TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

DEPARTMENT OF ARCHITECTURE

PULCHOWK CAMPUS, LALITPUR

PLANNING FOR URBAN EXPANSION OF THE KATHMANDU VALLEY- A THRESHOLD APPROACH

SUBMITTED BY

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M Sc URBAN PLANNING

BATCH 2000

NEPAL

FEBRUARY 2003

CERTIFICATE

This is to certify that this thesis entitled **Planning for Urban Expansion of the Kathmandu Valley-AThreshold Approach** submitted by Kirti Kusum Joshi has been examined and it has been declared successful for the fulfillment of the academic requirement towards the completion of the Master of Science Course in Urban Planning.

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DECLARATION

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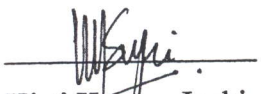

Kirti Kusum Joshi

Date: 19/05/2003

ACKNOWLEDGEMENT

The thesis dissertation entitled Planning for Urban Expansion of the Kathmandu Valley- A Threshold Approach is an outcome of lessons learnt during the two-year course of M Sc (Urban Planning) at Institute of Engineering (IOE). It is just natural that the teachers who shared their knowledge and experiences patiently with us, deserve the first words of acknowledgement.

I owe my gratitude to **Mr. Kishore Thapa**, for accepting me under his supervision to carry out this research. His long involvement in urban planning, as a senior official at the Department of Urban Development and Building Construction, has been a guiding factor to understand the complexities of urbanization and planning. I sincerely admit that his experiences have filled the void created by my lack of professional experience.

It is my luck and honor to be selected for an exchange program to Osaka Sangyo University (OSU) from September 2002 to March 2003. I am even more honored to have **Prof. Dr. Masahiro Nakano** as my supervisor, who familiarized me with the aspects of urbanization in Japanese cities, particularly Osaka and Nagoya. I would be grateful to Prof. Nakano, forever, for sharing his valuable knowledge.

I would like to join my colleagues in offering sincere thanks to **Prof. Dr. Jib Raj Pokharel** and **Prof. Dr. Sudarshan Raj Tiwari** who spent most of their times in introducing us to the world of urban planning and assisting us to be a part of it. I remember all the teachers who poured their wealth of knowledge and experiences- particularly **Mr. Kumar Lohani** (actually I was inspired to take this topic during one of his modules), **Mr. Bharat Sharma** (who suggested me to take the issue of drinking water), and **Mr. Surya Bhakta Sangachhen** (who shared his first hand experiences in the planning of the Valley).

My very special thanks go to **Miss Sudha Shrestha**, Coordinator of M Sc. (Urban Planning) Program for standing behind us in every problem during the last two years. I am personally indebted to her for her valuable support and cooperation for my study program in Osaka. Likewise, I owe my deepest gratitude towards my sponsor Association of International Education Japan (AIEJ), my home institute IOE and Tribhuvan University (especially **Prof. Dibya Man Karmacharya** and **Mr. Binod Dongol** of TU Center for International Relation) and my host University OSU

(especially the wonderful officials at International Exchange Office- **Mr. Shozo Yamamoto** and **Ms. Yoshiko Kato** in particular).

I am personally thankful to **Mr. Ajay Lal**, lecturer, for his suggestion regarding my research topic at the time when I was going through some confusion.

I wish to extend my sincere thanks and gratitude to very cooperative **Mr. Hideki Ooshima** of Nakano Research Room, OSU who gave me every support that I needed.

While at OSU, I enjoyed the warm company of some Nepalese and Japanese students. In particular, I had productive discussion with **Mr. Sunil Babu Shrestha**, an IOE-graduated Urban Planner and doctorate student at OSU.

Cooperation received from engineers at Nagoya City Office and Osaka City Office, as well as from **Mr. Surya Narayan Shrestha** and **Mr. Ramesh Guragain** of NSET is highly acknowledged.

The words of acknowledgement will be incomplete without giving thanks to **Mr. Sudarshan Rajbansi** of our Department and the wonderful friends with whom I had the pleasure of studying together. Their inspiration and friendship have always been a motivating factor for me to do my best. Particularly I wish to mention the name of **Mr. Suresh Lal Shrestha**, **Mr. Tapendra B Khadka**, **Mr. Umesh Silwal** and **Mr. Roshan Pande** for their valuable cooperation during research period..

Finally, I dedicate this thesis dissertation to all the planners working for the Kathmandu Valley, now and in the past, whose dreams are yet to come true.

ABSTRACT

The socio-economical and political value of the Kathmandu Valley has never been challenged in the history of Nepal. Even the victory by King Prithivi Narayan Shah of Gorkha over the Valley did not change the status but only highlighted the place of the Valley in the map of Nepal, with the capital city of unified Nepal in its heart. But times changed, and the modern addition in traditional cities of the Valley tarnished the glory which had been so fondly treasured.

Today, the Valley faces a number of problems- poor environment, water scarcity, traffic congestion, ugly built-up areas and so on. The list seems endless. But these problems have not stopped the high rate of urbanization of the Valley with annual population growth rate of over 4 %. In fact, the urban problems are the unwanted by-products of uncontrolled urbanization. So to prevent further deterioration of the Valley, which in near future will be a conglomeration of settlements, analysis of population, including migrants, needs to be carried out to figure out under certain circumstances, how many people the Valley can accommodate and at the same time, provide adequate urban services.

The physical boundary of the Valley with high hills around it, puts a limit on the urban growth beyond the foothills. Even for the area within the boundary, there is agricultural land to be preserved for ecological reasons, and there are open spaces to be left for seismic safety. There are people, and many are added each year. Services have to be provided to them, and among all, water stands as the most crucial one. The Melamchi Project is at the doorway, but it needs to be examined for how long it can satisfy the thirst of the Valley people. Of all the perspectives, physical space and drinking water requirements are particularly important in suggesting the threshold capacity of the Valley. Definitely, the carrying capacity is not a static value and changes with change in social and technological changes. But for a country which cannot carry out dramatic development works, planning works have to be based on the realistic limitations and constraints.

This study attempts to define the carrying capacity of the Valley based on selected factors, and recommends strategies based on threshold approach.

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LIST OF ABBREVIATION

Organizations

ADB	Asian Development Bank
AIEJ	Association of International Education Japan
CBS	Central Bureau of Statistics
DBHPP	Department of Building, Housing and Physical Planning
DDC	District Development Committee
DOR	Department of Road
DUDBC	Department of Urban Development and Building Construction
GHI	GeoHazards International
HMG	His Majesty's Government
HMIS	Highway Maintenance and Information System
ICIMOD	International Centre for Integrated Mountain Development
IOE	Institute of Engineering
IUCN	International Union for Conservation of Nature
KMC	Kathmandu Metropolitan City
KVERMP	Kathmandu Valley Earthquake Risk Management Project
KVMP	Kathmandu Valley Mapping Project
LSMC	Lalitpur Sub-Metropolitan City
MMI	Modified Mercalli Intensity
MOPE	Ministry of Population and Environment
MWSDB	Melamchi Water Supply Development Board
NPC	National Planning Commission
NPG	Negative Population Growth
NSET	Nepal Society for Earthquake Technology
NWSC	Nepal Water Supply Corporation
NWSDB	Nepal Water Supply Development Board
OSU	Osaka Sangyo University
TIA	Tribhuvan International Airport
TU	Tribhuvan University
UNESCO	United Nations Educational, Scientific and Cultural Organization
VDC	Village Development Committee
WB	World Bank

WHO	World Health Organization

Studies/ Reports

KVUDPP	Kathmandu Valley Urban Development Plans and Programmes

Technical Terms

BOD	Biochemical Oxygen Demand
CBD	Central Business District
CDI	City Development Index
CD ROM	Compact Disk Read Only Memory
EAP	Economically Active Population
EIA	Environmental Impact Assessment
FAR	Floor Area Ratio
GLD	Guided Land Development
PWL	Pumping Water Level
IT	Information Technology
WHO AQG	World Health Organization's Air Quality Guidelines

Measurement Units

g	gram
ha	hectare(s)
lcd	liter consumption per day
lpcd	liter per capita per day
km	kilometer(s)
kmph	kilometer per hour
m	meter(s)
mld	million liters per day
ppha	persons per hectare
sft	square feet
sq km	square kilometer(s)
sq m	square meter(s)

Miscellaneous

INGO	International Non-Governmental Organization
NGO	Non-Governmental Organization

GLOSSARY

Aana	Traditional unit of measuring land area (1 *aana*= 342.25 sft)
Baha	A type of *Newar* Buddisht monastry*
Bahi	Another type of *Newar* Buddisht monastry*
Jatra	Festival
Newar	Indigenous people of the Valley
Pati	Rest-house
Pith	Seat of a divinity.
Saagaa	Compost pit
Stupa	A stylized monument, symbolizing Buddha's teaching and recalling his life and examples*
Tar	Plain
Vamshavali	Chronicle
Yela	Traditional name of Patan (Lalitpur)

(***Source**: Macdonald and Stahl 1979)

CHAPTER I
INTRODUCTION

1.1 Background

Since ancient times, the Kathmandu Valley has the honor of being the socio-economic and political hub of the country. It has had its glorious days during the Lichhavi and Malla times, with its status unchallenged even after the victory of King Prithivi Narayan Shah who decided to make Kathmandu the capital of the unified country. During the period of political stability after the fall of Rana regime, the Valley began to see a new kind of invasion in the form of migration from all corners of the country, unplanned development of roads and buildings, deterioration of environment- all being the byproducts of haphazard urbanization.

Urbanization is a global phenomenon, and many developing countries suffer from similar problems that Nepal faces in its urban areas. But what is unique about the Kathmandu Valley is the dramatic rate of urbanization despite its geographical constraints and poor provision of infrastructures including water among all. The Valley has been studied many times, but even after a series of diagnosis and prescriptions in the form of plans and programs, developments always superseded planning. Population increase continues to put pressure on already inadequate and poor infrastructures.

For some time now, the rate of population increase in the Valley has been controlled to some extent by the poor availability of drinking water. But with the operation of much-awaited and much-debated Melamchi project, this scenario is likely to be changed. But the critical issue of availability of drinking water versus population growth will continue to exist.

Apart from water, there is the geographical limit to urbanization posed by the mountains surrounding the Valley. Furthermore, the geo-technically poor soil of the Valley cannot permit large-scale development as the Valley had already faced worst consequences in the past due to earthquakes. Though only moderately urbanized at that time, the memoirs of destruction caused by the Great Earthquake of 1934 are still enough to judge the scale of destruction should a similar earthquake take place in the present concrete-jungle of the Valley. A study shows that in case of an earthquake similar to that the 1934 earthquake,

40,000 people will lose their life and 90,000 will be injured.

Though limiting the growth of cities is somewhat more of a theoretical concept, it is useful from the planning point of view to recognize the factors that can or tend to limit the growth of cities. Though difficult to calculate, the threshold approach of defining carrying capacity of the Valley offers a best guidance in the formulation of right plans.

1.2 Objectives

In view of providing a guiding factor for planned urbanization of the Valley, the study undertakes the two-fold objectives-

- To define the carrying capacity of the Valley for optimum population from the viewpoint of service, space and safety factors
- To recommend strategies based on threshold approach for the urban expansion of the Valley to achieve sustainable development

1.3 Rationale of the Study

A large number of studies have been carried out for the planning of the Kathmandu Valley. Plans, whether they are the land use maps or structure plans, have been based on the land functionalities and projected population as per the prevailing trend. The importance of defining carrying capacity of the Valley in terms of population, services and land availability among others, has been recognized in some studies. But, no study has come forward to define the optimum population that the Valley can accommodate. Studies have recommended policies to provide urban services to meet the growing demands, but most of the studies have remained silent on the issue of limiting the growth itself. Certainly, no area can grow forever. For the Valley also, there should exist some threshold which would, could and should limit its growth.

1.4 Scope of the Study

The study is carried out to cover up the followings-

- Study of urbanization trends and issues triggered by population boom in the Kathmandu Valley
- Review of past planning approaches in relation to the linkage between population and urban services

- Assessment of needs for space, safety and service for the population of the Valley, with time series future scenario
- Strategic recommendations on urban expansion and growth management

1.5 Limitation of the Study

Though the canvas of the study is large, calculation of the optimum population to be inhabited in the Valley and prediction on the future scenario are based on following factors, as follows-

- Population density (in terms of space and safety from seismic hazards)
- Service of drinking water

The study is largely based on the previous works on the Valley.

1.6 Methodology

The study follows the following methodological steps-

1. Literature review of relevant publications on the planning of the Valley
2. Collection and analysis of the secondary data from authentic sources regarding the status of population, urban services and land availability in the Valley
3. Discussion with planners and intellectuals on the issues underlying the urban expansion of the Valley, supplemented by interactive presentations to gather creative comments[1]
4. Examination of issues and adoption of threshold planning approach
5. Preparation and submission of final report

[1] Held at IOE, Lalitpur and OSU, Osaka. A study program to Osaka, Japan (September 2002 to March 2003) has assisted in gathering views of some Japanese intellectuals based on their experiences of the Japanese cities.

CHAPTER II
LITERATURE REVIEW

2.1 Introduction

The growth of urban areas in many developing countries is taking place with very little concern for the future. Though urban dwellers in the fast growing cities suffer from shortages in at least one of the basic urban amenities, the cities continue to grow to fulfill the economic needs of the people. In some cities of developed countries, rate of population increase has attained stability, thereby indicating optimum maximum population for the time being. But the concern still exists about the ecological sustainability.

Carrying capacity is the population of a given species that can be supported indefinitely in a given habitat without damaging the ecosystem upon which it depends (Joshi 1997). Ecological footprint[2] represents the land area necessary to sustain current levels of resource consumption and waste discharge by a given population (Burke 1997). The concept of carrying capacity (and thereby ecological footprint) has regional implication over urban as well as rural areas since urban areas have been consuming the rural resources (located at the periphery of urban areas) at subsidized prices.

> "With an increase in the size of the city, the per capita investment on infrastructure decreases and jobs and employment are created more easily. But the carrying capacity elsewhere is decreased. " (Joshi 1997)

2.2 Exploding Cities[3]

Fast growing cities have been a topic of debate since the times of Industrial Revolution (at the end of eighteenth century) in the West. But in fact, important cities before the Industrial Revolution were not free from problems of economic and social organizations because of their size. Rome, with an estimated population of 800,000-1,200,000 in the third century AD, had to be supplied with water brought over considerable distances by aqueduct, and so did London

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[2] A term invented by University of British Columbia regional planner William Rees (Burke 1997). The Earth Council report states that a biologically productive area of 1.7 ha is available per capita for basic living. Assuming no further ecological degradation, the amount of available biologically productive space will drop to 1 ha per capita once the world population reaches its 10 billion which may happen in only little more than 30 years (Wackernagel, et al. 1997).

[3] title of a book by Wilsher and Righter (1977)

which had to draw water from 35 miles away by aqueduct (Hall 1982) in the seventeenth century. Referring to the historical account of urbanization in the West (Hall 1982, Gallion and Eisner 1986), it seems a similar trend is taking place in the developing countries of today.

> "The people who flooded into the burgeoning nineteenth century industrial and port cities of Britain were overwhelmingly coming from the countryside. They tended to be drawn from the poorer section of the rural population- those who had least to lose and most to gain by coming to the city". (Hall 1982)

Serious debates have started in 1970's about the future scenario of the global cities. Wilsher and Righter (1977) look at the cities of the developed world, which embodied the achievements and aspirations of the Industrial Revolution, which, with all their manifold failings, have firmly set the pattern for what a city should look like, contain and be, and that pattern, rightly or wrongly, is still being followed throughout the Third World. An ever-important question still awaits proper answer- how big a city can or should grow.

> "…. however dramatic and appalling the current trends, and some of their side-effects, may happen to be, there would be less reason for concern about the future if some effective self-limiting and self-balancing mechanism were quietly at work. But does it exist?" (Wilsher and Righter 1977)

Though the Asian urbanization is similar in many respects to western urbanization, it is quite different too. Rural-urban migration, high-density urban clusters, social heterogeneity, inadequate economic infrastructure, and social stress are common factors in both environments. But, the compact nature of settlement, the generally greater reliance upon, and development of, basic public transportation, and the much greater mixing of land uses differentiate the Asian city from its Western counterpart. A study on Asian cities (Costa et al. 1989) views that "The depressing physical and social conditions of nineteenth-century European and American societies are reflected today in Asia- and here again the extent of physical and social disorder has not been experienced previously". The great Asian metropolitan centers have grown to such a size that they are rapidly becoming so inefficient that can ultimately act as a brake on national development.

The urbanization trend in the neighboring countries of Nepal has many similarities with that of Nepal. But the probable solutions to control urban

growth differ from country to country. For instance, the Shiv Sena[4]'s threat in May 1985 to launch an Assam-like agitation to ban migration into Bombay[5] (Nath 1989) is not a solution at all, but still is a powerful voice of anger and frustration against the in-migration. Banning migration cannot be an acceptable solution in democratic countries like India and Nepal. But in China, a balanced form of urbanization has been achieved through state control and regulation of migration, with diffusion of urban industry to rural areas, and the formation of more joint industrial enterprises run by urban and rural interest groups (Ye 1989). This has helped to control the size of large cities, and promote the development of small cities and towns.

Studies on cities across space and time provide not only account of what had happened, but also indicates the forthcomings. The advantage with the developing countries is that they can learn from the rise and fall of the developed ones.

> "We have moved through a series of historical stages- since before the turn of the century through the 1920s, from the City efficient to the City Beautiful and to the City Achievable; since the 1920s, from the City Governable to the City Manageable; and since World War II, from the City Possible to the City Tolerable." (Meltzer 1984)

2.3 Urban Growth and Limits

The most important aspect of urban growth is the growth of population in cities and their suburbs. The city grows upwards (in density) as well as outwards (in area) which means the city expands both vertically and horizontally. Both these two dimensions of urban growth shape urban demography. When the city expands outwards, a portion of the rural population is automatically transformed into urban one. When the city grows upwards, its demographic change is profoundly influenced by migration apart from the natural factors of births and deaths (Bhattacharjee 1995).

Impact of population over the urban infrastructures, especially when the latter are already inadequate and limited, is a critical issue. Voices against population

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[4] a militant pro-Maharastrian organization in India

[5] now Mumbai

control, especially migration, have been raised for a long time[6].

The issue of urban utilities and population growth as to which should control the other, is not a new debate. It is only now that issue of drinking water, among others[7], has come forward as the probable limiting factor for the growth of the Kathmandu Valley. In this regard, even in the United States, attempt to look utility as a means of control, was carried out, as in the analysis of the role of water utility to limit or control growth in the context of United States, by Forestell and Seeger (1975) based on the responses of key people in the water field. Many responses were against the use of water utility to control growth, terming the option as "negative management", "backdoor way of doing things", "like the tail wagging the dog", and so on. But at the same time, it was accepted that provision of water at any place and in any amount was not practically applicable (Forestell and Seeger 1975).

2.4 The Kathmandu Valley

Earlier, it was mainly the historical and cultural aspects of the Kathmandu Valley that drew attention of researchers. The framework of study has widened as to corporate the contemporary issues of a large modern urban settlement. Significant studies on urbanization and planning of the Valley have been carried out by the Government bodies in fulfilling their duties of formulating plans and programs.

Carrying capacity was not much of a concern for the Valley even in the 1970s since it was predominantly agricultural land with moderate population. Even after the population boom, the topic has been less seriously dealt with, most probably because of the inherent property of cities to attract migration. There is nothing unnatural in the growth of cities. But it is not acceptable if the growth is unlimited, dramatic and uncontrollable.

The conventional planning approaches adopted included mainly physical plans including land use maps. Earlier efforts (such as HMG/DBHPP 1969) gave priority towards absorbing population growth through densification within the

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[6] For instance, Negative Population Growth (NPG), founded in 1972 with more than 25,000 Americans working, advocates a smaller and truly sustainable United States population through smaller families and lower immigration levels < http://www.npg.org >2003.2.21.

[7] Water utility stands as the most important and essential urban utility not only in Nepal but also in global context

existing peripheral urban areas and accommodating future growth in the designated urban expansion area[8]. Zoning and infrastructure development were recommended to be used to direct and encourage growth towards the designated areas. The link between urban growth and infrastructure, with the latter as a regulatory mechanism, has been recognized even in the late sixties. However, infrastructure continued to be considered as a factor which could regulate growth in designated areas, but not as something which could control or minimize the growth itself in the whole of the Valley.

Considered as one of the most comprehensive works on the Valley, the Kathmandu Valley Urban Development Plans and Programmes (KVUDPP 1991) also proposed to link as well as control urban growth through planned infrastructure development. But recognizing the limited ability of the Government to intervene in the development process, it chose the option of "continuation of prevailing trends, with minimum (necessary) intervention only" (HMG, ADB 1991). So the continuation of providing infrastructure to the increasing population, regardless of the rate of growth, was neither advocated nor denied. For instance, sidelining the role of drinking water in controlling future population, the KVUDPP cleverly stated, "This (Melamchi) would take care of all Valley's water supply needs beyond the (KVUDPP) plan horizon" (HMG, ADB 1991).

The over enthusiasm over the Melamchi project is not shared by all. For instance, HMG/MOPE 1999 predicts that even after the completion of the Melamchi project, the water supply situation by 2011 will run more or less at an approximate 30% deficit.

> "... This (water) could be the most important factor limiting the growth in the Kathmandu Valley". (HMG/MOPE 1999)

The debate over whether to restrict population growth or to manage it, will continue, with the latter having more supporters among planners and policy makers. Policies to restrict population growth could often be counterproductive and bring about economic slowdown since it is necessary to retain the tax base of the city as well as to create jobs (Burathoki 2001). But to think that municipal services can be continuously provided irrespective to the population increase in

[8] for instance, the highlands to the west of Bishnumati River were designated areas for urban expansion in the Physical Development Plan for the Kathmandu Valley (1969)

developing country like Nepal with poor economic status, would be even more counterproductive. At the same time, it is also true that urban growth is an evolutionary phenomenon and carrying capacity of an urban area is influenced by many external factors which can increase or decrease the carrying capacity.

The most recent and significant work on the Valley by HMG/KVTDC 2002 proposes an urban expansion strategy which will " to some extent, increase the carrying capacity of the Valley" but it avoids determining the optimum population because of the complexities involving "political, economic and social reasons". Nonetheless, the acceptance that "determining the maximum population that the Valley can carry, is expedient to have environmental balance and sustainable development" (HMG/KVTDC 2002) indicates necessity for a series of research on this very complex topic.

CHAPTER III
URBAN GROWTH IN THE KATHMANDU VALLEY

3.1 The Kathmandu Valley- An Introduction

Kathmandu Valley is situated between the latitudes 27° 32' 13" and 27° 49' 10" north and longitudes 85° 11' 31" and 85°31'38" east (Burathoki 2001). It covers an area of about 667 sq. km[9] (HMG/KVTDC 2002) and its mean elevation is about 1350 m above sea-level (Burathoki 2001). The Valley is bowl shaped-with rivers draining towards the center of the basin. The rivers merge into the Bagmati River which drains out through the Chobhar gorge located at the southwest corner of the Valley.

The geographical boundary of the Valley is defined differently in different studies. Lately, HMG/KVTDC (2002) defines it to be bound by the Shivapuri mountain range in the north, Nagarkot in the east, Phulchoki in the southeast, Lamdanda in the south, and Bhim Dhunga and Nagarjung range in the west.

The Kathmandu Valley is politically divided into three districts of Kathmandu, Lalitpur and Bhaktapur (Map 3.1). Kathmandu district consists of Kathmandu Metropolitan City (KMC), Kirtipur Municipality and 57 Village Development Committees (VDCs). Lalitpur consists of Lalitpur Sub-Municipality and 41 VDCs. Bhaktapur consists of Bhaktapur Municipality, Madhyapur Thimi Municipality and 16 VDCs. There are altogether five municipalities, and 99 VDCs inside the boundary of the Valley, including all of the VDCs of Kathmandu district and Bhaktapur district, but only 26 out of 41 VDCs of Lalitpur district (as per map of the Valley in HMG/KVTDC 2002, also refer Table A1 of Appendix A).

Within the Kathmandu Valley, apart from the municipalities, there are many other old settlements, such as Sankhu, Tokha, Thankot, Pharping, Khokana, Bungamati, Harisiddhi, Chapagaun and Lubhu. These settlements had earlier served as an important agricultural marketing and servicing centers. However, during the past few decades, they have been experiencing a gradual decline in their traditional function as a result of rapid urbanization in the Valley.

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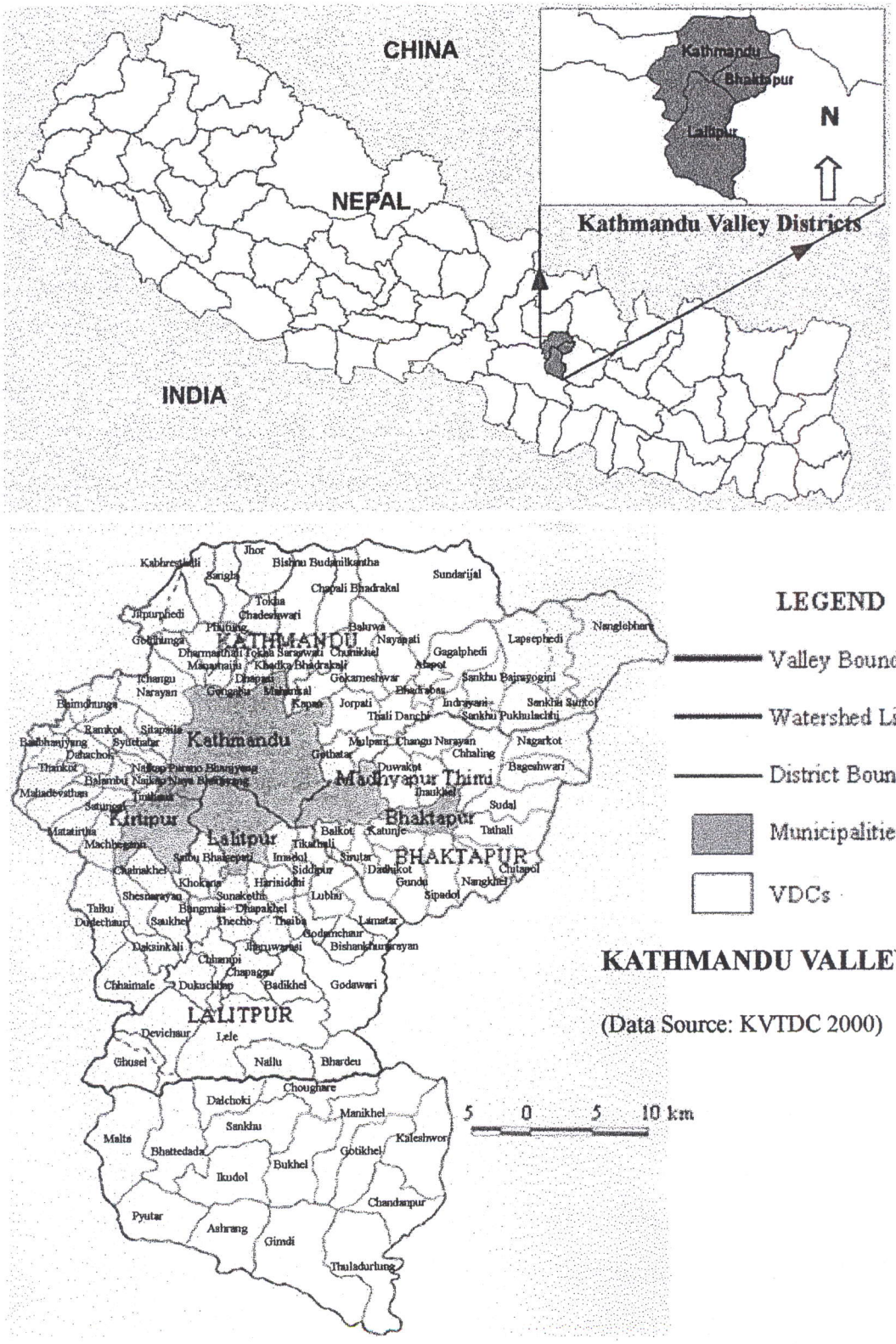
[9] the area derived by KVTDC is quite consistent with the area of 660 sq. km. calculated by ICIMOD in 1993 and 640 sq. km. derived by IUCN in 1995 (Burathoki 2001). The discrepancy is due to different definitions of geographical boundary of the Valley.



Map 3.1 Location of the Kathmandu Valley

3.2 Historical Account of Urban Growth

According to the primeval history, the Kathmandu Valley was a huge bowl-shaped lake. Human settlements began to emerge after the lake dried out. The early chronicles, the *Vamshavalis*, claim that the Valley was ruled by the pastoral dynasties of the Gopala and Mahispala who were later subjugated by the Kirats. Later the Lichhavis defeated the Kirats and ruled the Valley and its surrounding areas beginning from the 1st century AD till about 900 AD. They were followed by the Thakuris who reigned till about 1200 AD when the Malla state was organized. The Malla rule lasted until 1768 AD, and then King Prithivi Narayan Shah conquered the three kingdoms of the Valley long with many of the petty states to build what forms much of the present day of Nepal (Burathoki 2001).

The periods of rule in the Valley by various dynasties have been mentioned differently in different literatures. However, it is established now that dense settlements began to emerge in the Valley at least 1500 years ago in the form of a cluster of small settlements during the Kirat period.

The evolution and growth of settlements in the Valley can be classified in the following phases (after Tiwari 1992)-

Latter half of the first Millennium BC when the Valley was inhabited and ruled by the Kirats

The Kirat settlements were mostly located at the foothills of the Valley rim and on the ridge spurs extending inward (Tiwari 1992).

The ancient records of the Valley mention Devpatan, a new town believed to have been founded at 250 BC at the proximity of Pashupatinath. The establishment of Lalitpur, known as 'Yela', which is one of the three important urban centers of the Valley, is accredited to this period, and hence, the oldest among the three towns (Malla 2000).

The Kirati period is characterized by a relatively advanced stage of urban culture and the deliberate efforts towards planned establishment and development of the towns reflecting some degree for planning consciousness and discipline (Malla 2000).

Around the 2nd century AD (Towards the end of the Kirat period and by the early Lichhavi period)

Small town-like settlements began to emerge on high ground on the Valley floor, such as Khopring (now Bhaktapur), Lembati (Lele), Bungayumi (Bungmati), Thencho (Dahachok) and Mathang (possibly Bansbari now) (Tiwari 1992).

About the 7th century AD (Middle of the Lichhavi period)

Many temple towns developed, usually on ridges adjaeent to rivers, on agriculturally unproductive land, within the Valley, such as Maneswor, Sankasya, Gokarna and Deupatan, which were expanding. Strategic and changes in the ruling houses (or *piths*) probably caused periodic shifting of settlements within the Valley and growth of towns like Gokarna, Deupatan, Kathmandu, Bhaktapur, Lele, Kisipidi and Naxal (Tiwari 1992).

Lichhavi rulers adopted a sound economic policy by striking a balance between commerce and agriculture. This helped to establish new towns and expand existing towns guided by sound land use principles (Malla 2000).

The salient features of the planning traditions of the Lichhavi period can be listed out as follows (after Malla 2000)-

- A regional concept seems to have evolved in planning of towns and villages expressed in terms of hierarchical order of settlements according to the nature of functions and services, such as '*grama*' (consisting of as many as 500 houses) which was elevated to the status of '*dranga*' after its development as commercial center and after fortification. Similarly, '*tala*' and '*puri*' denote distinct settlements after acquiring administrative status.
- The location of settlements seems to have been governed by three main land use planning criteria- the conservation of fertile land for agriculture production, the uplands plains (*tars*) for residential use, and the distance from the flood level of the rivers.
- The installation of temples dedicated to the gods and the development of habitation at the proximity or around those temples are stated to be the important aspects of the town development process at the local level. The tradition of religious processes that followed, must have guided the evolution of road networks within the towns.

8th to 12th century (Late –Lichhavi and early-Malla periods)

Temple towns doubled as tax collectors and as defense units away from the capital towns, further polarizing settlements around them. In the early Malla period, efforts were made to restrict the growth of the capital towns, such as, through the formation of satellite towns. For instance, Kirtipur was a satellite town of Patan (Tiwari 1992).

12th to 18th century (during Malla Period)

Malla towns saw continuous development over the six centuries until the 18th century. Just prior to the Malla's dominance, Kathmandu (then a settlement between Pashupati and Naxal) grew to about 1800 houses. In the 13th century, Anand Malla expanded the town of Bhaktapur to about 12,000 houses, while the nearby Banepa, Panauti, Nala and other settlements on the eastern reaches of the Valley had about 700 houses each. By 1655, Patan had 24,000 (Tiwari 1992).

The Malla period, which was the 'medieval period' in Nepalese history was marked by expansion and development of the three principal towns of the Valley, and a number of important settlements such as Kirtipur, Sankhu, Bungmati, Thimi etc. (Malla 2000).

The salient features of the planning tradition during the Malla period can be listed out as follows (after Malla 2000)-

- The creation of 'daughter' settlements (or satellite towns) of varying sizes inside the Valley points to the evolution of concept of settlement planning in regional scale. These settlements were the spill-over from the three royal cities of the Valley which could no longer contain the excess population within their fortified boundaries, the reasons being-
- the defense requirement leading to the fortification and to the excessive concentration of houses with narrow streets and confined courtyards
    - the need to protect and conserve well watered agricultural land from settlement encroachments
    - the urban pattern of the primary towns in concentric rings according to occupation arranged in such a way that high caste wealthy families occupied the circle nearer the center, the Durbar Square, and the lowest of the castes at the periphery of the towns.

- The form and structure of the urban and rural settlements of the Valley exhibit a distinct physical pattern and indicate basic continuities between the rural and urban variations of the compact Newar settlements of the Malla times. For instance, the royal palace, the center of power, art and culture, in all the towns occupies a central and strategic location with the streets radiated from the palace squares in all directions.

Pre-1950 period of Shah and Rana Rule

Even after Prithivi Narayan Shah's takeover of the Valley in 1768, the Valley remained the heart and soul of the unified state. But in 1846, after the *Kot* Massacre, Jang Bahadur Rana started the Rana rule, which later caused significant distress into the urban fabric marking the beginning of a change in medieval urban form and organization of the Valley towns.

The Ranas built their palaces with large compounds outside the settlement boundaries, which incidentally served as the physical barriers for the expansion of the towns. Migration into the Valley, restricted deliberately by the Ranas, also helped to control the urban expansion (Tiwari 1992).

The after-math of the earthquake of 1934 AD introduced new urban design aspects in the urban development pattern of Kathmandu as seen in the urban renewal schemes (the construction of 'Juddha Sadak' and 4-5 storied row-houses), the construction of black-topped streets lined with shade trees, and the development of modern resident-business section of Putalisadak and Dillibazaar on the east side of Kathmandu City (Malla 2000).

Since 1950's political change

After the downfall of Rana regime and establishment of democracy in Nepal in 1950, Nepal was opened to the outside world, causing rapid expansion of highways and air services giving international linkages to the nation. This era of openness with increased contact with the outside world and gradual accumulation of external capital led to gradual shift from the agrarian setting to modern economic activities, thus attracting people from all over the country. Kathmandu, being the capital of the nation, gained more importance. Urbanization in modern sense started from this point. Lalitpur city, being in touch with Kathmandu, also started urbanizing. Bhaktapur, little far away from

the capital city, remained isolated for a long period, got recharged and revitalized after the Bhaktapur Development Project in 1974.

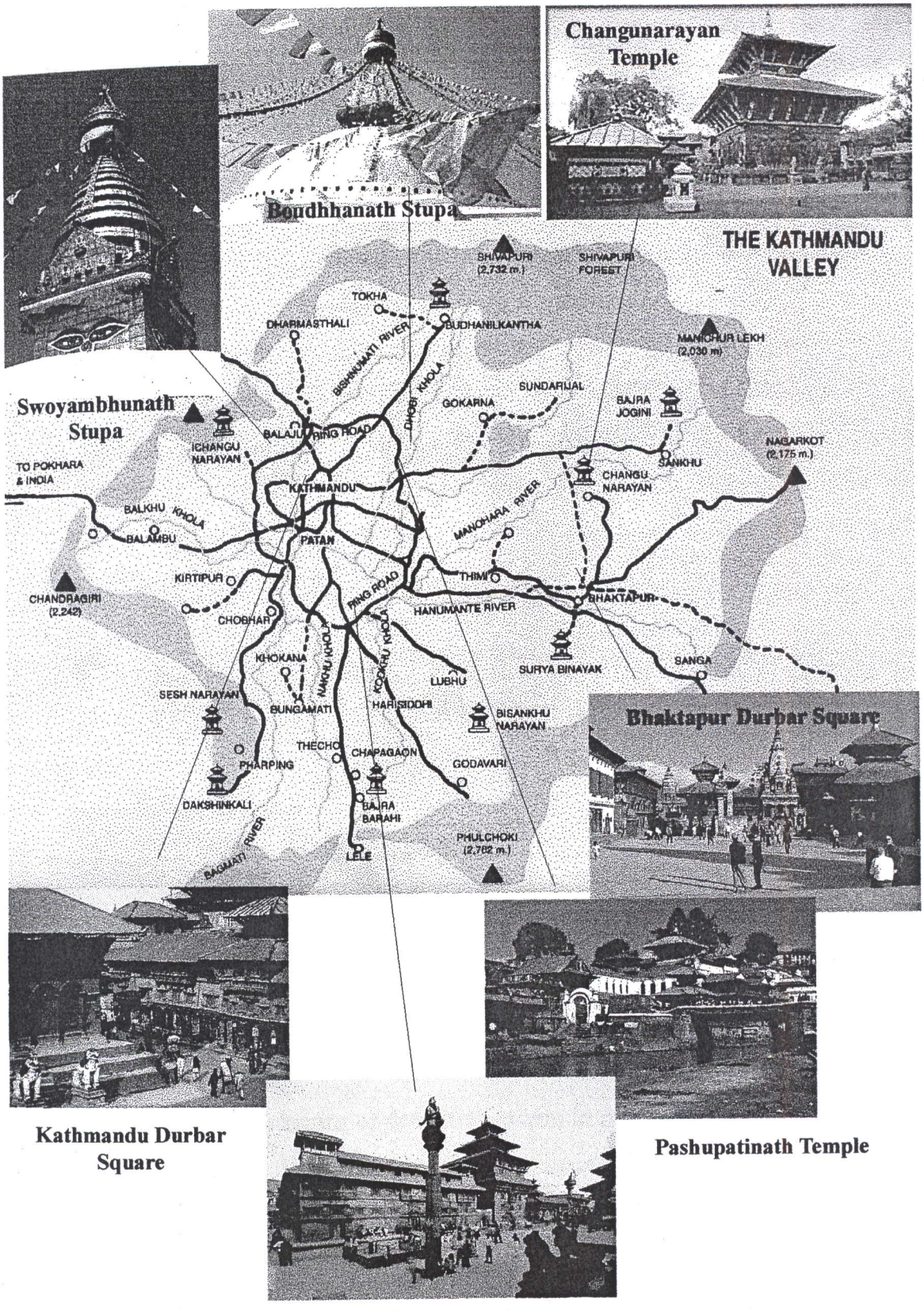
3.3 Functional Role of the Valley

3.3.1 Religious-Cultural Role

The Kathmandu Valley is a home of the magnificent artifacts and monuments built by the skilled craftsmen of Lichhavi and Malla periods. Once known as the land with "more temples than houses", the Valley also has numerous festivals as religion is deeply rooted in the heart of the local people. Apart from temples, there are historically important ponds, taps, wells, rest-houses, most of which are now deteriorating or lost. The Valley is a land where culture, religion and history are so much intermingled that it is not possible to separate them from each other. Respecting the glorious past of the Valley, UNESCO has declared seven[10] sites of the Valley as World Heritage Site in 1978, viz. Kathmandu Durbar Square, Patan Durbar Square, Bhaktapur Durbar Square, Swoyambhunath Stupa, Pashupatinath Temple, Bouddhanath Stupa, and Changu Narayan Temple (Fig. 3.1). Interestingly, these seven monuments are located within just 20 kilometers of distance. Moreover, there are numerous *baha* and *bahi*s (Buddhist monastries), *stupa*s (Buddhist temples), *pati*s (rest houses) and religious places like Dakshinkali, Budanilkantha, Bajrayogini, Bajrabarahi etc. in the Valley.

The Valley is also known for its continuous festivals. More festivals are said to be observed than there are days in the year. Festivals such as Bisket Jatra, Rato Machhendranath Rath Jatra, Gaijatra, Krishnastami, Indrajatra, Dashain, Tihar etc. have maintained the age-old cultural glory of the Valley. These festivals are not only important in religious sense, but are actually a part of the social life of the people of the Valley, especially of the indigenous people, i.e. the *newar*s.

[10] There are ten World Heritage Sites in Nepal



Source: Various

Fig. 3.1 Approximate Location of World Heritage Sites in the Valley

3.3.2 Administrative Role

After the unification of Nepal in 1768 AD by King Prithivi Narayan Shah, the Valley acquired special importance as the center of political power. The Ranas established numerous centralized institutes in the Valley. During the 1950's, the institutional set-up was organized to meet the administrative need of socio-economic development. In 1960's and 1970's, government institutions and corporation grew rapidly, along with an increasing number of donor-funded projects; while in the 1980's and early 1990's, many authorities and committees were established to support the government institutions (HMG/MOPE 1999).

Table 3.1 shows a list of institutions having their office in the Valley in 1999 (HMG/MOPE 1999). Besides them, there are number of educational, financial, health-related and tourism-related institutions functioning within the Valley. Also, there are 5 municipalities and 99 VDCs which are further divided into several wards.

Table 3.1 Institutions in the Valley (1999)

S.N.	Institutions	Number
1	Houses of Parliament	2
2	Courts	Supreme Court and other 6 courts
3	Ministries	26
4	Departments and equivalents	54
5	Corporate bodies	39
6	Other government bodies	37
7	Commissions	10
8	Councils	6
9	Local and International Non-Governmental Organizations	7000 local (approx.), and 65 INGOs
10	Residential diplomatic mission	25
11	Donor agencies	17 multilateral,15 bilateral agencies
Source: HMG/MOPE (1999)		

Despite the political slogans of decentralization, in many occasions, people still have to come to the Valley from their homelands for governmental and legal services which are not available at local or even district levels.

3.3.3 Economic Role

Traditionally, agriculture and trade were the two pillars of prosperity of the Valley. Because of the locational advantage, the Valley served as the trade route between India and Tibet, because of which some of the ancient settlers prospered though trade while others continued farming. The economic scenario has

changed completely after the Valley lost its glorious edge in trade and also lost agricultural prospects because of urbanization.

The economic base of Kathmandu Valley shifted dramatically from agriculture to non-agricultural sectors between 1981 and 1991 (Fig. 3.2). In the National Census of 1981, around 75 percent of the economically active population (EAP) were found to be absorbed by agricultural sector whereas by the National Census of 1991, the absorption of EAP by the agricultural sector reduced to slightly above one-third of the total (HMG/KVTDC 2000). By 2001, agriculture could absorb only 28 percent of the EAP of the Valley districts of 663105 (CBS 2002). Instead of agriculture, non-agricultural sectors emerged overwhelmingly, particularly in the form of service sector (led particularly by tourism), business and commerce, and manufacturing. These sectors are the major provider of employment, including daily-wage labors, and hence they are the contributors in attracting migrants to the Valley.

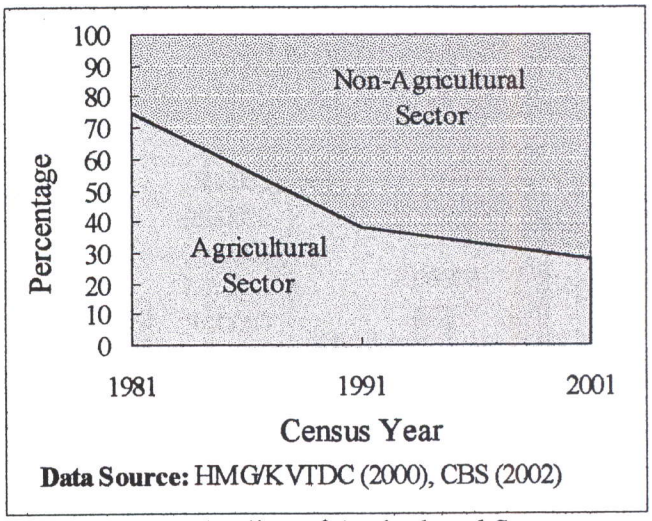


Fig. 3.2 Decline of Agricultural Sector

The Valley is itself the most prominent tourist destination of Nepal, and is blessed with the only international airport of the country. Still more than 85 percent of the total tourists arrive to Nepal by air, and the accommodation capacity of hotels in the Valley was 60 percent more than that outside the Valley in 1999 (CBS 2001). So the Valley continues to play the dominant role in the tourism sector (which recorded an earnings of 168.1 million US $[11] in 1999) of the country, giving rise to different forms of tourism-led economic activities from luxury hotels to small shops. Besides tourism, economic activities in a number of sectors, such as education, health, administration, are also functioning and growing.

[11] excluding earnings from Indian tourists

3.4 Trend of Urban Growth

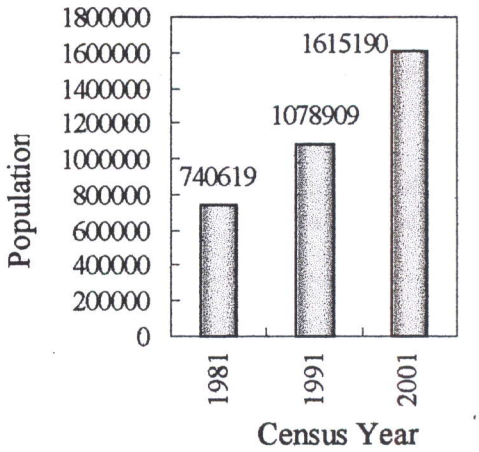
3.4.1 The Valley

The best indicator of urban growth is the population increase. Studies indicate fast growth of population not only in the urban areas of the Valley but also in the rural areas, especially the neighboring VDCs of the municipalities.

In 1981, the Valley constituted about 5 % of the total population of Nepal but by 2001, the mark has touched 7%. The Valley districts in total constitute only about 0.4 % of the area of the country, which indicates high concentration of population in the Valley (Table 3.2[12]).

A rapid urban expansion can be seen in the Valley between 1981 and 1991, during which the total population of the three districts of the Valley crossed the mark of one million.

The expansion continues in the following decade. Annual growth rate during 1991-2001 has been 4.12 % against the annual national growth of 2.27 %. By 2001, the total population of the Valley crossed the mark of 1.6 million (Fig. 3.3, Table 3.2).



Data Source: HMG/KVTDC (2000,2002), CBS (2002)

Note: Population of Lalitpur VDCs inside the Valley is based on the enumeration of VDCs under National Census 2001.

Fig. 3.3 Population Growth of the Valley

Table 3.2 Population Growth of the Kathmandu Valley (1981- 2001)

Census Year	Nepal		Kathmandu Valley		
	Total Population	Annual Growth Rate (%)	Total Population	Annual Growth Rate (%)	Share of National Population (%)
1981	15,022,839		740,619		4.93
1991	18,491,097	2.10	1,078,909	3.83	5.83
2001	23,151,423	2.27	1,615,190*	4.12	6.98

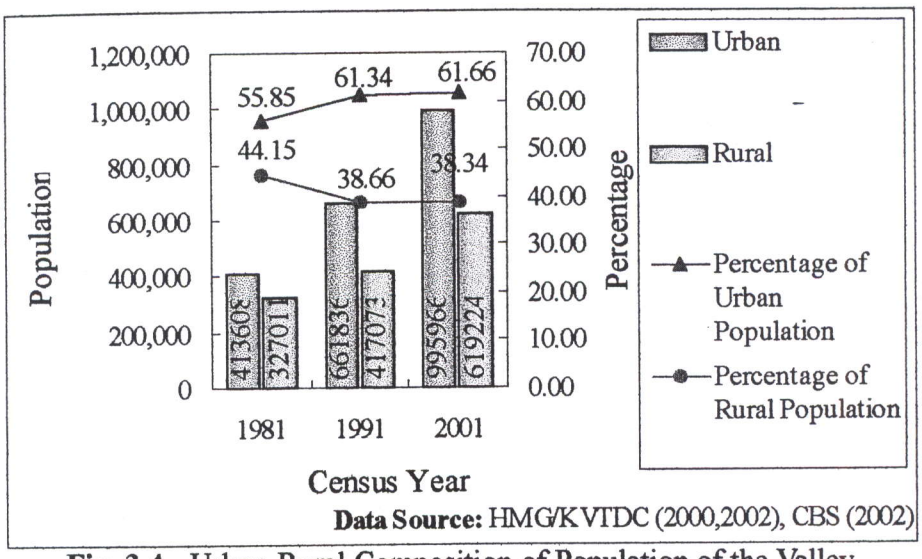
Source: Population from HMG/KVTDC (2000), Census 1991,2001 (CBS 2000,2002)

Note:

*Population of Lalitpur VDCs inside the Valley is based on the enumeration of VDCs under National Census 2001(Refer Table A1 of Appendix A).

[12] Refer Table A2 of Appendix A for details

Both the urban and rural population have increased in the Valley, particularly since the 1980's. In 1981, the urban population exceeded the rural population by 26.5%, but in 2001, the urban population exceeded the rural population by about 61 %. Even by 1991, the urban population was above 60 % of the total whereas the rural population was pushed below 40 % (Fig. 3.4, Table 3.3).



Data Source: HMG/KVTDC (2000,2002), CBS (2002)

Fig. 3.4 Urban-Rural Composition of Population of the Valley

Table 3.3 Rural and Urban Population in the Valley (2001)

Location	Urban	Rural	Total
Kathmandu	712681 (65.88)	369164 (34.12)	1,615,190
Lalitpur	162991 (52.94)	144893 (47.06)	1,081,845
Bhaktapur	120294 (53.35)	105167 (46.65)	307,884
Total of Valley	995966 (61.66)	619224 (38.34)	1,615,190

Source: HMG/KVTDC (2000,2002), CBS (2002)
Note: Values within the parenthesis denote percentage share of the total.

However, there in no significant change in the composition of urban and rural population between 1991 and 2001, which is mainly because of the fact that population in the urbanizing VDCs (neighboring VDCs of the municipalities) also grew at a high rate, but still the population has been mentioned as rural because of the VDC status. The annual growth rate of urban population in 1981-91 was 4.81 % which dropped to 4.17 % during 1991-2001, but during the same period, the annual growth rate of rural population raised from 2.46 to 4.03 %, which consists the growth of the urbanizing VDCs. There was only one VDC in the Valley with population more than 10,000 in 1991 (Burathoki 2001), but in 2001, the number has increased to 7 (CBS 2002).

Kathmandu, not surprisingly, is the most urbanized district, with above 65 % of

the total population designated as urban in 2001.Though Bhaktapur is about 3.5 times smaller than Lalitpur in population in 2001, it is as urbanized as Lalitpur, both having urban population at about 53 % of the total (Fig. 3.5).

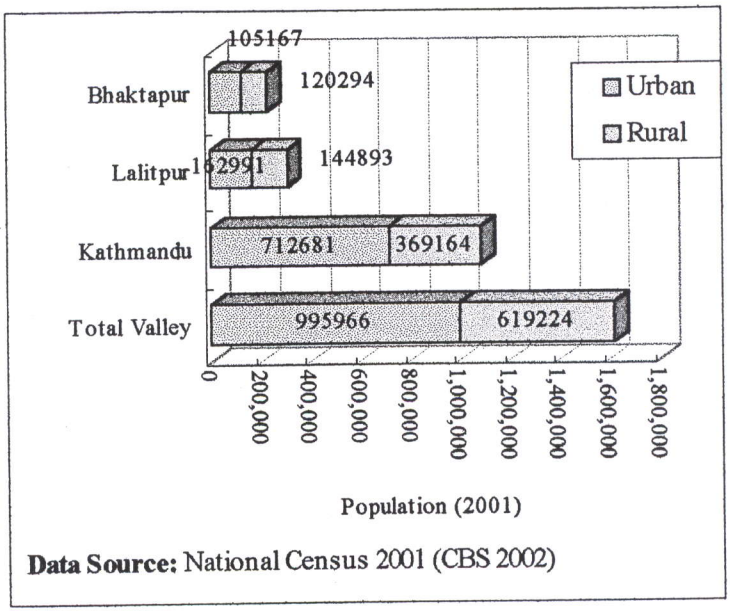


Fig. 3.5 Population of the Valley Districts

The gross urban population density of the Valley was small at 42.5 ppha (persons per hectare) in 1981, and even the gross urban density at 68 ppha in1991 can be regarded as small. But by 2001, the gross urban density raised by 1.5 times over the 1991 value. The gross rural population density is low at 11.1 ppha in 2001. The overall gross density of the Valley also increased by 50 % during 1991-2001 due to similar increase in urban and rural densities[13] (Fig. 3.6, Table 3.5).

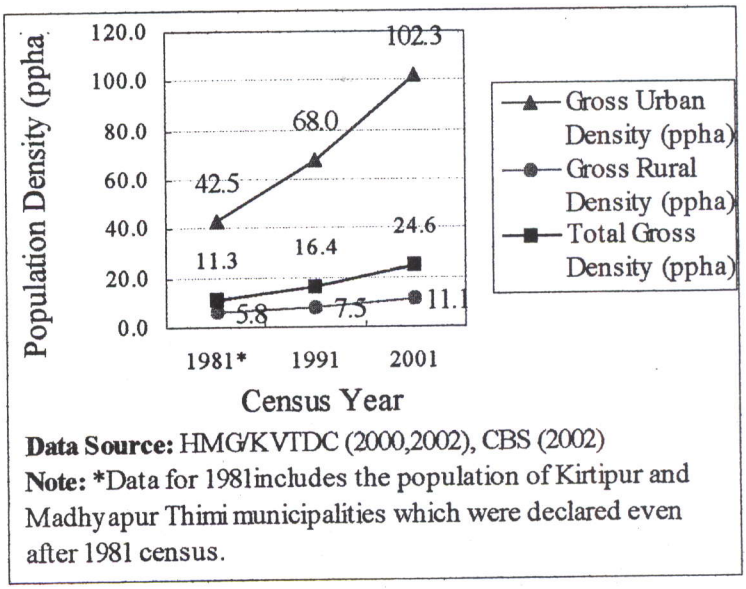


Fig. 3.6 Population Density of the Valley

[13] Slightly different values for urban density are obtained on the basis of municipal areas as per National Census 2001. See Table 3.6

Table 3.4 Gross Rural and Urban Density of the Valley

Census Year	Urban			Rural			Total		
	Area (ha)	Popula-Tion	Density (ppha)	Area (ha)	Popula-tion	Density (ppha)	Area (ha)	Popula-tion	Density (ppha)
1981*	7238	363507	50	58436	377112	6	65674	740619	11
1981**	9738	413608	42	55936	327011	6	65674	740619	11
1991	9738	661836	68	55936	417073	7	65674	1078909	16
2001	9738	995966	102	55936	619224	11	65674	1615190	25

Source: HMG/KVTDC (2000,2002), CBS (2002)

Note:
* urban population excluding population of Kirtipur and Madhyapur Thimi municipalities which were declared municipalities after 1991.
** urban population including population of Kirtipur and Madhyapur Thimi municipalities.
Area of municipalities in HMG/KVTDC (2000, 2002) differs slightly from the CBS values

The net urban density of the Valley however has declined. Based on the land use of 1984 and 1994 (Regulating the Growth- Kathmandu Valley as quoted in HMG/KVTDC 2000), the net average urban density of the Valley in 1984 is calculated to be 153.8 ppha, which declined to 90.6 ppha in 1994. During that decade, a percentage increment of about 57 % was observed in rural net density which increased from 8.6 to 13.5 ppha (Table 3.5).

Table 3.5 Net Urban and Rural Density of the Valley

Year	Urban (residential+ mixed commercial+ industrial)			Rural (agricultural land)		
	Population	Area (ha)	Density (ppha)	Population	Area (ha)	Density (ppha)
1984	476208	3095.5	153.8	352809	40950.3	8.6
1994	759393	8377.6	90.6	448291	33308.3	13.5

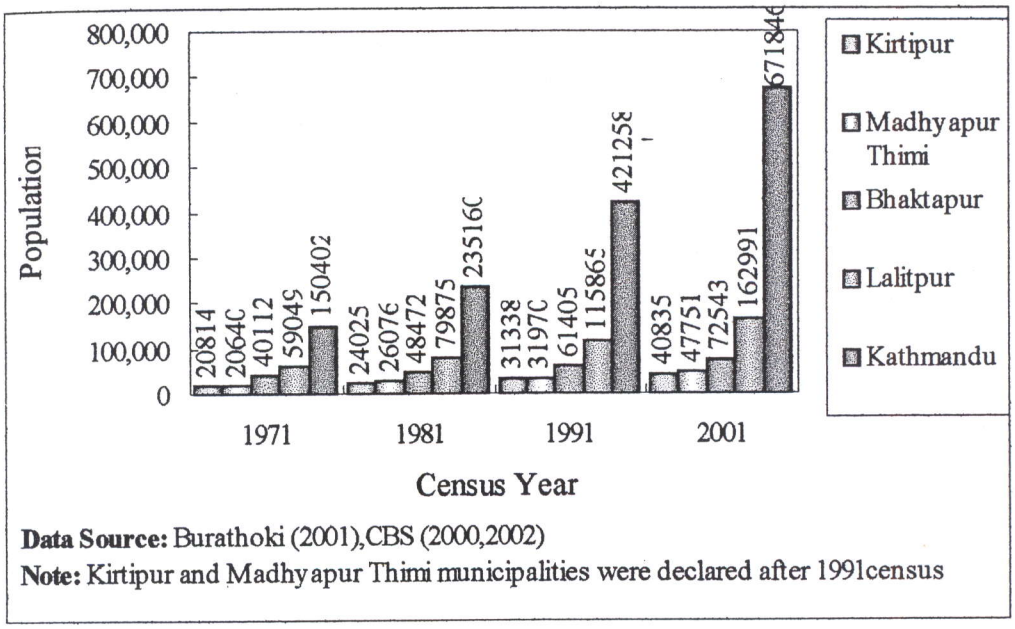
Source: HMG/KVTDC (2000)

3.4.2 Municipalities

The Valley has one metropolis, one sub-metropolis and three municipalities. Kathmandu Metropolitan City (KMC) has the largest population. Its population has increased more than 4 times since 1971. The decade between 1981-91 experienced dramatic urban population growth of the Valley at 4.81 % annually, but even more for KMC at 6 %. The rate of growth decreased during 1991-2001, but nevertheless, more than 250 thousand people were added in KMC, creating a population of 671846 in 2001 from 421258 in 1991 (Fig. 3.7, Table 3.6).

Population growth rate for other municipalities has remained below the average

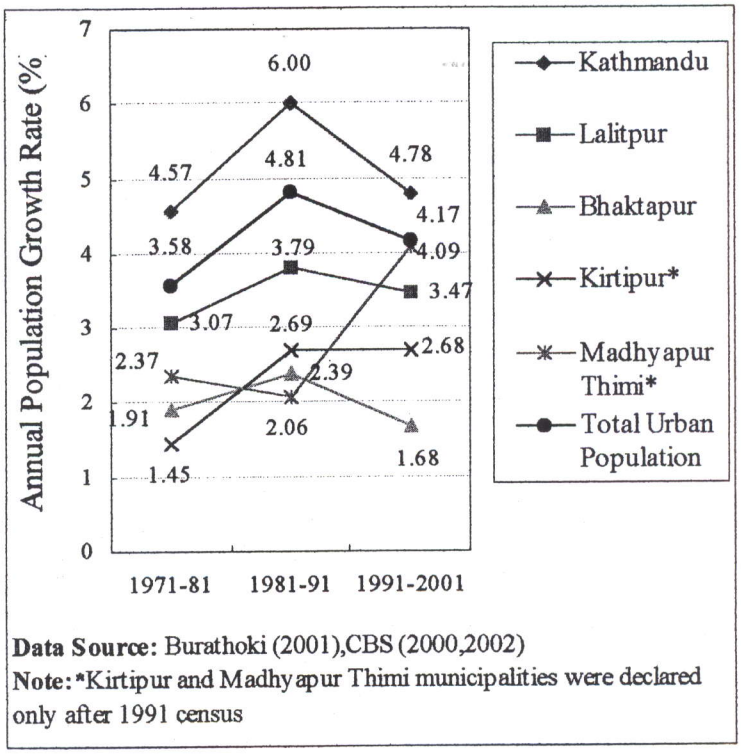
urban growth of the Valley because of dominance of KMC. In 1991, KMC was 3.6 times larger in population than Lalitpur Sub-Metropolitan City (LSMC), but the gap has increased in 2001 when KMC exceeded LSMC in population by more than 4 times.



Data Source: Burathoki (2001),CBS (2000,2002)
Note: Kirtipur and Madhyapur Thimi municipalities were declared after 1991census

Fig. 3.7 Population Growth of Municipalities in the Valley

The third largest municipality Bhaktapur has not seen significant urban growth, as its growth rate was only 2.39 % even during the highest growth period of the Valley. Its growth rate further dropped to a modest 1.68 % during 1991-2001.



Data Source: Burathoki (2001),CBS (2000,2002)
Note: *Kirtipur and Madhyapur Thimi municipalities were declared only after 1991 census

Fig. 3.8 Urban Population Growth Rate in the Valley

Table 3.6 Urban Population of the Kathmandu Valley

Municipality	Census Year				Annual Growth Rate (%)		% of Valley Urban Population			
	1971	1981	1991	2001	1981-91	1991-2001	1971	1981	1991	2001
Kathmandu	150402	235160	421,258	671,846	6	4.78	51.68	56.86	63.65	67.46
Lalitpur	59049	79875	115,865	162,991	3.79	3.47	20.29	19.31	17.51	16.37
Bhaktapur	40112	48472	61,405	72,543	2.39	1.68	13.78	11.72	9.28	7.28
Kirtipur*	20814	24025	31,338	40,835	2.69	2.68	7.15	5.81	4.74	4.1
Madhyapur Thimi*	20640	26076	31,970	47,751	2.06	4.09	7.09	6.3	4.83	4.79
Total Urban Population	291017	413608	661,836	995,966	4.81	4.17	100	100	100	100

Data Source: HMG/KVTDC (2000,2002), Burathoki (2001), CBS (2000,2002)
Note: *Kirtipur and Madhyapur municipalities were declared only after the 1991Census. However figures for the 1971,1981 and 1991 facilitate comparison

Table 3.7 Population and Household of Municipalities in the Valley

Municipality	Area (sq. km)	Census 1991				Census 2001			
		Household	Population	Average Household Size	Population Density (persons/sq km)	Household	Population	Average Household Size	Population Density (persons/ sq. km)
Kathmandu	49.45	81139	421258	5.2	8518.87	152155	671846	4.4	13586.37
Lalitpur	15.15	20630	115865	5.6	7647.85	34996	162991	4.7	10758.48
Bhaktapur	6.56	9187	61405	6.7	9360.52	12133	72543	6	11058.38
Madhyapur Thimi	11.11	5133	31970	6.2	2877.59	9551	47751	5	4298.02
Kirtipur	14.76	5672	31338	5.5	2123.17	9487	40835	4.3	2766.6
Total	97.03	121761	661836	5.5	6820.94	218322	995966	4.6	10264.52

Data Source: HMG/KVTDC (2000,2002), Burathoki (2001), CBS (2000,2002)
Note:*Kirtipur and Madhyapur municipalities were declared only after the 1991Census

Declared after the 1991 census, Kirtipur and Madhyapur Thimi municipalities have been showing significant growth. During the last two decades, Kirtipur has maintained a growth rate of 2.7 %, but surprisingly, Madhyapur Thimi municipality had a growth of 4.09 % during 1991-2001, and it was the only municipality in the Valley to record an increasing growth rate during 1991-2001 (Fig. 3.8, Table 3.6).

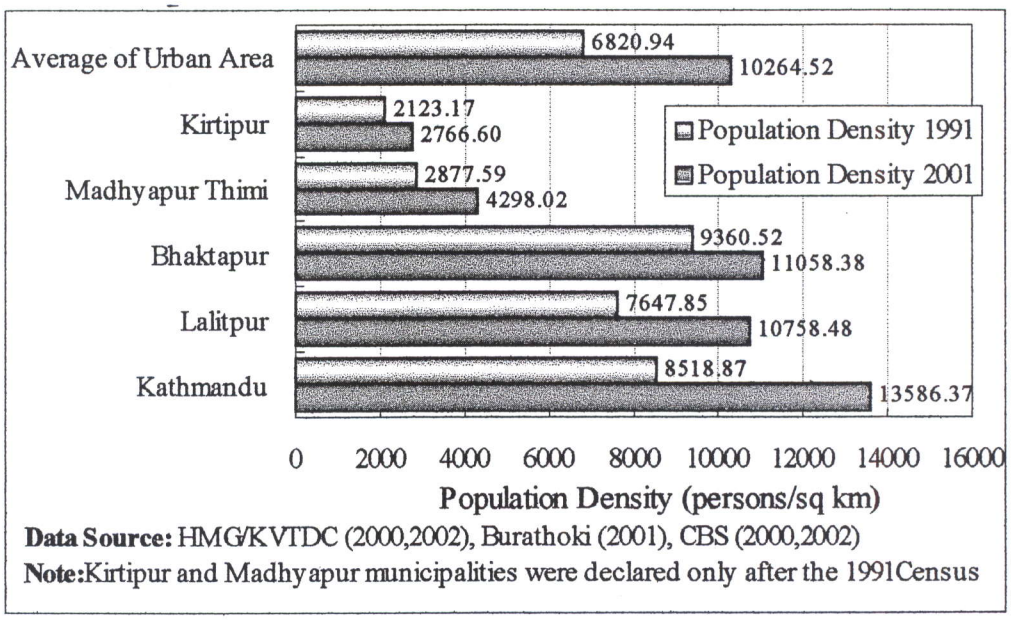
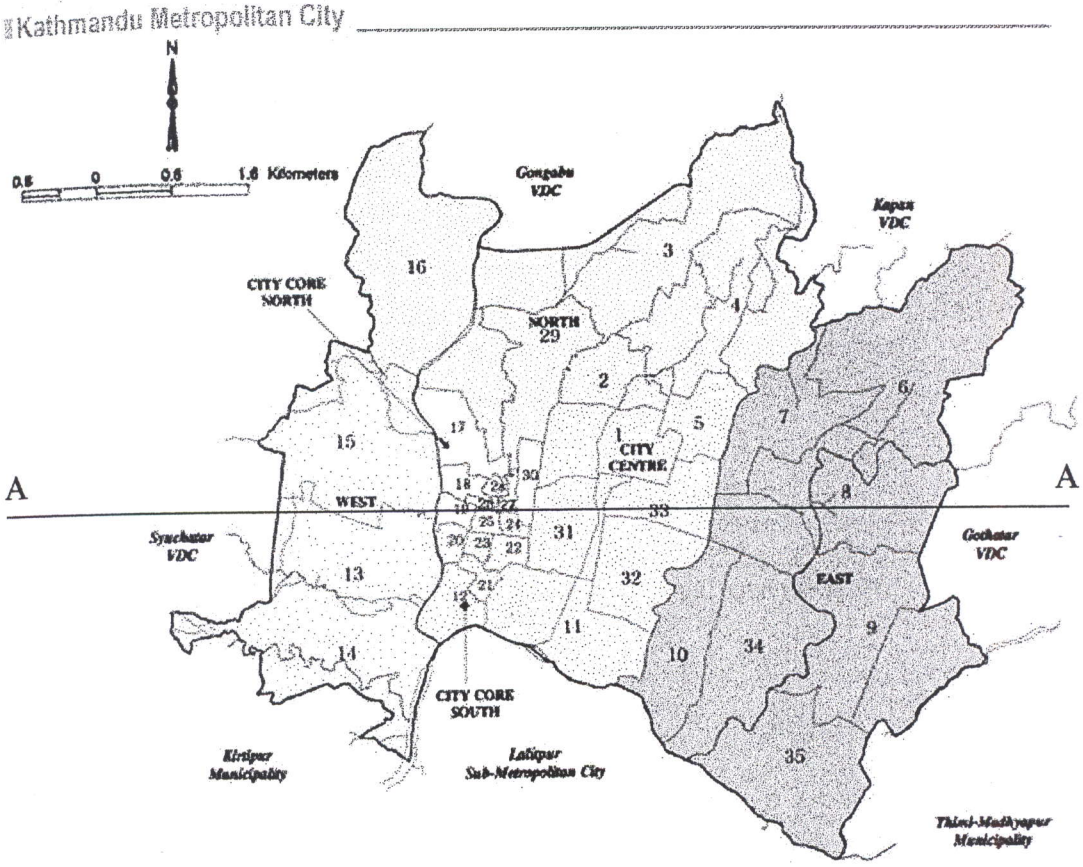


Fig. 3.9 Population Density in Municipalities of the Valley

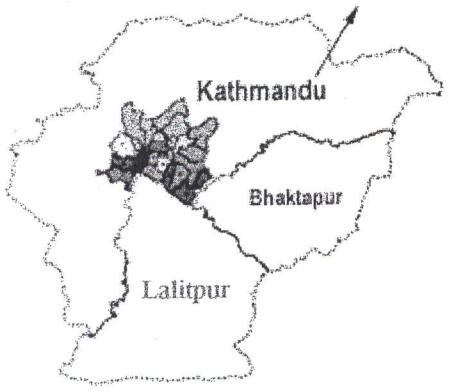
The average urban density of the Valley has increased by 50 % from 6820.94 in 1991 to 10264.52 persons/sq km in 2001. Meanwhile, the density of KMC increased by 60 %. Despite low population, the density of Bhaktapur Municipality is significant at 11058.38 persons/sq km, which is even higher than that of Lalitpur. Kirtipur and Madhyapur Thimi municipalities have low densities, though the values have increased by about 30% and 50% during the last decade. The average household size for the urban areas of the Valley has decreased from 5.5 in 1981 to 4.6, indicating trend of smaller family size (Fig. 3.9, Table 3.7).

The density profile of the Valley show high density in the core areas, exceeding 1000 ppha with very low density in the periphery indicating urban sprawl. Fig. 3.10 shows the density profile[14] of KMC (Map3.2) along the west-east axis A-A passing through the core area.

[14] Refer Table A4 of Appendix A



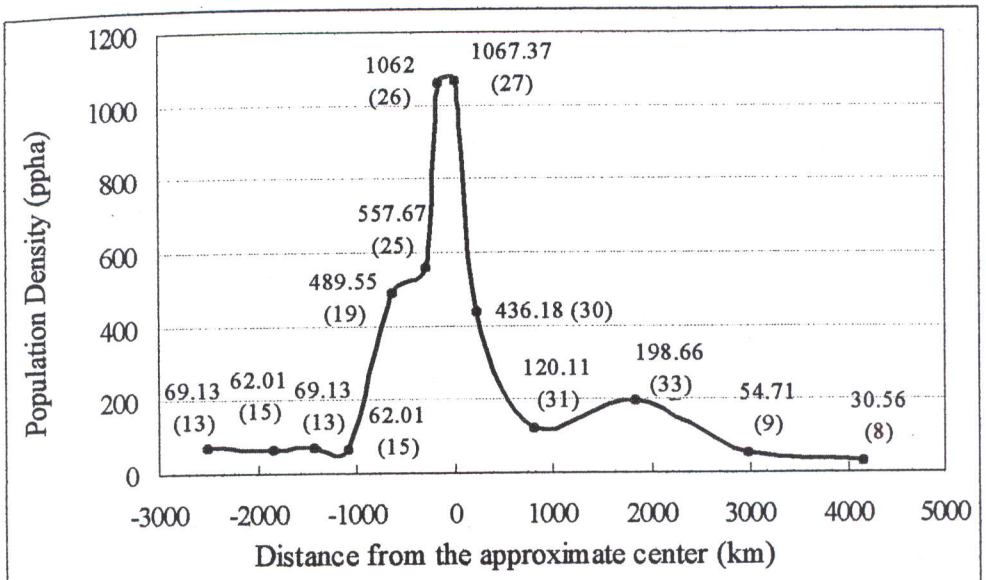
KMC



Kathmandu Valley

Source: http://www.kathmandu.gov.np

Map 3.2 Kathmandu Metropolitan City



Data Source: Population of wards from Burathoki (2001)
Note:
Distances are approximate, based on the KMC map
Values within the parenthesis indicated ward number.

Fig. 3.10 Population Density Curve for KMC

3.5 Role of Migration

On the basis of migration trends and the growth of urban areas, the theory of push and pull factors has been put forth. Accordingly, villages 'push' people into the urban areas because of limited economic opportunities in the rural areas, political reasons, such as war, natural calamities, such as flood, landslides etc. On the other hand, cities act as center of 'pull', offering various attractions to the migrants in terms of economic activities, safety, glamour etc.

Table 3.8 Migration in the Kathmandu Valley (1981-91)

Population		Population Increase			Population Increase %		
1981	1991	Migration	Natural	Total	Migration	Natural	Total
740619	1078909	126840	211450	338290	37.5	62.5	100.0

Source: HMG/KVTDC (2000,2002)

There is lack of comprehensive data on migration into the Valley. But studies show robust migration into the Valley between 1981-1991, during which migration constituted 37.5 % of total population increase (Fig. 3.11, Table 3.8) The Kathmandu Metropolitan City experienced the highest migratory growth, and during 1981-1991, migration alone accounted 52 % of the population increase. During the period, migration to Lalitpur was moderate; migration accounted for 12 % in population increase. Interestingly, the period showed an

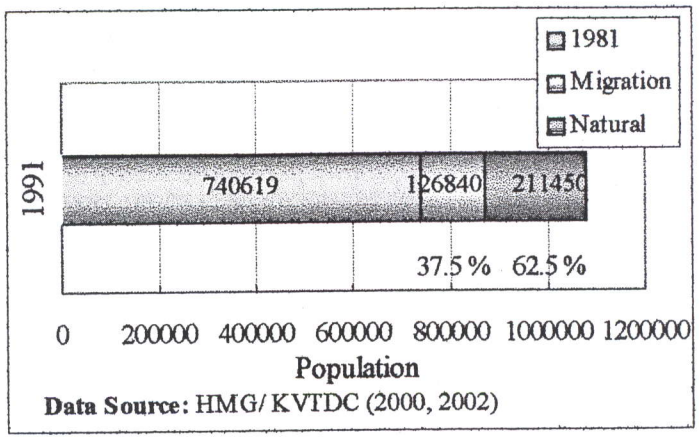


Fig. 3.11 Factors of Population Growth of the Valley (1981-91)

outward migration in Bhaktapur which sliced off the total population increase by 31%. It indicates the level of dichotomy even within the Valley where employment opportunities and services are excessively concentrated in Kathmandu (HMG/KVTDC 2000,2002).

3.6 Kathmandu City

3.6.1 Primate City

Kathmandu Metropolitan City (KMC) consisted of a little more than half of the urban population of the Valley in 1971. But by 1991, it consisted 63.65 %, which further increased to 67.46 % in 2001 (Fig. 3.12).

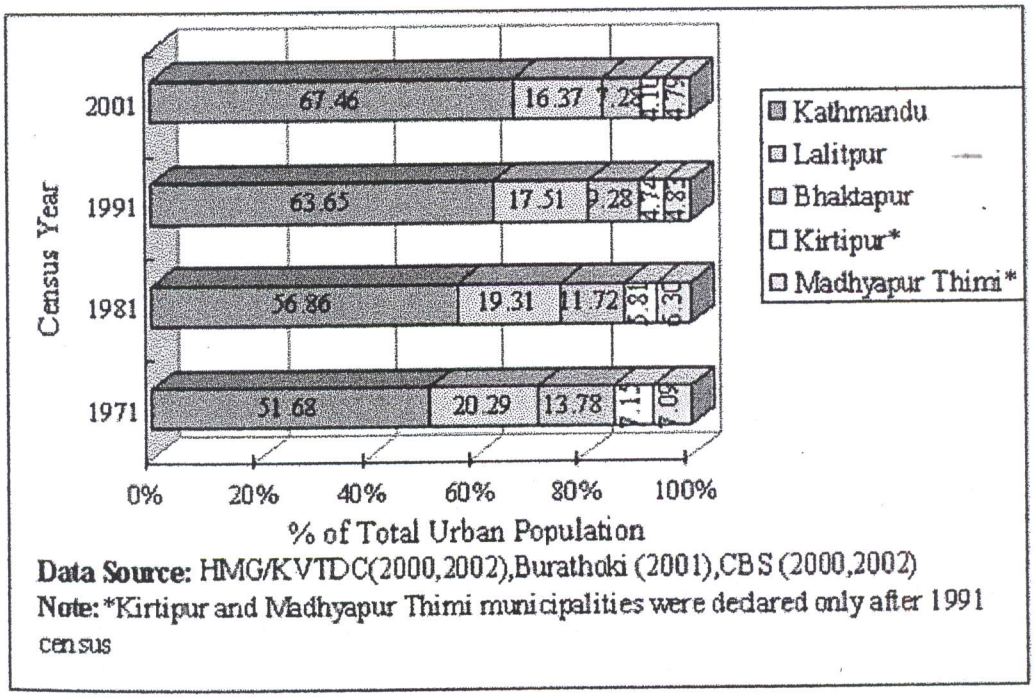
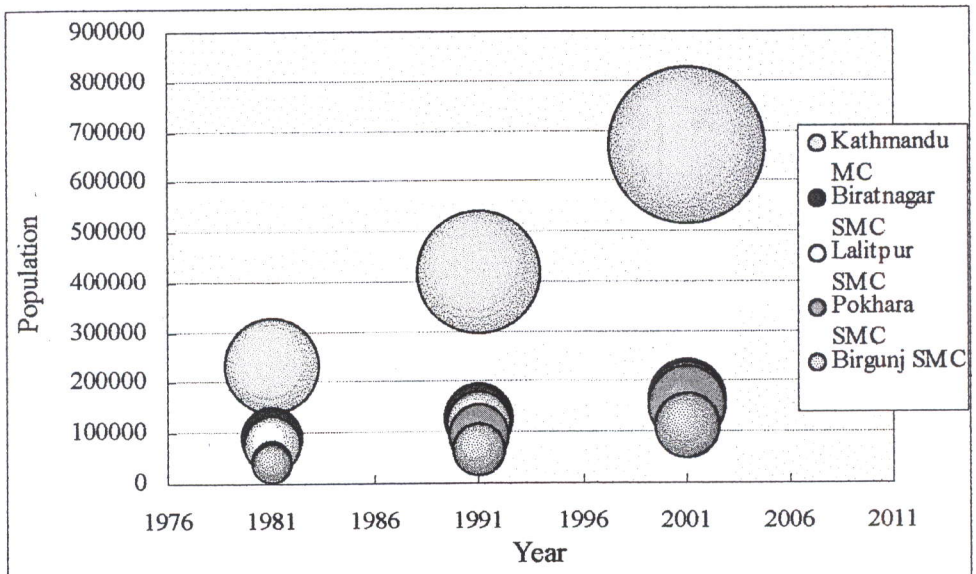


Fig. 3.12 Population Share of Municipalities in the Valley

There was a drop in all the remaining municipalities in their share of total urban

population. It indicates that all the other municipalities have still to contribute significantly in sharing the population load of KMC.

The regional dominance of KMC in the Valley is obvious from the fact that its population in 2001 was more than twice the total of the remaining municipalities. Despite efforts to minimize regional disparity, Kathmandu remains to be a very large primate city of the country. As per the Law of Primate City[15], a country's leading city is always disproportionately large, commonly at least twice as large as the next largest city and more than twice as significant. Their sheer size and activity become a strong pull-factor, bringing additional residents to the city and causing the primate city to become even larger and more disproportional to smaller cities in the country. This is very obvious in the case of Kathmandu.

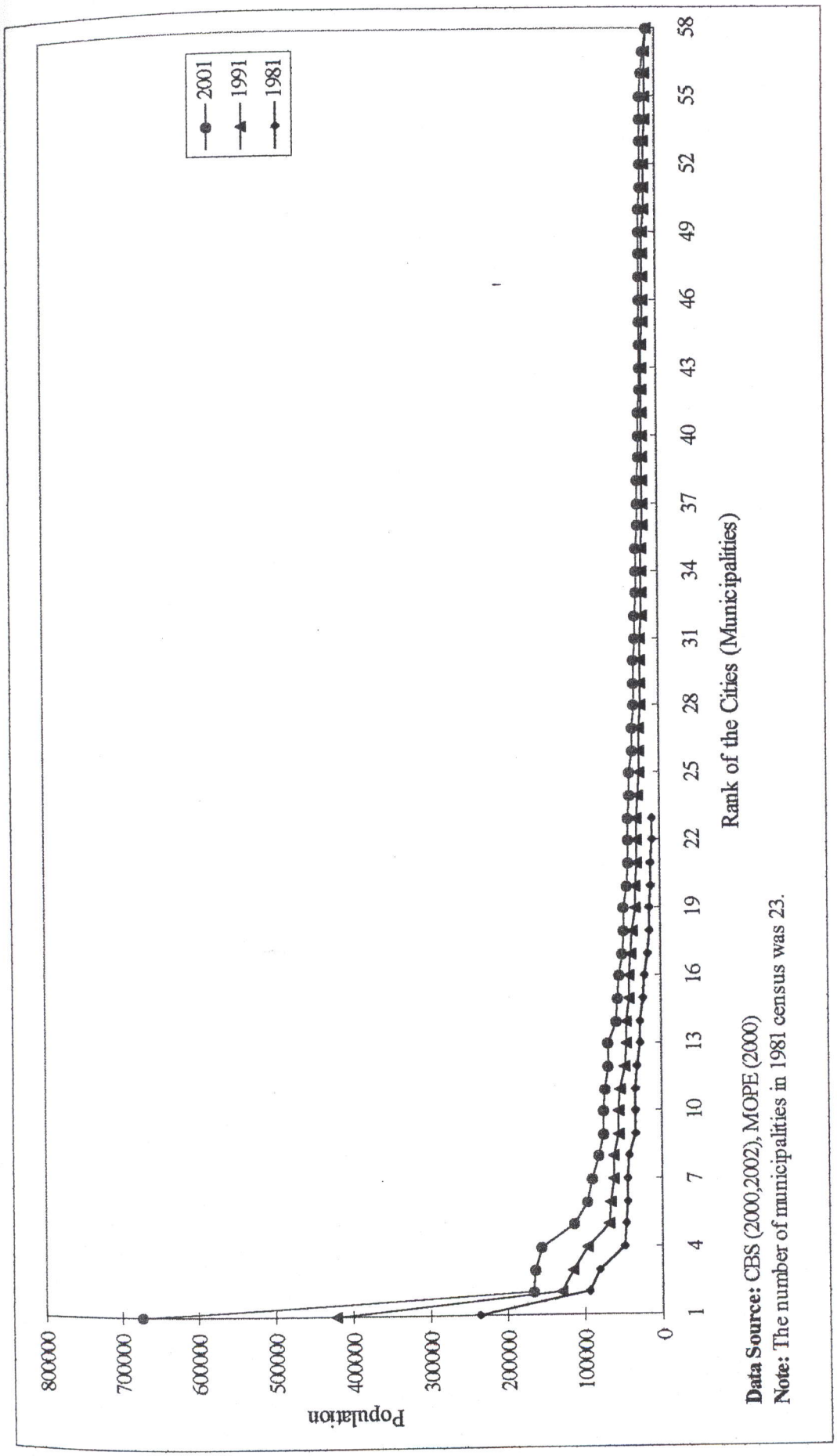


Data Source: MOPE (2000), CBS (2000,2002)
Note:
The size of the bubbles represents population, the value is indicated by the center

Fig. 3.13 Population Growth in the Largest Cities of Nepal

In the last three censuses, the rank of the five largest cities of Nepal has not changed (Table 3.9). KMC is followed by Biratnagar, Lalitpur, Pokhara and Birgunj respectively. But the gap between the primate city and the next city has widened. In 1981, KMC was already 5.4 times larger than Biratnagar but by 1991 and even in 2001, it was 6 times larger. In 1981, Kathmandu had population just below the total of the other four largest cities, but after 1991, it had more people than the combined population of the other four (Table 3.9, Fig. 3.13).

[15] first developed by geographer Mark Jefferson



Data Source: CBS (2000,2002), MOPE (2000)
Note: The number of municipalities in 1981 census was 23.

Fig. 3.14 Rank Size of Municipalities in Nepal

Table 3.9 Population of Largest Cities of Nepal

S.N.	City	Population			Growth Rate	
		1981	1991	2001	1981-91	1991-2001
1	Kathmandu MC	235160	421258	671846	6.00	4.78
2	Biratnagar SMC	93544	129388	166674	3.30	2.56
3	Lalitpur SMC	79875	115865	162991	3.79	3.47
4	Pokhara SMC	46642	95286	156312	7.41	5.07
5	Birgunj SMC	43642	69005	112484	4.69	5.01
	Pop.(1)/Pop.(2)	5.4	6.1	6.0		
	Pop.(1)/Pop.(2+3+4+5)	0.9	1.0	1.1	-	

Source: MOPE (2000), CBS (2000,2002)

Altogether 58 municipalities[16] have been declared so far. A regular pattern is seen among the least ranked municipalities in terms of population. But there is a strong dominance of Kathmandu among the top lines of municipalities, which has but increased in the course of time (Fig. 3.14).

3.6.2 A Growing Asian City

The Kathmandu City is considered as an important city of Asia with significant urban growth and regional importance. The Asian Development Bank (ADB) carried out a study on 18 representative cities (in terms of growth) of Asia and the Pacific Region (ADB 2001). Kathmandu was one of the less developed cities out of the 18 selected cities, expressed in terms of City Development Index (CDI) (Fig. 3.15). Interestingly, Kathmandu was found to be in a better position in terms of development in the South Asian region. But the growing urban problems in Kathmandu could have serious impact on its development status.

ADB's CDI ranks cities in the development spectrum and combines city product with infrastructure, waste management, health and education indicators[17]. In an overall maximum scale of 100, Kathmandu scores a little more than 60, leaving behind some important South Asian cities, such as Colombo, Dhaka, Lahore, Bangalore etc. But it is not sufficient enough for ADB not to include Kathmandu in the bracket of 'low' level of CDI among the four categories of development (Fig. 3.16).

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[16] Refer Table A5 of Appendix A.

[17] CDI = (Infrastructure index + waste index + education index + health index + Product index) / 5 (Refer Appendix B for explanation)

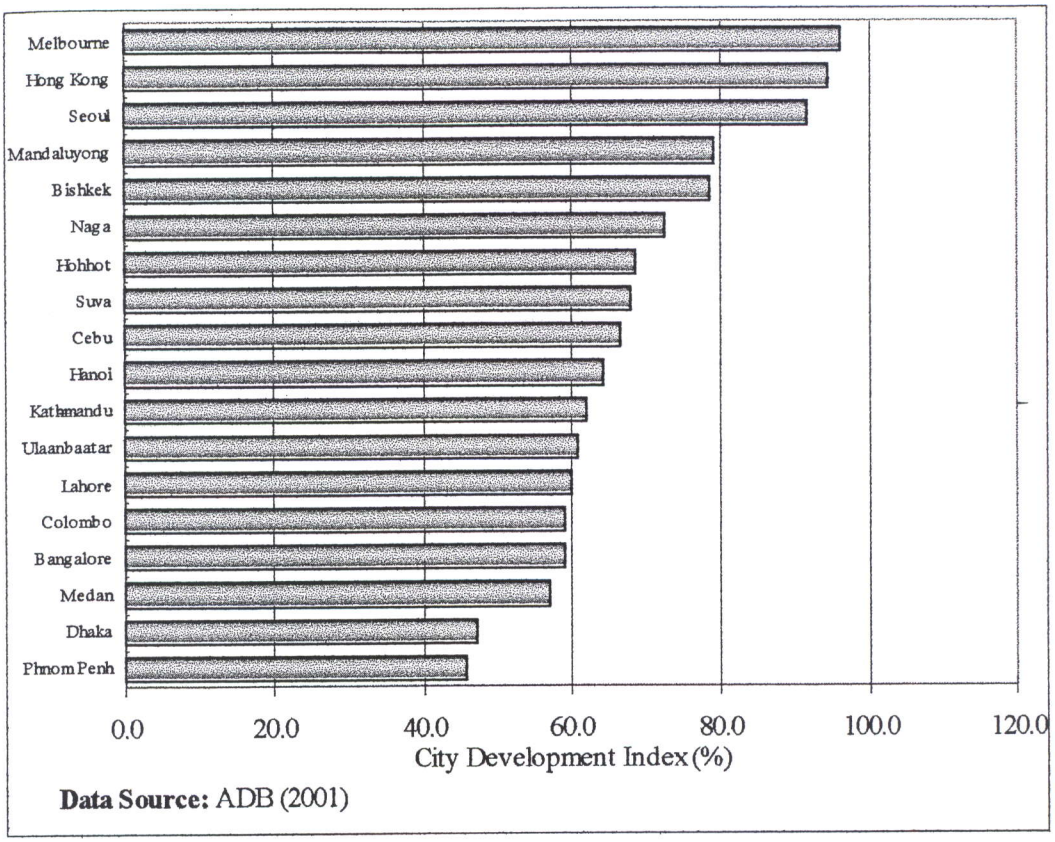

Fig. 3.15 City Development Index of Selected Cities of Asia and the Pacific

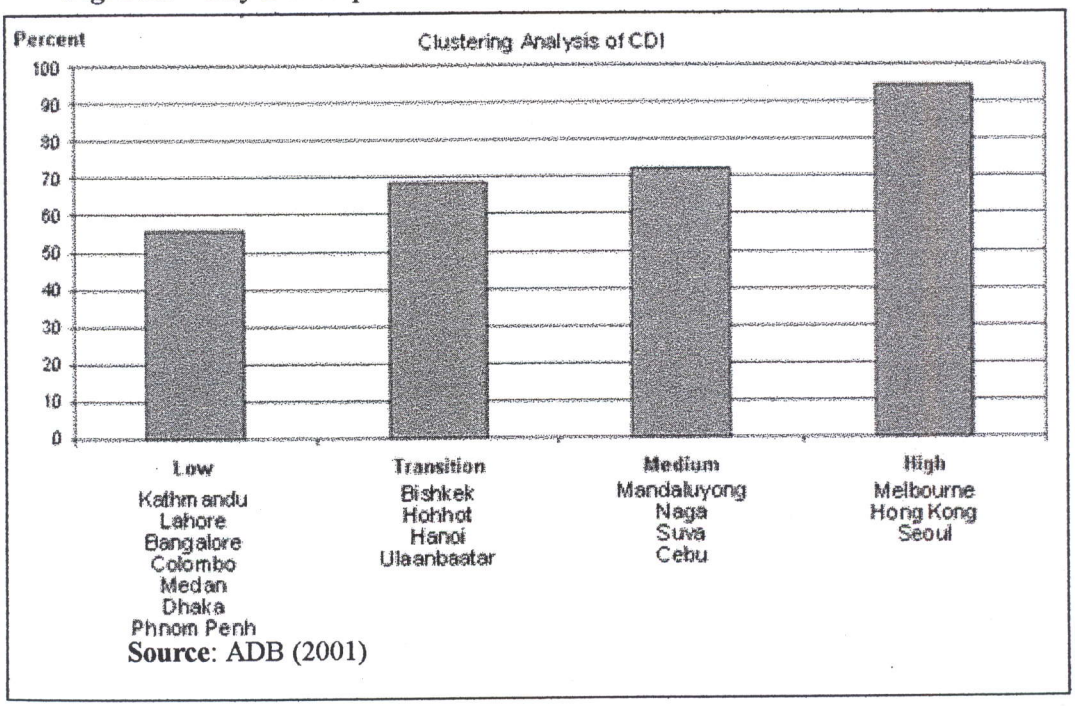

Fig. 3.16 Ranking of Selected Cities of Asia and the Pacific Region

The level of urbanization[18] of Kathmandu, at 14 % (Fig. 3.17, Table 3.10), is the lowest, indicating that the city will continue to grow though the urban problems are already similar to those of more urbanized cities. Overly rapid urbanization

[18] This covers the percentage of national population in urban areas. Urban areas are defined as settlements over 1000 people.

leads to pressure on infrastructure and resources whereas negative urbanization generally corresponds to a fall in national income.

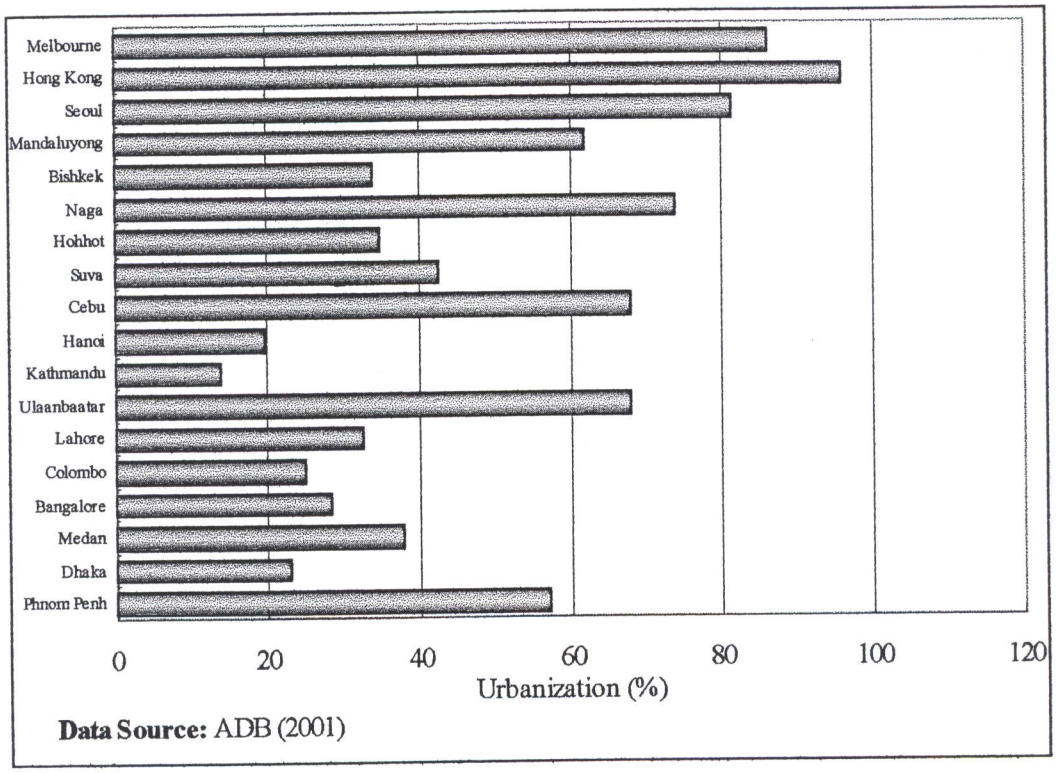

Fig. 3.17 Urbanization in Selected Cities of Asia and the Pacific Region

The population of Kathmandu is still low as compared to that of cities like Lahore and Dhaka of the South Asian region (Fig. 3.18, Table 3.10).

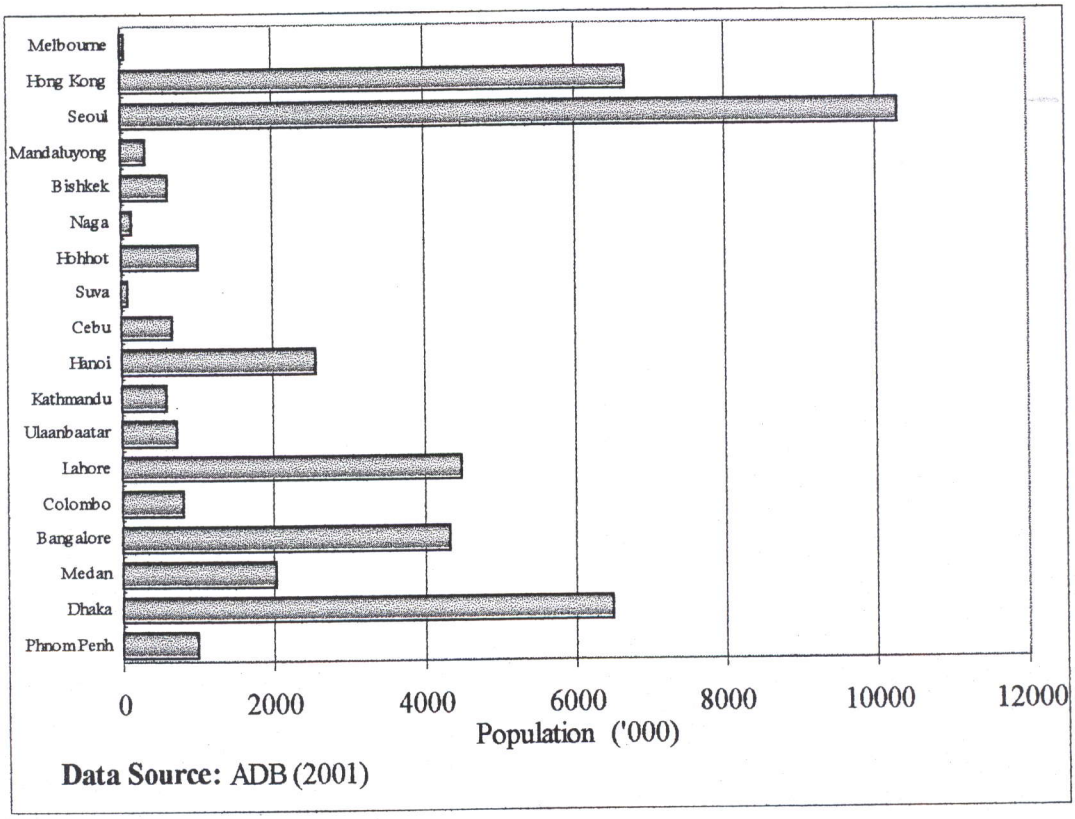

Fig. 3.18 Population in Selected Cities of Asia and the Pacific Region

Table 3.10 Population of Selected Cities of Asia and the Pacific Region (1998)

City	Country	Urbanization (%)	City Population			Pop. Net Density (ppha)	Average Household Size (person/hh)
			Resident Pop. Of Municipal Area (000)	Pop. During Daytime Working Hours (000)	Annual Rate of Pop. Increase (%)		
Bangalore	India	28.3	4328	4398	4.44	330	5.07
Bishkek	Kyrgyzstan	34	614	700	1	41.55	2.4
Cebu	Philippines	68	655	886	1.6	92.56	4.9
Colombo	Sri Lanka	25	800	1200	2.4	298	7.3
Dhaka	Bangladesh	23	6500	NAV	4.2	953	5.1
Hanoi	Vietnam	19.7	2553	NAV	3.5	146	4.2
Hohhot	China	34.9	1017.721	NAV	2.23	684	3.48
Hong Kong	China	95.7	6687.2	NAV	2.8	67	3.3
Kathmandu	**Nepal**	**14**	**575.652**	**625.652**	**6**	**175.7**	**5.15**
Lahore	Pakistan	32.5	4502	4802	3.1	240.57	6.85
Mandaluyong	Philippines	61.7	314	970	3.11	670	4.6
Medan	Indonesia	37.8	2035.2	2197.5	1.8	142	6.24
Melbourne	Australia	86	44.5	400	5.8	93	2.02
Naga	Philippines	73.7	137.546	158.178	2	115.57	5.4
Phnom Penh	Combodia	57	999.804	NAV	5.4	203	5.7
Suva	Republic of the Fiji Islands	42.5	77.36	137.4	1.7	74.7	5.33
Ulaanbaatar	Mangolia	67.9	725.3	NAV	4.5	133	4.8

Source: ADB (2001) **Note:** NAV - Not available

Population includes the resident population of the municipal area as well as the population during daytime working hours, if substantially different. Daytime populations of city centers can be much higher than resident populations, because of the presence of the workforce. This will affect demand for services.

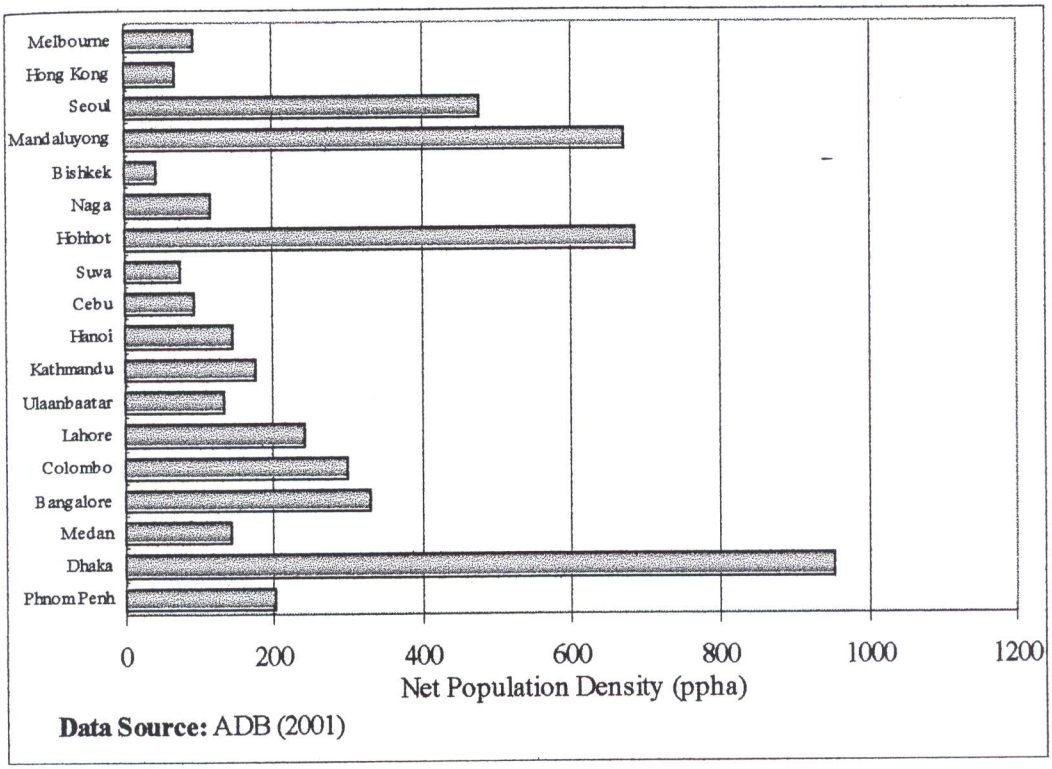

Fig. 3.19 Population Density in Selected Cities of Asia and the Pacific Region

One of the main indicators of urbanization and its impact is population density. The net population density[19] of Kathmandu is below 200 ppha, which is lower than the South Asian cities (Fig. 3.19, Table 3.10). But among the cities with high density, only Seoul (more than 400 ppha) belongs to the highly developed city. If the density is too high, crowding can lead to health risks, and pressure on transport and services. But if it is too low, it becomes expensive to provide services, and mass transit is also not viable.

Though the net population density of Kathmandu is still low, but it will increase in the course of time. There is city like Dhaka in the South Asian region itself with net population density of more than 900 ppha.

[19] city population divided by net residential land. Net residential land includes all built-up land zoned residential, including open space and roads. A proportion of mixed-use land has been added, according to an estimate of the relative floor space usage by business and residential. In estimating population net density, the land for the informal settlements can be added to the residential land, and a proportion of the mixed-use land based on floor space for residential and other uses (ADB 2001)

3.7 Planning Efforts

Several studies have been carried out for the planning of the Valley. Despite many good plans, the problem of non-endorsement, non-implementation or only partial implementation, continued to exist. So far, plans are more focused on regulating the urban growth rather than to control it though some plans have proposed development restrictions on environmental ground.

Some major studies from the viewpoint of growth management are as follows-

Physical Developmental Plan for the Kathmandu Valley (1969)

The 1969 Plan considered the Valley as a single planning unit. Priority was given towards absorbing much of the population growth through densification within the existing peripheral urban areas and accommodating future growth in the urban expansion area. Zoning and infrastructure development were recommended to direct and encourage growth towards the designated areas. However, the government did not formally adopt the Plan.

The Kathmandu Valley Town Development Plan (1976)

The 1976 Plan[20] consisted of detailed land use plans and accompanying regulatory measures, and was the first legally adopted planning document for Kathmandu and Lalitpur (mainly Greater Kathmandu area, lying within the Ring Road). The Plan failed to relate urban development with the infrastructure development. It still acts as the statutory plan for Kathmandu and Lalitpur.

Kathmandu Valley Physical Development Concept (1984)

The 1984 Plan attempted to revise the 1976 Plan by introducing zoning regulations under the changing scenario after 1981 when urbanization spread further to the tar lands at the city peripheries along the arterial roads[21] and along the Kathmandu-Bhaktapur transport corridor. It realized the need to accommodate the growing urban population in compact planned settlements instead of allowing urban sprawl beyond the city limits. So it proposed urban

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[20] In fact, the Plan was an attempt to revise the 1969 Plan to incorporate the proposed Ring Road around Kathmandu and Lalitpur cities.

[21] such as Bansbari, Boudhha, Koteshwor and Kalanki-Thankot in Kathmandu, Saibhu-Bhaisepati and Sunakothi in Lalitpur.

expansion to be confined to the physically feasible areas within the Greater Kathmandu and aimed to develop new planned settlements[22]. The Plan was not officially endorsed and therefore could not be implemented.

Kathmandu Valley Urban Development Plans and Programmes (1991)

One of the most comprehensive plans, the 1991 Plan recognized the limited ability of the government to intervene in the development process and thought it prudent to direct and regulate prevailing growth trends, instead of opting for other strategic options such as satellite towns or growth corridors. It proposed to link as well as control urban growth through planned infrastructure development. It suggested developing areas within the Ring Road as residential areas and developing certain areas beyond the Ring Road for wholesale market and industrial uses. The Plan was not officially endorsed though many of the strategic recommendations continue to remain relevant.

Revised By-laws for Greater Kathmandu (1994)

The KVTDC introduced greater regulatory controls on building activities through the revision of the building by-laws of Greater Kathmandu in 1994. It had provision to restrict development on land without road access or having an area less than 2.5 *aana* (about 855 sft). Building height restriction was replaced by Floor Area Ratio[23] (FAR) controls to encourage densification and vertical growth in areas except the historic zones. But, inability to upgrade infrastructures, low FAR and lack of incentives for planned area developments failed to overturn the prevailing pattern of low density urban sprawl.

Environmental Planning and Management of the Kathmandu Valley (1999)

This study[24] carried out by MOPE provided policies for regulating unplanned urban sprawl. It recommended preparation of a Valley-wide land use plan along with implementation of an integrated infrastructure development program. It

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22 proposed locations were Thankot-Mahadev, Chaulakhel, Sainbu-Bhainsepati, Chhampi, Imadol (on the way to Lubhu), Dibyeshwori (Lokanthali and areas west of Thimi) etc.

23 FAR is the quotient of the total built or planned floor area on a plotl, and the total area of that plot, expressed as FAR= Total floor area/ Total plot area (KVMP 2001).

24 It is an updated revision of Regulating the Growth of Kathmandu (1995) which was earlier titled as "Limits to the Growth of Kathmandu".

suggested de-concentrating development activities to the peripheral areas from the core areas. It raised the issue of carrying capacity of the Valley.

Development Plan 2020 of the Kathmandu Valley (Draft)

This Plan[25] is the 20-year strategic plan for the Valley. It is expected to provide a broad framework to the municipalities and VDCs for the preparation of detailed land use plans and local area plans.

The Plan has proposed principles of urban expansion including the followings-

- Equitable growth distribution based on the concept of the growth sharing by all three districts of the Valley.
- Growth confirming to infrastructure capacity so that the proposed development does not reduce the quality of basic services in the area
- Development within designated urban area only to facilitate planned growth.
- Avoid growth in risk or environmentally sensitive areas, such as seismically active areas, liquefaction zones, flood plains, and unstable and steep slopes.

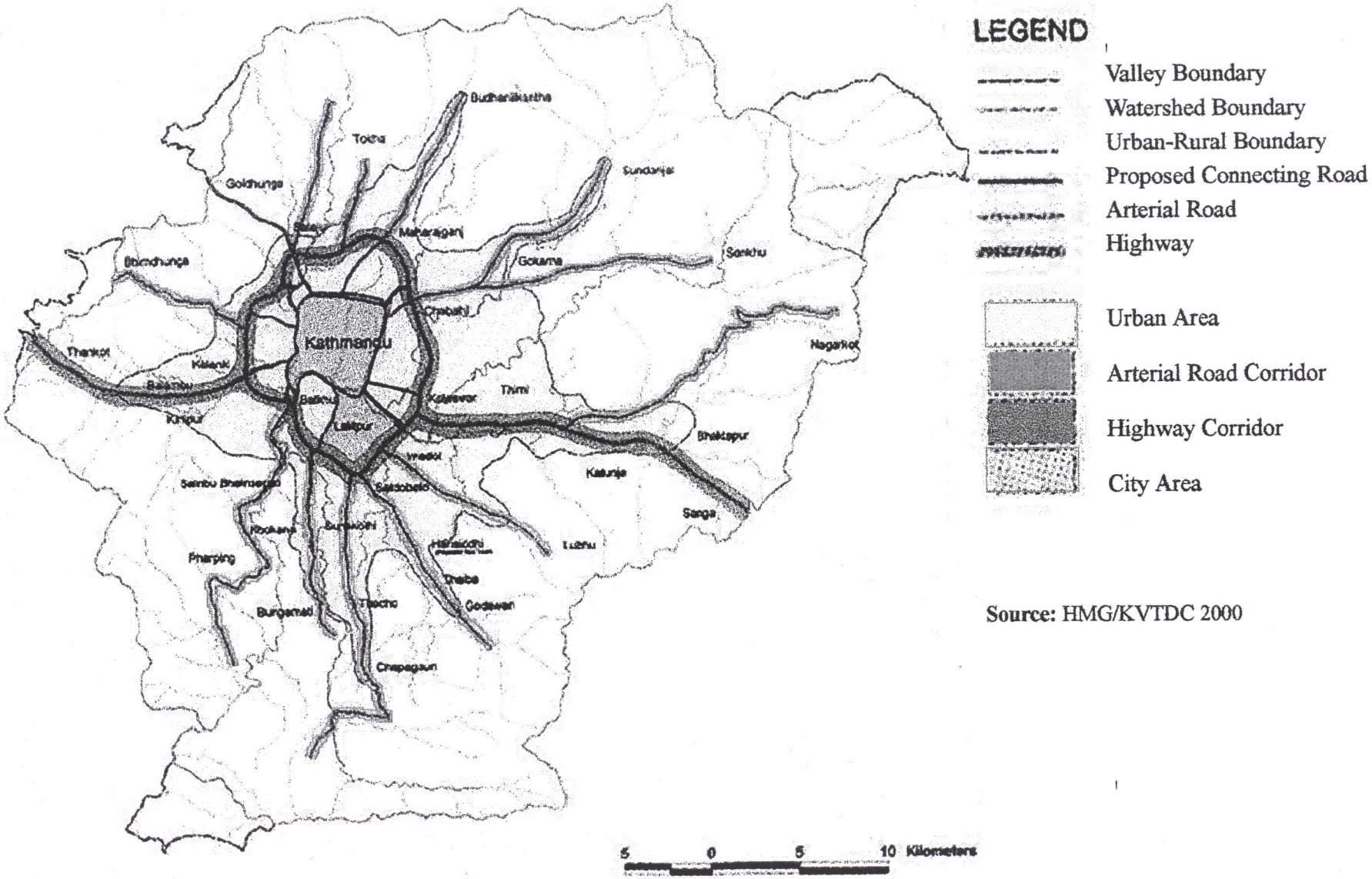
Likewise, management of urban expansion proposed in the Plan includes-

- Orderly rural-urban transition which would eventually facilitate a desirable urban form unlike the haphazard development pattern of the present Valley.
- Urban- rural land delineation to act as important policy intervention in order to contain the current urban sprawl and manage the growth of the Valley.
- Preservation of agricultural land to maintain the functional open spaces, to maintain some level of agricultural production, to contain urban sprawl, and for sustainable development of the Valley.

Some of the policies forwarded include densification and in-fill development instead of uncontrolled urban sprawl, provision of infrastructure to guide development of desired areas, high-density development nodes in major road intersections along the ring road, promotion of mixed land use within the city, and location of industrial activities to the peripheral areas. It also calls for broad regional policies aimed at economic de-concentration, urban containment and regional planning approach to manage urban growth of the Valley.

Map 3.3 shows development proposition for the Valley as proposed in the Plan.

[25] The Plan is now published as Long Term Development Concept of the Kathmandu Valley 2059 (in Nepali).



Map 3.3 Development Corridors in Development Proposition of Development Plan 2020

CHAPTER IV
EFFECTS OF URBAN GROWTH

4.1 Land Use

The Kathmandu Valley is one of the most fertile and agriculturally productive areas in Nepal. But ironically, it is also the fast urbanizing area. Land use trend of the Valley shows rapid decline of the agricultural land which occupied 64 % of the total Valley area in 1984, 52.1% in 1994/96 and about 41% only in 2000. On the other hand, non-agricultural land has increased dramatically from 5.6 % in 1984 to 27.6 % in 2000 (Table 4.1, Fig. 4.1)[26].

Table 4.1 Land Use Trend of the Valley

S.N.	Land Use Type	1984		1994/96		2000	
		Area (ha)	%	Area (ha)	%	Area (ha)	%
1	Agricultural land	40950.3	64.0	33308.3	52.1	27570.0	41.4
2	Forest and grasslands	19438.7	30.4	20945.2	32.7	20677.0	31.0
3	Non-agricultural land	3574.7	5.6	9710.2	15.2	18408.0	27.6
	Total	63963.7	100.0	63963.7	100.0	66655.0	100.0

Source: HMG/KVTDC (2000), HMG/MOPE (1999)
Note:
- Areas under land use types in 1984 are measured from the existing land utilization maps
- Data of 1994/96 is based on aerial photo interpretation (1992) and land use map (1996), Department of Topography

Such conversion of agriculture land to non-agricultural land is basically for urban use, mainly in the form of built-up area. The greater conversion of

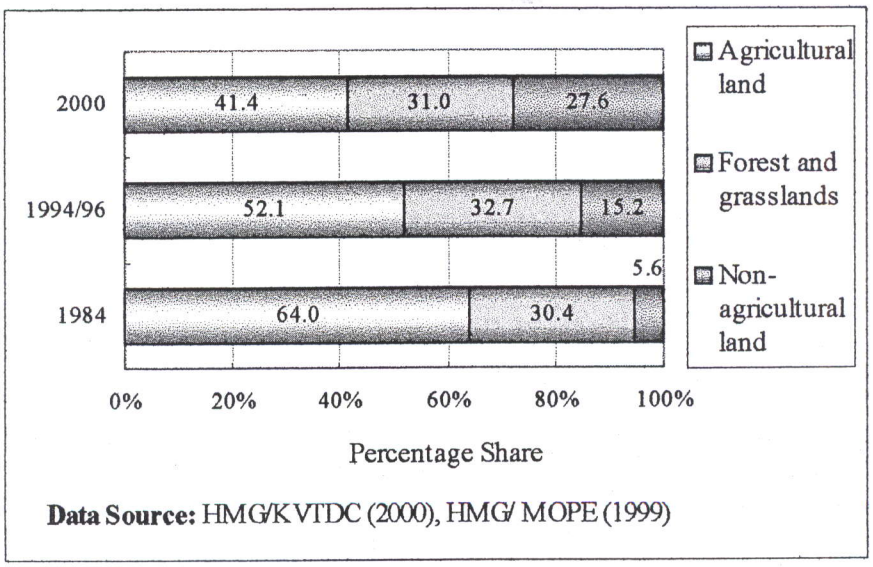


Fig. 4.1 Change in Land Use of the Valley

[26] Refer Table C1 of Appendix C for land use detail of the Valley for 2000

agriculture land in later half of the 1990's, despite the wider belief of reduced land transaction during that period, appears to indicate that the building construction may have remained unabated (HMG/ KVTDC 2000) not only in urban areas but also in the rural areas.

It is feared that with the current trend, all the remaining agricultural land will be converted to urban use by 2025 (HMG/KVTDC 2000,2002). Loss of agricultural land will have negative ecological effects, with loss of economic base for agro-products, functional open spaces, and cultural linkages.

4.2 Environment

4.2.1 Air Pollution

The population of Kathmandu Valley grew by 44 percent from 1980 to 1990. This growth was accompanied by a doubling in the number of vehicles. The number of registered brick kilns, one of the main industries, tripled in the same time period (Shah and Nagpal 1997).

Air pollution measurements show that particulate pollution is the most significant environmental problem in the Valley[27]. The pollutant concentrations often substantially exceed the World Health Organization's Air Quality Guidelines (WHO AQG). Atmospheric visibility data analyzed onward from 1970 show that there has been a very substantial decrease in visibility in the Valley since 1980. Presently there are very few days that have good visibility[28] at noon. The number of foggy mornings has increased from 35-40 days around 1970 to more than 60 in 1993 (Shah and Nagpal 1997).

The bowl-like topography and generally low wind speeds during the winter season create poor dispersion conditions, predisposing Kathmandu Valley to serious air pollution problems.

If pollution sources are allowed to grow unchecked, the economic cost of productivity lost due to health problems will escalate. Past studies, as well as anecdotal evidence suggest that Kathmandu Valley residents' health is under assault. Based on dose-effect relations, it is estimated that the health impact of air

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[27] The main sources of particulate pollution are the brick industry, domestic fuel combustion, the cement industry, vehicle exhaust and re-suspension of the road dust.

[28] Visibility reduction is caused by combustion aerosols from sources such as vehicles, coal, fuel wood and agricultural residue combustion

pollution on Kathmandu residents causes approximately 85 pollution-related premature deaths, 1.5 million days in which people experience respiratory problems and 475,000 restricted activity days due to pollution-related illness, with estimated health damage costs of Rs. 210 million a year. Furthermore, pollution-related loss in tourism earnings for the Valley is Rs. 0.5 billion a year (Shah and Nagpal 1997).

4.2.2 Water Pollution

The rising demand of water due to population increase has put pressure on not only the quantity, but also the quality of water, including both the surface water and ground water. Factors leading to contamination of water bodies, and thus making it a serious problem in the Kathmandu Valley are basically domestic and industrial waste.

Domestic wastewater includes both gray and black water. About 85 % of the total wastewater used ends up as domestic wastewater. In the Valley towns, only 15 % of the houses have access to a sewerage facility (NWSC, 1999, as quoted in MOPE et. al 2001). Much domestic wastewater percolates directly into the groundwater or flows as runoff into local streams. Likewise, domestic sewers are discharged directly into rivers without treatment.

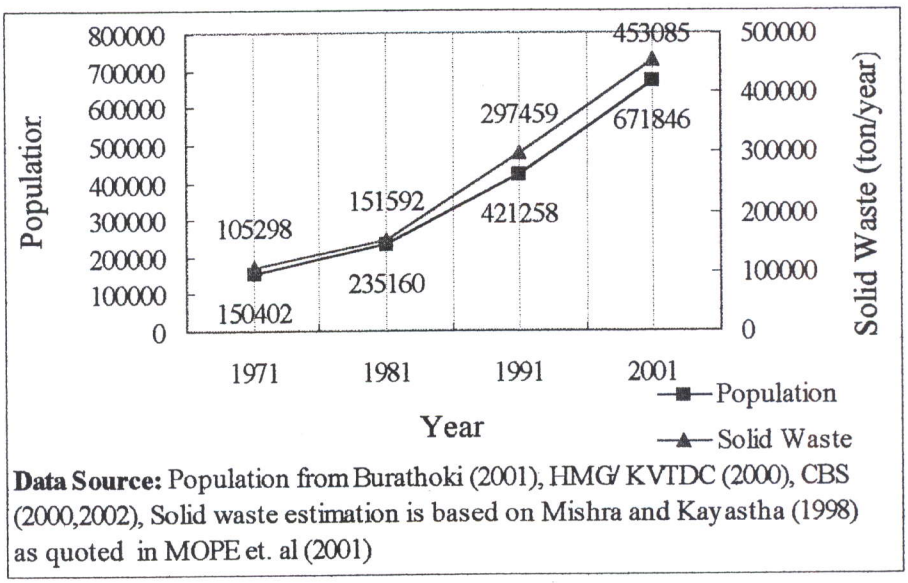
Based on the analysis of domestic waste water, it is estimated that an average of 50 g of Biological Oxygen Demand (BOD) per person per day is produced in the Valley (MOPE et. Al. 2001). Hence one million inhabitants in the Valley means production of approximately 50,000 kg of BOD per day. An average of 20,846 kg of BOD per day has been recorded at the outlet of the Bagmati River which is the most important river of the Valley, constituting about 42 % of the total BOD load produced by the people of the Valley (CEMAT 2000, as quoted in MOPE et. al, 2001). Almost all rivers of the Valley are the recipients of untreated municipal and industrial sewage causing severe organification, nitrification and faecal contamination.

4.2.3 Solid Waste

In the earlier times, when the population of the cities was low and people well predominantly involved in agriculture, solid waste was not a major problem Almost all of the solid waste in earlier days was organic. In the traditional system,

waste generated in the households was either directly sold to the farmers, or placed in the pits called *saagaa* [29] which were located in between houses, to be used as compost manure. But with the change in waste content and rise in population, it is one of the major problems in the Valley.

Urban areas are the main source of waste production. Based on the estimation of Mishra and Kayastha [30] (1998) (as quoted in MOPE et al. 2001), waste generation in the Valley is 0.30 to 0.50 kg/person/day depending on the population size. Accordingly, it can be estimated that waste production in 2001 was about 1241 ton/day, with Kathmandu contributing about 74 %.



Data Source: Population from Burathoki (2001), HMG/ KVTDC (2000), CBS (2000,2002), Solid waste estimation is based on Mishra and Kayastha (1998) as quoted in MOPE et. al (2001)

Fig. 4.2 Solid Waste Production in the Valley

Since waste production is directly related to population, it can be safely assumed that the waste production trend closely follows the trend of population increase (Fig. 4.2).

Ironically, there is no landfill site now for any of the municipalities after Gokarna landfill site, which was used by Kathmandu, was closed. Quest for a permanent landfill site for the Valley is still going on; environmental impact assessment (EIA) of Okharpauwa and Bhimdhunga has been carried out. But solid waste can be disposed in these sites for a minimum of 16 years and maximum of 27 years (HMG/KVTDC 2002).

[29] *saa* means compost and *gaa* means pit in the Newari language

[30] Refer Table D1 of Appendix D

4.3 Drinking Water

Drinking water is supplied in the Valley by seven major systems[31] operated by Nepal Water Supply Corporation (NWSC)- Balaju, Bansbari, Sundarijal, Saibu, Dudhpokhari, Chapagaon and Bhaktapur. The total yield from these sources varies from a minimum yield of 61 mld (in March, April) to a maximum yield of 114 mld in September (HMG/MWSDB 1999) (Fig. 4.3). To provide adequate supply during the dry season, maximum groundwater is extracted during March to May. Besides the NWSC sources, people also use water from other sources such as wells, stone spouts, taps, ponds etc.

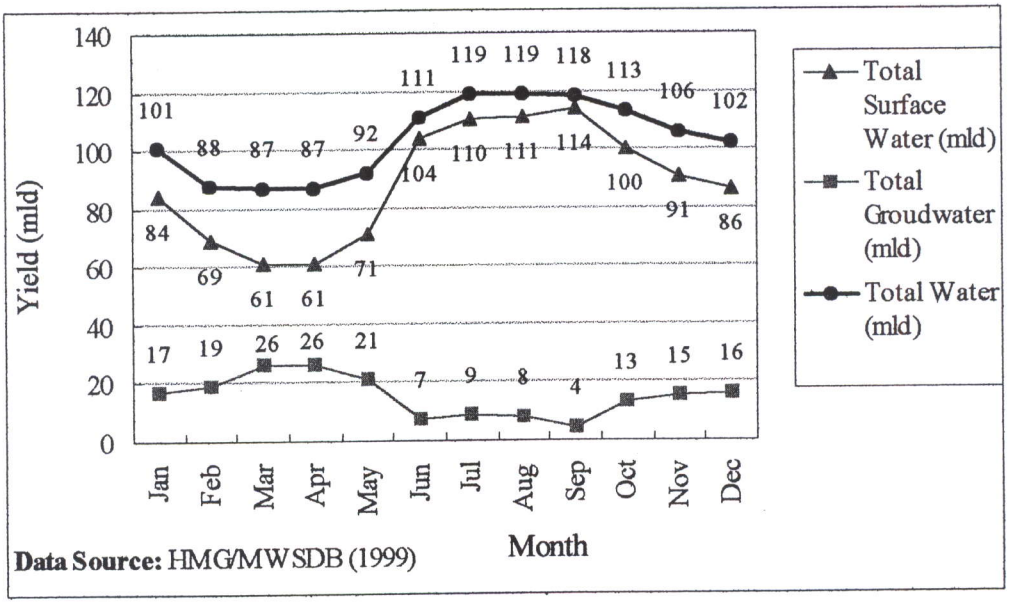


Fig. 4.3 Production of Drinking Water in a Year

Table 4.2 Water Supply and Coverage in the Kathmandu Valley

Particulars	Before 1992	End of 1998
Population ('000)	780	1097
Population Served (%)	68	87
Total water produced (mld)	87	107
Total surface water produced (mld)	61	78
Total groundwater produced (mld)	26	29
Water sold (mld)	52	64
Unaccounted water (%)	40	40
Per capita consumption (lcd)	98	67
Consumption per connection (lcd)	674	636
Total connections	77468	100916

Source: NWSC (1999) as quoted in MOPE at al (2001)
Note: lcd= liter consumption per day, mld= million liter per day

[31] Refer Tables E1 and E2 of Appendix E for the source details

The Valley needs at least 170 mld of water. But even during the rainy season, the supply is only about 115 million liters/day (mld) which is 79% of the estimated demand of 145 mld (NPC 1998, as quoted in MOPE et al 2001).

Both the population and the percentage of population being served by drinking water have increased. With increase in population, the total water demand has also increased. But because of the scarcity of water, per capita consumption has decreased. Though the percentage of population served had an increased of 19 % from 68% before 1992 to 87% at the end of 1998, the per capita consumption has decreased by 31 lcd, followed by a decrease of 38 lcd in consumption per connection (Table 4.2). The demand of water in urban areas is around 150 lcd (CEDA 1989, EMA Group 1992, as quoted in HMG/MOPE 1999), the per capita consumption in the end of 1998 is only 67 lcd, at a deficit of 55 %. It is obvious that the quantity of water supplied is lagging behind the demand because of high population growth. A striking feature of the water supply system is that leakage (or unaccounted water) accounts for 40% of the total supply.

Because of the inadequate supply from the surface sources, there is immense pressure on the groundwater of the Valley resulting in a decline of the water level. The study of Metcalf and Eddy (2000) (as quoted in MOPE et al. 2001) depicts an alarming situation related to drop in the pumping water level (PWL) which ranged from 9 m to as much as 68 m in some parts[32] of the Valley over a few years. The total sustainable withdrawal of groundwater from the Valley's aquifers is approximately 26.3 mld (Stanley 1994, as quoted in MOPE et al. 2001), but the total groundwater extracted is about 58.6 mld (Metcalf 2000, quoted in MOPE et al. 2001). It indicates the overexploitation of groundwater, which is more unfortunate because the support from the surrounding watershed areas to replenish the groundwater is decreasing.

Moreover, despite the fact that about 88% of the total water supply in the Valley is treated (in 1998), the residual chlorine level in the drinking water of the majority of water samples in the Valley is lower than the WHO standard of 0.2 mg/l (NWSC 1999, ENPHO 2000, as quoted in MOPE et al 2001), pointing that treatment of water is less than effective.

The proposed Melamchi project is expected to fulfill the water demand of the

[32] The study locations were Bansbari, Baluwatar and Pharping with highest PWL decline in Bansbari. Refer Table E3 of Appendix E.

Valley. However, the long project implementation period, and much uncertainty and risks associated with the project from the beginning, have made it necessary to formulate mid-term projects.

4.4 Transportation

The road network of the Valley consists of several radial roads primarily radiating from the core areas to the outlying settlements according to the traditional urban form of the Valley. The Valley districts had a total of 1319 km of road in 2000, with the total 597 km of district roads[33] and 568 km of urban roads and. The Valley has a high concentration of urban roads (Fig. 4.4), including the 27-km Ring Road which encircles most urban areas of Kathmandu and Lalitpur.

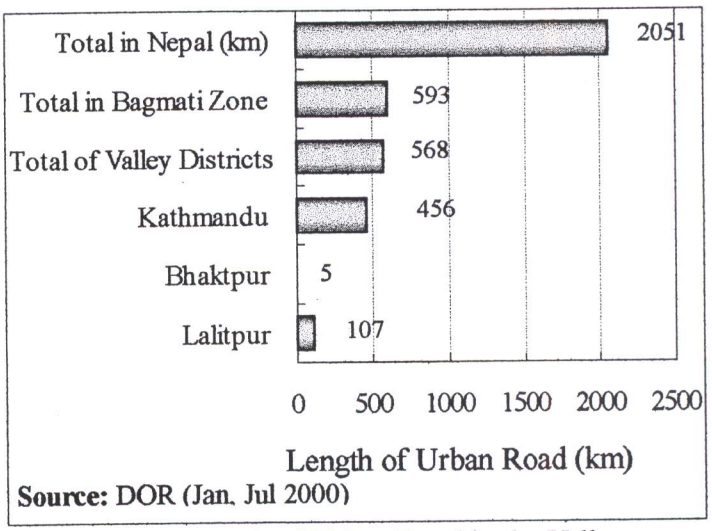


Fig. 4.4 Length of Urban Road in the Valley

Out of total 2051 km of urban roads in Nepal in 2000, the Valley districts contributed about 28 % (DOR, Jan. 2002). The district of Kathmandu alone had about 22 % of the total national urban roads and 80 percent of the total urban roads in the Valley districts.

Till 2000, only about 53 % of the total road in the Valley could be black-topped (Fig. 4.5). Furthermore, even the condition of blacktopped roads in many parts of the Valley is less than satisfactory. Despite the bad conditions of the road, the traffic volume on the Valley roads is excessive as compared to the carrying capacity of the roads.

[33] Refer Table F1 of Appendix F for the classification of roads

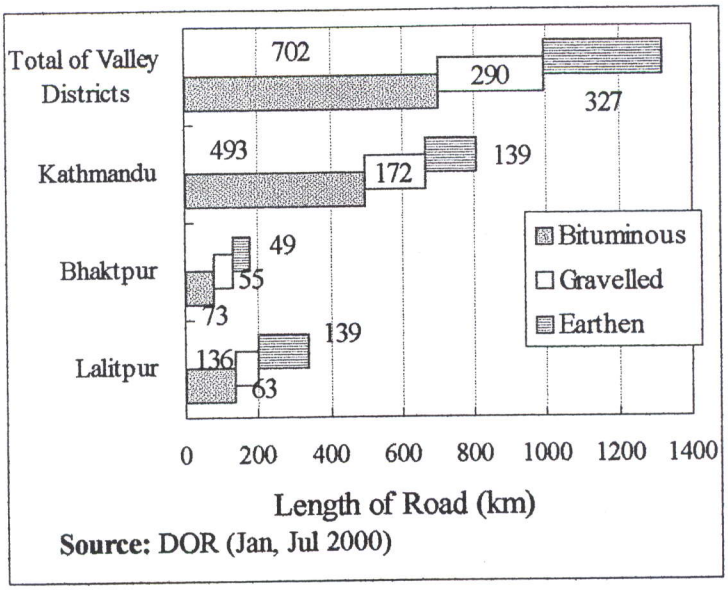


Fig. 4.5 Road by Construction Type in the Valley

The transportation system in the Valley depends upon private cars and motorcycles, and privately operated minibuses, taxis and buses. A number of vehicles, from bicycles to passenger-buses, ply on the roads at the same time along the same route. By mid-July 2001, the number of total vehicles registered in Bagmati Zone was 1,71,678 (Jha 2001), an increase by nearly 57 percent over just 4 years (Fig. 4.6).

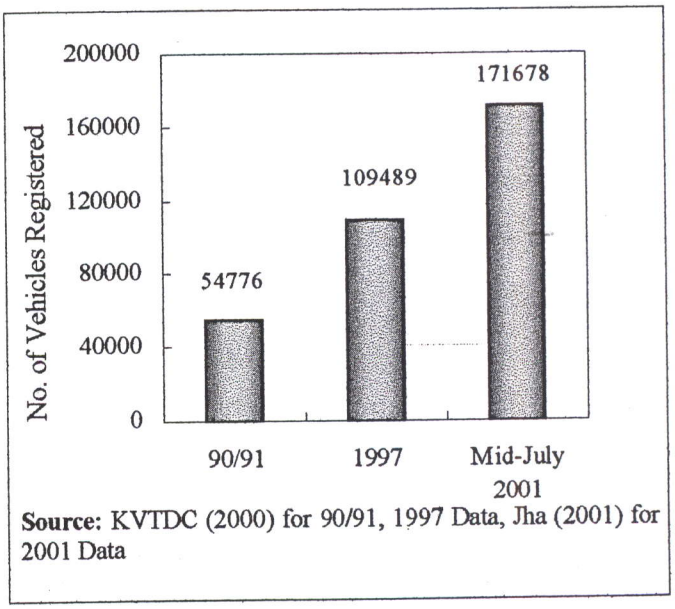


Fig. 4.6 Vehicle Registration in the Bagmati Zone

After the restoration of democracy in 1990, due to changes in market policy, vehicles with cheaper price and availability on installment basis caused the number of vehicles ownership to increase dramatically, particularly in the case of cars and motorcycles. In 1997, motored two-wheelers constituted about 59 percent of the total registered vehicles in Bagmati Zone, followed by cars and jeeps at 26.4 percent (Fig. 4.7, Table F2 of Appendix F). Furthermore, it is estimated that there are more than 35000 bicycles in the Valley after 1997(KVTDC 2000).

The traffic congestion in the Valley has already reached a high scale and intensity for the carrying capacity of the roads. The average vehicle speed has dropped as low as 15 kmph (Spotlight 11-17 Jan. 2002). Because of increase in vehicle numbers and not matching increase in length of the road, the traffic density (total vehicles per km of total road) in Bagmati Zone has increased by 34 percent from 51.04 vehicles per km in 1995 to 68.6 vehicles per km in 2001 (Jha 2001).

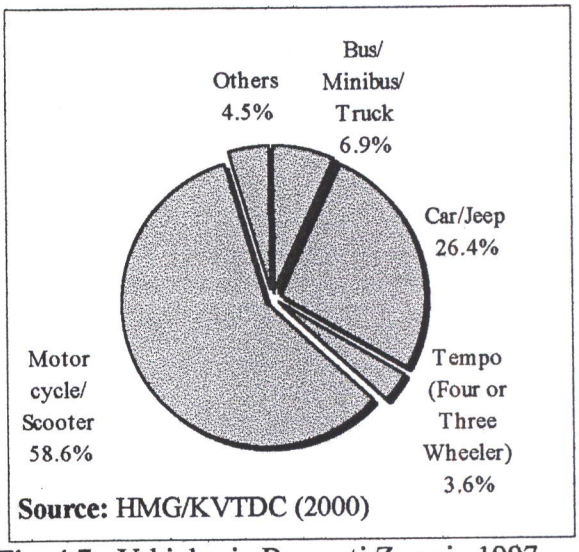


Fig. 4.7 Vehicles in Bagmati Zone in 1997

The pressure of the increasing number of vehicles on the limited stretch of roads in the Valley has led to a greater frequency of road accidents. Nearly 379 people were killed, 324 handicapped and 6071 injured due to road accidents in the last four years (The Rising Nepal 24 Jan. 2002).

Nepal spends about 40 percent of total merchandise export as a cost of petroleum products. Out of total consumption in Nepal, 79 percent of gasoline and 27 percent of diesel is consumed only in the Valley (Jha 2001). Because of the low quality of fuels, the wastage of money, damage to the machinery and contribution to the environmental pollution are high.

Furthermore, the rise in the number of vehicles is not matched by the availability of parking areas. The Kathmandu Metropolitan City has three bus parks within its jurisdiction with a total capacity of 174[34] buses (KVTDC 2000). Lalitpur has three bus-parks[35] within its jurisdiction whereas Bhaktapur and Kirtipur have one small bus park each. Apart from bus-parks, there is the growing demand for parking spaces for rising fleet of vehicles, mostly private ones. Currently, some roadsides have been used as parking spaces, besides small undergrounds parking areas, which has further decreased the carrying capacity of such roads.

[34] Gongabu bus-park (120), old bus-park at Tundikhel (40) and Bagbazaar minibus-park (14)

[35] at Patandhoka, Lagankhel and Jawalakhel

4.5 Seismic Hazards

The Kathmandu Valley is a major earthquake-prone area. The Valley is located on the site of a prehistoric lake which has been filled with the soft sediments that make up its floor. These soft sediments tend to amplify earthquake shaking, like a bowl of jelly when it is shaken. In addition, there is a high probability of liquefaction[36] in many of the Valley's urban areas, especially near rivers. Liquefaction was widely observed after the 1934 earthquake (Fig. 4.8).

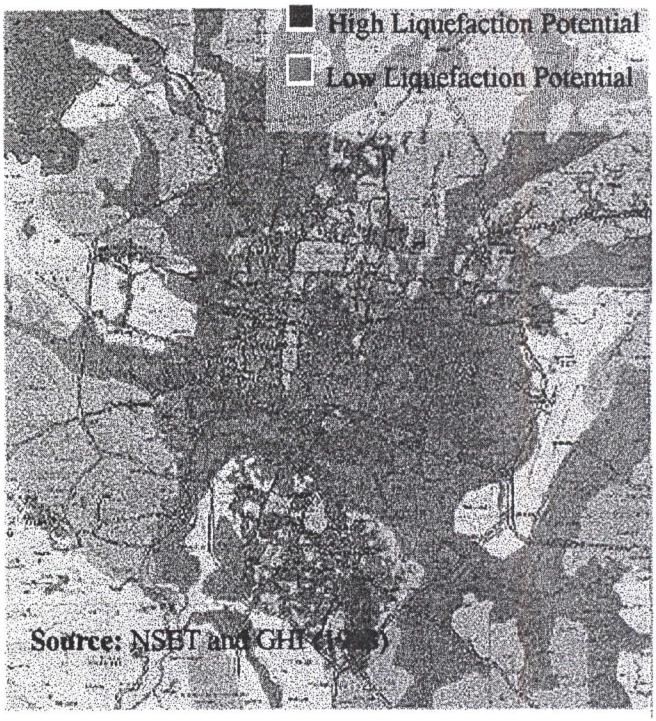
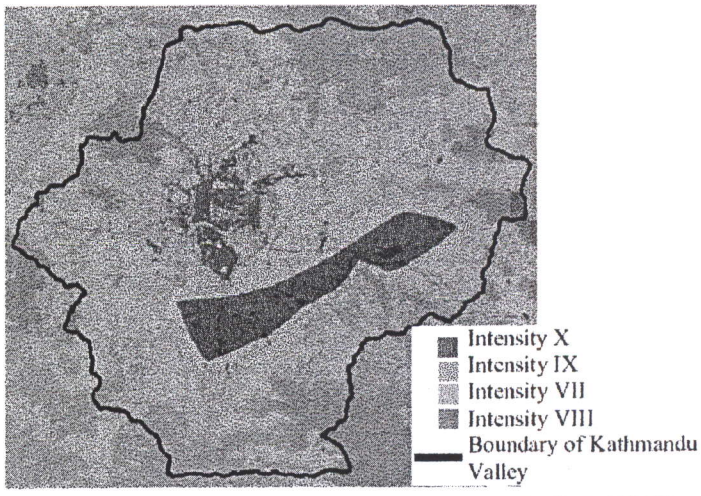


Fig. 4.8 Liquefaction Potential in Greater Kathmandu

The 1934 AD earthquake produced strong shaking in the Valley, and destroyed 20 % and damaged 40 % of the Valley's building stock. In Kathmandu itself, one quarter of all homes was destroyed. Many of the temples in Bhaktapur were destroyed as well (NSET and GHI 1998). The shaking observed after the 1934 earthquake is shown in Fig. 4.9 as it was documented immediately after the event. The shaking is shown according to the



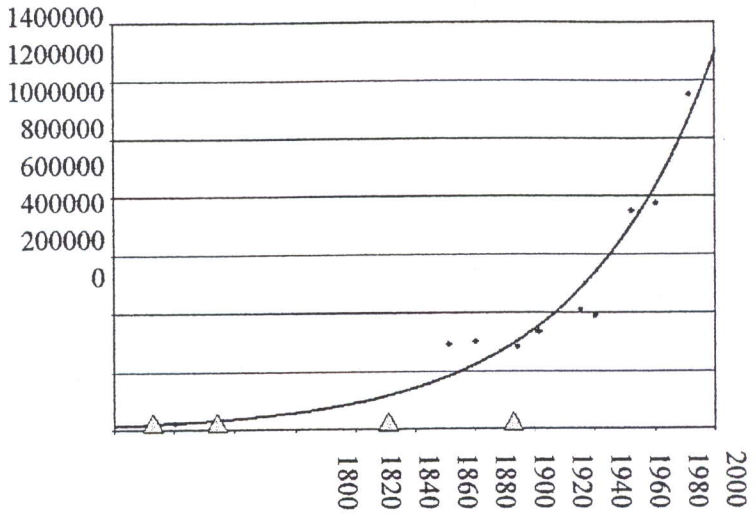
Source: NSET, GHI (1998)

Fig. 4.9 MMI Distribution from 1934 Earthquake

[36] Liquefaction is a phenomenon in which water-saturated soil changes from a firm material to a semi-liquid material when shaken and loses its ability to support structures.

Modified Mercalli Intensity (MMI) scale[37].

This earthquake was not an isolated event. Three earthquakes of similar size occurred in the Valley in the 19th Century- in 1810, 1833, and 1866 AD. The seismic record of the region, which extends back to 1255 AD, suggests that earthquakes of this size occur approximately every 75 years (Fig. 4.10, also refer Appendix G), indicating that a devastating earthquake is inevitable in the long term and likely in the near future.



Source: NSET/GHI (1998)
Note: Dot indicates population, Triangle indicates major earthquake

Fig. 4.10 Population Growth and Major Earthquakes

A simple loss estimation study was carried by the Kathmandu Valley Earthquake Risk Management Project (KVERMP) about the consequences[38] if the 1934 earthquake shaking were to occur in modern day Valley.

Some results of the loss estimation study are presented below to clarify the extent of the problem that faces the Valley[39] (NSET and GHI 1998)-

- As many as 60 % of all buildings in the Valley are likely to be damaged heavily, many beyond repair. Bhaktapur, which has historically suffered more than the rest of the Valley, will have as many as 75 % of all buildings heavily damaged.

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37 MMI scale indicates the amount of damage observed in the location. See Table G1 of Appendix G.

38 The next earthquake to severely damage the Valley will not have the same magnitude and location as the 1934 event. However, most probably, it will have approximately the same shaking pattern within the Valley due to soft soil beneath its surface.

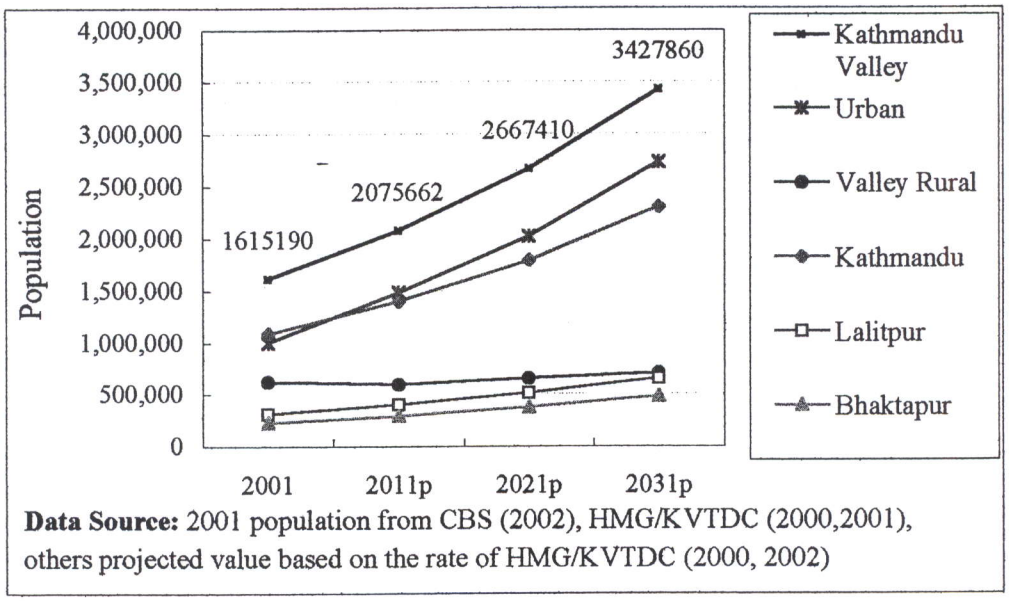
39 This loss estimation should not be viewed as a forecast of what will happen, but only as a tool to help make decisions about reducing the Valley's earthquake risk.

- Applying more recent earthquake casualty figures from cities comparable to the Valley, results in an estimate of 40,000 deaths and 95,000 injuries in the next major earthquake. An additional 600,000 to 900,000 residents of the Valley are expected to be homeless. There will be a major shortage of space for medical treatment.
- Almost half of the bridges in the Valley could be impassable, and that 10 % of paved roads will have moderate damage, such as deep cracks or subsidence. In addition, many of the narrowest streets will be blocked by debris from damaged buildings. Linkage among Bhaktapur, Kathmandu and Lalitpur will be severely disturbed because of road and bridge damage. Tribhuvan International Airport (TIA) is surrounded by liquefaction prone areas which means the airport may be isolated from the rest of the Valley, limiting emergency aid from outside.
- Nearly 95 % of water pipes and 50 % of other water system components (pumping stations, treatment plants, etc.) could be damaged seriously. Almost all telephone exchange buildings and 60 % of telephone lines are likely to be damaged. Nearly 40 % of electric lines and all electric substations are likely to be damaged.

The exact amount of damages or numbers of deaths, injuries, and homelessness are not needed for planning. The Valley's current facilities cannot cope with even a small fraction of these estimates. Vulnerability to disasters is closely linked with population density and economic resources (UNEP 2002). The Kathmandu Valley is at grave risk in the event of a big earthquake because of the population density of both its old and new neighborhoods. The epicenter of the 1934 earthquake was near Chainpur, around 200 km to the east of the Valley (Thapa 2001). But even at that time, though the Newar towns were a fraction of today's size, the devastation was fierce. The population of the Valley was around 300,000 in 1934, but now it is more than 1.5 million. The scale of loss of life will be even more if the construction practice of tall, slim buildings, and high occupancy rate are to be considered. Likewise, majority of new settlements are developing along the side of rivers, such as Bishnumati, Dhobikhola and Bagmati, where the effect of liquefaction is likely to be more pronounced.

4.6 Population Projection

Based on the annual growth rate of 2.54% (HMG/KVTDC 2000,2002), the total population of the Valley is likely to cross 2 million line by 2011, exceed 2.5 million by 2021 and reach almost 3.5 million by 2031 (Fig. 4.11, Table 4.3).



Data Source: 2001 population from CBS (2002), HMG/KVTDC (2000,2001), others projected value based on the rate of HMG/KVTDC (2000, 2002)

Fig. 4.11 Population Projection for the Kathmandu Valley

The urban population in 2001 is almost 1 million. It is estimated that by 2031, the urban population alone will be more than 2.5 million, constituting 74% of the total estimated population of the Valley.

Table 4.3 Projected Population of Districts within the Kathmandu Valley

Census Year	Kathmandu	Lalitpur	Bhaktapur	Kathmandu Valley		
				Urban	Rural	Total
2001	1,081,845	307,884	225,461	995,966	619,224	1,615,190
2011[p]	1,390,267	395,658	289,737	1,479,113	596,549	2,075,662
2021[p]	1,786,616	508,456	372,338	2,017,713	649,697	2,667,410
2031[p]	2,295,961	653,411	478,488	2,726,788	701,072	3,427,860

Source: 2001 population from CBS (2002), projected rate from HMG/KVTDC (2000)
Note: [p] projected population is derived from the 2001 population with growth rates from HMG/KVTDC (2000, 2002). Refer also Table A3 of Appendix A.

The district of Kathmandu alone will exceed 1.5 million people by 2021, which will be more than the 2001 population of the Valley. Similarly, population of Kathmandu will exceed 2 million by 2031 which will be more than the 2011 population of the whole Valley.

4.7 Issues

Some of the factors that define the carrying capacity of the Valley are related to the provision of urban services whereas some define the ecological boundary of sustainability. Even from different sectoral point of view, the urban growth of the Valley is alarming, but the degree of alarm or threat is not the same. But, at the same time, none of the sectors of urban development can be ignored just because of the relatively lesser degree of negativity on the urban future of the Valley. Sectoral issues have been briefly discussed below in relation to the carrying capacity of the Valley-

Land Use

1. Because of the fast conversion of agricultural land into urban uses, the built-up areas are increasing at the loss of farmlands. The loss of farmlands in one of the most fertile land in the country has not only economical but also social effects. Many cultural practices are associated with the farming practices and schedule. In economical sense, loss of agro-based activities will be compensated by rise in varieties of tertiary economic activities. Such activities will generate different kinds of jobs suitable for different levels of people- from unskilled labors, such as constructional workers, to professionals who are expert in a chosen field. The ultimate result is rise in migrants in a place where population rise is already a serious problem.
2. The loss of farmlands is also an indication of decrease in the food production within the Valley. But, transportation linkage of the Valley with outside is often affected by natural calamities and political reasons. Therefore, food shortage in the Valley can be acute at times if its food dependency is further increased. Dependency of foods on outside areas will also mean high cost.

Environment

1. The continued worsening of situation in the Valley in terms of air, land and water pollution has negative impacts on the quality of life of people and the aesthetic value of the place.
2. Poor environment is counterproductive for the economic prosperity of the Valley since the major economic backbone is considered to be tourism.
3. Environmental problems may discourage long-term migration (migration for

residential purpose). But for the number of residents in the Valley is already so high.

4. If nothing concrete is done immediately, the problems are bound to be too big to handle, in terms of time and cost.
5. The residents of the Valley, or even the long-term migrants are relatively more concerned about the degrading environment. The same cannot be hoped from the short-term or new migrants. The impact of migration on the environment is not difficult to realize.
6. Worsening of air quality has already sent a strong message for the closing down of brick-kilns and removal of old vehicles. Poor visibility has become problem for safe landing for airplanes at the Tribhuvan International Airport (TIA). Air pollution in the Valley has crossed the WHO threshold.
7. Clean rivers are the natural lifeline of a city. But almost all rivers in the Valley have turned into open drains. It is already late to revitalize the rivers, but because of the population increase and increase in the production of sewage, the time is running out at a faster rate. Cleaning the rivers in the future will need a huge amount of money and efforts.
8. The long search for permanent landfill site for the Valley is a good example of the difficulties that await the Valley as an urban area. Even if a feasible site is found, there will be a short-term solution since the volume of the solid waste is increasing at a high rate and the non-degradable content of the waste is also increasing.

Drinking Water

1. Water is considered as the most essential urban utility. But for a long time, the supply of water has lagged behind demand. As the population keeps on increasing, the situation is even more threatening since no significant breakthrough has been seen in improvising the water supply system. All hope now rest on Melamchi, but the project has already been much criticized for its big budget, slow progress, donor-vested interests, probability of high water price, and uncertainties in different aspects.
2. Even if the Melamchi Project delivers fruits as per the general hope, its ability to fulfill the long-term demand of drinking water is not beyond question mark.

3. Since the NWSC service is not sufficient, there is huge extraction of groundwater which has already reached the critical level. If unchecked immediately, it would lead to geological problems, such as ground subsidence and increased risks of danger during earthquakes.
4. Water scarcity has played a significant role in controlling migration into the Valley in some way. In an economically poor country like Nepal where urban services cannot be provided readily, water is the most important factor that can control or limit the urban growth control of the Valley.

Transportation

1. Because of the individuality factor in urban people, the demand for private vehicles has risen. Finance companies have made it possible to acquire them at a small initial payment. On the other hand, the need for public transportation has not decreased since population, as a whole, is still large. So both small and big vehicles run along the road though the road length and width has not and cannot increase at the same rate.
2. The open spaces in the city areas are decreasing. But the increased traffic requires significant parking area. Already the roads in the cities are very congested; provision of parking space inside the city area is becoming more and more difficult, if not impossible.
3. Urban cores suffer the most from traffic congestion. But it is unlikely that the cores will stop or reduce their economic activities. As long as there are economic forces emanating from the cores, people will continue to be attracted towards them. As long as the population keeps on increasing, these economic forces will be even more vibrant.

Seismic Hazards

1. Despite the terrible experiences of the Great Earthquake of 1934, little attention has been paid in the urban planning of the cities after the incident. Cities have seen ribbon-development (along roadsides), pencil-development (in core areas where the site area is extremely small but need of floor area is high), and spill-development (in the outskirt of cities in the form of sprawl). Such developments have resulted into unscientific distribution of density- too high in some places and too low in other places. Where the density is too

high, the place is naturally prone to disasters. Even the places with very low density could have been developed for post-earthquake measures for the better of the whole city, but ironically, such places are just heading towards becoming congested places in the future.

2. Seismic consideration has not been applied in significant way to any of the plans made so for the Valley. Earthquakes happen only once in about 75 years, and development cannot be stopped or controlled for long. But at the same time, it is important to note whether the urban areas can recover in reasonable time if a great earthquake leaves behind a massive destruction.
3. There is a direct relationship between population density and earthquake damage. But because of less information, or sheer negligence, the Valley, despite possessing the threat of massive earthquakes, has not lost its attraction as the most sought-after residential area.

CHAPTER V
THRESHOLD PLANNING

5.1 Growth Limiting Factors

By nature, urbanization is a natural process, and urban growth is the main step of urbanization. So urban growth restriction has little chance of practical implication. But several factors do the job of restricting or controlling urban growth, and often these factors are helpful in urban planning as they provide some time for the planners to put forth planning endeavors.

As the Valley grows into a large agglomeration of settlements, problems from almost every corner of urban development have emerged. Not all of these factors necessarily point towards the growth limit of the Valley. Problems related to sectors such as transportation, environment etc., can be solved with proper management. For instance, the transportation system is yet to be developed for the Valley, roads can still be constructed, vehicles running on the roads can be reduced. Similarly, to deal with the direct causes of pollution, strict laws can be enforced, by replacing the prevailing loose legal provisions. The prominent limiting factors are those which cannot be covered within the parenthesis of managerial efforts. Such factors act like the destiny of the Valley, providing constraints and confinement to the planners.

From the study of the urban growth and the future scenario, the following factors can be identified as the key factors[40] to limit the urban growth of the Valley-

1. Physical space

The physical boundary of the Valley offers the limit for urban expansion. Urban development in the hills in the periphery of the Valley is not feasible from economical and ecological considerations.

Physical space consideration can be best related to population density for the planning purpose. The relationship between ideal population density and availability of space can indicate the carrying capacity of the Valley.

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[40] These factors are not the ultimate or the only ones. In future, other factors may also emerge as significant limiting factor.

2. Seismic risks

If disasters happen in an area frequently, then it would automatically discourage habitation. But, seismic risks in the Valley have a long frequency of about 75 years. But the amount of destruction that awaits the Valley every 75 years is sensitive enough to plan for seismic safety. It would provision of enough open spaces, efficient disaster management and careful planning. Here also, population density is the key element that could be related to seismic safety for planning purpose. Despite the complexities in determining safe population from seismic risk considerations, the issue is not to be ignored because public safety is one of the most essential ingredients of any planning undertaking.

3. Drinking water

Drinking water has emerged as the most important growth limiting factors for the Valley. Because of water scarcity in the Valley, in-migration has been discouraged in some way. Water scarcity is the most commonly felt problem. Though Melamchi project has given high hopes, but it should be understood that Melamchi project is not the ultimate solution. As every project, Melamchi project also has its project period and limitations. Question arises if another similar project can be formulated in the future for continuity. The relation between the water demand and its fulfillment through projects like Melamchi should be studied carefully to check if water can play a role in limiting the urban growth of the Valley.

It is, therefore, rational to have a logical estimate of the carrying capacity of the Valley based on population density (satisfying both the criteria for physical space and seismic safety) and drinking water supply.

5.2 Population Density

The land use scenario of 2000 (Table C1 of Appendix C) shows the existence of about 41% agricultural land. Furthermore, adding 31 % of forest, the current land used for human settlements stands at about 28 % of total area of the Valley, half of which is occupied by municipalities. Significant portion of this will be consumed in the future for urbanization. But for ecological and social reasons, farmland and forest need to be preserved. It is a major benefit for the Valley still to have ample percentage of farmlands and forest area. Preservation of these

green areas will lead towards the formation of livable Kathmandu Valley. However, urban development in the Valley can take place in the Valley at the cost of agriculture farmlands. There is no hard and fast rule on how much agricultural land needs to be preserved. But if a ratio of 60:40 between development-free land and land for urban development, it will mean a reduction in agricultural land from the current 41% to 28% of the total Valley area (Table 5.1).

Table 5.1 The 60:40 Ratio for Urbanization in the Valley

Category	Percentage of Total Valley Area	Remarks
Forest, rivers, agricultural lands	60	Forest 31 % (same as now) Rivers 1 % (same as now) Agricultural land 28 % (from current 41 %)
Land for urban development	40	26270 ha

The ratio of 60:40 is not biased towards the environmental issues at the cost of urbanization because any area added for urban development is the area deducted from the farmlands, and preservation of farmlands at around 30 % is reasonable. A 13% reduction in the share of agricultural land on the total area[41] of the Valley means availability of around 8500 ha of land. The capacity of the current urban areas to accept some of the future population should also be considered. A total of 26270 ha of land can be considered for urban development (Fig. 5.1).

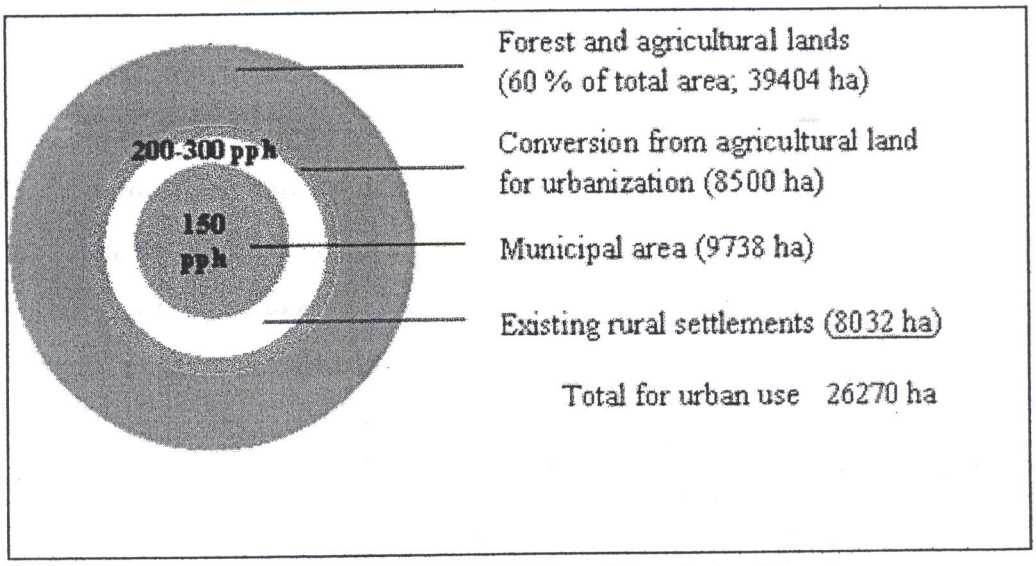

Fig. 5.1 Proposed Distribution of Population Density

The average population density of urban areas (municipalities) in 2001 stands at about 103 ppha. But drawing experiences from the present conditions of the

[41] 65674 ha

urban areas in the form of inadequate urban services, traffic congestion, unhygienic living environment in the core areas and so on, it is not wise to increase the population density any further. Furthermore, the urban areas lack sufficient open spaces and infrastructures for post-earthquake rehabilitation activities. Therefore, it is necessary to take action to confine the density of existing municipalities to a reasonable or manageable value. The population density for the new urban areas (or future municipalities) can be on higher side.

Table 5.2 Acceptable Population in the Municipalities

Municipality	Area (sq. km)	Census 2001			Overall Density of 150 ppha	
		Popula - tion	Pop. Density (persons/ sq. km)	Population Distribution	Tentative Max. Population to be Accepted	Resultant Density (persons/ sq.km)
Kathmandu	49.45	671846	13586.37	0.674	310040	19856
Lalitpur	15.15	162991	10758.48	0.164	75440	15738
Bhaktapur	6.56	72543	11058.38	0.073	33580	16177
Madhyapur Thimi	11.11	47751	4298.02	0.048	22080	6285
Kirtipur	14.76	40835	2766.60	0.041	18860	4044
Total	97.03	995966		1.000	460000	
Average			10264.52			15005

Note: Municipal areas are based on CBS (2002)

An adoption of 150 ppha of population density for the existing municipal area means that the municipalities will have to accept additional 460,000 persons in the future (Table 5.2). Following the same population distribution as that of 2001 census, the population density of Kathmandu would be around 200 ppha. This estimated density would be ideal for Kathmandu and other municipalities since many other Asian cities also tend to have a density of 200-300 ppha while they still struggle to maintain a good developmental status (Fig. 5.2).

An important question, now, arises as to how the remaining land outside the current municipal boundary be developed. HMG/KVTDC (2000,2002) recommends gross population density of 300 ppha, which would mean a net population density of 600 ppha, which is quite high and ambitious. Even an adoption of 200 ppha would mean that the new proposed urban areas in the Valley would be as congested as present Kathmandu. Owing to the fact that the Valley is highly prone to earthquakes, adequate open spaces should be left in the

new urban areas. This may mean adoption of population density lesser than the economically ideal population density.

Adopting an ideal population density of 200 ppha or 300 ppha has significant effect on the carrying capacity of the Valley in terms of physical space.

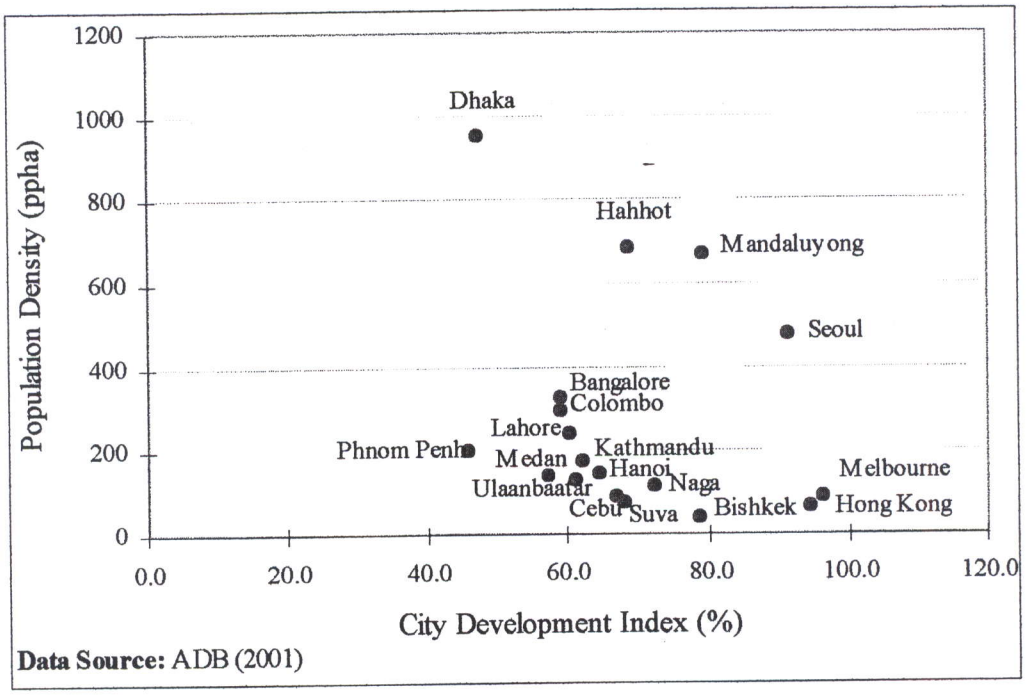

Fig. 5.2 Population Density vs. Development in Some Selected Cities

Considering the availability of 26270 ha of land for urbanization, if the population density of 200 ppha is to be adopted, the available land would be consumed by around 2049. But, if 300 ppha is to be adopted, the capacity can be extended, but by about one decade, up to around 2060 (Table 5.3, Fig. 5.3).

Table 5.3 Land Requirement for Future Growth

Year	Population	Excess over 2001 Population	Population to be Absorbed outside Municipalities	Required Land outside Municipalities(ha)	
				@200 ppha	@300 ppha
2001	1,615,190				
2011	2,075,662	460,472	472	2	2
2021	2,667,410	1,052,220	592,220	2,961	1,974
2031	3,427,860	1,812,670	1,352,670	6,763	4,509
2041	4,405,104	2,789,914	2,329,914	11,650	7,766
2051	5,660,950	4,045,760	3,585,760	17,929	11,953
2061	7,274,823	5,659,633	5,199,633	25,998	17,332

Note:
- Refer Table 4.3 for population projection
- It is assumed that all agricultural land is outside the current municipalities
- Population to be absorbed outside municipalities is obtained by deducting 460000 from the excess population over 2001 population

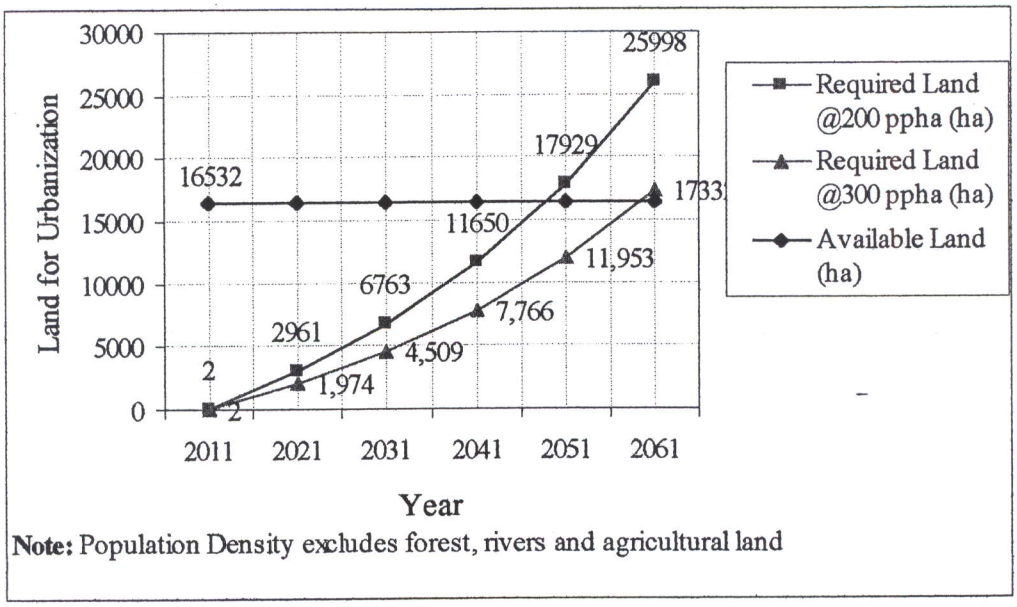

Fig. 5.3 Available vs. Required Land for Future Urbanization

Furthermore, it is likely the current municipal areas of the Valley would be saturated by 2011. After 2011, further population increase would have to be absorbed by new urban areas. So it is high time to identity new urban areas and endorse planned urbanization.

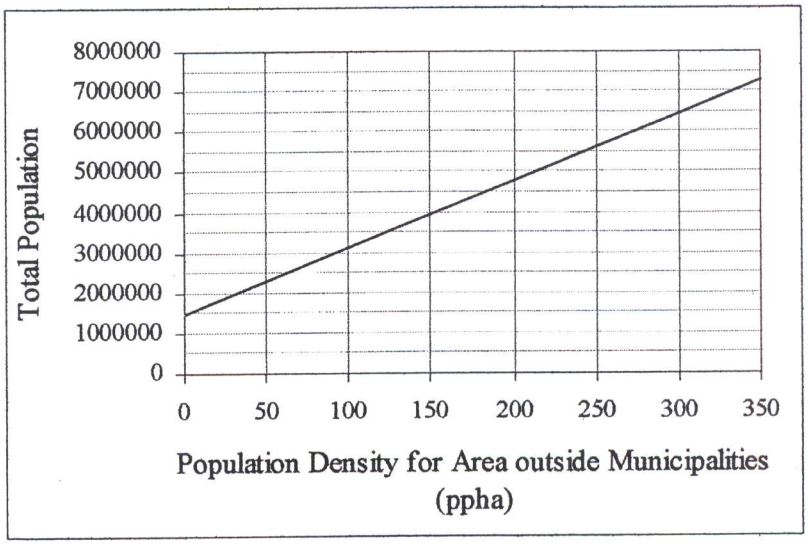

Fig. 5.4 Population Density vs. Total Population

If population of additional 460,000 could be incorporated in the existing municipal area, it would have a total population of about 1.5 million. Developing the remaining area outside the municipalities (i.e. 16532 ha out of total 26270 ha) for density of 200 to 300 ppha would result into a total Valley population of about 4.8 to 6.4 million (Fig. 5.4).

5.3 Water Supply

5.3.1 Demand

The Valley needs at least 170 mld of water, but only about 80 mld in dry season and 130 mld in wet season is been supplied. The supply of water in the pipeline managed by NWSC is highly unreliable- in terms of quantity and time schedule, not mentioning the quality issue. The unaccounted water stands at a high 40 % which means only 60 % of the water produced actually is available for supply. The consequence of all this is the panic among the consumers, especially during the dry season. With the rise in population, the demand will also rise, and at a higher rate. The rise in per capita demand is because of the natural change in habit of the consumers, such as more concern for hygiene, use of excessive water-consuming accessories, such as washing machines, bath-tubs, flush toilets etc. Apart from the urban residents, even the rural population will not be far away from changes that time brings. So per capita water demand in the rural area will also increase. Then, there is the commercial sector, such as hotels, restaurants, factories etc., which also has increasing water demand. It is a huge challenging task to fulfill ever-increasing water demand.

Table 5.4 shows the probable future water demand in the Valley. Accordingly, the water demand which is below 200 mld at present is likely to exceed 300 by 2011. The increase in the share of urban population to the total population will increase demand even more to 500 by 2021 and more than 780 by 2031[42]. The only hope for the Valley lies on the much-talked-about Melamchi Project. But there is a limit to the hope that the Project can deliver.

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42 The per capita demand adopted for the Valley is reasonable as compared to cities in Asia-Pacific Region (Refer Table E4 of Appendix E) where water consumption in urban areas is as high as 350 lpcd.

Table 5.4 Projection of Water Demand

Year	Urban		Rural		Population			Demand (mld)				
	Observed Demand (lpcd)	Annual Rate of Growth	Demand (lpcd)	Annual Rate of Growth	Urban	Rural	Total	Domestic			Commercial/ Industrial	Total
								Urban	Rural	Total		
1994	100		45									
2001	124	3.1	61	4.4	995966	619224	1615190	123	38	161	26	187
2006	135	1.7	76	4.5								
2011	149	2.0	95	4.6	1479113	596549	2075662	220	57	277	42	319
2021	182	2.0	100	0.5	2017713	649697	2667410	366	65	431	69	500
2031	221	2.0	100	0.0	2726788	701072	3427860	604	70	674	112	786

Source:

- Observed demand for urban area (lpcd) and demand for rural area (lpcd) are obtained from 1994 to 2011 from MOPE (1999)
- Commercial demand for 2001 from MOPE (1999)

Note:

- Refer Table for population projection
- Demand limited to 100 lpcd for rural area after 2021 to have reasonable, moderate value
- Demand for 2006 not shown; interpolation can be done if necessary
- Commercial demand of 2001 is increased by an annual growth rate of 5% as suggested by MOPE (1999)
- The demand for the urban areas is observed demand. Theoretical demand exceeds the observed demand.
- Per capita demand increases as per urbanization because of the changing habits and use of more household cleaning accessories.

5.3.2 Resources Availability

The Melamchi Water Supply Project (MWSP) is an inter basin water supply project which supplies water from snow fed Melamchi river in the Kosi basin in Sindupalchowk district to the Kathmandu Valley which is in the Bagmati basin, all by gravity. The Project is financed by a number of international agencies and the total cost is estimated at about half a billion US dollar [43]. Since Melamchi is a long-term project, need for medium term projects could not be avoided

Medium Term Projects

There are several medium-term projects with completion period of one to three years. The total production capacity is 45 to 75 mld (Table 5.5).

Table 5.5 Medium Term NWSC Projects

Proposed Projects	Production Capacity (mld)	Time (years)
Foothill Project	15	2
Impounding Sites (Tokha, Kabresthali and Baluwa)	20	3
Manohara Infiltration Gallery	20	2
Balkhu	0 to 13	2
Hwang Khola	0 to 4	2
Nakhu	0 to 3	1
Total	45 to 75	
Source: HMG/MWSDB (1999)		

Long Term Project

The only long-term project is Melamchi itself, which is implemented in three stages (Table 5.6). The original time schedule is not valid now since the first stage was scheduled to be completed by 2004 which is not possible now. It is most likely that the first phase will complete by 2010 at the earliest.

Table 5.6 Stages of Melamchi Project

Stage	Source River	Supply Capacity (mld)	Completion Year	
			Initially Stated	Most Likely
1	Melamchi River	170	2004	2010
2	Melamchi River and Yangri River	170	2011	2017
3	Melamchi River, Yangri River and Larke River	170	2018	2024
	Total	510		

[43] Refer Appendix H for details of Melamchi Project

5.3.3 Equation of Demand and Supply

The current average supply of 107 mld is likely to increase by about 65 mld though medium term projects in 2010; and in the same year, the first phase of Melamchi will add up 170 mld of water. Further 170 mld will be added in 2017 and in 2024. However, this hopeful figures have to be reduced by some factor to take account of unaccounted water in the form of leakage (Table 5.7).

Table 5.7 Net Availability of Water

Year	Resource Availability (mld)	Leakage (%)	Net Available (mld)
2001	107	40	64.2
2010	172 to 342	25	129,and 256.5
2017	342 to 612	20	256.5 to 489.6
2024	612 to 782	20	489.6 to 625.6
2031	782	20	625.6

Note: Leakage is based on comparison of values by HMG/MOPE (1999) and HMG/MWSDB (1999).

In constructing supply-demand lines, certain assumptions are made-

- Though the proposed distribution area of the Melamchi Project is the urban areas consisting of Greater Kathmandu and some surrounding VDCs, the Kathmandu- Bhaktapur corridor and Bhaktapur City, whole of the population of the Valley is considered to suit the future scenario of urbanization of the whole Valley.
- The percentage of population served which stands at 87% at present, is taken to be 100% from the year 2001.
- Groundwater sources and other sources, such as ponds, wells etc. have not been considered to be significant enough to influence the scenario.
- Assumed values of leakage of 20-25 % are significantly lower than the values seen in developing countries (Refer Table E3 of Appendix E).

The demand-supply lines shown in Fig. 5.5 result in the following deductions-

- Even in 2010 when there are additional supplies both from small projects and Melamchi, demand is likely to exceed the net supply (which is obtained after deducting leakage). Water scarcity will prevail till the second phase (2017) of Melamchi Project.
- Even after the second phase (2017), though total water supply will exceed demand, but the net supply will supply demand for just three more years. Then after, water scarcity will continue, as net supply will be less than

demand except for a year or two at the completion of third phase (2024) of Melamchi Project.

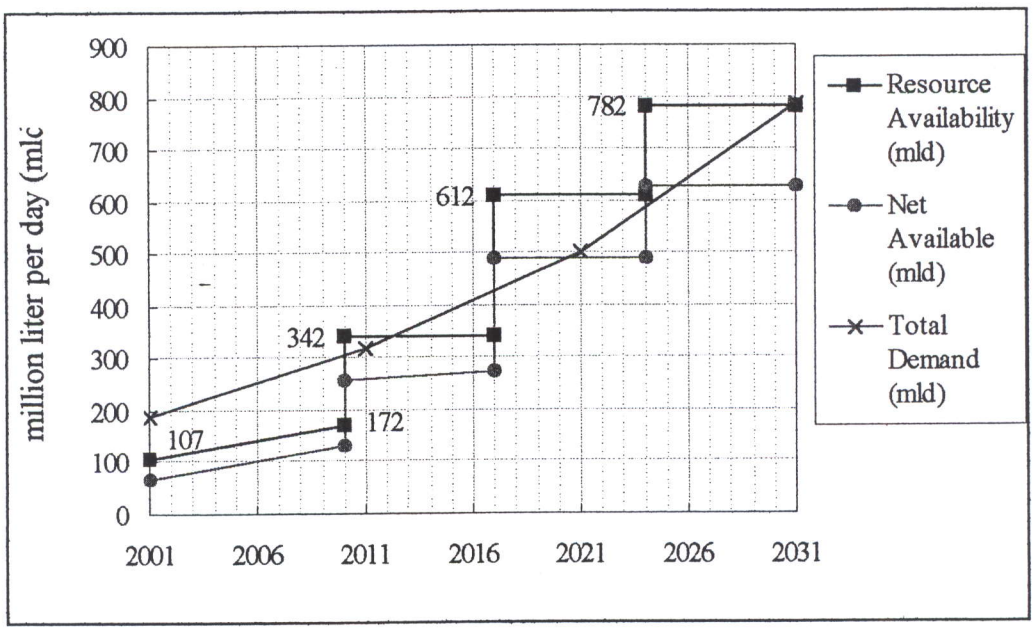

Fig. 5.5 Demand vs. Supply for Drinking Water

- By 2025, demand will continue to be more than supply in case of no additional projects. By 2025 or after the completion of the third stage of Melamchi Project, it is likely that the Valley would have a population more than 3 million. With about 625 mld of probable net available resources, the supply would be around 200 lpcd. Hence, for the water demand of 150 to 200 lpcd, the optimum population would be 4.5 to 6 million.
- In 2031, demand is likely to coincide with the total supply, but even with a moderate leakage value of 20 %, net supply will drop around 625 mld which would mean a deficit of more than 150 mld.
- The scenario is not promising despite high hopes on Melamchi. The point to note is the low assumption of leakage in the future which in itself is ambitious. Assumed values of 20-25 % are significantly lower than the values that are seen in developing countries which show a proportion of 32-65 % of unaccounted-for water (refer Table E3 of Appendix E). So in case of not limiting the leakage value, the scenario will only become too worse.

In short, the dream of Melamchi Project to provide sufficient water to foreseeable future is too much of an asking. The cat-and-mouse race between

supply and demand will continue, with demand having the upper hand. However, the scenario can be improvised only if water demand could be controlled and other water supply projects could be identified. At the same time, large-scale projects like Melamchi cannot be introduced again and again since that affects equitable distribution of development funds though out the country.

There is a growing concern about the cost of water too. Though it is natural that price of water will increase significantly after the Project, authorities claim it still will be affordable. According to Sōm Nath Poudel[44], Deputy Team Leader, Project Management Consultant, Melamchi Water Supply Project, the average tariff level after Melamchi Project is estimated to be NRs. 26-28 per cubic meter, which means a medium income family with an average of 5 members would have to pay approximately Rs. 560 as a normal monthly tariff for their water consumption.

The technical solution to prolong the carrying capacity of the Valley in terms of water supply includes measures such as quest for small-scale water supply projects, minimization of use of water in domestic as well as non-domestic sectors, recycling of water, and so on. But the main guiding factor is again the population. Once the Melamchi Project starts delivering, long-term migration which was discouraged by the water scarcity problem in the Valley, will again rejuvenated. More restaurants and hotels will open since the Valley is ideal for tertiary economic activities based on tourism above all. So the technical solution will not be enough to solve the water problem of the Valley.

5.3.4 Strategies for Urban Growth Management

As the growth of cities is viewed as healthy from economic point of view, and it is natural process too. The carrying capacity of the urban area is a directive indication of the future scenario and the strategies to be adopted to regulate growth and confine it to a manageable limit. The manageable limit is not static; it varies depending upon the resources and capability of the city.

The carrying capacity analysis for the Valley shows an urgent need in the planning of the Valley to avoid any saturation in near future. The criteria of physical space indicate symptoms of saturation within the next five to six

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[44] appeared in the official website of Melamchi Water Supply Project http://www.melamchiwater.org <2002.12.02>

decades if a gross density of 200 to 300 ppha is to be adopted and at the same time, 60 % of the Valley area is to be preserved as green area. Likewise, the drinking water has long shown symptoms of saturation, and the still worse, the Melamchi Project will help little to improve the situation since water supply will largely be below demand.

Strategies for the Valley should be based on such threshold scenario. Physical space limitation and water-related realities are the important guiding factors. Accordingly, the following strategic recommendations are put forth (Table 5.8)-

Table 5.8 Strategic Recommendations for the Urban Expansion of the Valley

S.N.	Strategies	Level of Significance		
		National	Valley	Municipal
1	Define and empower the Kathmandu Valley	•	•	
2	Prepare directional land-use map		•	•
3	Building regulation		•	•
4	Empower municipalities	•	•	•
5	Promote quality and not quantity of migrants		•	•
6	Promote infrastructure-guided development			
7	Promote water as social, but not free-for-all commodity		•	•
8	Promote growth of towns outside the Valley	•	•	
9	Generate public awareness on population growth and urbanization	•	•	•
10	Add transparency to planning procedures of the Valley	•	•	•

Note- Level of significance is the scope of the given strategies in terms of their implication, implementation and responsibility of HMG, the proposed body for the Valley and municipalities.

1. Define and empower the Kathmandu Valley

Definition

It is the long felt necessity that the Valley be treated as a single planning unit. Though there are five cities in the Valley, no city can be planned in isolation because of the influence of other cities in the neighborhood. Despite this, till now, no clear-cut definition of the Valley boundary has been come out. Definitions have been based on watershed boundary, and administrative boundary of the surrounding VDCs. Some studies include the VDCs excluded by others. The

physical boundary of the Valley should be defined formally and clearly so that studies carried out on the Valley which have to deal with the area, population and resources of the Valley, be more rational and scientific. Without clear demarcation of the boundary, it is not possible to find a clear picture of the trend of population growth, and migration flow.

Empowered Governing Body

Despite the need of an integrated planning action for the Valley, the main responsible planning authority, the Kathmandu Valley Town Development Committee (KVTDC) has not been adequately empowered both legally and technically. After the formation of municipalities, the KVTDC should have played the role of the coordinator among the municipalities which themselves do not have enough planning capability and experience. There is no doubt that the Valley needs a strong empowered planning organization, but first the Valley itself needs to be recognized as an administrative territory. Politically its people are jointly represented by the elected Mayors, the Member of Parliaments (MP), and District Development Committee (DDC) chairpersons to include representation of rural areas as well. In developmental aspect, the Valley should be a joint venture between HMG, municipalities and the DDCs. So instead of limiting the proposed organization as an advisory, it should be developed as a governing body with representation from all the major stakeholders of the Valley- HMG, municipalities, DDCs, MPs, select intellectuals, private parties as developers etc. Its main objective should be to formulate the Valley level plans and policy, make them realize through municipalities, and also integrate the local plans made by municipalities. The issue of population in the Valley needs such collective effort.

2. Prepare directional land-use map

Land-Use Map

The problem with the earlier land-use maps was that the maps were much detailed, laboriously prepared, costly in terms of time and cost, and in the end, not implemented. Nevertheless, importance of land use map is not challenged despite its failure in Nepal. Learning from the past experiences, instead of making much detailed land use maps, directional maps should be prepared in the

Valley level. The map should clearly indicate-

i. Development Restriction Area (agricultural, forest preserved areas)
ii. Development Promotion Area (largely non-built up areas suitable for urban development where large scale planning can be carried out)
iii. Development Coordination Area (already built up areas, including the urban cores, where development cannot be carried out in large scale)

The Development Promotion Area can further be categorized according to the desirable population density which can later be interpreted in terms of Floor Area Ration (FAR) by municipalities. Development can be introduced in time phases and accordingly, density can be gradually increased.

The land use map should also include regionally important infrastructures, such as road layout, water supply lines, sewerage network, electric and telephone lines etc. Then after, the municipalities will prepare a more detailed land use maps based on this directional map. With the guideline on population density, the municipalities can determine how many people they can optimally place within their territories.

For the Development Coordination Area, the municipalities work directly since the planning works in such areas mainly deal with urban renewal and rehabilitation works. But such areas are sensitive since they provide less room for adjustments and may be more costly in unit cost. Moreover, these areas are vital if redistribution of population density is to be considered. Population density in the core areas is excessive, leading to slum conditions. There is need to move some part of the population out from the core to the neighborhood to improve the built-environment of the Valley.

3. Building Regulation

Land

The minimum plot size has been defined as two-and-half *anna* which is approximately 80 sq. m. Ironically, this minimum size has become the basis for land subdivision with people attracted towards building houses on individual small parcel of land because of affordability. Whereas large-capacity housing lots are still in the developing process in the Valley, people tend to like individually made houses. To discourage people from buying small affordable pieces of land in the Valley, the minimum plot size should be revised and

increased.

Community housing or apartments buildings tend to be more economical in terms of time saving also. But for the people, land is more of a psychological and sentimental commodity rather than a commercial commodity. So the issue of ownership of land is vital for the people. Owner-built houses cannot be discouraged altogether because of the sentimental attachment with the land, particularly in the case of indigenous people of the Valley who want to move from one place to another within the Valley. But at the same time, migrants into the Valley do not have sentimental linkage with the soils of the Valley. So they can be lured towards the apartment buildings. Adequate taxation should be imposed on buying and selling of land so as to discourage new owner-built houses. At the same time, to respect the natural sentiments of the indigenous people, tax should not be high in the case of land transfer within the family.

Building Permits

Construction of buildings in the municipalities requires building permits. Only in Kathmandu and Lalitpur, the building permits are detailed. The neighboring VDCs of the municipalities enjoy the urban services but are not bothered so much by the building permit regulations of the municipalities. Because of this reason, new houses are being built immediately outside the municipal boundary. Ease of building construction in the Valley is an invitation to even not-so-serious migrants who happen to have sufficient money to build a house in the Valley. To discourage this trend, equally detailed building permit regulations should be made effectively throughout the Valley. Even in the rural areas, construction of permanent buildings should be made compatible to building regulations. Responsibility to check building construction in the neighboring VDCs can be handed over to the related municipality since VDC offices do not have adequate technical capability to undertake such assignment.

Building regulations not only include legal permits. It also includes provision for safety and proper construction practice. This is vital considering the seismic vulnerability of the Valley. Currently, in municipalities, for safety matters, structural drawings should be provided to obtain building permits for the buildings covering 1000 sft or more, or higher than 3 stories. Such structural drawings just largely serve the legal formality. The process of building permits

should be technically sound. Just satisfying the requirements of FAR, setback or ground coverage will not ensure planned development. Each house should be carefully designed through registered professionals, and safety details should be furnished, even if this means increase in cost and money. The need is construction of quality buildings, not just more buildings.

4. Empower municipalities

Municipalities are the main key players in the development of the Valley since they are the local governments, formed under public mandate. These bodies have been formed under Local Self-Governance Act 1998 with the aim of devolution of power from the center to the local level. The experience of the past, however, has shown that the performance of these bodies could not live up to expectation because of their dependency on HMG for financial resources as well as urban development programs.

Learning from the past, it is the need of time to empower municipalities so that they can undertake their challenging responsibilities effectively.

Planning

The municipalities should be able to add details on the Valley-wide directional land use map. Each municipality should come up with detailed building ordinance. The land use map should be interpreted in terms of FAR, ground coverage requirements. The municipalities should be able to regulate growth in their territory, but in harmony with the overall Valley environment.

Urban Services

The urban services in the municipal area should be provided through the municipalities. It is true that the municipalities have no investment in the state-owned infrastructures, such as road, electrification, water, sewerage etc. But the level of service of these infrastructures has largely been less than satisfactory and even for the Government, the cost-recovery has been difficult because of poor management. So the municipalities should be invited as the channel between the services and the consumers. Not all the municipalities are capable of undertaking this kind of responsibility, and hence municipalities such as Kathmandu and Lalitpur should come out first. In this way, the municipalities

should be more responsible towards the people, and the aim should be to provide guaranteed service though at a cost higher than the prevailing one. Urban people should be ready to pay for the services they consume provided that the service is adequate and regular. This may mean high cost but it is necessary to maintain developmental level. Migration towards cities may be regulated. The adverse effect of high social cost on urban poor may be neutralized by social welfare programs which the local governments can carry out.

Development Tax

In order to increase the financial resources and to make the citizens more responsible towards the developmental efforts, municipalities should impose development tax to the formal as well as informal sectors. The informal sector should be brought within the framework of tax though registering them and providing suitable place and schedule for their operation. This will be instrumental in controlling the number and scope of the informal sector workers. Furthermore, foreigners working in the Valley should be registered for working permit and tax should be charged for the use of urban services.

Expansion of Municipal Area

Already congested municipalities like the Kathmandu Metropolitan City (KMC) and Lalitpur Sub-Municipality require additional area to manage their population concentration. This can be done by incorporating the neighboring VDCs which have already experienced urbanization.

While declaring municipalities, only the population criterion is not enough. There should be a definite criteria on the level of urban service that can be provided, the range and adequacy of economic activities to suit urban environment, road network and transportation facilities etc.

5. Promote quality and not quantity of migrants

Cities are defined as the engine of growth. Migrants play an important role in creating vibrant economy in the urban areas. The main concern is to limit the number of migrants, but at the same time, exploiting their capabilities to contribute to the economic development of the cities.

Study of migration and daytime population

There has been no scientific record-keeping on the migrants who enter into the Valley. It is necessary to have details on migration so as to formulate plans in municipal and Valley level. Such details should include the number of migrants in a month, nature of migration (long-term, short-term), purpose, place of origin and destination, the economical, educational and social background of migrants, nature of their engagement in the city etc. Furthermore, the database should also include the foreigners- especially the job seekers from the neighboring countries. Such study will help formulate policy to regulate migration into the Valley.

Daytime population of leading cities tends to be significant as compared to the basic population. Within the Valley, the daytime population of the Kathmandu City is observed to rise significantly. The daytime population puts additional pressure on the limited urban services. The record of daytime population will assist in planning relocation or distribution of service centers which attract a large number of people during the office-hours.

Non-labor- intensive economy

Labor-intensive economic activities invite large number of migrants which lack skills for alternate works. They form informal sector, and contribute to increase the volume of urban poor because of lack of adequate jobs. Since the Valley is not suitable for industrial establishments, but still has to have strong economic base, service-led tertiary economic activities, such as professional services, information technology (IT) etc, as well as traditional skill-based occupations. Such strategy will invite educated, skilled migrants, and reduce the flow of non-skilled ones. However, some informal sector is still required which can be absorbed in the construction industry. The strategy is to increase quality of the migrants, not their quantity.

Relocation of "magnets"

A survey conducted in 1996 revealed that 41% of the urban population consisted of lifetime migrants; among them 45.6 % were farmers prior to migration, 19.6% were students and 15% were service holders (CBS 1997 as quoted in MOPE et. al 2001). The pulling factors for the long-term migration in the Valley are

undoubtedly the Government and other offices, and educational institutions. To substantially control migration into the Valley, such 'magnets' are required to be shifted outside the Valley.

There are a number of state-run colleges in the Valley providing affordable education to many students. But the majority of the students in such colleges are from outside the Valley. So it is the financial burden for the students too to come and study at a distant place. Also, there are many government colleges with the same curriculum. So a study should be carried out to list possible relocation of some of the colleges to cities outside the Valley. Furthermore, some government colleges have been providing cheapest lodging and fooding facility, which have unnecessarily attracting youth from the corners of the country. Not only for the better quality of education, government colleges in the Valley should be qualitative, not quantitative. Similarly, from the private sectors also, many institutes offering more or less similar curriculum are established inside the Valley turning the Valley as an educational area. Promoting the Valley as an educational area has never been recommended in the previous studies too since it would attract unnecessary migration as well as disturb equitable distribution of educational opportunities across the country.

A similar approach should be taken for the Government offices too. The branch offices of all major state offices should be opened across the country and be linked with the headquarters in the capital which is now possible through internet and computerized networking. This will prevent people from going to the Valley to have their works done in the Government offices.

As for the private offices and institutions, their location should be guided by the land use map prepared in the municipal level. The municipalities should decide if they need more offices, schools and colleges in their territory.

Informal Sector

Many migrants do not have urban skills and so end up in the informal sector. There are wide range of skill-free jobs in the informal sector, and such migrants tend to assist other migrants to come. Many of such migrants work as labors, street-vendors, conductors in the vehicles, and so on. The scope of the informal sector should be limited. For instance, allowing certain places at certain times for street-vendors and banning other places altogether for such activities will limit

the scope of street vending. Similarly, removal of small-capacity buses out of the Valley will reduce the number of children workers who migrated to the Valley at very tender age.

Foreign Employment

Earnings thought remittance has been a sound support for the national economy. Foreign employment for skilled and semi-skilled people from undeveloped parts of the country has been vital for the economic upliftment of the poor societies. The Government should encourage and promote foreign employment with due attention to their welfare aboard through embassies. Such foreign employment eases up pressure of internal migration to the cities, assists directly to poverty alleviation as well as refines skill of the rural people.

6. Promote infrastructure- guided development,

Planned urbanization process in the form of Guided Land Development (GLD), site and service, and land-pooling, has mixed results in the Valley in the scale of success. Despite some failure has been observed in such endeavors, their importance is nevertheless reduced. So learning from the managerial and operational mistakes, in every Development Promotion Area, land management programs should be launched. The current practice of development taking place before the provision of infrastructures should be stopped. First there should be infrastructure-layout, then only the construction of buildings should be allowed. This will also reduce the mushrooming of new buildings in the areas where urban services have yet to reach properly. Infrastructures should be the tool to check urban growth.

7. Promote water as social, but not free-for-all commodity

Water is a social commodity, not a commercial one. But the gap between the social and commercial image of water is getting narrower as water is becoming scarcer. After the implementation of the Melamchi Project, the 'social' past of water supply has to be forgotten since privatization of water supply has been initiated as per the condition of donor agencies behind the Melamchi Project. Under the new circumstance with urban population consuming 'private' water, it will not be unrealistic if water is used as a tool for regulating urban growth.

However the water as a social commodity cannot be ignored. To ensure that the people are not made pay for the donor-driven interests, municipalities should be involved in the distribution of water even if the Central Government is to quit altogether.

The high cost of Melamchi water will still be welcomed if the service has no flaw. But nevertheless, the high cost of water will have multiple effects on other costs, and so it can be assumed that the overall living expense in the city will rise. The urban residents should be able to pay the cost for living in the urban area which is a dream shared by so many rural people across the country. The privilege of living in a place like the Kathmandu Valley should not come cheap. This will ensure that only serious long-term migrants will want to settle in the Valley. However, the municipalities should take care that water does not become a total commercial product. Water supply through public taps and tanks should be made available to the people with poor economic condition. Even for those who can afford, the water tariff should be reasonable so that people do not cut other essential expenses, for example health, education etc., for the sake of water.

8. Promote growth of towns outside the Valley

Migration into the Valley cannot be controlled or limited without providing a good alternative to the aspiring migrants. Not only to reduce migration pressure on the Valley, but for the regional development of the country, it is necessary to promote growth of urban centers outside the Valley. Development of towns outside the immediate boundary will have two positive impacts- firstly, the towns will absorb the short-distance migrants by providing opportunities nearby, and secondly the towns will trap the long-distance migrants from entering into the Valley. Already the Valley has four municipalities in its immediate surrounding- Banepa, Dhulikhel, Panauti and Bidur municipalities. The municipalities of the Valley should co-act with these municipalities to have development linkage. For instance, the four municipalities can be the supplier of vegetable and milk products in the Valley. If worked together, there can be a good market for the surrounding towns in the Valley. Likewise, growth of emerging cities like Bharatpur, Birgunj, Hetauda will also help divert migration away from the Valley.

9. Generate public awareness on population growth and urbanization

Education among the urban population is high, and hence public awareness in social issues is also significant. The same cannot be said about the rural areas where still people are largely uneducated. The Kathmandu Valley has still many villages where the ill-effects of high population growth are not well-understood. So awareness programs for small manageable family size should be launched with special focus on the surrounding VDCs of the Valley.

Similarly, the urban and semi-urban population also need education- not so much on population growth, but on urbanization issues. There are issues such as construction practice, unregulated urbanization, seismic risks etc., which at first may sound technical but these are very much rooted into the practicability of urban life.

10. Add transparency to planning procedures of the Valley

After the achievement of People's Movement of 1990, public participation and concern on the issues related to them have surface more prominently. In the past, many plans for the Valley have been formulated, but the public knew little or none. But now, public participation is a must in the planning process, and the public have been recognized one of the major stakeholders.

Plans should be demand-driven. They should be prepared by a competent technical team. But as the plan starts to take a visible shape, the developments should be put forth in front of the public for their comments. Public participation can be arranged through various channels, such as newspapers, electronic media, stakeholders' meetings, or interaction in the ward-level. After the plan becomes definite in terms of its contents, the results should be made public since everybody cannot be made satisfied, and even the dissatisfied portion of the public may have some thing important to say. The aim of providing transparency to the planning process is to ensure success in implementing the plan. It will also involve them in 'their' plan. It is particularly important to note the differences in opinion between what the indigenous people of the Valley and the migrated ones.

CHAPTER VI
CONCLUSION

6.1 Conclusion

The carrying capacity analysis reveals the fact that the Valley is fast approaching its threshold to accommodate increasing number of inhabitants. Pressure of infrastructure demand has always existed, but that also has not stopped the high rate of urbanization. Waiting for the hopeful scenario, the octopus-growth continues with more buildings coming up even where there is no provision of urban infrastructures. Though it is the duty of the state and the local governments to provide services to the population, the situation should be considered logically and reasonably. Because of the poor economic condition of the country, great expectations cannot be fulfilled. The reality should be accepted that factors like physical space and drinking water, among all other requirements, are acting to limit the potentiality of the Valley as a settlement, and the capacity of the Valley should not be exploited since it would mean painful living for the people without the sense of decent and safe living.

However, the carrying capacity analysis should not be considered as "negative" planning. There is little argument about the need of urbanization for the economic upliftment of people. The aim of calculating the capacity is to know the future scenario of the Valley so that necessary steps can taken beforehand to prolong the capacity, and look for alternate measure before the threshold situation is arrived at. Thinking beforehand about the future possibilities is the core of any planning activity, and it is most required in the case of the Valley.

The Melamchi Project has been portrayed as something close to "lifesaver" for the Valley. But planning should be based on raw facts, not dreams. Just like the Valley has physical limitations to grow in the long run, the Melamchi Project also has its service limitations. The need is to control population growth in the Valley, giving main focus on the in-migration. Unless it is done effectively, the Valley would need not one but many projects like the Melamchi which is not possible. Planning strategies should be based on the ground realities, and hence the carrying capacity analysis cannot be ignored though it tends to be more theoretical.

To make the Valley as a leading region of the country, it should be healthy, and it

should have healthy growth. Migration should contribute to the economic prosperity of the region, and not create parasites on the scarce urban resources. Planning for the Valley is important for the whole country, and hence the planning process should be serious enough though unpleasant decisions have to be made at times.

The Valley has been studied again and again, so its situation is not unknown. The vision is always for a hopeful scenario, but various uncertainties and limitations have to be crossed over to reach the stage of livable Kathmandu Valley. There should be enough courage to plan amidst the most unpleasant possibilities. The threshold approach of planning based on the carrying capacity of the Valley is one such step.

6.2 Further Research

Planning is a continuous process. For a place of high importance and wide range of complexities, the Valley needs to be continuously studied to realize the vision of economically vibrant livable Kathmandu Valley. For this, the following topics can be recommended for further research-

- Carrying capacity of the Valley in terms of other sectors, such as sanitation, transportation etc.
- Infrastructures and policy requirements to promote service-based tertiary economic activities that could form a sound economic base for the Valley.
- Growth policy for the towns outside the Valley and their impacts (positive and negative) on the urbanization of the Valley
- Participation of private parties in the planned urbanization of the Valley

Since the Valley has been studied many times under different themes and objectives, subsequent attempt should be made to utilize the findings of the earlier studies.

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APPENDICES

APPENDIX A: POPULATION

Table A1 Population of VDCs/ Municipalities of the Valley Districts (2001)

S.N.	VDC/Municipality	Population (2001)
Kathmandu District		
1	Aalapot	2884
2	Baadbhanjyang	3286
3	Bajrayogini (Sankhu)	3880
4	Balambu	5164
5	Baluwa	4245
6	Bhadrabas	2139
7	Bhimdhunga	2622
8	Budanilkantha	10636
9	Chalnakhel	3636
10	Chapali Bhadrakali	4544
11	Chhaimale	4142
12	Chouketar Dahachok	3860
13	Chunikhel	3878
14	Daanchi	7676
15	Daksinkali	4427
16	Dhapasi	11618
17	Dharmasthali	4688
18	Futung	3125
19	Gagalphedi	5229
20	Gokarneshwor	4464
21	Goldhunga	6967
22	Gongabu	20848
23	Gothatar	8269
24	Ichangu Narayan	7694
25	Indrayani	2958
26	Jhor Mahankal	3619
27	Jitpurphedi	4757
28	Jorpati	41262
29	Kabhresthali	3546
30	Kapan	15340
31	Kathmandu Metropolitan City	671846
32	Khadka Bhadrakali	5539
33	Kirtipur Municipality	40835
34	Lapsephedi	5603
35	Machhegaun	2871
36	Mahadevsthan	7908
37	Mahankal	6808
38	Manamaiju	10959
39	Matatirtha	3653
40	Mulpani	5880
41	Naglebhare	4656
42	Naikap Nayabhanjyang	4425
43	Naikap Puranobhanjyang	3456
44	Nayapati	5228
45	Pukhulachhi	2746
46	Ramkot	6517

47	Sangla	3226
48	Satikhel	4328
49	Satungal	5834
50	Seuchatar	6628
51	Sheshnarayan	3428
52	Sitapaila	9594
53	Sundarijal	2499
54	Suntol	4417
55	Talududechour	2736
56	Thankot	8583
57	Tinthana	5992
58	Tokha Chandeshwori	3542
59	Tokha Saraswoti	2681
	Total of Kathmandu	**1063821**
Bhaktapur District		
1	Bageshwori	5013
2	Balkot	7454
3	Bhaktapur Municipality	72543
4	Changunarayan	5858
5	Chhaling	7674
6	Chitapol	5497
7	Dadhikot	7244
8	Duwakot	6290
9	Gundu	5757
10	Jhaukhel	6678
11	Katunje	13043
12	Madhyapur Thimi Municipality	47751
13	Nagarkot	4247
14	Nankhel	5213
15	Sipadol	7004
16	Sirutar	4532
17	Sudal	7053
18	Tathali	5652
	Total of Bhaktapur	**224503**
Lalitpur inside the Kathmandu Valley		
1	Badikhel	3212
2	Bhardev	2068
3	Bisankhunarayan	4526
4	Bungmati	5667
5	Chapagaun	12448
6	Chhampi	4192
7	Devichour	2734
8	Dhapakhel	6345
9	Dhusel	1589
10	Dukuchhap	2501
11	Godamchaur	4459
12	Godawari	6257
13	Harisiddhi	5939
14	Imadol	9615
15	Jharuwarasi	3662
16	Khokana	4542
17	Lalitpur Sub-Metropolitan City	162991
18	Lamatar	7572

19	Lele	7921
20	Lubhu	7610
21	Nallu	2165
22	Sainbu	8337
23	Siddhipur	5566
24	Sunakothi	6199
25	Thaiba	6308
26	Thecho	8020
27	Tikathali	5439
	Total of Lalitpur inside the Valley	**307884**
Lalitpur outside the Valley		
1	Ashrang	1536
2	Bhattedanda	2339
3	Bukhel	1847
4	Chandanpur	1223
5	Choughare	1925
6	Dalchoki	1319
7	Gimdi	2525
8	Gotikhel	2059
9	Ikudol	2133
10	Kaleshwor	1618
11	Malta	2130
12	Manikhel	1981
13	Pyutar	1903
14	Sankhu	2394
15	Thuladurlung	1811
	Total of Lalitpur outside the Valley	**28743**
Source: CBS (2002)		

Table A2 Population of Districts within the Kathmandu Valley

Census Year	Kathmandu [a]			Lalitpur [b]			Bhaktapur [c]			Kathmandu Valley [d]		
	Urban [e]	Rural [e]	Total	Urban [e]	Rural [e]	Total	Urban [e]	Rural [e]	Total	Urban [e]	Rural [e]	Total
1981 [h]	259,185	163,052	422,237	79,875	94,087	173,962	74,548	69,872	144,420 [c]	413,608	327,011	740,619
1991 [h]	452,596 [f]	222,745 [f]	675,341	115,865	114,751	230,616	93,375	79,577	172,952	661,836	417,073	1,078,909
2001	712,681	369,164	1,081,845	162,991	144,893 [g]	307,884	120,294	105,167	225,461	995,966	619,224	1,615,190
2001 [P]	767,567	298,146	1,065,713	163,923	137,696	301,619	114,695	89,656	204,351	1,046,185	525,498	1,571,683
Diff. in projection for 2001 (%)	7.2	-23.8	-1.5	0.6	-5.2	-2.1	-4.9	-17.3	-10.3	4.8	-17.8	-2.8
2011 [P]	1,057,582	312,395	1,369,977	229,852	157,881	387,733	155,328	107,366	262,694	1,442,762	577,642	2,020,404
2021 [P]	1,439,328	321,784	1,761,112	319,655	178,777	498,432	209,921	127,773	337,694	1,968,904	628,334	2,597,238
2031 [P]	1,937,756	326,161	2,263,917	440,882	199,854	640,736	283,062	151,045	434,107	2,661,700	677,060	3,338,760
1981-91	5.73	3.17	4.81	3.79	2.01	2.86	2.28	1.31	1.82	4.81	2.46	3.83
Growth Rate 1991-2001(actual)	4.64	5.18	4.82	3.47	2.36	2.93	2.57	2.83	2.69	4.17	4.03	4.12
Growth Rate 1991-2001 [P]	5.42	2.96	4.67	3.53	1.84	2.72	2.08	1.20	1.68	4.69	2.34	3.83

Source: CBS 2000, KVTDC 2000,2002

Note:

1. Entries with explanation are underlined. Bold letters indicate projected values in KVTDC (2000,2002); see [P].
2. [a] All VDCs of Kathmandu lie within the Valley.
3. [b] The population of Lalitpur district in the Valley is less than that mentioned in the census because some VDCs of Lalitpur district lie outside the Valley
4. [c] All the VDCs of Bhaktapur district lie inside the Valley. The difference in the population of Bhaktapur district in 1981 and corresponding CBS data is because three VDCs, Tikathali, Lubhu and Lamatar, are included in Lalitpur from Bhaktapur to facilitate comparison as these VDCs were incorporated in Lalitpur in 1991 Census.
5. [d] The geographical boundary of the Kathmandu Valley is defined by the Shivapuri mountain range in the north, Nagarkot in the East, Phulchoki range in the southeast, Lamdada in the south, and Bhim Dhunga and Nagarjun range in the west. The Valley includes 5 municipalities, and 99 VDCs including all 57 of Kathmandu, all 16 of Bhaktapur and 26 VDCs of Lalitpur.
6. [e] The urban population is considered those living within the municipalities whereas the rural population is considered as those living outside the municipalities.

7. [f] Combination of population of KMC (421258) and Kirtipur Municipality (31338) as per National Census 1991 (CBS 2000). Rural population is obtained by deducting urban population from the total since all the VDCs of Kathmandu District fall within the Valley boundary.
8. [g] derived from the population figures of the 26 VDCs of Lalitpur from the VDC Sample Survey of National Census 2001 (CBS 2000) (Refer Table A1)
9. [h] Though Kirtipur Municipality was formed only in 1996, its population has been included in the urban population of Kathmandu district to facilitate comparison, for both 1981 and 1991. For similar reason, population of Madhyapur Thimi Municipality is included in the urban population of Bhaktapur district for 1981 and 1991
10. [p] Projected values in HMG/KVTDC 2000,2002. Explanation on projection methodology includes-
    A) The period 1981-1991 is taken as the base period for the estimation of birth and death rates.
    B) Migration from outside to the Valley is calculated to be 13.32 % and kept constant throughout the projection period
    C) Projected district level population is adjusted by ± 1.5% in order to confirm to the Valley wide total projected population
    D) In order to make adjustment with the projection of the rural and urban population of the Valley, alteration of ± 0.2-3% and ± 0.4-7.5% have been made in the urban and rural areas respectively; longer the projection period, higher the adjustment margin.
    E) Total (rural +urban) annual growth rate of 2.54 is assumed

Comparison of projected values for 2001 with that of census data, show that total population for the Valley exceeds the projected value. Certain significant errors are also observed, for instance, the rural population of the Valley in 2001 already exceeds the projected value for 2011.

Table A3 Projected Population of Districts within the Kathmandu Valley

Census Year	Kathmandu			Lalitpur			Bhaktapur			Kathmandu Valley		
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
Population Composition (%)-												
2001	65.88	34.12	100.00	52.94	47.06	100.00	53.35	46.65	100.00	61.66	38.34	100.00
2011[e]	77.20	22.80	100.00	59.28	40.72	100.00	59.13	40.87	100.00	71.41	28.59	100.00
2021[e]	81.73	18.27	100.00	64.13	35.87	100.00	62.16	37.84	100.00	75.81	24.19	100.00
2031[e]	85.59	14.41	100.00	68.81	31.19	100.00	65.21	34.79	100.00	79.72	20.28	100.00
Population-												
2001	712,681	369,164	1,081,845	162,991	144,893	307,884	120,294	105,167	225,461	995,966	619,224	1,615,190
2011[P]	1,073,245	317,022	1,390,267	234,550	161,108	395,658	171,318	118,419	289,737	1,479,113	596,549	2,075,662
2021[P]	1,460,172	326,444	1,786,616	326,084	182,372	508,456	231,457	140,881	372,338	2,017,713	649,697	2,667,410
2031[P]	1,965,183	330,778	2,295,961	449,604	203,807	653,411	312,001	166,487	478,488	2,726,788	701,072	3,427,860

Source:
2001 population from CBS (2002), HMG/KVTDC (2000,2002)

Note:
- [P] Projected, [e] Estimated
- Total population (urban+rural) is population at the rate of 2.54 per annum over the previous census year. Breakdown of rural and urban is based on the estimated percentage share of rural and urban areas as per HMG/KVTDC (2000,2002)

Table A4 Population of KMC Wards (1991)

Ward No.	Area (ha)	No. of Households	Population	Population Density(ppha)
1	138.4	1555	8731	63.09
2	81.3	1804	9163	112.71
3	329.7	2756	14347	43.52
4	324.1	3086	15337	47.32
5	79.0	1691	8646	109.44
6	366.8	3292	17509	47.73
7	153.5	3810	19797	128.97
8	253.8	1607	7756	30.56
9	301.9	3209	16516	54.71
10	156.8	3375	16000	102.04
11	183.9	1814	10055	54.68
12	51.0	1774	9940	194.90
13	213.3	2774	14746	69.13
14	302.9	3655	18425	60.83
15	316.5	3838	19627	62.01
16	437.4	4121	21286	48.66
17	65.7	2263	11605	176.64
18 [cc]	18.9	1428	8081	427.57
19 [cc]	15.5	1284	7588	489.55
20 [cc]	15.7	1702	8920	568.15
21 [cc]	15.4	2343	12383	804.09
22 [cc]	18.8	1288	7884	419.36
23 [cc]	10.2	1580	8711	854.02
24 [cc]	8.9	1044	6288	706.52
25 [cc]	10.3	954	5744	557.67
26 [cc]	4.0	766	4248	1062.00
27 [cc]	7.6	1417	8112	1067.37
28 [cc]	6.8	845	5077	746.62
29	218.6	3885	19179	87.74
30 [cc]	25.4	1974	11079	436.18
31	103.7	2260	12455	120.11
32	128.0	3339	14613	114.16
33	85.7	3636	17025	198.66
34	232.1	3375	16000	68.94
35	395.0	2532	12000	30.38
Total	5076.6	82076	424873	83.69

Source: as quoted in Burathoki (2001)

Note:

[cc] City Core

The total ward population deviates slightly from census data because population figures for wards 34 and 35, which were formed after the census, were general estimates

Table A5 Population of Municipalities of Nepal

Municipality	Census 1981	Census 1991		Census 2001				Population Growth		Ranking of City		
	Total Population	Household	Total Population	Area (sq. km)	Household	Total Population	Pop. Density (per sq. km)	1981-91	1991-2001	1981	1991	2001
Kathmandu Metropolitan City [v]	235160	81139	421258	49.45	152155	671846	13586.37	6.00	4.78	1	1	1
Biratnagar Sub Metropolition City	93544	24043	129388	58.48	33678	166674	2850.1	3.30	2.56	2	2	2
Lalitpur Sub Metropolitan City [v]	79875	20630	115865	15.15	34996	162991	10758.48	3.79	3.47	3	3	3
Pokhara Sub Metropolitan City	46642	20273	95286	55.22	37305	156312	2830.71	7.41	5.07	5	4	4
Birgunj Sub Metropolitan City	43642	11084	69005	21.17	19910	112484	5313.37	4.69	5.01	7	5	5
Dharan Municipality	42146	12549	66457	103.38	20428	95332	922.15	4.66	3.67	8	6	6
Bharatpur Municipality	27602	10918	54670	162.16	19922	89323	550.83	7.07	5.03	13	10	7
Mahendranagar Municipality	43834	9875	62050	171.24	13738	80839	472.08	3.54	2.68	6	7	8
Butwal Municipality	22583	9195	44272	69.28	16281	75384	1088.11	6.96	5.47	15	14	9
Janakpur Municipality	34840	9668	54710	24.61	13734	74192	3014.71	4.62	3.09	9	9	10
Bhaktapur Municipality [v]	48472	9187	61405	6.56	12133	72543	11058.38	2.39	1.68	4	8	11
Hetauda Municipality	34792	10420	53836	47.77	14271	68482	1433.58	4.46	2.44	10	11	12
Dhangadhi Municipality	27274	7240	44753	103.73	11738	67447	650.22	5.08	4.19	14	13	13
Nepalgunj Municipality	34015	8232	47819	12.51	10592	57535	4599.12	3.46	1.87	11	12	14
Triyuga Municipality	NA	7350	37512	319.88	10506	55291	172.85	NA	3.96	NA	17	15
SiddharthNagar Municipality	31119	6870	39473	36.03	9419	52569	1459.03	2.41	2.91	12	16	16
Mechinagar Municipality	NA	7077	37108	55.72	9926	49060	880.47	NA	2.83	NA	18	17
Madhyapur Thimi Municipality [v]	NA	5133	31970	11.11	9551	47751	4298.02	NA	4.09	NA	19	18
Gulariya Municipality	NA	5015	30631	95.14	7939	46011	483.61	NA	4.15	NA	21	19
Tribhuwan Nagar Municipality	20608	5235	29050	74.45	8945	43126	579.26	3.49	4.03	16	23	20
Lekhnath Municipality	NA	6165	30107	77.45	9362	41369	534.14	NA	3.23	NA	22	21
Itahari Municipality	NA	5135	26824	42.37	8624	41210	972.62	NA	4.39	NA	24	22
Kirtipur Municipality [v]	NA	5672	31338	14.76	9487	40835	2766.6	NA	2.68	NA	20	23

Tikapur Municipality	NA	3804	25639	67.11	6287	38722	576.99	NA	4.21	NA	26	24
Ratnanagar Municipality	NA	4578	25118	35.62	7456	37791	1060.95	NA	4.17	NA	27	25
Damak Municipality	NA	7644	41321	70.63	7178	35009	495.67	NA	-1.64	NA	15	26
Tulsipur Municipality	NA	4168	22654	92.22	7056	33876	367.34	NA	4.11	NA	31	27
Kamalamai Municipality	NA	4469	24368	207.95	6447	32838	157.91	NA	3.03	NA	28	28
Kalaiya Municipality	NA	3010	18498	18.98	5113	32260	1699.68	NA	5.72	NA	43	29
Birendranagar Municipality	13859	4773	22973	34.95	7139	31381	897.88	5.18	3.17	18	30	30
Rajbiraj Municipality	16444	4382	24227	11.96	5445	30353	2537.88	3.95	2.28	17	29	31
Putalibazar Municipality	NA	5160	25870	70.14	6675	29667	422.97	NA	1.38	NA	25	32
Byas Municipality	NA	3708	20124	60.02	6511	28245	470.59	NA	3.45	NA	36	33
Lahan Municipality	13775	3622	19018	20.23	5262	27654	1366.98	3.28	3.81	20	38	34
Kapilbastu Municipality	NA	3063	17126	37.2	4338	27170	730.38	NA	4.72	NA	46	35
Prithbinarayan Municipality	NA	4145	20633	60.28	5588	25783	427.72	NA	2.25	NA	33	36
Panauti Municipality	NA	3739	20467	31.73	5134	25563	805.64	NA	2.25	NA	34	37
Gaur Municipality	NA	3498	20434	21.53	3956	25383	1178.96	NA	2.19	NA	35	38
Siraha Municipality	NA	3832	21866	23.78	4314	23988	1008.75	NA	0.93	NA	32	39
Inaruwa Municipality	NA	3382	18547	22.36	4497	23200	1037.57	NA	2.26	NA	42	40
Ramgram Municipality	NA	3095	18911	34.72	3893	22630	651.79	NA	1.81	NA	39	41
Dipayal Silgadhi Municipality	NA	2330	12360	73.98	4203	22061	298.2	NA	5.96	NA	57	42
Jaleshwor Municipality	NA	2945	18088	15.49	3680	22046	1423.24	NA	2.00	NA	44	43
Bhimeswor Municipality	NA	4077	19261	65.04	4909	21916	336.96	NA	1.30	NA	37	44
Khandbari Municipality	NA	3769	18756	91.03	4624	21789	239.36	NA	1.51	NA	40	45
Bidur Municipality	NA	3736	18694	33.48	4234	21193	633	NA	1.26	NA	41	46
Baglung Municipality	NA	2940	15219	18.35	4847	20852	1136.35	NA	3.20	NA	51	47
Dhankuta Municipality	13836	3637	17073	48.21	4789	20668	428.71	2.12	1.93	19	47	48
Tansen Municipality	13125	2699	13599	21.72	4813	20431	940.65	0.36	4.15	21	54	49
Waling Municipality	NA	3145	16712	34.76	4292	20414	587.28	NA	2.02	NA	48	50

Narayan Municipality	NA	2907	15738	67.01	3854	19446	290.2	NA	2.14	NA	50	51
Malangawa Municipality	NA	2403	14142	9.39	3141	18484	1968.48	NA	2.71	NA	53	52
Amargadhi Municipality	NA	3092	16454	138.95	3538	18390	132.35	NA	1.12	NA	49	53
Dasharathchanda Municipality	NA	3412	18054	55.01	3481	18345	333.48	NA	0.16	NA	45	54
Bhadrapur Municipality	9761	2860	15210	10.56	3896	18145	1718.28	4.54	1.78	23	52	55
Ilam Municipality	9773	2718	13197	26.63	4007	16237	609.73	3.05	2.09	22	55	56
Banepa Municipality	NA	1956	12537	5.56	3015	15822	2845.68	NA	2.35	NA	56	57
Dhulikhel Municipality	NA	1624	9812	12.08	2255	11521	953.73	NA	1.62	NA	58	58
	Total	422427	2287487	3276.28	664507	3227879	985.23	NA	3.50			

Source: MOPE (2000), CBS (2000,2002)

Note:

municipality in the Kathmandu Valley

NA- not applicable since only 23 municipalities were declared at the time of 1981 census, which later increased to 58.

APPENDIX B: CITY DEVELOPMENT INDEX

The ADB's City Development Index ranks cities in the development spectrum and combines city product with infrastructure, waste management, health and education indicators. The CDI is calculated using the following formula-

CDI = (Infrastructure index + waste index + education index + health index + Product index) / 5

Infrastructure	25* water connections+25* sewerage+25* electricity+25* telephone
Waste	Wastewater treated* 50+garbage collection* 50
Health	(life expectancy-25)* 50/60+(32-Child mortality)*50/31.92
Education	Literacy*25+primary enrollment*25+ secondary enrollment*25+graduates /350
Product	((log internet+.71)/6.34) + log corporations/6.7+(log tourists-3.42)/5.75+(log flights-4.33)/5.27-0.07)/3.3

Source: ADB (2001) < http://www.citiesdatabook.org >

APPENDIX C: LAND USE

Table C1 Land Use of the Kathmandu Valley (2000)

S.N.	Land Use Type	Area (ha)	Percent (%)
1	**Agriculture** (predominantly used for agriculture and farming purpose)	**27570**	**41.4**
2	**Forest** (Exclusively forest, bush and grassland)	**20677**	**31.0**
3	**Non-agricultural** (other than above)	**18408**	**27.6**
3.1	Urban Area	(6915)	(10.4)
3.1.1	Residential	4829	7.3
3.1.2	Mixed residential- commercial (Predominantly commercial)	423	0.6
3.1.3	Commercial	19	0.03
3.1.4	Industrial	210	0.32
3.1.5	Institutional	518	0.77
3.1.6	Military	150	0.23
3.1.7	Public Utilities (water supply, drainage, power supply, solid waste management etc.)	28	0.04
3.1.8	Transportation (road network, public parking, transport facility area etc.)	310	0.47
3.1.9	Special area (Protected monuments, Royal Palace)	272	0.41
3.1.10	Recreational/Open Space (parks, stadiums, zoo, convention center etc.)	156	0.23
3.2	Rural Area	(10997)	(16.5)
3.2.1	Residential	2592.7	3.9
3.2.2	Rural settlement (traditional village settlement pockets)	8404.3	12.6
3.3	Water body (river systems, ponds or lakes)	(496)	(0.7)
	Total	66655	100.0

Source: HMG/KVTDC (2000)

APPENDIX D: SOLID WASTE

Table D1 Table Estimated Waste Generation in the Valley Municipalities

S.N.	Municipality	Population				Estimated Waste Generation (ton/year)			
		1971	1981	1991	2001	1971	1981	1991	2001
1	Kathmandu	150402	235160	421258	671846	60161	94064	210629	335923
2	Lalitpur	59049	79875	115865	162991	20667	27956	46346	65196
3	Bhaktapur	40112	48472	- 61405	72543	12034	14542	21492	25390
4	Kirtipur	20814	24025	31338	40835	6244	7208	9401	12251
5	Madhyapur Thimi	20640	26076	31970	47751	6192	7823	9591	14325
	Total	291017	413608	661836	995966	105298	151592	297459	453085

Source:
Population from Burathoki (2001), HMG/ KVTDC (2000), CBS (2000,2002), Solid waste estimation based on Mishra and Kayastha (1998) as quoted in MOPE et. al (2001)

Note:
Per capita municipal waste generation (kg/ person/day) as per Mishra and Kayastha (1998) as quoted in MOPE et. al (2001)-

Population size	
Less than 20,000	0.25
20,001 to 50,000	0.30
50,001 to 100,000	0.35
100,001 to 400,000	0.40
More than 400,000	0.50 kg/ person/day

APPENDIX E: DRINKING WATER

Table E1 Drinking Water Systems in the Valley

S.N.	System	Name of the Sources	Reservoir
1	Balaju (Tri Bhim Dhara Scheme)	Alleye, Boude, Bhandare, Panchmane, Chahare	Balaju
2	Bansbari	Bishnumati, Shivapuri	Maharajgunj, Bansbari
3	Sundarijal	Bagmati River	Sundarijal, Mahankalchaur
4	Bhaktapur	Mahadev Khola	Bansbari
5	Dudhpokhari	Dudhpokhari, Lunkot, Nakhu Khola	Sundarighat, Bhajangal
6	Sainbu (Pharping Scheme)	Satmul, Shes Narayan, Kutorimul	Shainbu
7	Chapagaun	Basuki Mul, Nallu Khola, Muldole pump, Charghare pump and Dhobighat water spout	Tahkhel

Source: HMG/MWSDB (1999)

Table E2 Supply from the Valley Sources over a Year

S.N.	System	Yield (mld)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Balaju	6	6	6	5	5	10	10	10	10	10	10	6
2	Bansbari	7	7	6	6	17	26	26	26	25	15	10	9
3	Sundarijal	40	26	22	24	25	43	43	43	47	43	41	41
4	Bhaktapur	4	3	3	3	3	4	4	4	4	4	4	4
5	Dudhpokhari	3	3	3	3	3	2	3	3	3	3	2	2
6	Sainbu (Pharping Scheme)	18	18	15	15	13	13	17	18	18	18	18	18
7	Chapagaun	6	6	6	5	5	6	7	7	7	7	6	6
	Total Surface Water (mld)	84	69	61	61	71	104	110	111	114	100	91	86
	Total Groudwater (mld)	17	19	26	26	21	7	9	8	4	13	15	16
	Total Water (mld)	101	88	87	87	92	111	119	119	118	113	106	102

Source: HMG/MWSDB 1999

Table E3 Deep Aquifer Depletion at Selected Locations during Dry Season in the Valley

Location	Previous Water Level (m)			Water Level (1999)		Decline (m)	
	Base Year	SWL	PWL	SWL	PWL	SWL	PWL
Bansbari	1997	48.08	67.60	80.63	136.14	32.55	68.54
Baluwatar	1976	FW	21.00	22.41	30.00	22.41	9.00
Pharping	1976	FW	25.00	13.00	44.00	13.00	19.00

Source: quoted in MOPE et al (2001)
Note: PWL= pumping water SWL= static water level FW=flowing well

Table E4 Water Consumption in the Asia-Pacific Region (1985)

Country	Actual water Consumption (lpcd)	
	Urban	Rural
India	107	40
Indonesia	150	60
Bangladesh	115	30
Thailand	100-150	50-80
Burma	70-110	30-45
Sri Lanka	200	70-170
Maldives	175	175
China	100-200	40-60
Philippines	155	50
Malaysia	230	120-160
Singapore	331	Not available
Samoa	350	300
Minimum necessary for a healthy life (World Bank)		30-50
Source: as quoted in Nickum and Easter (1994)		

Table E5 Unaccounted-for Water in Municipal Systems in Developing Countries

City	Country	Proportion of Unaccounted-for Water to Total Water Supply (%)	Year
Manila	Philippines	55-65	1984
Jakarta	Indonesia	50	1976
Mexico City	Mexico	50	1983
Cairo	Egypt	47	1978
Bangkok	Thailand	32	1990
Source: quoted in Nickum and Easter (1994)			

APPENDIX F: TRANSPORTATION

Table F1 Length of Roads in the Kathmandu Valley

Region/ Zone/ District	Type of Road			Total	Road Category					Total	Area (sq. km)	Road Density (km/ 100 sq.km)
	Black-topped	Graveled	Earthen		National Highway	Major Feeder Road	Minor Feeder Road	District Road	Urban Road			
Kathmandu	493	172	139	804	21	17	43	267	456	804	395	204
Lalitpur	136	63	139	338	0	0	35	196	107	338	385	88
Bhaktpur	73	55	49	177	15	23	0	134	5	177	119	149
Valley Districts	702	290	327	1319	36	40	78	597	568	1319	899	147
Total in Bagmati Zone	1021	449	1033	2503	244	254	79	1333	593	2503	9428	27
Total in Nepal	4617	3959	7329	15905	2974	1649	171	9060	2051	15905	147181	11

Source: DoR (Jan. 2002), DoR (July 2002)

Note:
-All length in km.
- The roads in the Valley can be broadly classified as (KVTDC 2000) -

- National highway consists of Tribhuvan Highway and Arniko Highway, which also constitute as major radial roads.
- Feeder roads link the district headquarters to national highways, such as Thimi and Trishuli roads.
- District roads are the arterial linking the city and the outlying key settlements such as Lubhu, Godawari, Chapagaun, Bungmati, Dakshinkali, Bhimdhunga, Phutung, Tokha, Budanilkantha, Sundarijal, Sankhu and Nagarkot
- Urban roads consist of all city roads including the Ring Road, and contributed 43.1 % to the total road length in 2000.

Table F2 Number of Vehicles Registered in Bagmati Zone

Vehicle Type	90/91	1997	Mid-July 2001
Bus/Minibus/Truck	7069	7557	
Car/Jeep	18000	28915	
Tempo (Four or Three Wheeler)	2414	3925	
Motorcycle/Scooter	24211	64142	
Others	3082	4950	
Total of Bagmati Zone	54776	109489	171678
Total of Nepal	87008	190672	305395
% Share of Bagmati	62.96	57.42	56.22

Source: HMG/KVTDC (2000) for 90/91 and 1997 data, Jha (2001) for 2001 data

APPENDIX G: EARTHQUAKE IN NEPAL

Large and damaging earthquakes are known of in Nepal as far back as 1255 A.D. Recent studies indicate the presence of a dangerous seismic gap in western parts of Nepal. This region has had very few large earthquakes as compared to neighboring areas and hence it is thought to have the potential for great earthquake. All of Nepal is a high-risk earthquake zone. If the Indian seismic zones were extended into Nepal, the whole country would lie in Zone IV, with a danger of experiencing a maximum intensity of VIII. Two regions, one along Nepal's western border with both India and China, and another along the border with India, in eastern and central sections of the country lie in Zone V. The maximum intensity in these areas could be as high as MM IX.

LARGE EARTHQUAKES

1255- This earthquake struck during the reign of King Abhaya Malla (1216-1255 AD). Many houses and temples collapsed, killing one-third to one-fourth of the population in Kathmandu Valley. The only report of this earthquake is from the Kathmandu valley which at that time may have hosted 1,00,000 people (Campbell 1833). This event is also believed to have been the last great earthquake in Nepal, and is thought to have been stronger than the 1833 and 1934 events.

1408- "A tremendous earthquake was felt in Nepal. The temple of Machchhindranath and all other buildings fell down and innumerable human beings perished (12th of Bhadra Sudi, Sambat 528)" (Wright 1877).

1681- Many houses collapsed in this quake. It hit during the rule of Sri Nibas Malla.

1767 - Kathmandu Valley. "Twenty one shocks of earthquake felt in 24 hours on the 1st of Asarh Sudi (Wright, 1877)

1808 or 1810 -Kathmandu Valley. 10th of Jeth Sudi (Nepal Sambat 930) a violent earthquake occurred and many houses fell down. The great temples escaped injury but in Bhadgoan numerous lives were lost.

1823- Kathmandu Valley. Seventeen shocks in one day and one night (Wright 1877)

26th August 1833 -About 500 people were killed. Event was felt widely in Nepal and northern India. The magnitude of this event is estimated between 7.5 to 7.9 (Bilham 1995)

1834 - the Kathmandu Valley (Wright, 1877)

23rd May 1866 – near Kathmandu, Nepal

28th August 1916 – Near Mount Api (Far Western Nepal). This earthquake caused heavy damage to civil structures at Dharchula (Uttaranchal), India.

15th January 1934 -At Indo-Nepal Border. This was one of the strongest earthquakes in the sub-continent this century. Tremors from the shocks were reportedly felt at Kottayam, in southern Kerala, near Cape Comorin for four minutes. Places like Kolkata (formerly Calcutta) and Lucknow were also shaken strongly. Vast areas of Nepal and the Indian state of Bihar were

laid to waste. The epicenter of the shock was 5.6 kilometers north-west of Laukahi, Bihar, along the Indo-Nepal Border. Worst affected were Monghyr, Motihari, Bhatgaon and Kathmandu. Patna, Dharbhanga, Sitamahri, Saharsa, Samastipur, Muzaffarnagar and countless other towns and villages were severely damaged by the shock. 10700 people were killed in this earthquake in both Bihar (India) and in Nepal.

21st March 1935 - Indo-Nepal Border region

27th May 1936 - Near Mount Dhaulagiri (Western Nepal), Nepal

4th September 1954 - Near Pokhara (Western Nepal), Nepal

11th January 1962 - Indo-Nepal Border region

26th September 1964 - NW of Dharchula (Uttaranchal), India

12th January 1965 - NE of Dhankuta (Eastern Nepal), Nepal

27th June 1966 - ESE of Dharchula (Far Western Nepal), India

20th May 1979 - Near Dhamigaon (Uttaranchal), India

29th July 1980 - Western Nepal. Between 150 - 200 persons were killed and hundreds of others were injured. There was extensive damage in several towns in western Nepal. It also caused damage in Pithoragarh area, nearly 50 kilometers away from the epicenter, where 13 persons were killed and 40 were injured. The quake was felt as far away as Kathmandu and New Delhi.

9th August 1987 - Nepal-China Border region

21st August 1988 - Udaypur Gahri, Nepal (Indo-Nepal Border region). This earthquake was the strongest in the immediate region since 1934. The earthquake struck at 04:39am on 21th of August 1988, just 14 days after a massive 7.3 earthquake on the Indo-Burma border. The damage however, was not restricted to Nepal alone. In the state of Bihar, in India, heavy damage occurred in the districts along the Nepalese border, like Dharbanga, Saharsa and Madhubani. The shock was felt all over Nepal, Eastern India, Bhutan, Bangladesh, north-western Burma (Myanmar) and parts of Xizang, China. Officials at the Chinese Seismological Agency said that the earthquake had a magnitude of 7.0. The shock was felt in Patna, Lucknow, Kolkata (formerly Calcutta) and even New Delhi. Tremors were felt in wide area of Bihar, West Bengal, Uttar Pradesh, Madhya Pradesh, Orissa and the North-eastern states. Damage from the quake was severe in the Kathmandu Valley, Nepal and in northern Bihar state.

9th December 1991 - NE of Bajura (Mid-Western Nepal), Nepal

Source: <http://asc-india.org/seismic/nepalseis.htm >quoting the following references-

Bilham, R. University of Colorado <http://cires.colorado.edu/~bilham>

IRIS - Earthquake Database Search

Mathur, S.M. "Physical Geology of India"

NEIC - Earthquake Database, India Catalog

Seismotectonic Atlas of India, GSI, 2000

Table G1 Modified Mercalli Intensity (MMI) Scale

Average Peak Velocity (cm/s)	Intensity Value	Description	Average Peak Acceleration (g= 9.80 m/s^2)
	I	Not felt except by a few under especially favorable circumstances	
	II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.	
	III	Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing automobiles may rock slightly. Vibration like passing of truck.	
1-2	IV	During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing automobiles rocked noticeably	0.015g-0.02g
2-5	V	Felt by nearly everyone, many awakened. Some dishes, windows, and so on broken; cracked plaster in a few places; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.	0.03g-0.04g
5-8	VI	Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster and damaged chimneys. Damage slight.	0.06g-0.07g
8-12	VII	Everybody runs outdoors.Damage negligible in buildings of good design/construction;slight to moderate in well-built ordinary structures;considerable in poorly built/badly designed structures;some chimneys broken.Noticed by persons driving cars.	0.10g-0.15g
20-30	VIII	Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving cars disturbed.	0.25g-0.30g
45-55	IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.	0.50g-0.55g
More than 60	X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed, slopped over banks	More than 0.60 g

Source: Bolt (1999)

APPENDIX H: MELAMCHI WATER SUPPLY PROJECT

The Melamchi Water Supply Project (MWSP) is an inter basin water supply project which supplies water from snow fed Melamchi river in the Kosi basin in Sindupalchowk district to the Kathmandu valley which is in the Bagmati basin in Kathmandu, Lalitpur, Bhaktapur districts. The Project is financed by a number of International banks and the total cost is estimated at about half a billion US dollar.

The Project is designed to solve the chronic water supply shortage in the Kathmandu Valley with the diversion of 170 MLD water from the Melamchi River through a 26-km long tunnel. The Project comprises of five parts:

1. Infrastructure Development

- Melamchi Diversion Scheme (MDS): Includes diversion weir, desilting basin, 26 km tunnel, 25 km audit access road, 18 km main access road, and upgrading of 22 km approach road
- Water Treatment Plant (WTP): 170 MLD plant at Mahankal in Sundarijal of Kathmandu district
- Bulk Distribution System (BDS): 54 km of bulk transmission mains (300 to 1,400 mm diameter) and ten storage reservoirs around the Kathmandu Valley with total capacity of 72,000m^3.
- Distribution Network Improvement (DNI): Recruitment of a Private Operator for water supply management and rehabilitation and extension of existing facilities.
- Wastewater System Improvement (WSI): Includes rehabilitation of the existing sewer networks and treatment plants.

2. Social and Environmental Support

- Social Uplift Program (SUP): Includes buffer zone development, health, education, income generation and community development, and rural electrification
- Resettlement Action Plan (RAP): Implementation of land acquisition along the Main Access Road, Adit Access Road, reservoir and pipeline routes for the Bulk Distribution System (BDS) and Water Treatment Plant (WPT) in Sundarijal. Compensation for the above land to be acquired
- A hygiene and education program in Kathmandu Valley and a public awareness program in the Project area.
- A groundwater monitoring program, and
- An Environmental Management Plan (EMP).

3. Institutional Reforms

- Establishment of the National Water Supply Regulatory Board
- Establishment of the Kathmandu Valley Water Authority
- Groundwater licensing in Kathmandu Valley
- Promulgation of the Groundwater Resources Management Act
- Private Sector Management of Urban Water Supply

4. Project Implementation Support

- Establishment of the Project Management Unit (PMU): For the Project period
- Recruitment of Panels of Experts (POEs): Technical POE and Social and Environmental POE

5. Other Studies

- Kathmandu Valley Water Source Improvement Study
- Review of water use in the Kathmandu Valley: Water use optimization study

Table H1 Key Organizations in the Melamchi Project

S. N.	Organizations and Role in the Project
1	**Asian Development Bank (ADB)** *Construction-* Bulk Distribution System, Tunnel 6 km, Sub-station and Power Transmission *Social & Environment* - Social Uplift Program, Environment Monitoring Program *Consultants-* Project Management Consultant, Bulk Distribution System
2	**World Bank (WB)** *Construction-* Distribution Network Improvement *Consultants & Management-* Private Operator
3	**Japan Bank for International Cooperation (JBIC)** *Construction-* Water Treatment Plant (WPT) at Sundarijal Mahankal *Consultants & Management-* Water Treatment Plant Consultant
4	**Norwegian Agency for International Development (NORAD)** *Construction-* Melamchi Diversion Scheme (MDS) Tunnel 20.5 km (part) *Social & Environment-* Environment Monitoring Program (EMP)
5	**Swedish International Development Cooperation Agency (Sida)** *Construction-* Tunnel 20.5 km (part) *Social & Environment-* Environment Monitoring Program (EMP)
6	**Nordic Development Fund (NDF)** *Supervision Consultancy*
7	**Organization of Petroleum Exporting Countries (OPEC)** *Construction- Audit Access Roads, Upgrading Roads*
8	**Japanese Government** *Design Consultant & Construction- Manohara Ground Water*
9	**His Majesty's Government of Nepal (HMGN)** *Construction- Main Access Road* *Consultants- Main Access road, Land Acquisition and Compensation*
Source: http://www.melamchiwater.org <2002.12.02>	

Table H2 Project Affected VDCs and Municipalities

Schemes Under Project	Affected Districts	Affected VDCs and Municipalities
Melamchi Diversion Scheme	Kathmandu	Sundarijal, Nayapati, Gagalphedi, Gokarneswor, Alapot, Thali Danchi, Jorpati, Baluwa, Sankhu Bajrajogini, Lapsephedi
	Sindhupalchowk	Helambu, Ichowk, Palchowk, Mahankal, Thakari, Haibun, Bhotechour, Sindhukot, Talamarang, Melamchi, Bansbari, Phataksila, Kiul, Duwachour
	Kavrepalanchowk	Mahadevsthan, Jaisithok, Panchkhal
Water Treatment Plant Bulk Distribution System	Kathmandu	Sundarijal, Nayapati, Gagalphedi
	Kathmandu	Sundarijal, Nayapati, Gokarneswor, Kapan, Mahankal, Bishnu Budhanilkantha, Dhapasi, Gongabu, Manamaiju, Phutung, Ichangu Narayan, Sitapaila, Syuchatar, Naikap Purano Bhanjyang, Naikap Naya Bhanjyang, Tinthana, Jorpati, Gothatar, Mulpani, Kathmandu, Kirtipur
	Bhaktapur	Duwakot, Katunje, Madhyapur Thimi, Bhaktapur
	Lalitpur	Sunakothi,Sainbu Bhaishepati,Thecho,Harishidhi,Thaiba,Godavari,Imadol,Dhapakhel,Lalitpur, Lubhu
Water Supply Distribution System Improvement	Kathmandu	Sundarijal, Nayapati, Gokarneswor, Kapan, Mahankal, Bishnu Budhanilkantha, Dhapasi, Gongabu, Manamaiju, Phutung, Ichangu Narayan, Sitapaila, Syuchatar, Naikap Purano Bhanjyang, Naikap Naya Bhanjyang, Tinthana, Jorpati, Gothatar, Mulpani, Kathmandu, Kirtipur
	Bhaktapur	Madhyapur Thimi, Bhaktapur
	Lalitpur	Sunakothi, Sainbu Bhaishepati, Thecho, Harishidhi, Thaiba, Godavari, Imadol, Dhapakhel, Lalitpur
Wastewater System & Rehabilitation of Sewer Treatment Centers	Kathmandu	Kathmandu Metropolis, Kirtipur Municipality
	Bhaktapur	Madhyapur Thimi Municipality, Bhaktapur Municipality
	Lalitpur	Lalitpur Municipality

Source: http://www.melamchiwater.org <2002.12.02>