	17,116.1	24,878.1	79,00.4	11,009.9	9,542.2	70,446.7
Total programme costs	29,028.8	42,744.9	48,951.4	53,243.7	57,389.3	23,1358.1

Source: WECS 2005

- The following observations can be derived from the drinking water programme of NWSSP (Nepal Water Supply and Sewerage Programme).
  - NWSSP basically emphasises enlarging drinking water coverage, but emphasis alone will not be adequate unless quality (potable) and quantity (per capita) aspects are determined. These two aspects are vital in terms of health and sanitation.
  - NWSSP's health and sanitation education programme to reduce water-related diseases will not be effective unless the water sector defines a potable water standard for Nepal. Further, to make it effective, the living standards of the rural communities need to be raised through providing income-generating activities. This will make them capable of paying the ever-increasing water and sanitation tariffs. However, this issue is not only one for the drinking water sector, it is interlinked with many other sectors related to water, sanitation, and health. A coordination mechanism is required at national, sub-national, and local levels because water-related diseases are connected to all of them.

Irrigation water payments

Farmers in the valley do not pay for the use of river water to irrigate their fields. Virtually there is no irrigation canal in the valley's urban areas and even the traditionally built Raj Kulos are not maintained and therefore are not working. However, the household pays for its sewer connection to the river each month together with the payment for drinking water.

Industries

MoEST is responsible for determining environmental standards. The maximum tolerance by different selected parameters has been determined by NBSM (2003) for three types of effluents, e.g., industrial waste into inland surface water, wastewater from combined wastewater treatment plants (CWTPs) into inland surface water, and industrial effluents into public sewers. Field observations show that these standards are not followed strictly in practice. Similarly, the general standard has been determined as the tolerance limit of wastewater effluents discharged into inland surface waters and public sewers for nine different industries: leather, wool processing, fermentation, vegetable ghee and oil, dairy products, sugar, cotton textiles, soap, and paper and pulp (NBSM 2001). However, the implementation of these standards is not in practice in most cases.

Legislations – acts

Efforts to conserve water resources undertaken by the government through legal measures can be described in terms of the acts and regulations; viz. the (a) Environmental Protection Act (EPA) (1997) and Environmental Protection Rules (EPR) (1997) and the Amendment of 1999; (b) Water Resources Act (1992), Water Resources Regulations (1993), (c) Solid Waste Act (1987), Solid Waste Regulations (1989), (d) Electricity Act (1992), (e) Soil and Watershed Conservation Act (1982), and (f) Aquatic Animals' Protection Act (1965).

However, the existing laws and byelaws for managing the urban environment are not adequate. Furthermore, failure to enforce laws and byelaws and absence of clear-cut institutional responsibilities are major reasons for pollution of urban rivers.

Millennium Development Goals (MDG)

The activities planned to help meet the MDG goals by 2015 for drinking water and sanitation are as follows.

(i) Drinking water

- Water supply in Kathmandu is piped and the Melamchi tunnel built
- Total resource requirements estimated = $936 million for drinking water
- Provides 51% of the total drinking water for Kathmandu ($576 million)

(ii) Water and sanitation (WAS)

- Per capita cost for WAS technology for a small town = $40
- Per capita cost for WAS technology for Kathmandu = $312
- No. of additional households to be served per month per VDC = 1.8
- Urban area of an additional five households per ward to be served each month
- To meet the sanitation goals, 2.5 toilets in each VDC and five toilets in each municipal ward to be constructed each month

Future water supply projects

Table 5.16 describes the future water projects for Kathmandu Valley towns divided into three stages.

Table 5.16: **Future water projects – stages**

Duration	Project	Capacity
Short term	Small surface water and groundwater extraction	20 mld
Mid term	System rehabilitation	45 mld
Long term	Melamchi	170 mld

Key: mld = million litres per day
Source: WECS 2005

(i) Melamchi drinking water project

- The Melamchi drinking water project will bring a total of 510 mld to the Kathmandu Valley, and this will be sufficient up to the year 2030. The project will be completed in three stages, viz. (a) Stage I: 170 mld from the Melamchi River, (b) Stage II: 170 mld from the Yangri River, and (c) Stage III: 170 mld from the Larke River.
- Upon completion of the Melamchi water supply project, the consequences can be envisioned as follows.
  - The consumption of water will increase and, as a result, wastewater will also increase and eventually raise the water level in the rivers, rendering them capable of carrying away their loads.
  - The rate of extraction of groundwater will decrease and, as a result, groundwater recharge will increase and be maintained.
  - Settlements, particularly on the river banks, will be at risk due to an increase in the water levels.
  - Awareness in local communities will be raised about water use rights to streams flowing through their own areas. Upstream communities will begin to demand the right to control the use of water from streams originating or flowing through their own areas. For instance, the inhabitants of the Melamchi area have demanded the right to share in the use of the water from the Melamchi River with the inhabitants of the Kathmandu Valley for drinking purposes. They are demanding compensation for use of the water from the river.

Other water sector activities

The Ministry of Physical Planning and Works (MPPW) in collaboration with different organisations, including local organisations, NGOs, and INGOs, has introduced the following activities to improve the water quality and environment of the Bagmati River.

ENPHO/ADB/UN-HABITAT/WAN have introduced community wastewater treatment in Madhyapur-Thimi by artificial wetland treatment for 200 households. About 50,000 litres of wastewater have been treated and reused, and an awareness programme is being implemented in the communities and schools.

- Kathmandu municipality has been operating a small-scale, localised wastewater treatment plant at Teku since 1998. The treatment system is based on a constructed wetland management system. KMC is collecting the sludge of 10-15 truckloads (each load with $6m^3$) from the septic tanks of private houses and treating it before discharging it into the river.
- Ecological sanitation (ECONSAN) – as per 2005, the number of Econsan units in the Kathmandu Valley has reached 124.
- The solar disinfection (SODIS) method for drinking water has been introduced by KMC and EDWAG /SANDEC particularly in squatter settlements and schools; it has targeted over 50,000 households for awareness raising). There are about 12,000 SODIS producers in Kathmandu Valley.
- The UN-HABITAT Water for Asian Cities (WAC) Programme Nepal has recently prepared terms of reference for cleaning the Bagmati River. The activities include (i) preparation of a comprehensive local catchment management strategy in one watershed area in the upstream reaches of the Bagmati River System for the Bagmati Area Sewerage Project (BASP), and (ii) preparation of a comprehensive faecal sludge management strategy for Kathmandu Valley for BASP. Likewise, to achieve one of the goals to improve water and sanitation under the MDGs, MPPW, in collaboration with WAC, has introduced programmes to improve water and sanitation in peri-urban centres in the Kathmandu Valley, e.g., Khokana, Bungamati, Siddhipur, and Lubhu.
- Other activities include rainwater harvesting, recharging shallow groundwater through dug wells and ponds, water quality standard acts for approval, wastewater standards approved for nine industries, and water guards.

Figure 33 demonstrates the water disinfectant practices in Kathmandu Valley. The Kathmandu Participatory River Monitoring (KAPRIMO) project is working on a demonstration of a functioning and non-functioning river monitoring system through a participatory approach.

International conventions and treaties

Nepal is a party to a number of broader international conventions and treaties, including the Rio Conference of 1992 related to water, environment, and development.

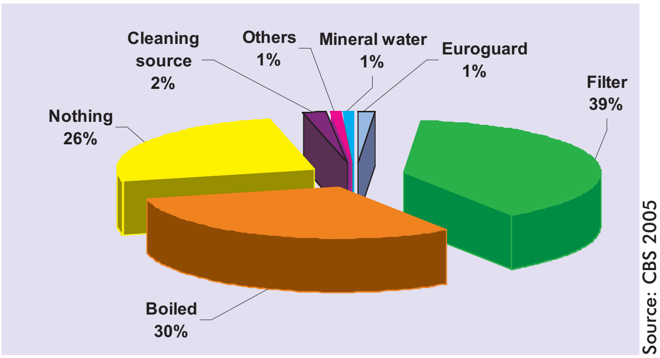


Figure 33: Disinfectant methods

In addition, Nepal is committed to various conventions, treaties, and agreements related to water and sanitation and ecology, such as the Convention on Wetlands which is of of international importance, especially for waterfowl habitats (Ramsar Convention) – to prevent the loss of wetlands, Convention on Biological Diversity (CBD) – to ensure conservation, sustainable use and equitable sharing of the benefits of biological resources, UN Convention to Combat Desertification (CCD) – to combat desertification and mitigate the effects of drought through effective action at all levels, the Basel Convention on Transboundary (international) shipments of waste, the Rotterdam Convention – prior informed consent (PIC) for shipment of chemicals, and the Stockholm Convention – Persistent Organic Pollutants (POPs)

6

Waste Management

Solid waste and wastewater are the two most visible environmental nuisances and major causes of pollution in the urban areas of Kathmandu Valley with consequences beyond the urban limits. Managing solid waste and wastewater in Kathmandu has become a daunting task as urban areas have grown haphazardly without provisions or plans for appropriate infrastructure and services in these sectors: a typical trend is that first housing/ settlements/ urban areas expand without any plan and then infrastructure and services are demanded. Theoretically, this should be the reverse. Urban expansion should follow plans and provision of infrastructure. Consequences of unplanned haphazard urban growth are that providing infrastructure and services becomes complex and difficult; infrastructure and services provided become inefficient and ineffective; and pressure on the existing infrastructure and services increases beyond their capacity as they were designed for certain conditions/limits.

Traditionally, solid waste and wastewater generated in Kathmandu Valley's urban areas were re-used/ re-circulated in agricultural activities in nearby rural areas. This was possible as the waste was mostly organic and urban settlements were surrounded by agricultural fields. But this is no more the case and this waste is polluting the environment. The DPSIR analysis of waste generation is presented below.

Drivers

Centralisation and rapid urban growth

The main driving force behind rapid urban growth in the Kathmandu Valley is centralisation. As power, wealth, and services such as education and health facilities, infrastructure, and international linkages have been historically concentrated in the Kathmandu Valley, it has attracted people from all over the country. Kathmandu Valley is the most urbanised region in Nepal. About 60% of its population reside in urban areas; and this was only 47% in 1980. Over the years not only the urban population, but also the urban growth rate has increased, e.g., the urban growth rate was about four per cent in the 1970s and over five per cent in the 1990s (Sharma 2003). Some studies indicate a rate as high as seven per cent or more in the case of Greater Kathmandu[7]. The urban population of Kathmandu Valley has increased five-fold since 1950. Increased population generates increased waste, both solid waste and wastewater.

Pressure

Unplanned and haphazard urban expansion

Although various plans were prepared for urban development of the Kathmandu Valley, urban areas continue to grow haphazardly and without appropriate planning and infrastructure such as water supply and sewerage systems, solid waste management facilities, and services. Properly planned urbanisation can play a positive role in promoting economic activities, as well as in promoting conservation of resources to reduce pressure on land resources. However, haphazard and unplanned urbanisation leads to many environmental difficulties such as those presented by solid waste and wastewater management.

Change in consumption patterns and living standards

The consumption patterns and living standards of the urban dwellers of Kathmandu Valley have been changing gradually over the years. Availability and use of modern facilities, such as flush toilets, and changes in lifestyle/consumption patterns have contributed to i) producing more waste and ii) changing the composition of waste, e.g., plastics in solid waste and detergents/ chemicals in wastewater. Solid waste and wastewater generated in the urban areas of Kathmandu Valley are more polluting now than they were five decades ago.

[7] Kathmandu Metropolitan City and Lalitpur Sub-metropolitan City together are referred to generally as Greater Kathmandu.

Commerce, business, industry, and services

Over the last thirty years, Kathmandu Valley has experienced significantly higher commercial and business activities than other parts of the country. Services, such as hospitals, have expanded. The World Conservation Union (IUCN 1999) reported that about 51% of the total industries in Nepal with employment of more than 10 persons are located in Kathmandu Valley. Balaju, Patan, and Bhaktapur are the three industrial estates in the valley: out of 2,174 industries in the valley, only 202 industries are operating inside the industrial estates. Industries have been established in a haphazard manner in the absence of land-use planning and industrial zoning. The main areas in which industries are concentrated are the central and southern part of the valley, Balambu-Satungal, Satdobato-Godavari, Koteshwor-Bhaktapur, and Kalanki-Thankot. There are over 40 types of industry in the valley, including carpet weaving, garment manufacturing, washing, dyeing, dairy products, bakeries, animal feed, breweries and distilleries, pharmaceuticals, plastic products, and chemicals. About 80% of the industries scattered throughout the valley have the potential to affect land, water, and the environment. The business, commerce, services, and industries generate waste, and this is quite different from domestic waste.

State

Municipal solid waste

Municipal solid waste generation rates – Solid waste generation rates vary depending upon living standards, livelihood practices, and consumption patterns. Studies carried out in the past suggest that the waste-generation rate has changed over the years in Kathmandu's urban areas (Table 6.1). The current estimated generation rates of municipal solid waste in five municipalities of the Kathmandu Valley are given in Table 6.2.

Amount of Municipal Solid Waste – The amount of municipal solid waste generated can be estimated on the basis of unit rates and population. The five municipalities generate daily approximately 435 tons of solid waste, of which more than 70% comes from KMC. An estimated amount of municipal solid waste generated in the five municipalities of Kathmandu Valley is shown in Table 6.3.

Table 6.2: **Recent estimates of waste generation rates in five municipalities (kg/person/day)**

Municipality	IDI Pvt. Ltd. 2004 (2003 survey)		Nippon Koei 2005 (2004 survey)	
	Household rate	Municipal rate	Household rate	Municipal rate
Kathmandu	0.39	0.52	0.250	0.416
Lalitpur	0.54	0.72	0.285	0.416
Bhaktapur	0.39	0.52	0.120	0.316
Madyapur Thimi	0.11	0.15	0.160	0.266
Kirtipur	0.34	0.45	0.150	0.266

Note: IDI 2004 assumes the same multiplying factor (1.333) to calculate municipal waste generation rates from the household rates. Nippon Koei 2005 uses different multiplying factors in each of the five municipalities.

Table 6.3: **Waste generation in five municipalities (tons/ day)**

Municipality	Generation in 2004	Collection in 2004	Projected generation 2015
Kathmandu	308.4	250	547.9
Lalitpur	75.1	52	135.4
Bhaktapur	25.5	19	46.2
Madhyapur Thimi	14.3	5	27.8
Kitipur	11.6	4	18.1
Total	**434.9**	**330**	**775.4**

Source: Nippon Koei 2005

Table 6.1: **Municipal waste generation rates in Kathmandu over the years, kg/person/ day**

Study	Year							
	1978	1988	1990	1993	1998	1999	2003[a]	2004[b]
Lohani and Thanh	0.25							
GTZ		0.4						
Rai			0.565	This estimate appears to be high compared to the trend shown by other studies.				
Khanal				0.46				
Mishra and Kayastha (vary depending on population size: 0.4 kg/person/day from 100,001 to 400,000 people; 0.5 kg/person/day for more than 400,000 people)					0.25 to 0.50 kg/person/day			
RESTUC						0.48		
IDI Pvt Ltd							0.52	
Nippon Koei et al. (CKV study)								0.416

Source: Various sources quoted in UNEP 2001 and [a] IDI 2004, [b] Nippon Koei et al. 2005

Composition of Municipal Waste – Composition of municipal waste changes over time as consumption patterns change. Various studies carried out since 1976 indicate that around two-thirds of the municipal solid waste generated in Kathmandu Metropolitan City is organic: this has remained relatively unchanged over the years. The amounts of plastic, paper, metal, and textiles in municipal solid waste have changed significantly: plastic increased from less than one in 1976 to more than 16% in 2004; paper increased from around six to around nine per cent; metal decreased from about five to less than one per cent; and textiles decreased from around six to around three per cent (UNEP 2001; CBS 2005).

Electronic waste such as parts of mobile phones, computers, televisions, and so on are new constituents of solid waste in the Kathmandu Valley: solid waste management workers report these waste products although no data are available at present regarding their share.

The recent composition of solid waste in the five-municipalities is compared in Table 6.4 below.

Municipal solid waste management

Figure 34 shows the institutions involved in solid waste management in Kathmandu Valley's urban areas and Figure 35 those involved in wastewater management. At the operational level, the municipalities are the main bodies responsible for solid waste management on a daily basis. They spend significant amounts (typically in the range of 20 to 25% of their total expenditure) on solid waste management and have established separate sections within their institutions to deal with waste.

A significant number of non-government organisations (NGOs), community-based organisations (CBOs), and the private sector are involved in solid waste management activities in the five municipalities. They

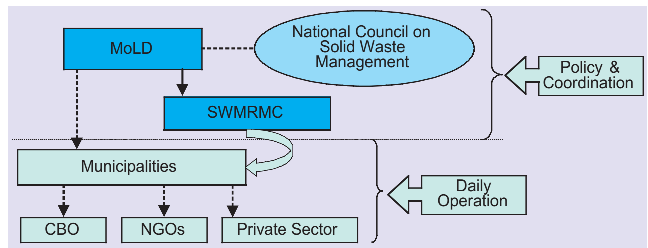


Figure 34: Institutions and their roles in Solid Waste Management (SWM) in Kathmandu Valley

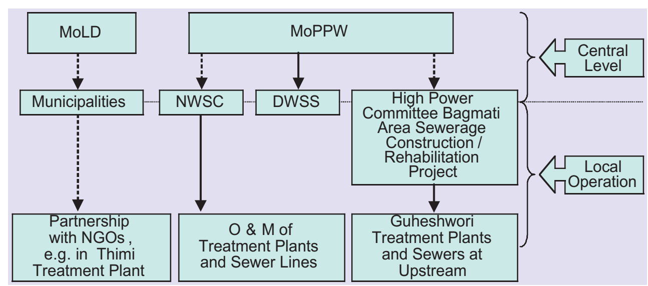


Figure 35: Institutions and their roles in wastewater management in Kathmandu Valley

Table 6.4: **Composition of municipal solid waste, % of waste (by weight)**

Content	Kirtipur	Kathmandu			Lalitpur		Bhaktapur	Thimi
	2000	**2002**	**2003**	**2004**	**2003**	**2004**	**2003**	**2003**
Organic	74	69	69	66.00	54.0	67.5	70.16	70.1
Paper	3	9	9	10.40	9.9	8.8	2.37	4.9
Rubber	1	1	1	0.24	-	0.3	0.05	0.55
Leather	2	n.a.	n.a.	0.24	-	-	-	-
Wood	0	1	1	-	-	0.6	-	-
Plastic	9	9	9	16.30	9.49	11.4	3.23	8.25
Textile	6	3	3	3.58	2.72	3.6	1.69	2.31
Ferrous metal	-	1	1	0.84	2.03	0.9	0.07	0.25
Inert	-	-	-	1.01	0.03	-	21.05	12
Glass	1	3	3	1.38	12.8	1.6	1.33	1.29
Other	4	4	4	0.04	7.54	5.3	0.05	0.19
Medical waste	-	-	-	-	1.3	-	-	0.2
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Average collection				65.20	38.2		51.28	47.18

Source: IDI 2004 and Kathmandu Metropolitan City, Lalitpur Sub-metropolitan City cited in CBS 2005 play an important role in waste collection (including door-to-door waste collection), in promoting composting by households and the community, as well as in running awareness campaigns. According to informal estimates, around 58 such organisations are active in the urban areas of Kathmandu Valley. They charge about NRs 100 per month per household for door-to-door collection of waste (charges vary from about NRs. 50 to NRs. 200).

The Solid Waste Management and Resource Mobilisation Centre (SWMRMC), established under the Solid Waste Management and Resource Mobilisation Act, used to be the key central agency responsible for solid waste management. However, the Local Self-Governance Act 1999 allocated most of the operational-level functions of solid waste management to the municipalities, and SWMRMC under the MInistry of Local Development (MoLD) is now responsible for developing policies, identifying and developing landfill/ waste disposal sites, and coordination functions. Discussion about roles, responsibilities, and mandates of municipalities and the SWMRMC has been going on since the enactment of the Local Self Governance Act (LSGA). Current practices of municipal solid waste management in urban areas are summarised below.

Street sweeping. Street sweeping is usually carried out by municipal or private sector or NGO employees, usually in the morning (5 to 7 a.m.). In some areas, sweeping is also carried out later in the day (around 1 p.m.) and at night (7 to 10 p.m.).

Collection and transport. The waste deposited on the roadside or on the ground is picked up and transported by municipality vehicles (or recently and to a limited extent by the private sector). The waste is either transported to a transfer station or directly to the final disposal point.

Door-to-door collection. NGOs and the private sector have recently started door-to-door collection services in limited areas. Tricycles or rickshaws are used and households are charged (around Rs 100/ month) for the service. There are around 58 NGOs/ private sector organisations involved in solid waste management.

Composting. Household composting is promoted by distribution of compost bins (100-litre bins). NGOs/ CBOs manage community composting at different locations. Vermi-composting is also being promoted. There is no large-scale or well-managed composting facility, except in Bhaktapur. The composting facility in Bhaktapur receives about three tons of waste/day, and the composting method used is simple, manual open-field heaping: this has been in operation for over 20 years, although it encounters minor management difficulties at times. The composting facility at Teku (capacity 15 tons/day) has been closed since 1990. The private sector has shown an interest in setting up a compost plant: this, however, has not progressed because no site is available and low priority is given to this approach.

Reuse and recycling. Metal, glass/ bottles, plastics, and paper are the main items reused/recycled. Independent collectors collect metal and plastic from houses and sell them to scrap shops. Informal estimates suggest that there are around 250 scrap dealers in Kathmandu Valley. A total of about 116 tons of recycleable material is exported daily from the Valley, excluding bottles, feathers, and waste oil from automobiles (Nippon Koie 2005). Bhaktapur Municipality operates a paper-recycling facility. NGOs/ CBOs are also involved in small-scale paper recycling.


Source: A. B. Manandhar, SEED-Nepal

Solid waste collection


Source: ENPHO

Waste at Teku station

Source: Drona

Bin composting

Source: ENPHO

Okharpowa

Source: ENPHO

Sisdole compaction

Final disposal. Until recently, solid waste from Kathmandu and Lalitpur used to be disposed of along the banks of the Bisnumati and Bagmati rivers. Since June 2005, solid waste from Greater Kathmandu is being transported to the Sisdol landfill site for final disposal. This site also faces public opposition periodically. The long distance, about 25 km, makes transportation to the site costly. The Sisdole landfill site has been designed for three years: about half the time is over. Therefore, it is of some urgency to develop a long-term integrated plan and facility (ies) for managing and disposing of solid waste. Bhaktapur used to dump the waste at the Hanumante River dumping site: at present its solid waste goes to different locations on the banks of rivers and is also used for filling low-laying spots. Kirtipur and Madyapur Thimi have no landfill sites: solid waste collected in Kirtipur is dumped openly on the western bank of the Bagmati River and that collected in Thimi is disposed of by dumping it in open spaces and also along the banks of local rivers.

Industrial solid waste

Balaju Industrial Estate, Patan Industrial Estate, and Bhaktapur Industrial Estate are the main sources of industrial solid waste in Kathmandu Valley. These three estates generate 103,910 kg of solid waste a month (Table 6.5)

There is no systematic approach to managing the solid waste generated by the industrial estates or from industrial enterprises. Enterprises employ sweepers to clean up the premises. The waste is collected in sacks or drums and dumped into pits or backyards or in open spaces, or else it is burned within or outside the premises of the enterprise. The waste is also mixed with municipal waste. Not enough effort is being made to recycle the waste, apart from selling off scrap metal, although around 50% of the waste generated in the industrial estate is recyclable.

Medical waste

Categories of medical waste – The National Health Research Council (NHRC) classifies waste generated in health care institutions (HCIs) into three types: general, hazardous, and sharp. A survey of six hospitals in Kathmandu showed that the proportions of general, hazardous, and sharp in the hospital waste are typically 77, 15, and 8% (Table 6.6). The higher percentage of hazardous waste is present in the bigger HCIs.

Table 6.5: **Waste generated at the industrial estates in Kathmandu Valley, kg/month**

Waste type		Balaju I.E.	Patan I.E.	Bhaktapur I.E.	Total
Bio-degradable	Food/ kitchen	2,500	500	500	
	Agriculture	10,000	2,000	500	
	Sub-total	*12,500*	*2,500*	*1,000*	*16,000*
	%	26.04	5.0	16.7	15.4
Recyclable (not currently recycled)	Paper	10,000	200	1,000	
	Plastic	5,000	2,300	3,000	
	Tin/ iron/ steel	1,300	2,000		
	Wood	3,000	30,000		
	Milk products	200	-		
	Other			20	
	Sub-total	*19,500*	*34,500*	*4,020*	*58,020*
	%	40.63	69.1	67.0	55.8
Non-recyclable	Rubber/ leather	9,500	-	n.a.	
	Inert material + dust	5,000	12,800	960	
	Sub-total	*14,500*	*12,800*	*960*	*28,260*
	%	30.21	25.6	16.0	27.2
Other waste	Hazardous	500	-	n.a.	
	Medical	500	50	n.a	
	Chemical	500	50	20	
	Liquid waste	-	10		
	Sub-total	*1,500*	*110*	*20*	*1,630*
	%	3.13	0.2	0.3	1.6
	Total	**48,000**	**49,910**	**6,000**	**103,910**

Key : I.E. = industrial estate
Source: Based on Nippon Koei 2005

Table 6.6: **Amount and type of waste generated by selected hospitals (kg/day)**

Hospital	Waste type, kg/day (%)			Total, kg/day
	General	Hazardous	Sharp	
Bir	521 (74%)	120 (17%)	60 (9%)	701
Om	221 (83%)	31 (11%)	16 (6%)	267
TUTH	456 (74%)	105 (17%)	53 (9%)	614
Patan	304 (74%)	70 (17%)	35 (9%)	410
Prasuti	251 (86%)	26 (9%)	16 (5%)	292
Total	**1,752 (77%)**	**352 (15%)**	**179 (8%)**	**2,282**

Source: Based on Rawal 2004 and Basyal and Pokhrel 2004 cited in Poudel et al. 2005.

Quantity and rates – There are approximately 61 health care institutions (HCIs) in the Kathmandu Valley with 3,905 beds (Nippon Koei 2005). Surveys carried out in 1997 and in 2000 indicate that rates of generation of Health Care Waste (HCW) as well as health care risk waste (HCRW) in HCIs have increased: in 1997[8] average rates of generation of HCW and HCRW in Kathmandu HCIs were 0.54 kg/patient/ day and 0.16 kg/ patient/ day respectively. In 2000[9], these rates were found to be 1.7 kg/ bed/ day and 0.48 kg/bed/day. By considering the occupancy in HCIs, ENPHO estimated the total infectious waste generation in the Kathmandu Valley in 2000 to be 1,312 kg per day. Table 6.7 presents waste generation at selected health care institutions in the Kathmandu Valley.

Handling of waste in HCIs – Only a limited number of HCIs carry out segregation and treatment of waste. Larger-sized HCIs in Kathmandu Valley use colour-coded bins to segregate waste at the source. However, there is no uniform colour coding system. Although the National Health Research Council (NHRC) categorises three types of waste, some HCIs use two different coloured bins, some three, and some even five. Waste from these bins is typically collected once or twice a day (except in some private nursing homes): the number of bins and frequency of collection are usually inadequate, resulting in complete filling/ overfilling and even spillage of waste. Waste thus deposited is transported either in plastic bags or in open buckets. In many cases, the waste accumulated in separate bins is mixed either

Table 6.7: **Waste generation rate and amount of waste generated at selected hospitals**

Hospital	Waste (m^3/d)
Infectious diseases, Teku	NA
Nepal Eye, Tripureshwor	11
Bhaktapur Hospital	9
TB Hospital, Thimi	7
Ayurvedic	3
Patan	60
Mental	6
Maternity	66
Kanti Bal	40
Birendra Police	NA
TU Teaching	80
Bir	93
Central Veterinary	2

Source : Tuladhar, Bhusan cited in CBS 2005

[8] Surveys conducted in 11 HCIs in Kathmandu.
[9] ENPHO

Source: Lalitpur Sub Metropolitan

Waste pickers collecting medical waste with other waste

in the process of removal from the bins, or during transportation from the point of generation, or during collection in the storage area; and hence making the segregation at source meaningless. The waste storage area in some HCIs is an open space in the premises or at the back of the hospital (except for Patan hospital which has assigned a 'dirty' room in each unit as a waste storage area).

Final disposal of HCI waste – In a few large HCIs, incinerators have been installed for infectious/ hazardous waste. However, many of these are not proper incinerators (they are rather burning chambers) as they operate at low temperature and have low-stack height. Proper incinerators require a lot of investment and operating costs as well as skilled human resources. Incinerators are difficult to operate and maintain, and there is also public opposition to them as they could emit objectionable gases and fumes. Incinerators installed by KMC at Teku could not be used because of public opposition. In recent times, autoclaves have come into relatively wide use in HCIs.

In many cases, infectious waste and sharp objects as well as general waste are disposed of in municipal containers – turning the municipal waste into infectious/ hazardous waste.

Municipal wastewater

Quantity of municipal wastewater. Many factors influence the volume of wastewater generation: the volume of water available for domestic and commercial use, the living standards of consumers, and the types of commercial establishment, e.g., hotels, restaurants, offices, schools, and shops. In urban Kathmandu, residential and commercial areas are not clearly separated, making it difficult to separately quantify the volumes of wastewater generated from these sources. Potential domestic wastewater generation in Kathmandu's urban area in 2000 was estimated to be 124 million litres per day (Mld) , of which only about 47 Mld (about 38%) was collected through the sewerage system (Metcalf and Eddy 2000). The volume of wastewater is likely to increase after the Melamchi Water Supply Project starts supplying water in adequate amounts. The capacity of the existing sewerage system to carry wastewater in future is questionable.

Sewers and drains. Several agencies are involved in construction of storm-water drains and sewers in the urban areas of Kathmandu: the Nepal Water Supply and Sanitation Cooperation (NWSC), Municipalities, Department of Water Supply and Sewerage (DWSS), local communities, the 'High Powered Committee' for Implementation and Monitoring of the Bagmati Sewerage Construction/Rehabilitation Project, and the Department of Roads (DoR). Their work is, however, uncoordinated and unplanned. Sewer construction by municipalities has increased recently, and the sewerage system is expanding significantly (although exact data are hard to find): but all these activities are not well thought out and do not consider treatment aspects. The existing sewers and drains are obviously overloaded; particularly during monsoon when many of them have to cope with storm water although they are not even designed for rain water or for extended areas.

Most of the sewers constructed in Kathmandu Valley by NWSC (which is estimated to be 200 km) are designed as gravity sanitary sewers[10], whereas the DoR constructs roadside drains for surface runoff. The communities and municipalities do not generally differentiate between sanitary sewers and storm drains. In practice, all sewers and drains carry sewage and storm water, as well as industrial effluents if there are industries in the locality, as there is no control and coordination. One example is that the sanitary sewers constructed under international development aid- (IDA) funded projects and storm drains constructed by the Kathmandu Municipality under the ADB-funded project are currently carrying both sanitary sewage and storm water, thus functioning as combined sewers which was what they were designed to do. Outlets from households are also connected to the DoR-constructed road drains and the DoR also connects road drains to sewers. As

[10] Pumping introduced at Sundarighat and in Bhaktapur could not be operated satisfactorily.

there is no zoning, technicians find it difficult to size/ design the capacity of sewers/ drains – as a consequence, the size they select may be inappropriate and the sewers/ drains become overloaded.. There is no coordination between agencies and the provision of sewers does not follow an overall development plan. Many of these sewers may have to be replaced under a well-engineered master plan (Nippon Koei et al. 1999).

Maintenance of existing sewers is very poor: most of the sewers, including the interceptor mains and manholes, are clogged. Street waste and littered garbage are often the items clogging sewer pipes. Currently, only about 70% of the solid waste is collected and disposed of. Overflowing of sewers, drains, and manholes is very frequent in rainy season.

The consumer survey of 1997 indicated that only about half of the NWSC water supply consumers have sewerage connections, on the other hand there are households that receive no water from NWSC which do have connections to sewers (Consumer Survey 1997, cited in Nippon Koei et al. 1999).

Wastewater treatment. Although several wastewater treatment plants have been constructed over the years in Kathmandu Valley, none, except for one at Gaurighat and another at Thimi, is fully functional. The Gaurighat treatment plant also faces technical difficulties (foaming in the aeration tank and sludge floatation in the secondary clarifier, besides high cost of operation). The untreated wastewater is discharged into the rivers.

Quality of municipal wastewater. Residential wastewater mainly contains discharge from the toilets (containing urine, faeces, soap, detergents, etc) and from the kitchen (containing foodstuff, fats, oils, etc). The composition of wastewater from residential sources can be expected not to vary much. However composition of wastewater generated by commercial activities varies according to the type of activity; for example, dry cleaning and photograph development use

Source: ENPHO

Kathmandu Guheshwori wastewater treatment plant

Source: ENPHO

Thimi wastewater treatment plant

Source: ENPHO

Kathmandu Dhobighat wastewater treatment plant

Source: ENPHO

Kathmandu Dhobighat wastewater treatment plant different chemicals generating wastewater of completely different compositions. However, wastewater from both residential and commercial sources is discharged into municipal sewers. Results of municipal wastewater quality tests on samples taken from sewers just before their discharge into rivers are summarised in Table 6.8.

Management of municipal wastewater. Many institutions are involved in dealing with wastewater in the urban areas of Kathmandu Valley (Figure 35).

The NWSC owns most of the sewer lines and treatment plants and is responsible for their operation and maintenance. However, as described elsewhere in this report, municipalities and other agencies also construct these facilities. The government has also formed a high-level committee for improving collection and treatment of wastewater in Kathmandu: the committee has constructed main sewers and a treatment plant upstream from Guheshwori.

Table 6.8: **Composition of municipal wastewater at selected locations**

Parameters (unit)	Location		
	Shantinagar, Naya Baneshwor	Jwagal, Patan	Dhalko Chhetra-pati
Total suspended solids (TSS, mg/l)	264.6	55.8	51.8
Total dissolved solids (TDS, mg/l)	446	504	321
EC (μS/cm)	891	1006	640
pH	7.2	7.3	7.2
Total alkalinity (mg/l as $CaCo_3$)	284	322	182
Dissolved oxygen (DO, mg/l)	0.21	0.36	0.27
BOD (mg/l)	164	57	62
COD (mg/l)	187	69	84
Sulphate (mg/l)	17	41	24
Chloride (mg/l)	89.7	74.6	50.8
Total phosphate (mg/l)	13.2	4.5	8.2
Total nitrogen (mg/l)	81.6	74.1	71.5
Ammonia-N (mg/l)	21.3	15.7	13.8
Nitrate-N (mg/l)	<0.01	0.02	<0.01
Nitrite-N (mg/l)	51.3	50.6	51.6
Lead (mg/l)	<0.05	<0.05	<0.05
Cadmium (mg/l)	<0.05	<0.05	<0.05
Chromium (mg/l)	<0.05	<0.05	<0.05
Mercury (mg/l)	<0.001	<0.001	<0.001
Phenol (mg/l)	0.03	0.03	0.02
Detergent/ soap (mg/l)	0.12	0.16	0.13
Total coliform (number / 100 ml)	TNTC	TNTC	TNTC
Faecal coliform (number / 100 ml)	TNTC	TNTC	TNTC

Source: ITECO Nepal (P) Ltd. 2002
Key: TNTC – Too numerous to count (>50,000 per 100 ml)

Although municipalities are constructing drains that feed into the sewers and have recently begun construction and operation of treatment plants, such as the one in Thimi, there is little coordination with NWSC which owns most of the sewerage works in Kathmandu. Lack of coordination is also apparent between the two ministries, the Ministry of Local Development (MoLD) and the Ministry of Physical Planning and Works (MoPPW) which are the line ministries respectively for municipalities and the NWSC. Although NWSC has been the key central agency for municipal wastewater management in the country, the LSGA gives municipalities the authority to manage wastewater.

Septic tanks and septage

Septic tanks are the most common method of managing domestic wastewater in those parts of municipal areas where there is no sewer line. Effluent from the septic tank is discharged either into a soak pit where the effluent percolates inside the ground or into a drain. The number of septic tanks in the municipalities of

Source: ENPHO

Teku sludge septage

Kathmandu, Lalitpur, and Bhaktapur is estimated to be 33,000, 8,400, and 2,300 respectively (Metcalf and Eddy 2000). Although various agencies, including the private sector and the municipalities, provide facilities for suctioning and cleaning them, septic tanks are not cleaned as frequently as required. The tanks, therefore, do not function efficiently; consequently septage has a higher pollution load than normally expected. When cleaned, the septage collected is generally dumped into the river or into a sewer/ drain which is connected to the river. There is no septage treatment facility (constructed wetland developed by KMC is not functional at present).

Industrial wastewater

Washing and dyeing (carpets and garments), dairies, paper and pulp board mills, textile mills, fat and oil presses, alcohol distilleries, and pharmaceutical industries in Kathmandu are identified as the main water-polluting industries in the valley. Kathmandu Valley hosts more than 72% of the country's water-polluting industries. Carpet washing and wool dyeing units discharge 6.1 Ml/day of wastewater, while other water-consuming industries discharge 2.4 Ml/day (MoPE 1999). These industries meet their water needs from the NWSC network or through their own groundwater supplies. The industrial wastewater is discharged without pre-treatment or neutralisation either to municipal sewers that flow into rivers or directly into rivers without pre-treatment or neutralisation.

Of the total wastewater (domestic and industrial) discharged into the rivers of the valley, the proportion from industrial effluents is about seven per cent (Devkota and Neupane 1994, cited in UNEP 2001). The pollution potential of industrial effluent, however, is higher than for other wastewater sources as it contains chemicals and toxic substances.

The contents of industrial wastewater vary widely depending on the type of industry and products. Municipal wastewater treatment plants are not designed to treat industrial effluents without pre-treatment or neutralisation.

Test results on mixed industrial effluents from Balaju and Patan industrial estates are given in Table 6.9.

Table 6.9: **Composition of effluents from Balaju and Patan industrial estates**

Parameters	Balaju	Patan
Total suspended solids (TSS, mg/l)	86	27.7
Total dissolved solids (TDS, mg/l)	324	550
EC (µS/cm)	646	1096
pH	7.7	7.3
Total alkalinity (mg/l as $CaCo_3$)	193	238
Dissolved oxygen (DO, mg/l)	4	0.57
BOD (mg/l)	113	92
COD (mg/l)	194	164
Sulphate (mg/l)	25	39
Chloride (mg/l)	55.6	150.8
Total phosphate (mg/l)	4.9	1.4
Total nitrogen (mg/l)	8.03	14.9
Ammonia-N (mg/l)	6.2	5.5
Nitrate-N (mg/l)	0.18	<0.01
Nitrite-N (mg/l)	1.09	7.6
Lead (mg/l)	0.08	0.11
Cadmium (mg/l)	<0.05	<0.05
Chromium (mg/l)	<0.05	<0.05
Mercury (mg/l)	<0.001	<0.001
Phenol (mg/l)	0.06	0.04
Detergent/ soap (mg/l)	0.1	<0.1
Total coliform (number / 100 ml)	TNTC	TNTC
Faecal coliform (number / 100 ml)	TNTC	TNTC

Key: TNTC = too numerous to count (>50,000 per 100 ml)
Source: ITECO Nepal (P) Ltd. 2002

Impact

The impacts of inadequate and improper management of waste are many: direct and indirect adverse impacts on health and well-being, pollution of water and air, impacts on cultural sites, impacts on aquatic life and the ecosystem, bad aesthetics, and others.

Health impact

Although disaggregated data are not available on health impacts of waste, it is well understood that there is a vital link between them. Water and air pollution definitely have impacts on people's health. Water and sanitation-related diseases are the most prevalent diseases in Nepal, including in the Kathmandu Valley: people who come into direct contact with waste are the most vulnerable, e.g., waste-management workers, waste-pickers, people living near waste facilities, users of polluted river water, and so on.

Air and water pollution

People quite commonly burn solid waste, including plastic, in the open air. This sends particulate pollutants as well as some toxic elements into the air that people inhale. Street sweeping also sends particulates into the air. As only around 75% of the solid waste generated in Kathmandu Valley's municipalities is collected, the remaining waste stays on the street and is a source of dust in the air. Solid waste dumped on the bank of the Bagmati and Bishnumati rivers is a long-term source of pollution for these rivers.

Wastewater from the urban areas of Kathamndu Valley ultimately flows into the Bagmati River and its tributaries: Manohara, Hanumante, Godavari, Kodku, Dhobhikhola, Tukucha, Bisnumati, Balkhu, and Nakhu. Studies indicate that most of the streams in the urban stretches of the valley are unsuitable for use as sources of water or for any other purpose.

The findings of a recent study on the water quality of these rivers/ streams post-monsoon are summarised in Table 6.10. The pre-monsoon tests also show a similar pattern, although values differ: pollution levels are generally higher during pre-monsoon, as there is less flow/ less dilution, and lower during monsoon due to higher flow/ dilution.

As expected, the study also showed that, in most of the rivers of Kathmandu Valley, the upper stretches before urban settlements begin are relatively clean: apart from bacterial contamination, most of the quality parameters were found to be within WHO guideline values for drinking water. The river becomes more and more polluted downstream as it flows through the urban area: during dry season the rivers are so polluted in the urban

Source: ENPHO

Dhobhikhola polluted

Table 6.10: **Summary of water quality in the Bagmati and its tributaries (post-monsoon test November 1999)**

River	Summary of findings
Bagmati River (Sundarijal to Khokana)	TSS increases from about 5 to 70 mg/l; chloride from 1.0 to 24 mg/l; Ammonia from 0.03 to 11 mg/l; BOD form 1.3 to 65 mg/l; and DO decreasing from 8.9 to 1.7 mg/l as the river flows through urban areas. The water quality suddenly deteriorates after joining the Dhobi Khola and becomes worse after joining the Tukucha and Bishnumati. After this, however, the water quality improves: at Khokana, DO value revives to 6.0 mg/l with corresponding decreases in BOD, NH_3, and other pollutant concentrations. Phenol concentration up to 0.07 mg/l in Jorpati and its immediate area (a number of carpet dyeing and washing facilities exist along the riverbanks in this area).
Hanumante River (Khasyang-khusung to Koteshwor)	The water quality first declines as it flows, but improves after other streams join (Manohara, Godavari). For instance, Cl^- increases from 9 to 12 mg/l and then decreases to 10 mg/l; similarly Ammonia from 0.19 to 4 mg/l and then to 2.8 mg/l; BOD from 5 to 12.07 mg/l and then to 7.3 mg, DO decreases from 7.5 to 2.1 mg/l and then increases to 7.8 mg/l. Phenol is detected at 0.002 mg/l.
Manohara River (Sarangchowk to Sankhamul)	Although it also becomes dirtier flowing downstream, the flow also increases from about $1m^3/s$ to $4m^3/s$. In comparison to other tributaries of the Bagmati River, the Manohara is much cleaner. For instance, DO values never go below 7.0 mg/l; BOD increases from 1 to 7.3 mg/l; COD from 1 to 21 mg/l, and ammonia from below 0.1 to 18 mg/l. The ammonia value jumped to 18 mg/l from about 0.2 mg/l just before joining the Bagmati.
Dhobi Khola	Upstream from the Kapan area (Lasuntar), water quality is fairly good except for bacteria contamination. Although suspended solids and iron content are fairly high, other parameters are within the drinking water limits. But as the stream flows downstream, it gets rapidly polluted with BOD load increasing from 78 kg/day to 2,132 kg/day and then to 11,919 kg/day (the highest BOD load of all tributaries except the Bishnumati). The causes may be attributed to proliferation of industrial activities, particularly carpet dyeing and washing and rapid urbanisation in the area. Pb, Cd, Cr, Al and Hg are not detected. Phenol concentration is found in one sample of around 0.07mg/l.
Bishnumati River (Tokha to Teku)	Water quality degrades gradually as it flows downstream and flow rate increases from 0.1 m^3/s to 2.6 m^3/s. Cl^- increases from about 2 to 26 mg/l, ammonia from 0.1 to 11 mg/l, BOD from 5 to 85 mg/l and DO decreases from about 7 to 1 mg/l. BOD load increases from 26 kg/day to 18,654 kg/day just before mixing with the Bagmati. The Bishnumati River carries the highest BOD load of all Bagmati tributaries. At the uppermost point near Tokha, the river quality seems to be much better than at downstream points. Cd, Cr, Al and Hg are not detected. But Phenol concentration (0.05 mg/l) and Pb (0.015 mg/l (in one sample) were found.
Nakhu,Godavari, Tukucha, and Balkhu rivers	The water quality of the Nakhu and Godavari kholas are in very good condition except for bacterial contamination. Tukucha is almost sewage with DO near zero and BOD 260 mg/l. Balkhu Khola upstream is good whereas the downstream stretch is a little more contaminated, with BOD increasing from 3 to about 12 mg/l.

Source: MWSP- Project Management Consultant 1999 sections that they resemble open sewers. Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Ammonia exceed the accepted quality standards for river water. Dissolved Oxygen (DO) levels during dry season in most of the river stretches near settlements within Kathmandu Valley are nearly zero. Domestic/ municipal sewage appears to be the main contributor to pollution as heavy metal and toxic substances, e.g., toxic metals, such as Lead (Pb), Cadmium (Cd), Chromium (Cr), and Mercury (Hg), have not been detected in most samples tested. Phenol is found more frequently. During low-flow periods, the water conditions are septic and are an unfavourable habitat for any kind of freshwater aquatic life (Nippon Koei et al. 1999)

The quality of river water near urban settlements is so poor that it resembles sewage. The BOD_5 counts of water from the Bagmati at Tinkune and Kamochan were 108 mg/l and 140 mg/l respectively. Figures 36 and 37 show the variations of BOD5 and DO respectively along the length of the Bagmati River as it flows through urban areas (NESS 2006). The DO starts to rise and BOD_5 decrease after Chobhar. The quality of water samples from the Bishnumati, Dhobikhola, and Tukucha are no different from this or are even worse.

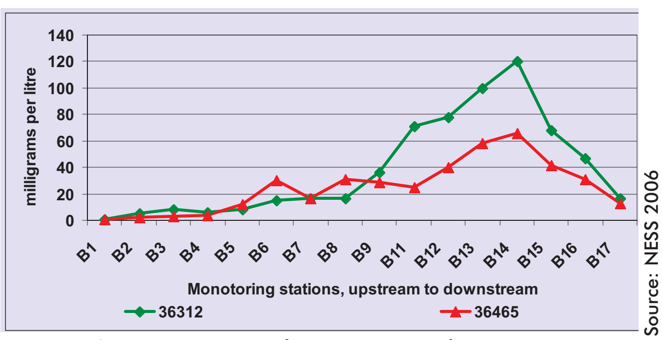


Figure 36: BOD_5 seasonal variations in the Bagmati River

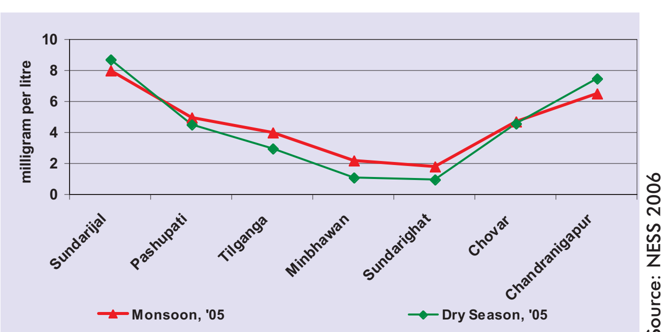


Figure 37: Change in DO levels in the Bagmati River in both dry and monsoon seasons

Uses of river water

Villagers immediately downstream from Kathmandu have stopped using water from the river for irrigation, and fishermen have ceased their traditional occupation, as there are no fish left in the river (ADB/ ICIMOD 2006).

Aesthetic and cultural practices

An extremely polluted, sewage-filled, black stream flowing through the heart of a city obviously destroys its beauty. There are several points on the Bagmati and Bishnumati rivers that are considered holy: people perform rituals and bathe at these points. Pollution has affected cultural and religious activities and rituals – ritual bathing is almost a thing of the past, and people do not use water from the river even when performing 'puja' (worship) (NESS 2006; ADB/ICIMOD 2006). Bad aesthetics may also adversely affect tourism.

Water ecology

The Bagmati, Bishnumati, Dhobikhola, Tukucha, Manohara, and Hanumante rivers in Kathmandu Valley's urban areas or close to it no longer have any freshwater aquatic life: the river is almost dead, and aquatic life almost non-existent by the time the river reaches Chobhar (NESS 2006; ADB/ICIMOD 2006)

Response

Policy, legislation, and standards

Sustainable Development Agenda for Nepal (SDAN) 2003. The SDAN is wide-ranging and incorporates several goals related to the environment. Its objectives for solid waste management include promoting waste reduction as well as increased re-use and recycling. It states that the government will encourage research and industry to work together to create cyclical flows of material, requiring factory products to be easily disassembled and separated by material type, and factory by-products to be reused. The agenda also includes a commitment to creating conditions that facilitate establishment of recycling centres that have economy of scale and establishment of hazardous waste management centres whose costs are met by the product causing the waste. Only non-recyclable waste is to be disposed of in environmentally-sound sanitary landfills.

Tenth Five-year Plan (2002-2007). The 10th plan identifies solid-waste management as a priority environmental issue / concern in the urban areas of Nepal. The final disposal sites for solid waste are recognised as the main difficulty; hence, importance is given to developing land-fill infrastructure, particularly for the Kathmandu Valley (at Banchare Danda and Okharpauwa). The 10th Plan also proposes the monitoring of air, solid waste, and water quality to reduce hazards to human health.

National Solid Waste Management Policy 1996. The aim of the policy is to make the solid-waste management system simple and effective; minimise its adverse impacts on the environment and public health; mobilise it as a resource; privatise its management; and raise public awareness on the importance of managing it. The policy gives various promotional activities to meet the above aims: awareness campaigns, development of technology/ expertise at local level, and tax rebates for products that use solid waste. The policy envisions institutional arrangements at two levels: national level to develop the capabilities and skills needed and local level for management in respective areas. Local institutions are to follow standards and concepts approved by the government and are to be responsible for mobilising human and other resources at local level, involving NGOs, collecting service charges, and fines for offenders.

Although there is room for improvement, the policy is a good initiative; although implementation has been weak. There was no budget or plan of implementation.

Industrial Development Perspective Plan. The perspective plan offers an economic analysis of the manufacturing industry, long-term vision (2020), and the challenges expected to emerge. The plan recognises the need to prevent pollution and gradually improve the performance of industries in the global as well as national context in this respect. It suggests a two-pronged approach to improve environmental performance on the part of industry: first through cleaner production in existing industries and second through effective compliance with IEEs and EIAs in newly-proposed industries. It also recommends introduction of tradable pollution permits.

Solid Waste Management and Resource Mobilisation Act/ Rules. Promulgated in 1987, these acts and rules were the first laws in Nepal related to solid waste management. The act provided a basis for managing solid waste in Kathmandu's urban areas; and established SWMRMC as an autonomous body to deal with solid waste, particularly in Kathmandu, Lalitpur, and Bhaktapur municipalities. After enactment of the LSGA in 1999, most solid-waste management functions were handed over to municipalities and the Centre was placed under the MoLD to focus on policy issues.

Nepal Water Supply Cooperation (NWSC) Act/ Rules. This act appoints the Nepal Water Supply Cooperation as the body responsible for water supplies in urban areas of Nepal. It also makes it responsible for sewerage management and wastewater treatment plants in the municipalities. The act is currently being revised to promote private-sector participation and bring it into line with with the LSGA 1999.

Industrial Enterprises Act/Rules. This act categorises industries in relation to their impact on public health and the environment. It empowers the government to issue directives to industries to prevent and mitigate environmental pollution. The act also provides tax relief on investments in pollution control.

National Water Supply Sector Policy 1998. This policy aims to integrate water supply and sanitation as well as to reduce the incidence of water-related diseases.

Waste Water Management Policy (draft 2006). The draft policy is probably the first national-level response to the environmental and public health impacts of wastewater. It recognises the need to improve compliance with standards, to improve coordination among various stakeholder agencies, and to foster public-private partnership; proposes separate sewerage for storm and sanitary sewage; and aims to improve quality of water bodies.

Water Resources' Strategy, National Water Plan, 2005 advocates additional water supply and sanitation coverage and improving the level of services

Environment Protection Act 1996/ Rules 1997. This Act makes pollution a punishable offence and empowers the government to provide additional incentives (concessions and facilities) to encourage any enterprise, activity, technology, or process that will have positive environmental impacts. The EPA/ EPR also provide a framework for environmental assessment such as Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA). All activities proposed are subject to environmental screening on the basis of type, size, and location. The SWMRMC has developed EIA Guidelines for a Solid Waste

Management Project in the Municipalities of Nepal (2004) to help implement the environmental assessment provisions of the EPA/EPR.

Local Self Governance Act/Rules 1999. This Act makes the municipalities responsible for solid-waste management in their respective territories. The LSGA authorises levées for fines and recurring expenses to dispose of waste and issuing of orders to maintain cleanliness and safe disposal of waste and maintain sanitary conditions in public places.

There are contradictions/overlaps/ duplications of authority in the Solid Waste Management and Resource Mobilisation Act 1987, Solid Waste Management National Policy 1996, and LSGA 1999. Streamlining these policy and regulatory provisions is essential to determine where the authority and responsiblity of institutions involved in solid-waste management lie. A review is currently being undertaken at the MoLD in this respect.

Standards. The government has issued three generic effluent standards (tolerance limits) for discharge of industrial waste into inland surface water, wastewater from combined treatment plants into inland surface water, and industrial effluent into public sewers, as well as one sampling standard and one testing standard. Besides, there are nine industry-specific effluent standards (tolerance limits) for discharge into inland surface water: the industries included are tanning, wool processing, fermentation, vegetable ghee and oil production, paper and pulp mills, dairy products, sugar mills, cotton textile mills, and soap manufacturing. However, these are neither monitored nor enforced.

Plans, programmes and projects

CKV – Clean Kathmandu Valley Study. The Study of Solid Waste Management for the Kathmandu Valley, popularly known as th Clean Kathmandu Valley (CKV) Study is the most recent and comprehensive study on solid waste management in the five municipalities of the Kathmandu Valley. The study proposes an umbrella concept for solid waste management facilities with short-term, mid-term, and long-term plans by grouping municipalities into two zones. The study lasted 20 months (from January 2004 to August 2006) during which time a series of pilot projects were designed and implemented for improving collection and transportation, minimisation of waste, improving disposal, promoting awareness and behavioural change, and developing operation and management capacity.

High Powered Committee for Implementation and Monitoring of the Bagmati Area Sewerage Construction/Rehabilitation Project. The government formed this High Powered Committee to examine ways of improving the quality of water in the Bagmati River through priority sewer lines and treatment plants. A master plan was prepared in the late 90s envisioning roads and a green belt on either side of the Bagmati from Sundarijal to Chobhar; repair of the existing sewers and treatment plants; and establishment of additional treatment plants, e.g., at Gokarna, Guheshwori, Dhobi Khola confluence; Sanepa, Manohara, Bishnumati confluence; Dhobighat; and at Nakhkhu. The master plan suggested parallel development of sanitary sewers and storm water drains with interceptor lines. The High Powered Committee established a treatment plant at Gaurighat, the main sewer line upstream from it, and a tunnel for a sewer from Gaurighat to Tilganga that conveys sewage downstream from the Pashupatinath area, bypassing religious and ritual sites.

Melamchi Water Supply Project. The Melamchi Water Supply Project plans to divert water from the Melamchi River to Kathmandu Valley through a 26 km long tunnel. The idea is to improve water supplies through water treatment plants, bulk supply lines, and improvements in the distribution network and wastewater disposal system. The total cost is estimated at US $ 500 million and its target is to bring 170 million litres of water per day to the capital. It is hoped that this will increase water supplies to the Kathmandu Valley in the medium-to-long run. The ADB is the lead donor with contributions from the government and other donors such as the World Bank, the Japanese Bank for International Cooperation, Nordic Development Fund, Swedish International Development Agency, and Norwegian Aid Agency.

Past Plans and Projects. Several plans and projects have been prepared and implemented in the past to improve solid waste and wastewater management in urban areas of the Kathmandu Valley: the GTZ supported solid-waste management project for Greater Kathmandu and Bhaktapur Development Project; and wastewater related projects such as the Master Plan for Water Supply and Sewerage in Greater Kathmandu and Bhaktapur, Second Water Supply and Sewerage Project, Greater Kathmandu Drainage Master Plan Studies, Kathmandu Valley Urban Development Plan and Programmes, Bagmati Basin Water Management Strategy and Investment Programme, Urban Water Supply and Sewerage Rehabilitation Project, and Environmental

Sector Programme Support.These projects all contributed to establishing the facilities extant.

The results of these efforts are given below.

- Introduction of modern solid-waste management practices (e.g., construction and operation of the Teku Transfer Station, Gokarna Landfill Site (closed now), and now construction and operation of the Sisdol Landfill Site.
- Construction of sewers (Table 6.11) and wastewater treatment plants (Table 6.12).
- Construction of Wastewater Treatment Plants. There are seven wastewater treatment plants (WWTPs) in five-municipalities in the Kathmandu Valley (Table 6.12). At present, most of these treatment plants are either not in operation, or in a poor state of maintenance. Most of the centrally collected wastewater treatment plants are not functioning due to high cost of spare parts, chemical additives, utility bills, and lack of trained human resources.
- Emerging initiatives. These include initiatives by the private sector and NGOs in solid waste management activities such as door-to-door collection, community composting and recycling, promotion of household composting by the municipalities, constructed wetland to treat wastewater, and promotion of cleaner production by industries, etc.

Table 6.11: **Length of sewers in five municipalities of Kathmandu (km)**

Municipality	Sewer length (km)	Remarks
Kathmandu	3,246	Includes major and minor sewers as well as 'nali' (s). Kathmandu's data probably cover Lalitpur as well. It's unsure whether these data include sewers and drains built by all agencies.
Lalitpur	N.A.	
Bhaktapur	30	
Madhyapur Thimi	26	
Kirtipur	19	

Source: Relevant municipalities cited in CBS 2005

Table 6.12: **Wastewater treatment plants in Kathmandu Valley**

Plant	Capacity (mld) and type	Status
Dhobighat: receives wastewater from the main urban area of KMC. Constructed in 1978 with IDA funding.	15.4 mld. Oxidation Pond consisting of two primary anaerobic ponds, one secondary facultative pond, and a tertiary aerobic pond. Wastewater requires pumping from Sundarighat pump station.	Not operational, out of operation almost since construction. Problem began with pumping wastewater and conveying through under-river sewer.
Kodku: receives wastewater by gravity from the eastern core areas of Lalitpur. Constructed in 1978 with IDA funding.	1.1 mld. Oxidation pond: consists of two primary/ anaerobic ponds, one secondary/ facultative pond, and one tertiary/ maturation pond.	Partially operational but inefficient. Poor O & M: sludge accumulation and non-functioning flow-control valve, resulting flow short-circuiting (less detention time). Farmers tap raw sewage flowing through sewers for irrigation.
Sallaghari: receives wastewater from some parts of Bhaktapur urban area. Constructed in 1983 with GTZ support.	2.0 mld. Originally designed as an aerated lagoon system using diffused aeration equipment. The plant is now converted to a non-aerated lagoon.	Partially operational. Difficulties related to pumping and operation of mechanical aerators. Farmers tap raw sewage flowing through the sewers for irrigation.
Hanumanghat: serves only a small part of the core area of Bhaktapur. Constructed in 1977 with GTZ support.	0.5 mld. Originally developed as an aerated lagoon.	Partially operating as an oxidation pond/ non-aerated lagoon with low efficiency.
Guheshwori: constructed by the High Power Committee in 1999.	17.3 mld. Activated sludge oxidation ditch.	In operation. High operating costs: in 2005, it was over NRs 10 million (about 65 % of this was for electricity). Foaming in aeration tank is the major technical difficulty. there is also a sludge rise/ flotation problem in the secondary clarifier (Sah 2006).
Teku: constructed by Kathmandu Municipal Cooperation.	Constructed wetland – vertical flow bed	For treating septage (from septic tanks). Not in operation
Madyapur Thimi: constructed with technical support from ENPHO as a pilot demonstration activity of ADB, UN-Habitat, and Water Aid Nepal	Reed Bed Treatment System – horizontal/ vertical flow bed	Serves around 200 households, and receives about 30 m^3/ day of sewage. This has recently come into operation. The municipality looks after the O& M.

Key: mld = million litres per day

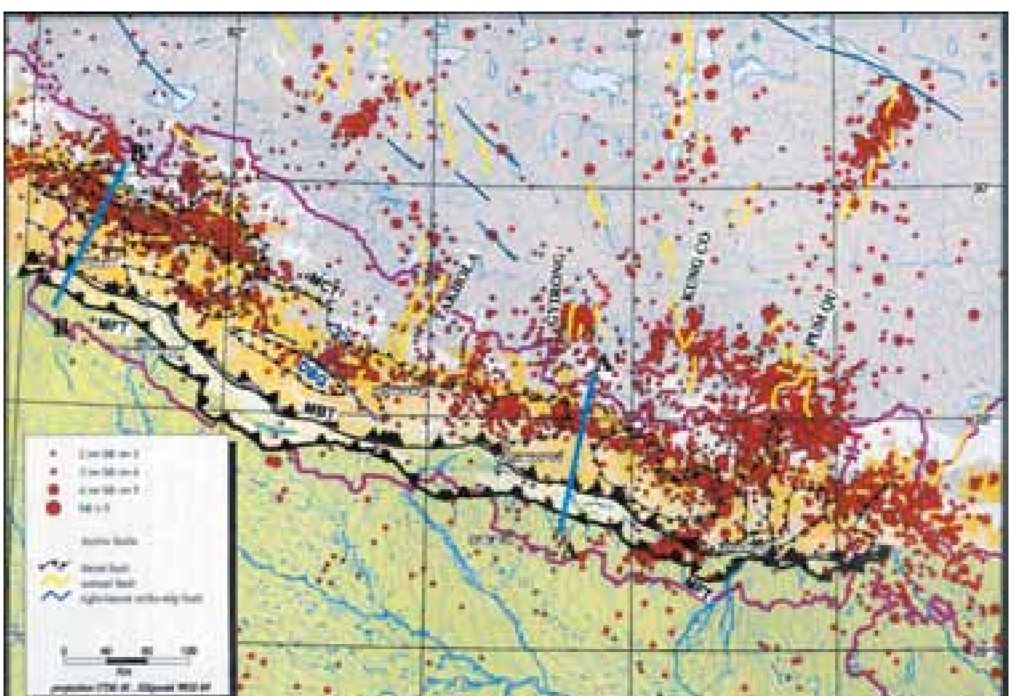
Source: Timilsina 2004; Nippon Koei et al. 1999; Metcalf and Eddy 2000; ENPHO leaflet

7 Natural Disaster Preparedness

Earthquakes and landslides are the most serious natural disasters occurring in the Kathmandu Valley. As far as earthquakes are concerned, the valley can also be affected when the event takes place in other parts of the country.

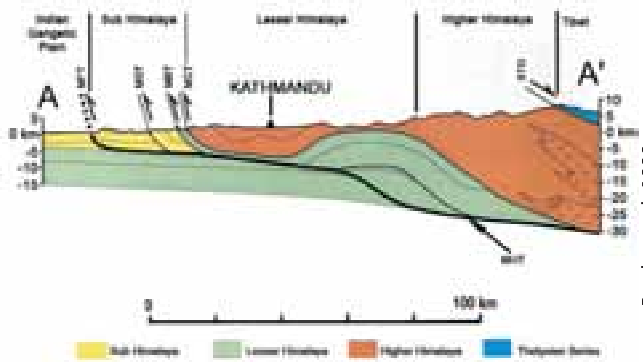
Many devastating earthquakes have occurred in Nepal, resulting in great economic loss and social disruption. Such events bring about radical environmental changes and hamper development.

The lithosphere (100-km thick upper surface of the earth) is broken into many pieces called plates. During the process of plate deformation an immense amount of energy is gradually accumulated and ultimately released when the rock body no longer can hold the stored energy. Deformed rock ultimately breaks along a fracture and moving in the opposite direction to it causes an earthquake. The intense seismic activity in Asia, and in particular along the Himalayan Arc, is related to this ongoing process. The large-scale thrusts developed from north to south in the last 25 million years are the Main Central Thrust (MCT), which separates the Lesser from the Higher Himalaya; Main Boundary Thrust (MBT), which separates the Lesser Himalaya from the Siwaliks (Churia Range); and the Main Frontal Thrust (MFT) which separates the Churia Range from the Indo-Gangetic plain. The MCT, MBT, and MFT all join a decollement (a weak contact boundary) rooted in Southern Tibet which is called the Main Himalayan Thrust (MHT). This is the source of big earthquakes (Figures 38 and 39). Four great earthquakes with magnitudes greater than 8.0 have occurred in the Himalayan Arc over the last 100 years, and the great



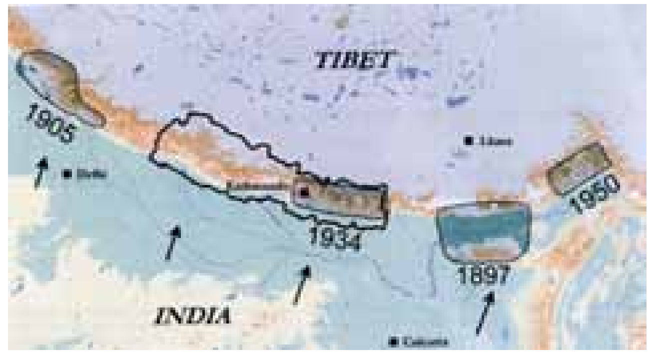
Source: Pandey et al. 1999

Figure 38: Distribution of epicentres between May 1994 and January 1998 showing two sections. Lines and their geological cross sections are shown in Figure 39 with MCT, MBT, and MFT



Source: Pandey et al. 1999

Figure 39: Geological cross section showing MFT, MBT, MCT, and MHT



Source: Pandey et al. 1999

Figure 40: Distribution of probable rupture zone of the 1897, 1905, 1934, and 1950 earthquakes along the Himalayan Arc

earthquake of 1934 (Nepal – Bihar earthquake) is one of them (Figure 40) There was no big earthquake between 1905 and 1934, creating a seismic gap (Figure 40).

Kathmandu Valley is an Intramontane Basin filled by thick lacustrine (lake sediment) and fluvial deposits (deposited by rivers) and is more than 550m thick. The Kathmandu sedimentary basin was formed in the early Pliocene (Yoshida and Igarashi 1984) and from the Late Pleistocene to Holocene (1,000,000-10,000) age (Yoshida and Gautam 1988). The basin is in the middle of the Lesser Himalayas and bounded by the Phulchowki and Chandragiri hills in the south and Shivapuri hills in the north. The engineering and environmental geological map of Kathmandu Valley (Figure 41) gives a broader perspective of the engineering properties of valley sediment and also gives some information about hazardous areas and potential sources for groundwater; landslide prone areas; and sites for industrial areas, hospitals, and new settlements. This map can be used for town /urban development planning, infrastructural development, land-use planning, and potential areas for natural resources.

Historical records show that the Kathmandu Valley was hit by an earthquake of intensity X on the Modified Mercalli Intensity (MMI) scale (a measurement for earthquakes graded from I to XII) in 1255. This earthquake took the lives of one third to one fourth of the total population in the Kathmandu Valley. King Abhaya Malla also died in that event.

Most of the buildings in Kathmandu Valley are vulnerable to even moderate earthquakes, and loss of life in earthquakes can often be attributed to inadequate buildings. More than 4,000 buildings are constructed every year by builders or owners, most without any knowledge of engineering. Hence, vulnerability to earthquakes is increasing due to urbanisation.

Like earthquakes, landslides destroy not only life and domestic dwellings but also major installations such as dams, roads, and bridges. They commonly occur in connection with other major natural disasters such as earthquakes, volcanoes, wildfires, and floods. Growth of urban areas and expanded land use elsewhere have increased the probability of landslide disasters.

Similarly, although land subsidence is a slow process, it causes damage to infrastructure and other buildings. Land subsidence is being reported within Kathmandu Valley in the Shantibasti area, Hyumat tole, and in Imadol, but detailed studies have not been carried out. Until now there has been no record of large areas of subsidence in Kathmandu Valley. This may be because the recharge of groundwater to the aquifer is adequate. This does not mean that subsidence will not occur in future, as in Mexico City which has similar geological conditions.

Kathmandu Valley's geological condition is unstable because of the presence of fluvial-lacustrine deposits such as clay, silt, and fine sand. There has been extensive extraction of groundwater for drinking as well as industrial purposes. The supply of water from underground sources has met more than 50% of the total demand of Kathmandu Valley. The sea of concrete buildings constructed in the valley reduces the percolation of surface water, increasing the demand for water and causing a fall in the water level each year. This renders the valley prone to land subsidence.

The following paragraphs analyse the status of natural disaster preparedness using the DPSIR framework.

Figure 41 Map on this page

Figure 41: Engineering and environmental geological map of Kathmandu Valley

Drivers

Kathmandu Valley has a long history of destructive earthquakes caused by its location in the seismic zone. There is little public awareness about earthquakes, rendering people vulnerable. The tendency for disaster is increased by poverty, lack of education, political instability, lack of planning, inefficiency of policy-makers and decision-makers, lack of social commitment, lack of coordination, and lack of political commitment. There is no central department of disaster management, although there are many organisations working in disaster management. The population of the valley is increasing annually at a rate of more than four per cent. The main driving force is the centralised development of Kathmandu Valley.

The main driving forces causing landslides are geological, morphological, and physical and human intervention. The geological conditions include tectonic uplift, erosion of slope toes, erosion of lateral margins, and deposition of loads on slopes or crests and removal of vegetation. Morphological conditions include weak material, sensitive material, weathered material, sheared material, jointed or fissured material, adversely-oriented mass discontinuity (bedding, schistocity, etc), and adversely-oriented structural discontinuity (fault, unconformity, etc). Morphological conditions include contrast in permeability and contrast in stiffness (stiff, dense material over plastic material) and physical conditions include intense rainfall, prolonged exceptional precipitation, and occurrence of earthquakes. Human interventions include excavation of a slope or its toe, deposition of a load on the slope or

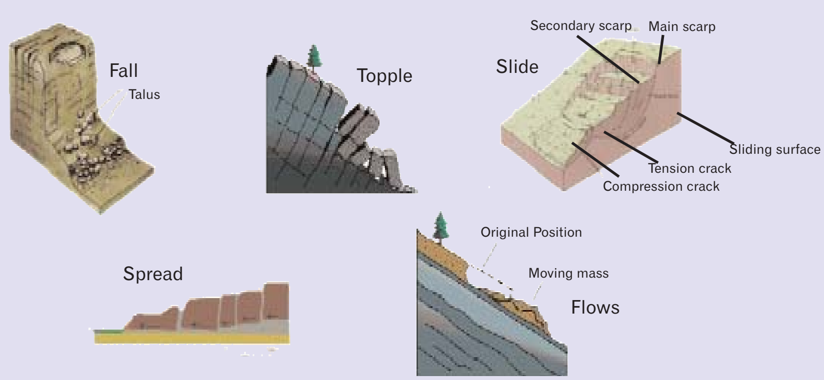
Box 6: Different types of landslide

Varnes (1978) classified slope movement mainly into five categories, based mainly on morphology mechanism, type of material and rate of movement as shown in the Table 7.1 and Figure 42. The complex type of slope movement includes a combination of two or more of the other types of movement.

Table 7.1: **Varnes classification of mass movement**

Type of movement		Type of Material: Bed rock	Debris predominantly coarse	Soil predominantly fine
Falls		Rock fall	Debis fall	Earth fall
Topples		Rock topple	Debris topple	Earth topple
	Rotational		Debris slump	Earth slump
Slides		Rock block slide	Debris block slide	Earth block slide
	Translational	Rock slide	Debris slide	Earth slide
Spreads		Rock spread	Debris spread	Earth spread
Flows		Rock flow	Debris flow	Earth flow
		Deep creep		Soil creep
Complex		Combination of two or more principle types of movement		

Source: Deoja et al. 1991



Source: Varnes 1978

Figure 42: Different types of landslide

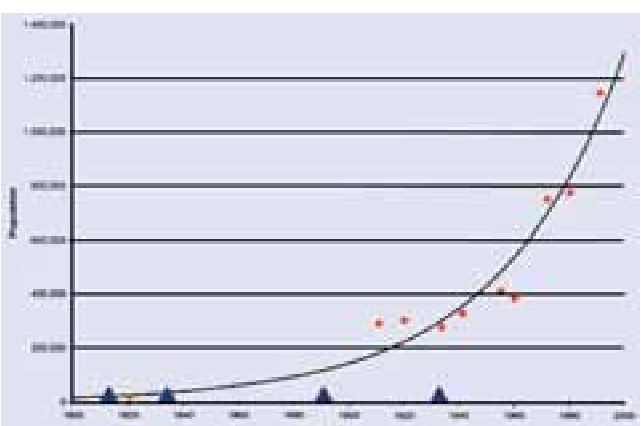
its crest, deforestation, irrigation, mining, and water leaking from utilities. Lack of awareness and poverty can indirectly lead to landslides in hilly regions. The construction of roads without proper geological knowledge of an area also increases the probability of landslides.

Pressure

Infrastructural development in the valley facilitates the concentration of population from other parts of the country. Encroachment on land, haphazard construction of buildings, and rapid urbanisation lead to rapid population growth No building codes are implemented athough they were introduced in 1994; although Lalitpur Sub-Metropolitan City has implemented a Nepal National Building Codes since 16th January, 2003 to make city dwellers aware of the risk of earthquakes. Sky scrapers are being built without taking sub-surface geology into account. Although this is more prevalent in Kathmandu, Lalitpur and Bhaktapur are beginning to follow suit. Population growth trends are shown in Figure 43. The red triangles indicate the occurrence of major earthquakes. According to the figure, the population increased thrice in 50 years.

According to Pandey and Molnar (1988), the population and number of houses in Kathmandu Valley in 1920 were 306,909 and 66,440 respectively. According to the 1991 census the population of Kathmandu Valley was 1,105,379 and according to that of 2001 it was 1,653,951. This means the population has increased five times since 1920. Similarly, the urban area of Kathmandu Valley has increased extensively from 1920, as can be seen in the two images of Lalitpur (IKONOS-2001 and CORONA-1967) (shown in plates a and b on page 91).

This is a situation that could lead to disaster if, in future, there is another big earthquake in the valley. Rapid urbanisation and uncontrolled population growth means that river corridors are encroached upon, open lands are being captured and haphazard construction practices are being used. All these are factors that have increased vulnerability.



Source: Piya 2004

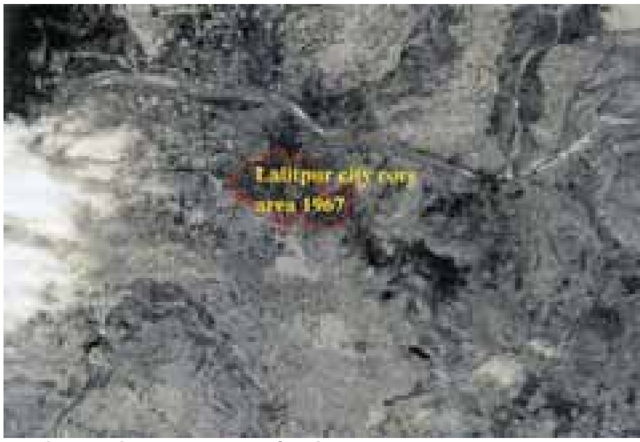
Figure 43: Population trend

Another aspect of population growth is the need for land. People cut down trees for settlements and for cultivation, leading to deforestation. Global climatic change causes imbalance and irregular precipitation in the region. Exorbitant oil and fuel prices lead to dependance on dwindling forests for firewood.

State

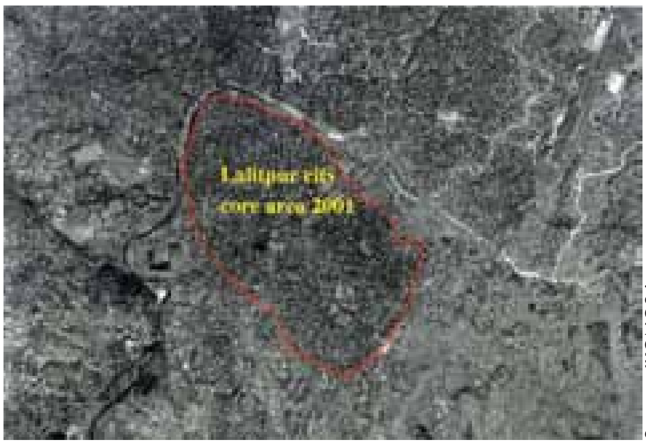
The loose fluvio-lacustrine sediment in the Kathmandu Valley plays a key role in amplifying ground vibrations during earthquakes. It is estimated that the amplification factor is six to ten times greater in loose sediment than in bed rock inside the valley. Maximum shakability is confined to Chhauni, Imadol, Sanogaon, and Lubhu. The valley lies between the MCT and MBT, and there are also numerous active faults existing in and around it , e.g., the Chandragiri and Chobhar faults in the southwest and the Kalphu Khola faults in the northeast. Earthquake models were prepared by JICA and the Home Ministry in 2002 for 'The Study of Earthquake Disaster Mitigation in the Kathmandu Valley'; and were based on seismic, seismotectonic, and geological conditions in and around the valley. Earthquake models are of Mid Nepal (West of Nepal), North Bagmati (around Rasuwa), and KV Local (around Kathmandu City). Peak ground acceleration (PGA values), intensity, magnitude, and liquefaction potentials have been estimated based on these models (Table 7.2). Estimated casualties and probable damage to residential buildings are shown in Tables 7.3 and 7.4.

According to JICA and MoHA (2002) report, there are 47 hospitals in Kathmandu and most of them are in municipalities. Quite a number of hospitals are of three or four storeys, built of brick with cement mortar or reinforcement which is less vulnerable to earthquakes than other types of material. According to JICA and MoHA (2002), there are 1,588 doctors and 1,998 nurses looking after 5,390 beds in total. Hospitals and beds are insufficient to deal with the injuries estimated for an earthquake in Mid Nepal. Also of concern is the fact that there are only five fire brigades with a total staff of 48 in the valley as a whole. Considering the size of the population and the fact that, in the event of a Mid Nepal earthquake, their services would have to extend outside



Source: Corona image

a) The settlement area of Lalitpur in 1967



Source: IKONOS image

b) The settlement area of Lalitpur in 2001

the valley, the present strength is deplorable. There is a special fire brigade for the airport, but this would make a negligible difference in the event of an earthquake disaster.

The following types of building are found in the Kathmandu Valley.

- Adobe (AD): These buildings are mainly made of sun-dried brick with mud mortar. They are found mostly in rural areas and some can still be found in old urban and suburban areas on elevated ground
- Stone with mud mortar (ST): These buildings are found mainly in rural areas. The houses are constructed either with river boulders or dressed, squared stone.
- Brick with mud mortar (BM): This type of building is found in the suburban areas where floors and roofs are constructed with timber. Some houses have front walls built of fired brick.
- Brick with cement mortar (BC): This is the most common type of building in the valley. A distinctive feature is the lack of or insufficient number of reinforced concrete (RC) columns. Cement and sand are used as mortar. Such buildings were constructed 30-40 years ago. Although the resistance of houses of this type could be observed in the Udayapur earthquake of 21st July 1988, those in the Kathmandu Valley had to endure the same degree of earth movement.
- Reinforced concrete frame with masonry (RC): This is the most common building type at present in the urban area.

Table 7.2: **PGA value, intensity/magnitude and liquefaction potential based on earthquake models**

Earthquake Model	PGA value	Intensity/magnitude	Liquefaction potential
Mid Nepal	Most parts 200 gal (Some areas >300 gal)	VIII/8.0	Moderate potential
North Bagmati	<200 gal	VI-VII/6.0	No liquefaction
KV local	>300 gal,	IX/5.7 along fault, VII-VIII in most parts	High close to fault, moderate along some parts of the Bagmati River
1934 Eq	>200gal, > 300 gal (Bhaktapur), > 400 (In some areas)	VIII/8.4 in most parts, IX in some areas in eastern parts	Moderate potential but in some areas higher potential

Table 7.3: **Estimated casualties based on different earthquake models**

Earthquake model	Deaths	Injured	
		Seriously	Moderate
Mid Nepal	17,695 (1.3%)	53,241 (3.8%)	93,633 (6.7%)
North Bagmati	2,616 (0.2%)	7,204 (0.5%)	14,709 (1.1%)
KV local	14,333 (1.4%)	42,667 (3.1%)	76,344 (5.5%)
1934 Eq in Present	19,523 (1.4%)	58,728 (4.2%)	103,313 (7.4%)
1934 Eq in 1934	3,814 (1.3%)	10,635 (3.6%)	21,263 (7.2%)

Table 7.4: **Estimated number of damaged residential buildings**

Earthquake model	Heavily	Partly	Total
Mid Nepal	53,465 (20.9%)	74,941 (29.25%)	128,406 (50.1%)
North Bagmati	14,796 (5.8%)	28,345 (11.1%)	43,141 (16.8%)
KV local	46,596 (18.2%)	68,820 (26.9%)	115,416 (45.05%)
1934 eq in present	58,701 (22.9%)	77,773 (30.45%)	136,474 (53.3%)
1934 eq in 1934	19,395 (36.2%)	16,197 (30.25%)	35,592 (66.3%)

Key: eq= earthquake; gal = 1 cm/sec^2
Source: JICA, MoHA 2002

The old durbars (palaces) are based on Gothic (Italian) architecture and have walls very thick at the base and thinner on the upper floors. The binding material is lime with surki. Some houses are built with four walls having 22-inch, 18-inch, 14-inch, and 9-inch brick walls in mud or cement mortar. The general assumption for constructing the houses regarding the foundation is foot/stories. It means that for four-storied houses the foundation should be four feet deep. Nowadays people make pillar houses which rest on pillars. DPC (damp proof cement concrete) is applied after the foundation on the ground floor for most of the houses in Kathmandu. Most of the pillar houses are made either with 9-inch or 4-inch walls (Chitrakar 1998)

Mostly, the AD, ST, and BM buildings are most vulnerable to earthquakes even of moderate size (magnitude Ms 6.5) while BC buildings will suffer little damage with a magnitude of Ms 6.5. BC buildings can be found in the vicinity of the core area of Kathmandu Valley. Most BM buildings are two to three storeys high, while BC buildings are of three to four storeys. The majority of these buildings were constructed 40 years back and some old BM buildings in the core area have been replaced by BC buildings. At present, most of the buildings are RC types in urban areas and some are in the vicinity of the core area. These were constructed 20 to 25 years ago and their storeys range from three to five. Most people think that such buildings are safe and strong enough to withstand moderate to strong earthquakes. People in the valley have started to construct RC buildings that are very high. Some RC buildings have eight storeys located in the heart of the city; and houses 2.5 metres in width at the front have six to seven storeys. RC buildings constructed by owners who know nothing about architecture or engineering, supervised by unskilled craftsmen/masons, will not be strong enough to withstand even moderate earthquakes.

Box 7: Difference between magnitude and intensity of earthquakes

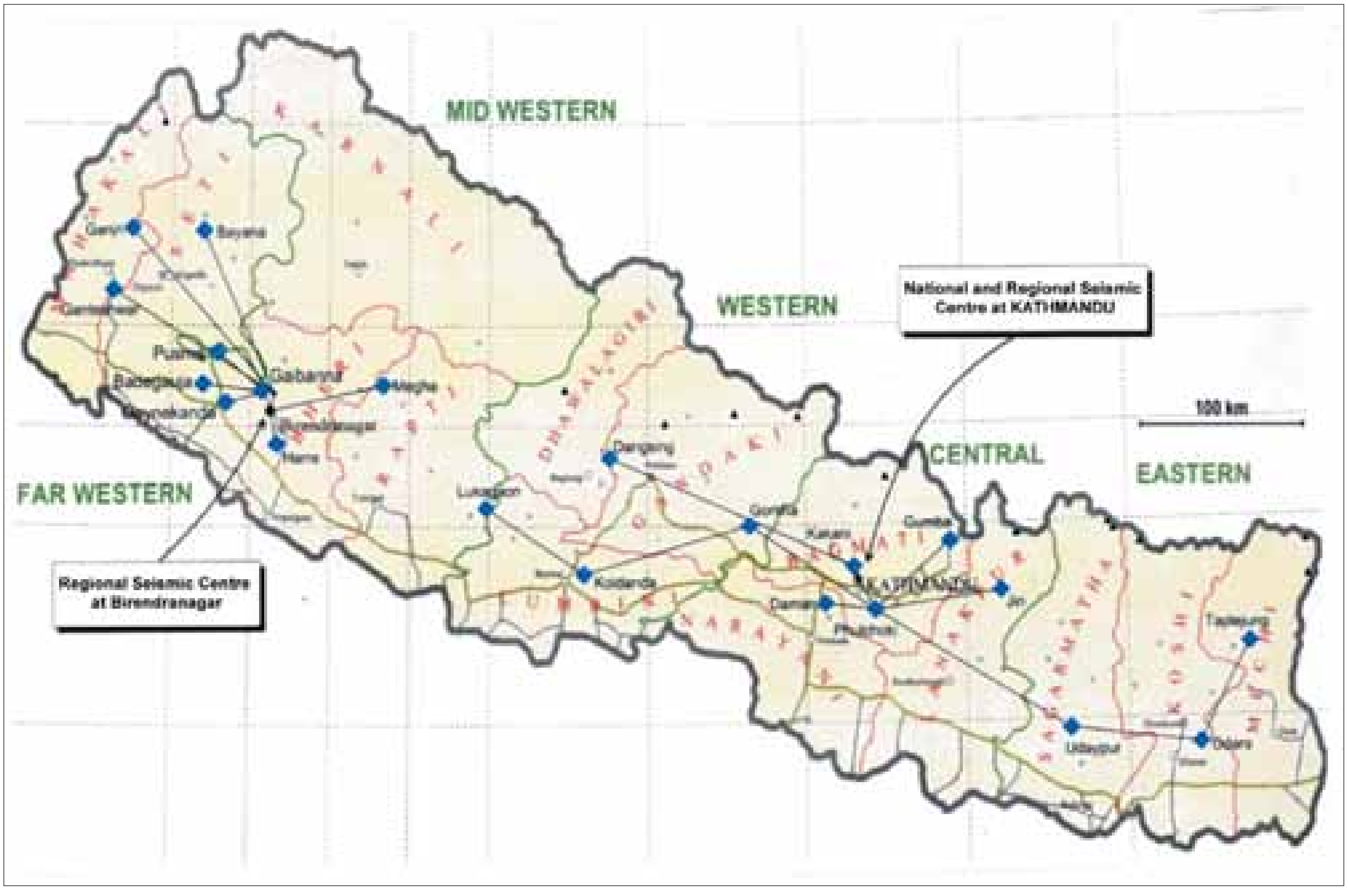
Magnitude requires instrumentally-recorded signals whereas Intensity requires the type of building and its damage pattern. Magnitude is used to measure the quantity of energy released by an earthquake. The most famous scale is the Richter scale, which ranges from 1 to 9, was devised by U.S. Seismologist Charles F. Richter in 1935 A.D. Increase of one unit in magnitude is equivalent to a 10-fold increase in amplitude and ground shaking and a 30 times increase in energy. Nowadays the Moment magnitude scale is used which has no upper limit. Intensity varies from place to place and decreases with increasing distance from the epicentre (generally maximum intensity). However, in some cases, maximum intensity is determined by local site conditions. Intensity is measured on Modified Mercalli Scale which ranges from I-XII. It was originally introduced by Italian Seismologist, Mercalli, in 1902 and modified by Wood H.O and Neumann in 1931.

Implementing a building code for the valley would be a step forward towards building constructions that reduce earthquake vulnerability. RC buildings incorporating such a code can be considered safe, but vulnerability largely depends on whether the area is free from liquefaction possibilities or not. There are some very weak old buildings in the core area, and they need to be demolished or retrofitted. Any structure built on soft soil is much more vulnerable than one built on hard rocks. Hard rocks are exposed in places like Kirtipur, Swayambhunath, Chobhar, Pashupatinath, and Panauti, and these will be safer in an earthquake event than places without hard rock. It is estimated that the centre of Kathmandu will shake six to ten times harder than the surrounding hills.

There are altogether 54 bridges in the Valley; 33 in Kathmandu district, 10 in Lalitpur district, and 11 in Bhaktapur district. The design standard is not uniform, and there is excessive scouring around the foundation of the pier in most of the bridges connecting the ring road and other linked roads due to lowering of the river bed. The bridges upstream from Bagmati, Bishnumati, and Dhobi Khola are badly scoured. Most of them could collapse during a big earthquake. Hence the cities of the valley will be cut off from each other.

The National Seismological Centre (NSC) has been monitoring earthquakes since 1978 in cooperation with the Laboratoire de Géophysique (LDG), France. Altogether 20 seismic stations have been installed and have been running since 1998 in cooperation with the Département Analyse Surveillance Environnement (DASE) (Figure 44).

The monitoring network can detect events as low as magnitude Ml 2.0 occurring inside the network. In the case of threshold events (Ml 4.0 or greater) or technical failure, the network automatically contacts the duty in-charge.Good maintenance is an important feature of the network, and the data gathered are valuable for designing building codes for earthquake-resistant buildings. The NSC of the Department of Mines and



Source: DMG

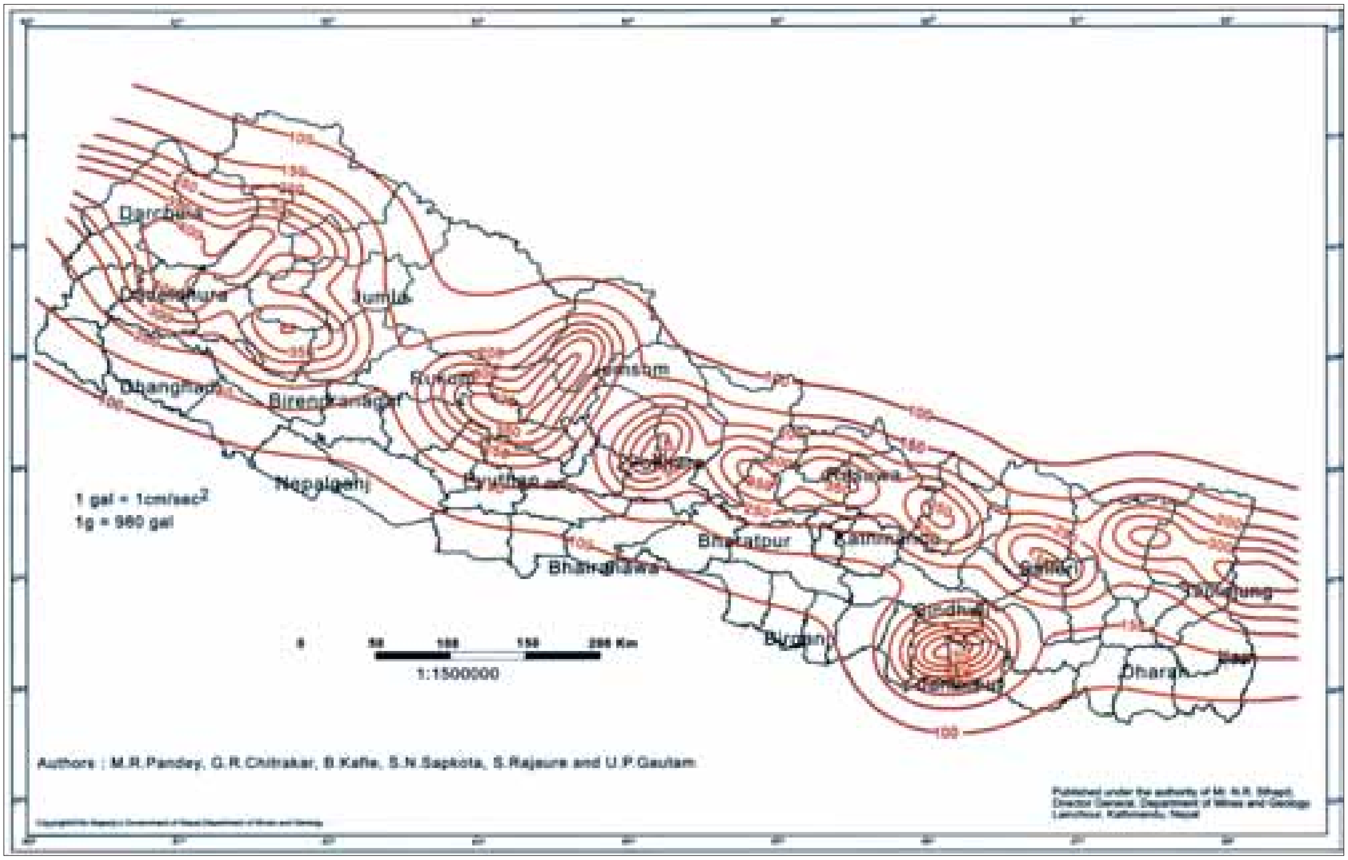
Figure 44: Location map of the national seismological network

Geology (DMG) has prepared a Hazard Map of Nepal which shows the peak ground horizontal acceleration in bedrock for a return period of five hundred years corresponding to a 10% chance to exceed in fifty years. According to this map, Kathmandu Valley lies within a PGA area of 200 – 250 gal (Figure 45).

The Department of Mines and Geology (DMG) also monitors crustal deformation through 13 global positioning system (GPS) networks in collaboration with DASE and the California Institute of Technology (CALTECH). DMG is also planning to install 10 more GPS stations in Far-west Nepal to cover the entire country. A slow motion of a millimetre in scale can be detected by a GPS. It will greatly contribute to our knowledge of earthquake precursors; and the characteristics of faults and their activities will help us assess seismic hazards.

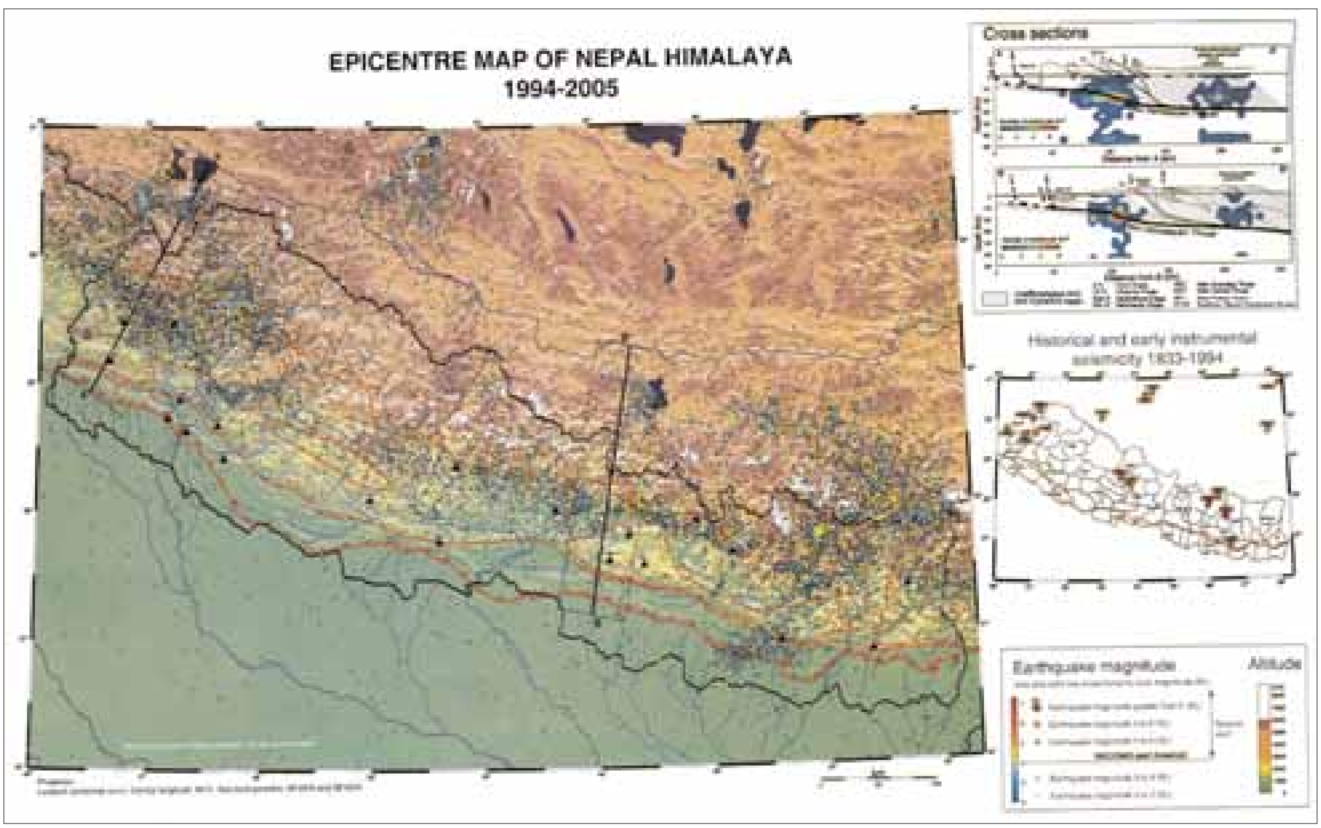
The new epicentre map of Nepal shows the distribution of earthquakes in the foothills of the Higher Himalaya (Figure 46). The Nepal Himalayan area has high seismicity judging by historical data, bulletins of the International Seismological Centre (ISC), and seismic data obtained from the National Seismological Network. The epicentres are clustered around the ramp (top right corner coloured blue in the geological cross-section) and the ramp beneath the Higher Himalaya behaves as an asperity focusing the build up of stress during interseismic periods. The modelling of levelling and GPS data (Jackson and Bilham 1994; Bilham et. al. 1997) indicate that the flat and ramp must be locked in the interseismic period. The continuous creep at depth beneath the Higher Himalaya is at a rate of 21 +/- 3mm/yr, and this is close to the long-term slip rate on the MFT of 21.5+/-2mm/yr (Lave and Avouac1999). Only during a big earthquake, will the the ramp and flat be activated and transfer all interseismic deformation to the most frontal structure (Lavé et al. 1995; Lavé and Avouac 2000).

The distribution of earthquake epicentres clearly shows segmentation of the Himalayan Arc. Most of the epicentres are distributed between the MCT and MBT in plan and depths lie between 10 and 30 km. The average convergence rate between the Indian Plate and Southern Tibet is considered to be 20 mm per year. A liquefaction susceptibility map of Kathmandu Valley prepared by Piya (2004) is shown in Figure 47.



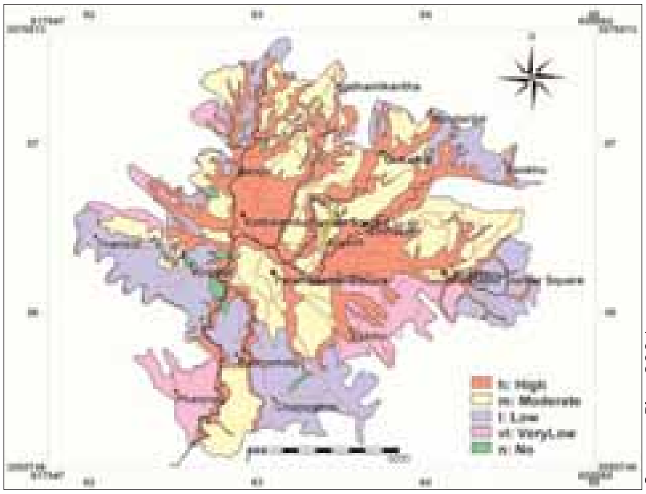
Source: DMG 2002

Figure 45: Seismic hazard map of Nepal showing bedrock peak ground horizontal acceleration contour in gals (1 gal = 1cm/sec²)



Source: DMG 2006

Figure 46: Epicentre map of the Nepal Himalaya (1994-2005)



Source: Piya 2004

Figure 47: Liquefaction susceptibility map of Kathmandu Valley


Adpated by G.R.Chitrakar and B. Piya

Figure 48: Location of landslides in the Kathmandu Valley

No great earthquake has been reported between the longitude of Kathmandu and Dehradun for 300 years, and that could be a potential area for a big earthquake in future. This location lies between two great earthquake locations (the Nepal-Bihar earthquake of 1934 and the Kangra earthquake of 1905).

Geological faults, fragile geological conditions, high intensity rainfall during monsoon, unplanned land use and insufficient fuel leading to deforestation are the forerunners to landslide occurrences. Figure 48 gives the location of landslides in the Kathmandu subsidence.

Impact

The impact of an earthquake is governed by the magnitude of the earthquake. Loss of life and property will be determined by the location of the epicentre. Epicentres in urban areas with greater magnitude will have a greater impact on the environment with greater loss of lives and property and social disruption than earthquakes in a sparsely populated area. It is said that 'earthquakes do not kill people, buildings do'. Buildings constructed without complying with the building code will suffer the most damage. Figures 49a and b show Bhaktapur Durbar Square before and after the Great Nepal-Bihar earthquake of 1934. The devastation is clear from these figures. Figure 50 is an intensity map of the valley during the 1934 Nepal-Bihar earthquake.Table 7.5 lists the earthquake disasters since 1255 to date that affected Kathmandu Valley.

In a big earthquake, a building can be destroyed by ground vibrations accelerated by resonance affects (amplification of ground vibration to a similar frequency as the earthquake because of the soft soils). There may be liquefaction in some parts of the valley in lowland areas near river banks, buildings may tilt. Infrastructure may be damaged. Similarly sewerage pipes, drinking water pipes, electricity cables, and transport and communication may be greatly affected. Secondary disasters such as ground failure, liquefaction, ground fissuring, ground subsidence, fire, and epidemics and famine also happen during big earthquakes.


Source: Rana 1935

Figure 49a: Bhaktapur Durbar Square before the earthquake of 1934


Source: Rana 1935

Figure 49b: Bhaktapur Durbar Square after the earthquake of 1934

Table 7.5: **Earthquakes since 1255 which have affected Kathmandu Valley**

Year	Magnitude/ intensity (MMI)	Epicentre	Human		Temples collapsed	Houses	
			Deaths	Injuries		Collapsed	Destroyed
1255	7.0 X (MMI)	NA	1/3rd to 1/4rth pop. of the Valley	NA	Many	Many	Many
1408	7.0 X (MMI)	NA	NA	NA	Many	NA	NA
1681	7.0 IX (MMI)	NA	NA	NA	N/A	Many	Many
1810	IX (MMI)	NA	NA	NA	N/A	NA	Some
1833	7.6 VII to X (MMI)	50 km north-east of Kathmandu	414	172	More than 6	Many	4,040
1934	8.3 IX to X (MMI)	Lat 27.45N Lon 87.0E	4,296	NA	19	12,397	43,342
1988*	6.6 V (MMI)	Lat 26.77N Lon 86.60E	8	71		650	1,814

Key: NA = not available; MMI = modified Mercalli intensity
Source: MoHA 1989; Pandey and Molnar 1988; Bilham and Bodin 1995; Chitrakar and Pandey 1986

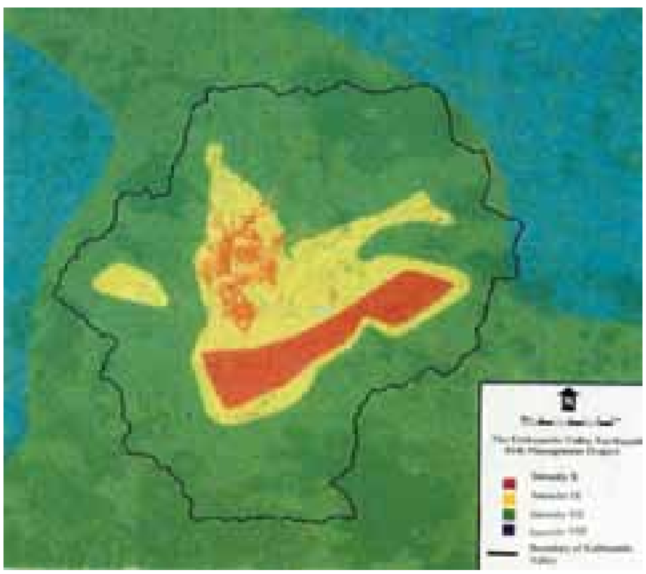
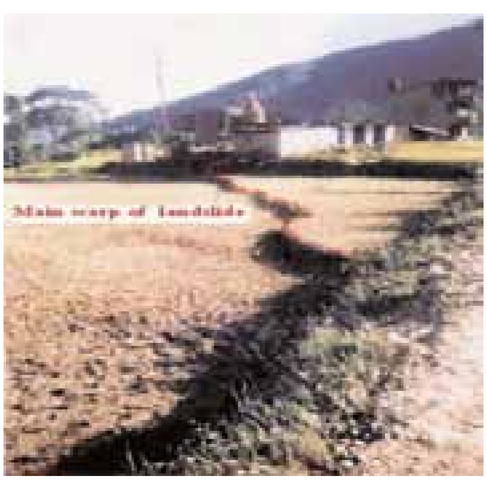

Source: NSET Nepal 1999

Figure 50: Intensity map of Kathmandu Valley during the 1934 Nepal-Bihar earthquake

The environmental impact of the natural disaster in 1993 was beyond description and caused the deaths of more than 1,200 people, great economic loss, and social disruption for more than a month. The total financial loss was Rs. 71.9 billion.

Damage to important infrastructure such as roads, dams, canals, bridges, underground pipelines, sewerage system, slow collapse of buildings into sink holes, loss of valuable crops, and disruption of socioeconomic conditions are among the most severe impacts of landslides. The landslide and debris flows of 1993 blocked the transportation of important commodities from outside the valley for more than one month. This caused loss of life and property and created havoc. Sixteen people died in Matatirtha in a landslide in 2002. Similarly, many houses in Chalnakhel, Chobhar, Kapan, and Siuchatar have been destroyed by landslides. The photographs show the impact of the Chalnakhel and Matatirtha landslides. Table 7.6 gives information about landslides that have occurred in the Kathmandu Valley.



Main scarp of landslide (Chalnakhel)

Source: Prakash Dhakal

Tilted electric pole (Chalnakhel)

Source: Prakash Dhakal

Table 7.6: **Information about landslides occurring in the Kathmandu Valley**

Name	Location	Causes	Formation	Impact	Response
Chalnakhel	Situated about 11.5 km south west of Kathmandu along the Kathmandu - Pharping road	High intensity rainfall, soil creeping r eactivated from July 2001. Two concrete houses collapsed and the road connecting Kathmandu - Pharping passes just above this.	Lukundol Formation overlay by thin layer of mountain wash deposits	First appeared in 1999. In July 2001 subsidence and flow occurr ed causing damage to two houses. Every year it subsided almost one metre. Occasionally reactivated each year during monsoon. It is a rotational landslide.	DWIDP ran a detailed study under the Kathmandu model site project.
Matatirtha Landslide occurred on 23 July 2002	600 m south of Matatirtha temple	Very heavy precipitation 207mm/day caused the Matatirtha landslide. It was slope failure.	Alluvial fan deposits and Tistung Formation	18 people were killed, 8 houses were buried under the debris. A school and cultivated land. were also damaged .	Mr. Ranjan Kumar Dahal and Kumud Raj Kafle have studied this landslide in terms of its velocity and volume of material.
Dahachowk	10 km west of Kathmandu in the Dahachowk VDC.	Steep topography, rugged surface, fragi le geological condition, soft and thin soil cover, high intensity rainfall in a short period, over grazing, unscientific and unplanned development of infrastructure	Kalimati Formation	There are many houses situated downstream and it may attack the se houses at any time during landslides in the upper parts.	DWIDP is monitoring these landslide areas by implementing the Disaster Mitigation Support Programme (DMSP) Project in cooperation with JICA. DWIDP has developed this area as Dahachowk Sabo Model.Site

Source: DWIDP 2003/04


Source: DWIDP


Source: DWIDP

Impact of landslide (debris flow) in Matatirtha area on the 23 July 2002

Response

Key stakeholders

Several agencies within the government and several other stakeholders are involved in disaster management. They provide cash, kind, and technical assistance for rescue and relief operations for disaster victims from time to time. Some of the key agencies involved are as follows.

Government Agencies. The Ministry of Home Affairs; Ministry of Industry, Commerce, and Supplies; Ministry of Environment, Science, and Technology; Ministry of Water Resources; Ministry of Physical Planning and Construction; Ministry of Forest and Soil Conservation; Ministry of Health and Population; Ministry of Finance; Ministry of Defense; Ministry of Information and Communication; Ministry of Foreign Affairs; Ministry of Agriculture and Cooperatives; Ministry of Children, Women, and Social Welfare; The National Planning Commission; Royal Nepal Army; Nepal Police Force; Nepal Armed Police Force; Nepal Scouts; Department of Mines and Geology; Department of Water Induced Disaster Prevention; Department of Hydrology and Meteorology; and the Department of Watershed Management are the key players.

The Central Disaster Relief Committee under the Home Ministry plays an important role in disaster management. The Home Ministry carried out a very important project 'Kathmandu Valley Earthquake Disaster Mitigation' with the support of JICA in 2001 and 2002. The project produced a valuable database containing information on important infrastructure as well as the socioeconomic circumstances of valley inhabitants.

Municipalities. Kathmandu Metropolitan City plays an important role in disaster management. It has a Disaster Management Section under the Department of Social Welfare and disaster management committees in different wards. Several activities have taken place at school level in disaster preparedness, mitigation, vulnerability assessment of different wards, assessment of emergency services, capacity building of KMC personnel for disaster management by participating in national and international training programmes, working together with them, implementation of a National Building Code, and identification and protection of open spaces and public open lands. Future plans include developing emergency plans and evacuation routes; establishing a network among the five municipalities; coordinating to create open spaces, and identifying recreational parks on vacant public land. All these activities lead to disaster preparedness in the event of an earthquake or other natural calamity.

Lalitpur Sub-metropolitan city has introduced a building code to reduce the impact of earthquakes on buildings. Together with the Department of Urban Development and Building Construction (DUDBC) and the National Society for Earthquake Technology (NSET), it made training available on earthquake resistant construction of buildings for masons working in Lalitpur. Other municipalities have also established disaster management committees.

The media. The media have an important role to play during natural disasters. Rescue and relief operations can be carried out more efficiently if there is sufficient and correct information. Radio Sagarmatha broadcasts important news about earthquakes and holds interviews to increase public awareness.

Initiatives from non-government organisations. The Nepal Red Cross Society, National Society for Earthquake Technology (NSET-Nepal), Nepal Scouts, Nepal Geological Society, Nepal Landslide Society, Disaster Preparedness Network, Caritas Nepal, Nepal Engineering College, Institute of Engineering, Khoppa Engineering College, Society of Nepalese Architects, Society of Consulting Architectural and Engineering Firms, Nepal Centre for Disaster Management, Nepal Disaster Reduction Centre, Centre for Disaster Studies, Nepal Disaster Management Forum, Department of Geology, Trichandra Campus, Central Department of Geology, and T.U are the main players.

The Kathmandu Valley Earthquake Risk Management Action Plan, which is a product of the Kathmandu Valley Earthquake Risk Management project contains valuable information about earthquake preparedness. NSET has been playing an instrumental role in issues related to general and specific safety requirements for owner-built buildings. It is supporting training programmes at community level to increase public awareness. It is also promoting integration of seismic resistance into new construction, improving the seismic performance of existing buildings, and vulnerability assessments. Structural and non-structural methods are used to reduce earthquake vulnerability. The Programme for

Box 8: Can we predict earthquakes?

Generally small earthquakes occur before the main shock nd are very close to the main shock in time and space.These are known as foreshocks or pre-shocks. They do not occur always. Similarly, numbers of small earthquakes, known as aftershocks, follow the main shock. Aftershock magnitude is less than the magnitude of the main shock. The most difficult task is to recognise foreshocks. Most events have foreshocks. In the case of the 1934 earthquake, two foreshocks were reported, bringing people outside their homes, eventually preventing a number of deaths.

In the Haicheng earthquake (M=7.4) on February 4, 1975, Chinese Seismologists recognised the foreshocks and gave orders to evacuate the city of Haichang. A series of small events occurred immediately prior to the main shock. Many people were outside during the main shock and very few lives were lost. They claimed this prediction was one of the greatest achievements of the Chinese earthquake prediction programme.Unfortunately, however, on July 27, 1976, Tangshan city was struck by a powerful earthquake (Ms = 7.8) that killed 242,000 people. This earthquake was not predicted.

Animal behaviour and other precursors do not always follow the same patterns, which makes prediction a difficult task Earthquake prediction is a challenge for seismologists worldwide.

Enhancement of Emergency Response (PEER) a training-based programme was introduced in 1998 by the U.S. Agency for International Development's Office of U.S. Foreign Disaster Assistance (USAID/OFDA) to improve disaster response in four Asian countries: India, Indonesia, Nepal, and the Philippines. The second phase was managed by NSET (2003-2008). PEER training includes Medical First Responder (MFR), Collapsed Structure Search and Rescue (CSSR), Hospital Preparedness for Emergency (HOPE), and Training for Instructors (TFR). PEER plays a vital role in earthquake disaster preparedness and earthquake mitigation.

The Disaster Preparedness Network plays an important role in disaster management. It has provided information about natural disasters and held seminars to create awareness about them.

International organisations. The Government of Japan, Japan International Cooperation Agency (JICA), United Nations Development Programme (UNDP), Technical Cooperation of the Federal Republic of Germany (GTZ), United States Agency for International Development (USAID), United Mission to Nepal (UMN), International Centre for Mountain Development (ICIMOD), Lutheran World Service (LWS), OXFAM, Save the Children Fund (SCF), Cooperation for American Relief Everywhere (CARE), World Food Programme (WFP), International Red Cross Society (IRCS),

Federal Emergency Management Agency (FEMA), Asian Disaster Preparedness Centre (ADPC), and Asian Disaster Reduction Centre (ADRC) are the main organisations in this category.

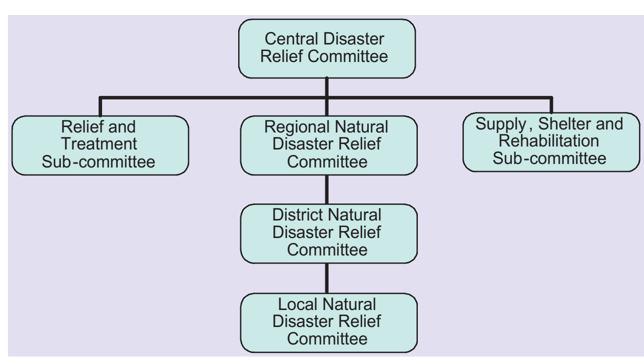
In 1991, UN agencies launched an inter-agency emergency planning process involving all UN agencies represented in Nepal and their respective staff. UN Nepal's inter-agency, Disaster Response, Preparedness Plan, Part 1 consists of Hazard Analysis and Response Guidelines prepared by the United Nations' Disaster Management Team (2001) and covers a wide range of topics regarding natural hazards such as earthquakes and landslides, response and emergency management, and coordination to reduce the loss of life and property in addition to physical damage.

Institutional framework

The Ministry of Home Affairs is acting as the national focal agency for disaster management in Nepal. All activities in disaster management are guided and directed by the Central Disaster Relief Committee chaired by the Home Minister in accordance with the Disaster (Relief) Act 1982.

Nepal observed the International Decade for Natural Disaster Reduction (IDNDR) through a national committee established under the chairmanship of the Home Minister for the decade from 1990 to 2000. Every year, IDNDR Day is observed by holding seminars, workshops, and other activities related to natural disasters to bring different disciplines on to a single platform and make disaster management more effective. Currently Nepal observes 'International Strategy for Disaster Reduction (ISDR) Day', an undertaking of the UN, with an annual seminar to foster awareness of the global framework for action. Similarly Earthquake Safety Day (second week of January or 2nd Magh of B.S.) is observed every year at central and district levels in coordination with various agencies working in disaster management.

Any earthquake occurring with a magnitude greater than 5.5 (Mb) is recorded at the NSC of DMG and an earthquake with a local magnitude greater than 4.0 occurring inside the kingdom will be processed immediately for location and magnitude and reported to the authorities (Home Ministry) and the media within half an hour of the event. The immediate reporting of location and magnitude helps mobilise rescue teams because the earthquake parameters indicate the severity of the earthquake as well as the actual site of maximum destruction. The NSC is well equipped with a 24-hour power supply with a back-up system. The loss of a few seconds' data could greatly impede response. The events are placed on the website www.seismonepal.gov.np. Thus, the National Seismological Centre is acting as a watchdog. Figure 51 shows the organisational chart for disaster management and Figure 52 shows the dissemination of earthquake information and disaster management to reduce loss of life and property.



Source: Home Ministry

Figure 51: Organisational chart for disaster management

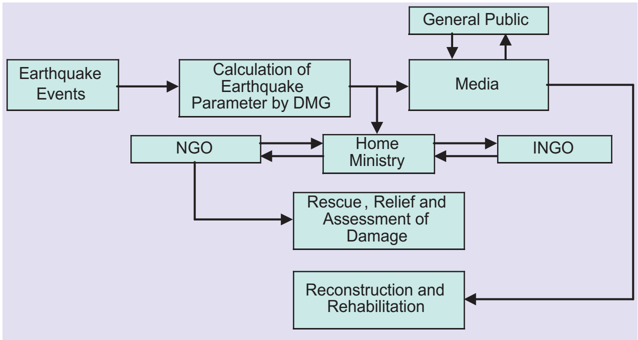


Figure 52 Flow chart showing dissemination of earthquake information and disaster management to reduce loss of life and property

Policy and legal framework for disaster management

The National Action Plan Matrix for Disaster Management was formulated in 1996. The plan depicts in matrix form the priority item groups and activities together with the executing agency and cooperating agency responsible for national hazard assessment, disaster reduction policy, awareness raising, information systems, training, land-use planning, regional and sub-regional cooperation between and among countries, and establishment of a documentation centre for natural disasters.

The plan was reviewed widely and submitted to the World Conference on Disaster Reduction (WCDR-II) 2005 in Kobe, Japan. The outcome of the WCDR has proved to be a milestone in the field of disaster reduction. The revised national action plan has included different national priorities on disaster risk management such as emergency response, strengthening policy, effective reconstruction and rehabilitation, institutional reform, and human resource development. An action plan has been prepared for disaster response, disaster preparedness, disaster mitigation, disaster reduction, and rehabilitation. The Government of Nepal has established a Steering Committee and a Working Committee to draft 'National Strategies on Disaster Management'.

Legal provision. The Natural Disaster Relief Act 1982 is the legal instrument for coping with disaster nationally. Before the promulgation of this Act, disaster management was ad hoc. The Act provides for the establishment of Disaster Relief Committees at central, regional, district, and local levels. This Act is applicable to natural disasters such as earthquakes, fires, storms, floods, landslides, heavy precipitation, drought, famine, and epidemics.

The Cabinet approved a National Building Code (NBC) in 2060 BS. After the approval of the NBC, the Department of Urban Development and Building Construction (DUDBC) has been attempting to enforce this code in all government buildings as well as in private buildings through the municipalities. Lalitpur Sub-Metropolitan City implemented the code first in 2003 (UN 2001).

Section 3

Conclusion

8 Problems and Policy Recommendations

Problems and Recommendations for Policy and Action

The environmental changes taking place in Kathmandu Valley are far from satisfactory, and, this trend, if it continues, will be unsustainable. Although steps have been taken that have produced positive results, much remains to be done to maintain and improve environmental resource use and improve the quality of life.

A two-pronged strategy is necessary to formulate and follow appropriate standards for new developments in all sectors; in using environmental resources, on the one hand, and in gradually preventing the unsatisfactory levels of use of existing environmental resources on the other. Public awareness and public pressure; critical analysis of the issues by involving all stakeholders; bold and appropriate decisions by the government; and planning and implementation by all stakeholders can ensure success.

Promotion and practice of a voluntary and preventative approach are more cost-effective and more suitable for sustainable development. The following sections deal with the main problems and suggest policies for the five key issues presented in the previous chapters.

Air pollution and traffic management

Air pollution, particularly concentration of particulate matter in Kathmandu Valley, are substantially greater than national and international standards. Although responses over the past few years have shown positive impacts and improvements, more effective steps need to be undertaken to bring air quality to the desirable level.

The main problems relating to air pollution in Kathmandu Valley presently are listed below.

- Kathmandu-centric development, causing rapid and haphazard urbanisation
- Institutional capacities are weak in this sector.
- Insufficient involvement of agencies and stakeholders
- Focus on a curative rather than on a preventative approach

The policy for this sector should focus on prevention and control of vehicular emissions as they are the main source of air pollution in Kathmandu. The policy should draw upon lessons learned from successful transformation of Kathmandu's brick industry and its positive impact on air quality. The key factors leading to success are public awareness, public pressure, and bold government decisions implemented with support from the private sector, NGOs, and international agencies. Road/transport planning and polluting industrial units should also be target areas for improvement.

The following policies are recommended.

Incentives for cleaner and zero-emission electric vehicles – The import duty on certified cleaner vehicles should be lowered to promote the purchase of cleaner vehicles.

Improve emission testing and control enforcement to discourage use of highly-polluting vehicles – Emission testing needs to be made effective. Surprise roadside testing should be increased.

Promotion of effective maintenance of vehicles – Awareness of the savings and benefits of preventative and timely maintenance should be emphasised. Skill training for mechanics must be promoted. Accredited private emission testing centres can be established on a pilot basis at good quality workshops where maintenance can be carried out immediately. Such facilities can then be expanded.

Effective planning for cities and their management – including traffic management – Newly-planned areas should have standard widths for roads. In existing city areas, roads should be improved to facilitate traffic circulation.

Promotion of non-motorised vehicles and public transport through providing them with better services and facilities – Good public transport services can help reduce the number of private vehicles. The emphasis should be on zero emissions from public transport.

Promotion of cleaner production and energy efficiency in industries using boilers and furnaces – Cleaner production assessments and energy audits for boilers and furnaces would help save fuel and reduce air emissions.

Improvement in air quality governance – Air quality governance is a comparatively new idea in Nepal. Stakeholders should be helped to coordinate their endeavours and to improve their capabilities by introducing continuous improvement cycles, both in plan and practice.

Settlement pattern

The ecosystem of Kathmandu Valley should be preserved not only to ensure healthy living conditions but also to mitigate disasters that may lead to loss of life and property. The most sought after tourist destination in Nepal may turn into a filthy settlement unless the settlement pattern is planned and managed properly.

The main problems are as follows.

- Centralisation of political and economic power
- Poor capacities of municipalities and local authorities
- Weak enforcement of existing legislation, plans, and programmes
- Overlapping roles of local authorities and central government
- Traditional land-use and management policies and complex land-ownership patterns
- Conflict between rural and urban strategies
- Inadequate trunk infrastructure

The long-term development concept approved by the government in 2002 needs to be translated into plans, programmes, and actions at both valley and local levels. At valley level, trunk infrastructure (such as the water supply system, electricity transmission and distribution network, sewerage and drainage network and treatment facilities, landfill sites and major arterial roads, and bus terminuses) has to be planned and developed. At local level, land and housing development schemes, infrastructural improvement, and conservation of open spaces and heritage sites have to be developed. Moreover, the local authorities in Kathmandu Valley need to develop a common vision.

Kathmandu is the national capital and the central government's role is crucial in the provision of valley-level infrastructure. The coordination of different government line agencies is needed to implement urban development projects. Hence, a valley-wide apex body with the representation from local authorities should be established. This body should be responsible for guiding government line agencies and local authorities in plan implementation. It should be able to mobilise resources from the government as well as the private sector. The proposed apex body should replace the existing Kathmandu Valley Town development Committee with offices in three districts.

Local authorities need to improve their delivery of basic services. Since it is their responsibility to enforce land-use plans and issue building permits, activities concerned with valley-wide planning should be coordinated among them. To do so financial and technical capabilities need to be improved.

The following actions are proposed to guide the future growth of settlements in Kathmandu Valley.

Formulation of an urban land-use and management policy for Kathmandu Valley – Such a policy should be integrated with the existing cadastral system. Land needs to be categorised into agricultural land or land for urban development. Land subdivision, transfer, acquisition, or assembly should take place as per the urban land-use policy. Similarly, expansion of the road network and trunk infrastructure should be carried out according to the land-use plan. Municipalities and VDCs should be entrusted with keeping land records and monitoring land subdivision.

Land zoning – Zoning of agricultural land that needs to be preserved; environmentally sensitive areas such as landslide and flood-prone areas; and public land to prevent settlement development in these areas

Streamlining issuance of building permits – by conforming to the existing planning framework, norms, and standards

Separate treatment of existing city core areas and traditional settlements – by formulating appropriate building byelaws and subdivision regulations

Reservation of land for national-level establishments – such as the national stadium, parliament house, inter-city bus terminus, and future government establishments

Development of appropriate sanitation systems – such as septic tanks for low-density areas and sewerage treatment plants for densely built-up areas

Improvement of the existing urban road network – to discourage ribbon development on radial roads

Upgrading existing settlements in both rural and urban areas – by improving the physical and social infrastructure

Encouraging the planned development of settlements – at appropriate locations by launching land-pooling and sites and service schemes by the government; and housing development programmes by the private sector

Introducing a vacant land tax – in municipal areas to discourage land speculation

Drinking water resources

There are many problems concerning drinking water in the Kathmandu Valley.

Widening gap between demand and supply of drinking water – household consumption and economic activities such as industry, hotels and restaurants, transport, and others

Deteriorating quality of water – the quality of drinking water has deteriorated because of the inadequacy of treatment plants, direct discharge of untreated sewage into rivers, mixing the storm-water drainage system with the sewerage system, and inefficient technical management of the piped water distribution system.

Depleting groundwater table and drying up of spring sources and ponds – due to overexploitation of groundwater, the groundwater table has fallen at an alarming rate each year.

Low priority given to sanitation in health programmes and frequent implications of drinking water in intestinal diseases – due to unhygienic conditions, water-borne diseases such as diarrhea, dysentery, and gastro-enteritis often occurr in the valley.

Damage to the aesthetic value of sacred rivers, lakes, and ponds – haphazard construction of buildings and sand and stone quarrying on the banks of rivers and ponds are responsible for the declining aesthetic value of the water bodies.

Arsenic contamination – indications of contamination in groundwater

Data gaps in water quality, quantity, and maintenance of rivers

Although there are many organisations and agencies involved in water supply and distribution, prevention of pollution, and contamination in the valley, the interventions have not yet produced adequate results. On the other hand, there has been a rise in awareness in local communities about water-use rights. The following policy actions are recommended.

Promote involvement of local communities in waste management to prevent water pollution and contamination – Waste disposal should be managed through local communities to control open defaecation, and impose minimum housing standards. Such activities will help prevent pollution of water bodies.

Promote biological treatment of wastewater – Biological treatment of wastewater is prefereable to discharging untreated domestic sewage and industrial waste into rivers. Treatment plants for industrial and domestic waste should be established: on-site treatment plants for treating domestic waste at community level should be introduced.

Allocate more resources for the supply of potable water – Providing potable water to the public will reduce the cost of treated water and decrease expenditure on health care for water-borne diseases in the long run. More resources should be allocated to research into water-source protection and strengthening the existing supply network.

Promote rainwater harvesting – Appropriate techniques for rainwater harvesting for domestic purposes should be adopted.

Promote awareness, water conservation, and use of water-saving equipment – Effective awareness activities about conserving water quality and quantity and techniques for recycling domestic grey water should be carried out across the valley.

Setting up a lead agency to coordinate water resources in the valley – This agency is urgently required to coordinate water-related organisations, set standards, and plan and organise supplies. Adequate data on water quality and quantity should also be collected and stored regularly. Research on drinking water resources should be continued.

Control of leakages – Leakage of piped water should be controlled through efficient monitoring mechanisms.

Waste management

Urban waste management remains unsatisfactory despite the fact that there are policy and legal frameworks and effluent standards and despite the many project efforts to improve the situation.

The main issues and concerns related to this state of affairs are the following.

Contradictions/overlaps/duplications of authority and confusion generated by the many acts and rules – (central agencies, municipalities, the private sector, and NGOs/ CBOs).

Poor capacity – of the institutions involved to undertake their assigned roles

Poor resource mobilisation and financing capabilities – Currently about one third of the municipal budget is spent on solid-waste management (SWM) activities. Long haulage to Sisdol is likely to increase the management costs.

Negligible efforts to encourage/ promote the 3Rs (reduce, reuse, and recycle) – The main approach taken to waste management appears to be collection and disposal without considering the consequences.

No clear strategy for dealing with industrial and medical waste – Although industrial waste is small in quantity compared to the total volume of waste, its pollution potential is higher than other forms of waste. This is also true of waste generated by health care institutions.

Inadequate/ineffective/weak compliance monitoring and enforcing mechanisms – Although standards exist, compliance is not monitored or enforced.

Lack of a long-term plan for wastewater treatment – Although several studies and plans have taken place in the past concerning collection and treatment of wastewater, particularly for the Kathmandu and Lalitpur municipalities, these have not been adopted in practice. This situation has been aggravated by uncontrolled expansion of settlements.

Poor operation and maintenance of facilities – Waste facilities are generally in poor repair. Landfill sites often meet with public opposition, basically caused by unsatisfactory operation and management. Most wastewater treatment plants are non-operational.

Waste management in the urban areas of the Kathmandu Valley needs substantial improvement. In order to achieve this, a holistic and integrated approach linked to overall urban development and management is required. The following actions are proposed for improvement of waste management in the urban areas of Kathmandu.

Clarify roles and mandates of agencies – The LSGA gives the authority and responsibility to municipalities to manage waste in their territories. However, central agencies, such as the SWMRMC, NWSC, DWSS, continue to be involved in planning and provision of waste-management facilities and in operating them. The overlapping mandates of various agencies and contradicting provisions of different legislations often create confusion at operational level. In order to increase effectiveness and efficiency, it is essential to revisit the current institutional and legislative provisions and assign clear and complementary rather than contradictory mandates and roles to the various agencies. Although efforts have been made, for example, to limit the role of SWMRMC (by ministerial directive not by amendment of the act) to policy, coordination, and development of landfill sites, such efforts are isolated. CBOs, NGOs, and the private sector can play meaningful roles in solid waste and wastewater management, particularly in waste collection, recycling, and operation of waste facilities.

Promote composting – Around 70% of the solid waste generated in Kathmandu's urban area is organic, and this will become a problem if not dealt with properly. Various attempts have been made by the government, municipalities, and NGOs to increase awareness about the benefits and methods of home composting. The compost bins subsidised by Kathmandu and Lalitpur municipalities are becoming popular among certain sections of the population. Similarly, community composting is being carried out by some NGOs. Although Teku compost plant has operational problems, the private sector is showing an interest in establishing and operating compost plants. Appropriate measures should be taken to promote this endeavour by making sites available for composting, purchasing the compost produced, or by paying tipping fees to process the waste.

Promote reuse and recycling – Reuse and recycling already take place to some extent: materials collected are either recycled in Nepal or exported to India. Hawkers collect recyclable materials from generation points and waste pickers collect recyclable materials from dump sites or transfer stations. These hawkers and waste pickers sell the materials to scrap dealers who export them outside Kathmandu. Recyclable materials include paper, plastic, bottles, broken glass, discarded wool pieces, iron/metal, leather, and animal bones. Incentives should be given to promote such activities (e.g., tax incentives) and the scrap tax levied on the export of recyclable material outside Kathmandu should be abolished.

Encourage door-to-door collection of solid waste – Door-to-door collection offers a number of benefits, including control of haphazard littering on the streets, improvements to hygiene, and reduction in overall waste collection costs: it is also possible to promote waste segregation at source. Door-to-door collection is already available in some city areas, mainly provided by NGOs and the private sector. These activities need to be expanded.

Upgrade existing facilities for solid waste management and develop new facilities – The current solid waste management facilities are inadequate and need improving. Old facilities should be renovated and new ones built in strategic locations.

Operate and maintain wastewater treatment plants – Wastewater treatment plants are not in full operation, with the exception of the treatment plants at Guheshwori and Thimi. Huge amounts of money and effort have been invested in developing these treatment plants. Their status should be assessed and they should be repaired if necessary. Operation and maintenance of these plants will reduce the pollution of surface water significantly.

Establish industrial wastewater treatment facilities – Treatment plants can be established for industrial estates (such as Balaju industrial estate) and clusters of industries (e.g., the carpet dyeing and washing industries from Boudha are planning to move to a cluster in Mulpani area).

Promote cleaner production in industries – Environmental Sector Programme Support (ESPS) has carried out studies on cleaner production (CP) potentials in various industries in Nepal. It has suggested a number of no cost, low cost, and high cost CP options: in most cases the return period of the investment is short. However, only a very few options have been implemented by the industries. The industries need to be convinced about the importance of adopting these options, as they will reduce waste.

Introduce waste management in health care institutions – At present there is no systematic system for management of solid waste and wastewater generated by health care institutions. Although there are some incinerators, these are generally not in operation because of operational difficulties or public opposition. A suitable plan is needed to deal with solid waste and wastewater generated by health institutions.

Promote community wastewater treatment plants wherever possible – Community wastewater treatment plants, such as the one recently built at Thimi, have potential in situations in which a few hundred households can come together and provide space to build such facility.

Develop decentralised wastewater treatment plants – Previous studies on wastewater have recommended decentralised wastewater treatment plants in Kathmandu and Lalitpur municipalities. Similarly, small separate treatment plants for populated institutions such as army camps, hospitals, and prisons have been recommended.

Introduce strong compliance monitoring – Although various standards are set, compliance enforcement is weak. Strong and independent monitoring mechanisms should be devised to ensure compliance with the standards and requirements laid down by legislation and permits.

Natural disaster preparedness

Kathmandu Valley is extremely vulnerable to earthquakes. There are numerous faults inside the valley that are active seismic sources. Incessant rainfall and unplanned land use also trigger landslides each year causing loss of many lives. Although some work on disaster preparedness has been carried out, there are still problems.

- Low level of awareness among the general public about natural disaster preparedness
- Weak capacity and poor coordination among the relevant agencies
- Absence/inadequacy of vulnerability assessment and hazard maps
- Financial constraints
- Haphazard settlement and absence of land-use plans
- Low-level of emergency preparedness

For effective disaster management and earthquake disaster preparedness, the following actions are recommended.

Awareness raising and education about disaster preparedness – Earthquake awareness programmes should be carried out by the relevant organisations. Earthquake Safety Day should be observed throughout the country to increase earthquake awareness. Natural disaster management courses should be included in secondary and higher secondary school curricula. A Master's degree course in disaster management should be established.

Institutional strengthening – The institutions responsible for disaster preparedness need improving. Coordination among them should be enhanced. An acceleration network should be set up to gather acceleration data in order to establish attenuation relations, as this will be useful for designing earthquake resistant buildings. Municipalities should have disaster management committees and networks.

Carrying out vulnerability analyses and preparing hazard maps – These analyses should be carried out for the public, schools, hospital buildings, and other infrastructure. Hazard maps should be prepared for all Municipalities.

Resource allocation – Each government organisation should allocate budgets for disaster management. Highly vulnerable old buildings should be either demolished or retrofitted.

Zoning of hazard-prone areas – Areas with faults and where repeated disasters have occurred should be abandoned for settlement purposes.

Enhancing emergency preparedness – Emergency plans and evacuation routes must be developed and drills practised. Location of safe places should be disseminated to the general publics. Fire brigade services should be increased and improved. A database on the availability of hospital beds should be maintained and kept up to date. Emergency material should be located in easily accessible areas, and this should be made known at least to municipal authorities and responsible personnel. Hospitals and other important buildings should have automatic power generators installed and maintained. Emergency food supplies and equipment for search and rescue should be stockpiled.

Enforcing building codes – Building codes should be enforced in all new buildings and plinth areas greater than 100 sq. m. for buildings with three or more storeys should be a sine qua non. Fire extinguishers should be kept inside important buildings.

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Annexes

Annexes

Annex 1
Annual Average Extreme Temperatures for 1985, 1999, and 2004

Annual average extreme temperatures for 1985, 1999, and 2004

Month	1985		1999		2004*	
	Max	Min	Max	Min	Max	Min
January	18.1	2.4	21.0	1.0	18.2	3.1
February	20.1	3.7	26.0	6.0	22.0	5.2
March	26.3	9.0	28.0	8.0	27.3	10.7
April	28.6	12.1	33.0	14.0	27.7	13.2
May	28.0	15.5	29.0	17.0	28.6	16.5
June	28.9	19.2	29.0	19.0	28.8	16.9
July	27.1	19.6	28.0	20.0	27.7	20.2
August	28.8	20.2	28.0	20.0	29.0	20.6
September	26.7	18.3	29.0	19.0	28.1	19.3
October	24.4	13.7	26.0	14.0	26.0	13.1
November	22.2	7.0	24.0	8.0	22.7	7.5
December	19.3	4.8	21.0	5.0	20.6	4.5

Source: Handbook of Environment Statistics, Nepal - 2002; * Statistical Year book 2005

Annex 2
The Seven World Heritage Sites of Kathmandu Valley

1. **Kathmandu Durbar Square**
   Kathmandu Durbar Square was built in 613 A.D. (B.S. 670) by the Lichchavi dynasty. During the reign of King Pratap Malla, a statue of Hanuman was installed at the entrance (dhoka) of the palace (1672 A.D.– B.S. 1729) and from that time the palace has been known as Hanumandhoka Palace. There are around 50 temples in and around Durbar Square, including the famous temple of Taleju Bhawani constructed in 1576 A.D. The majority of these were constructed in the 17th and 18th centuries. The main attractions of the square include the statue of Hanuman, the golden gate, Nasal Square, the nine-storied Basantpur Palace, a European style palace (Gaddi Baithak), Kumari Ghar (home of the living goddess, Kumari), Shiva Parbati Temple, Kasthamandap (from which Kathmandu derived its name as it is said to be built from the timber of a single tree), Vagwati Temple, Kala Bhairab, and the huge bell.

   Some of the houses built against the prescribed code have been demolished. Many of the important temples, including Kasthamandap, have been renovated. Presently, the Jagannath Temple is being renovated.

2. **Patan Durbar Square**
   At a distance of only five kilometres south-east of central Kathmandu, Patan Durbar Square is situated in the city of Lalitpur. It has a number of interesting monuments carved in stone and bronze statues, temples, and squares. The square and its surroundings provide very good examples of Newari architecture. The palace has three courtyards, the main being the Mulchowk. The main attractions of Patan Durbar Square are the Krishna Temple with 21 golden pinnacles, Bhimsen Temple, Taleju Bhawani Temple, the Old Palace with a golden gate and golden windows, Char Narayan Temple with fine wood carvings, and Chyasi Dega and Manga hiti (the stone spouts). The Char Narayan temple is the oldest and was constructed in 1565 A.D.

3. **Bhaktapur Durbar Square**
   Bhaktapur Durbar Square is about 15km from central Kathmandu. The main attractions of Bhaktapur Durbar Square are the the famous Fifty-five Windowed Palace, Lion Gate (Singhadwar), the golden gate, the statue of Bhupatindra Malla, Bastala Devi Temple, the Pashupati Temple, and the National Art Gallery. The golden gate was erected by King Ranajit Malla. It is the entrance to the main courtyard of the Fifty-five Windowed Palace (Pachpanna Jhyale Durbar). The palace itself was built during the time of King Yakshya Malla in 1427 A.D. and was remodelled by King Bhupatindra Malla in the 17th century. The palace is being renovated at the moment. The Nyatapola Temple (the tallest pagoda temple in Nepal built in 1702 AD) and Dattatreya temple are situated in the square slightly below the square where the palace is situated.

4. **Swayambhunath Stupa**
   The historically and culturally important stupa of Swayambhunath is located three kilometres west of central Kathmandu on a hillock about 77m above the level of Kathmandu Valley. There is a belief that the stupa is not human-made but was created by the power of god. The name 'Swayambhu' means self created. The stupa is believed to be more than 2,500 years old. According to history, the stupa was already there at the time of King Mandeva in the 5th Century A.D. On the west side of Swayambhu hill, there is a Buddhist Chaitya of Manjushri, which is worshipped by both Hindus and Buddhists. A number of statues and monasteries are being built in and around the hillock. A Buddha statue on the western side of the hill is among these new ones. Swayambhu hill has been stabilised.

5. **Pashupatinath Temple**
   Located five kilometres east of central Kathmandu and on the western bank of the Bagmati River, the temple of Pashupatinath is a world famous temple for Hindus. Built in the 5th Century, the temple draws a huge

number of Hindu pilgrims annually from South Asia and particularly from India. The temple has a gold-plated roof and four silver doors.

There are more than 550 small and big monuments in the area. The monument complex is important not only from a religious but also from historical and archeological perspectives. The raised platforms on the bank of the Bagmati and behind the temple of Pashupatinath are used for cremation. The important sites within the Pashupati area are the temples of Guheshwori, Vastsaleshwari, Bashuki, Jaya Bageshowari, Kirantashwor, Dhando Stupa, Vishworupa, Chandra Binayak, Shreeram Temple, Lolashwor, Bhandarashwor, Gorakhanath, Jamrashwor, Bhuwanishwari, Bankali, and Rajarajeshori.

Pashupatinath Development Trust has been active in demolishing buildings encroaching on the area and also in constructing new monuments and service areas, including green areas.

6. Boudhanath

Boudhanath Stupa is the biggest stupa in Nepal. It is located 8 kilometres east of the centre of Kathmandu. The stupa is 36 metres high and occupies a sizable area of 82.36by 82.03 metres. At ground level there is a brick wall with 147 niches and 108 images of the meditational Buddha inset behind copper prayer wheels. The stupa is said to entomb the remains of a Kasyap sage revered by both Buddhists and Hindus . Believed to be constructed during the 5th Century A.D., the stupa is located along the ancient trade route to Tibet. Tibetan merchants rested and offered prayers here for many centuries and when Tibetan refugees entered Nepal in 1950, many of them settled around this area. Boudhanath area is the centre of Tibetan culture in Nepal. There are more than 45 Buddhist monasteries in the Boudhanath area.

7. Changunarayan Temple

The temple of Changunarayan is situated in Changu Village in Bhaktapur at about five kilometres north of Bhaktapur on a hill top. It is one of the finest and oldest specimens of pagoda architecture and is dedicated to the Hindu god, Vishnu. The temple is embellished by stone, wood, and metal crafts. The temple has great historical, archeological, and religious importance. It was constructed in 306 AD by King Mandev. A fifth century stone inscription in the temple proclaims it to be one of the oldest shrines in the Kathmandu Valley.

Annex 3
Industrial Location Policy in the Valley

List A: Industries that may be established inside the municipalities of Kathmandu Valley

a. *Cottage Industries*
   - Traditional cottage industries (except rural tanning)

b. *Tourism Industries*
   - Travel Agency
   - Trekking Agency
   - Hotel Resort, Restaurant

c. *Manufacturing Industries*
   - Food Processing Industries (with machinery worth a maximum of Rs. 200,000) – except for meat processing
   - Electronic Assembly Industry
   - Candle Industry (with machinery worth a maximum of Rs. 100,000)
   - Stationery Industry (with machinery worth a maximum of Rs. 100,000)
   - Wooden Furniture Industry (Band saws are not allowed and with machinery worth a maximum of Rs. 50,000)
   - Woollen yarn spinning (by manual spinning)
   - Rexene Bag Industry (with machinery worth a maximum of Rs. 100,000)
   - Leather Products (with machinery worth a maximum of Rs. 100,000)
   - Herbal Medicine Industry (with machinery worth a maximum of Rs. 50,000)

d. *Construction Industries*
   - Flyover Bridges
   - Office, Commercial, and Residential Complexes
   - Trolley Bus Service (outside municipalities if they have a workshop and garage)

e. *Service Industries*

   The following service industries can not be established in the municipalities of the Kathmandu Valley
   - Medium and large chemical laboratory
   - Workshop (workshops with machinery worth more than Rs. 200,000)
   - Cut to length sheets, strips, and tubes
   - Repackaging industries other than food items packaging tea, household spices, sugar, maida flour, salt, dal, etc.
   - Processing laboratory for cinema or movie making
   - Washing dyeing plants, textile printing
   - Cold storage

List B: Industries that are not allowed in the Kathmandu Valley

- Tannery
- Chemical fertiliser
- Cement
- Medium and large steel melting foundry
- Pulp and paper except for traditional handmade paper and small-scale recycling plants
- Caustic soda chemical manufacturing industry
- Oil refinery – petroleum products (petrol, diesel, kerosene, lubricant, furnace oil, etc.)
- Medium and large dyeing
- Acid manufacturing
- Fermentation, distillation, and blending (distillery and beer)
- Electroplating and galvanising (medium and large)
- Sugar production and khandsari (food processing)
- Rubber processing (tube and tyre manufacturing)
- Paint industry (medium and large scale)
- Bleaching powder

Annex 4
Geological Features of the Kathmandu Valley and Surroundings

Geological Features

Kathmandu Valley is an intermontane basin surrounded by mountain ranges in the North and South: Shivapuri (2,732m) and Phulchowki (2762 m). The Kathmandu Valley is comprised of Quaternary sediments on top of basement rocks.

The Basement Rocks

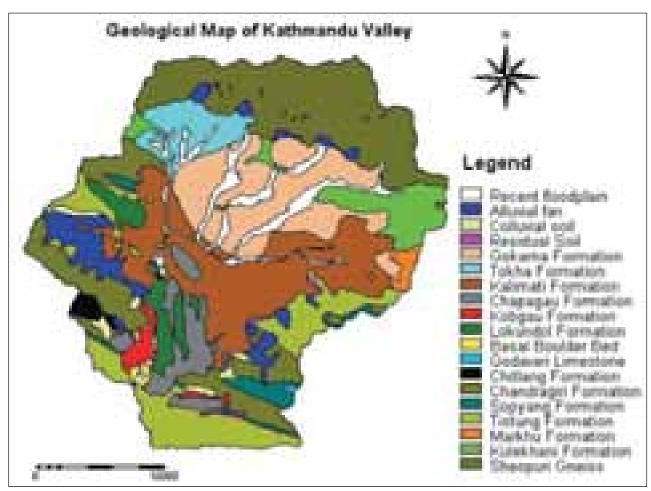
The basement rocks are of the Phulchowki and Bhimphedi groups of the Kathmandu complex of Stocklin and Bhattarai (1977) and are formed by Precambrian to Devonian rocks

The rocks of the Phulchowki and Bhimphedi groups together form the Kathmandu Complex, which is interpreted tectonically as thrust mass (allocthonous). The rocks of Kathmandu complex together with the underlying Para-autochthonous Nuwakot Complex constitute the Mahabharat Synclinorium, the axis of which passes along the Phulchowki-Chandragiri range, south of the Kathmandu Valley. The basement rocks are intersected by numerous fault systems within Kathmandu Valley (Figure 1). The Bhimphedi Group consists of relatively high-grade meta-sedimentary rocks of Precambrian age. The group is eight kilometres thick and divided into six formations. The Phulchowki Group is comprised of un-metamorphosed or weakly metamorphosed sediments containing fossils from the early middle Paleozoic age. It consists of a five to six kilometre thick sequence of rocks divided into five formations (Table 1). There are intensely folded and faulted meta-sediments, such as phyllite, schist, slate, limestone, and marble, covering the southern, eastern, and western part and intrusions of acid and basic rocks (granite and gneiss) known as the Shivapuri injection complex in the northern part of the valley. Some isolated rock outcrops of the Tistung and Chandragiri Formation can also be observed in some parts of the valley basin in Balkhu, Pashupatinath, Swayambhu, and Chobhar (see Figure.1). The source rocks of the basin fill sediments are limited to the Phulchowki group and Shivapuri injection complex because the Bhimphedi group lies outside the watershed boundary of the Kathmandu Valley. The geological succession of the Kathmandu Valley is given in Table. 1.

Quaternary Sediments

The Basement rocks of the Kathmandu Valley are covered by thick semi-consolidated fluvio-lacustrine sediments from the Pliocene to Pleistocene age. The basin is filled by thick semi-consolidated fluvio-lacustrine sediments. The maximum depth of the valley sediment is more than 550 m on the basis of borehole log DMG6 located at the central part of the valley. These thick sediments are mainly derived from the surrounding hills by the ancient drainage channel system.

The fluvio-lacustrine sediments of Kathmandu Valley have been studied by many researchers: Yoshida and Igarashi (1984); Dongol (1985, 1987); Yoshida and Gautam (1988); Shrestha et al (1998); Environmental Geological Project (EGP/DMG in cooperation with BGR/Germany, (1998); Natural Gas Project/DMG and Sakai (2001). Yoshida and Igarashi (1984) have divided Kathmandu Valley sediment into eight different stratigraphic units: Lukundol Formation, Pyangaon, Chapagaon, Boregaon terrace deposits, Gokarna, Thimi, Patan, and Lower terrace deposit. These eight units are again divided into three groups based on their different stages. Lukundol Formation (older deposits); Pyanggaon, Chapagaon, and Boregaon terrace deposits (middle stage deposits); and Gokarna, Thimi, and Patan Formations (more recent deposits).



Source: Department of Mines and Geology (DMG) 1998

Figure 1: Geological Map of Kathmandu Valley

Geological Succession of the Kathmandu Valley (modified after Stocklin and Bhattarai 1977)

Cenozoic	Holocene		Fan gravel, soil, talus, fluvial deposits (gravel, sand, silt)
	Pleistocene		Lake deposits (gravel, sand, silt, clay, peat, lignite and diatomite),
	Late Pliocene-Early Pleistocene		Fluvial deposits (boulder, gravel, sand, silt)
---	---------------------	--	------Unconformity---
Lower Paleozoic	Devonian	**Phulchauki Group**	Godavari limestone - limestone, dolomite
	Silurian		Chitlang formation - slate
	Cambrian-Ordovician		Chandragiri limestone - limestone, phyllite
	Cambrian		Sopyang formation - slate, calcareous phyllite
	Early Cambrian		Tistung formation - meta sandstone, phyllite
---	---------------------	--	------Unconformity---
Pre-Cambrian		**Bhimphedi Group**	Markhu Formation - marble, schist
			Kulekhani Formation - quartzite, schist
Intrusion			Metamorphic - Sheopuri gneiss
			Igneous rocks - pegmatite, granite, basic intrusive

Annex 5
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Kathmandu Valley is a place of extraordinary natural and cultural beauty. But it is a valley now transformed almost beyond recognition. Although some measures have been taken by the government, constantly growing traffic congestion, polluted air from vehicles and brick factories, rapidly expanding urban sprawl, streams and rivers that too often resemble sewers, piles of waste, and shortages of drinking water too often obscure the beauty beneath and beyond. In Kathmandu Valley Environment Outlook, ICIMOD has joined with the United Nations Environment Programme and the Ministry of Environment, Science and Technology, Government of Nepal to provide a detailed account of the status of the Kathmandu Valley environment highlighting five key environmental issues – air quality and traffic management, settlement pattern, water quality, waste management, and disaster preparedness. The book reviews their status, and recommends measures to prevent or minimise negative impacts, providing direct options for management by various levels of government, civil society, the public-private sector, and residents. The report provides a reference document for all institutions and individuals involved in the field of environmental management of urban areas, both in Kathmandu itself and in other cities in the region.

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