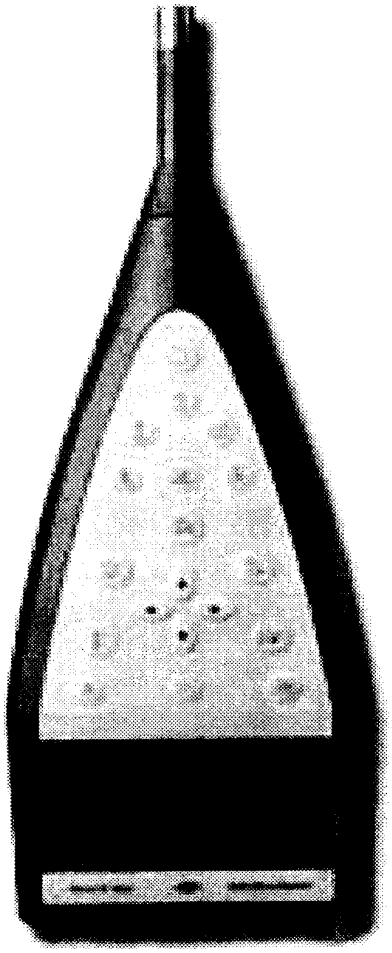
ASSESSMENT OF NOISE POLLUTION AND DEVELOPMENT OF CRITERIA FOR ITS PREVENTION AND CONTROL



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Foreword

Noise pollution from different sources is fast becoming major problem for the physical and mental health of people in Nepal.

This report addresses the problem of noise pollution in different settings of five cities in Nepal. The technical findings will assist the Government in the formulation and implementation of sound policies to prevent serious noise pollution problems from occurring or worsening.

It has clearly, demonstrated that excessive noise can have serious health effects on population. It is hoped that this report will provide a rational basis for administrations who are responsible for noise pollution management in order to develop appropriate control strategies as they strive to achieve a state of sustainable development that doesn't adversely affect the health of people.

Dr. S.K. Pahari,
Chairman, NHRC.

Preface

As per Nepal Health Research Council Act, 1991 Section-6, subsection (chha), it has been mentioned to publish and disseminate the knowledge, experience and achievement of research undertaken in Nepal. I want to attract the attention of concerned authority that noise can also play the role of a pollutant. While its physical and emotional effects are difficult to define quantitatively, the noise level itself can be measured. In our country there is a lack of appropriate statistical information to produce noise exposure estimates. When action is needed to lower noise levels, the absence of comprehensive information should not prevent the development of provisional noise exposure estimates. This project entitled "Noise pollution monitoring and its health effects in urban areas" is prepared to generate data base in noise pollution in order to assist the Government with regard to policies, strategies, and action plans including institutional arrangements.

Noise pollution in urban areas in Nepal is steadily increasing over time. Number of people exposing to noise is greatly increasing. This has direct and indirect affect to the people and that are leading to health hazard. This project is successful in addressing all these relevant issues in relation to noise pollution in Nepal.

On behalf of NHRC, I wish to thank WHO, Mr. Chandra Sekhar Yadav, chief, environmental health unit of NHRC, Mr. Salil Devkota, team leader of this study, Mr. Sandeep Chamling Rai, environmental management expert, Mr. Santosh Shrestha, environmentalist for successfully completing this valuable project.

This report will be helpful to sensitize the Government, policy makers, environmentalists, and planners of Nepal. It is hoped that this report will assist in developing proper guidelines, policies, standards and related legislations related to noise pollution in Nepal.

Dr. Anil Kumar Mishra
Member Secretary
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Acknowledgement

Noise pollution in urban cities is steadily increasing over the years. In Nepal, very few researches have been conducted in this field. The thorough study on noise pollution was realized in the past. Realizing the need, this project was conducted with an initiation of Nepal Health Research Council in collaboration and support from the World Health Organization/Nepal.

Sincere gratitude is expressed to Professor G.P. Acharya, Ex. Chairman, NHRC and Dr. Anil Kumar Mishra, Member-Secretary, NHRC for their support and encouragement in the formulation of this document. We would like to express our gratitude to Dr. Sacche Kumar Pahari, Chairman, NHRC for his inspiration and support in the completion of this report.

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Deep appreciation is also extended to all staffs at the NHRC.

Salil Devkota
Team Leader

Executive Summary

Modern technology has created many environmental pollutants of which noise is an immediate and identifiable example. During the last few years, a wave of the environmental consciousness and concern is being developed in Nepal. This project entitled " Noise Pollution and Its Health Effect in Urban Ares of Nepal" is the first of its kind.

Nepal Health Research Council (NHRC) conducted field level monitoring of sound pressure level in five major urban cities of Nepal namely; Kathmandu, Lalitpur, Bhaktapur, Kirtipur, and Janakpur. The objectives of the survey were to: 1) monitor the trend of community sound pressure level in different settings of five areas or cities; 2) find out noise induced health effect of people in a community (within the jurisdiction of survey); 3) find out noise induced hearing loss; 4) recommend technical aspects through outcome of survey for preparation of guideline that can assist in prevention and control of noise pollution in Nepal.

The above-mentioned 5 cities were categorized into five major areas based on international criteria, they were: 1) high traffic area; 2) commercial cum residential area; 3) commercial cum tourist area; 4) new residential area; 5) old residential area. Two or more than two sample sites were chosen for each settings mentioned above. Similarly an ambient noise level was monitored in the industrial area like Balaju Industrial State, and Patan Industrial State. There were altogether 169 samples monitored in 38 sample sites. Data supporting L_{eq}, L_{max}, L_{dn} was used to evaluate sound pressure levels in different settings mentioned above.

In order to obtain public opinion regarding environmental noise and its effect in human health, survey was administered through questionnaire. The audiometric test was also carried out in certain survey area to determine the audiometry sensitivity of the individual.

Among the high traffic areas, the highest L_{eq} was observed in Suryabinayak of Bhaktapur (81 dBA) during night hours, and Kupandole of Lalitpur (79 dBA) during office hours. The highest L_{dn} value of 74.36 dBA was observed in high traffic area and the lowest was observed at new residential area of 62 dBA. The above L_{dn} value exceeded the US-EPA standard of 55 dBA.

Monitoring results from industrial area shows that all values obtained in sites was above US standard. 28% of sampling sites have exceeded the Indian Standards.

Audiogram test and medical examination were taken in 61 samples. Samples from two different groups namely exposed and non-exposed groups were selected. Exposed groups were those residing or having regular activity near main road where SPL exceeds 70 dBA where as non-exposed group were those reside, lives or performs their activity away from the noisy environment where the SPL do not exceed 55 dBA. Results have shown that

14.75 % from the category of non-exposed group and 39.34 % from exposed group had noise induced hearing loss (minimum to severe). The result show that noise induced hearing loss is high in exposed group than non-exposed group. Health effect of examined sample found that in the category of non-exposed groups none of the sample has respiratory and intestinal tract disease where as only 2% out of total sample had cardio vascular and genitourinary tract disease. In exposed groups, 5% of the entire sample had cardio vascular disease, 3% respiratory disease, 2% genitourinary disease, and 7% intestinal tract disease.

Audiogram and medical examination of the residence of the Kupandole area of both exposed and non-exposed group were observed by applying logical regression tools. It has been found that the risk of getting noise induced hearing loss of exposed category is 4.250 times higher than that of non-exposed group. The traffic noise (above 70 dBA) is found mainly the dominant factor for higher noise level. The people staying in noisy area especially above 70 dBA must take precautionary measures in order to avoid noise induced hearing loss.

The survey shows that noise pollution is emerging as an environmental problem in majority of areas selected for monitoring. The noise pollution has also caused medical problems.

The result of noise monitoring has been analyzed in detail and compared with other international standards. The legal, policy, and other aspects related to noise pollution in Nepal were also reviewed. Based on the above, necessary recommendations have been produced for preparation of guidelines that can assist in prevention and control of noise pollution in Nepal.

Acronyms

ANSI	: American National Standard Institute
BID	: Balaju Industrial District
dBA	: Decibel unit of A-weighted Sound Pressure Level
CMFHD	: Community Medicine and Family Health Division
DESA	: Department of Economic and Social Affaires
EIA	: Environment Impact Assessment
EPA	: Environmental Protection Act/Agency
EPR	: Environmental Protection Rules
HMG	: His Majesty Government
ICIMOD	: International Center for Integrated Mountain Development
IEE	: Initial Environmental Examination
IUCN	: The World Conservation Union
MOPE	: Ministry of Population and Environment
NEPAP	: Nepal Environment Policies and Action Plan
NESS	: Nepal Environmental and Scientific Services Pvt. Ltd.
NHRC	: Nepal Health Research Council
OSHA	: Occupational Safety and Health Association
OSHP	: Occupational Safety and Health Project
PID	: Patan Industrial District
RONAST	: Royal Nepal Academy of Science and Technology
SchEMS	: School of Environmental Management
TOR	: Terms of References
TU	: Tribhuvan University
UK	: United Kingdom
USA	: United State of America
UNCED	: United Nations Conference on Environment and Development
WHO	: World Health Organization

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CHAPTER 1

1. INTRODUCTION

This report on the "Noise Pollution and Its Health Effect in Urban Areas of Nepal" has been prepared as per " The Terms of Reference" assigned by the Nepal Health Research Council (NHRC). It forms a part of the program of NHRC for the fiscal year 2002/03. NHRC has been conducting series of environmental studies with an objective to identify key environmental health issues in Nepal so as to assist the Government with regard to polices, strategies, and action plans including institutional arrangement. Policies and actions to remedy environmental problems like noise pollution mainly requires technical assessment of noise, setting standards and their enforcement through carefully designed package of incentive and regulations and a clear designation of responsible institutions. In the context of achieving these objectives, an information system plays a vital role. The first and foremost requirement for such an effort is the generation of reliable database on environmental noise pollution of the cities in Nepal. This project has assessed the noise levels in five cities in Nepal including details of sources of noise in different setting, pollution magnitude and its effects. The report has also analyzed the detail study on the existing plan, policies in relation to noise pollution, and has recommended the guideline on prevention of noise pollution in Nepal.

1.1 Background

In the modern world, development in technology, commerce, communication and education has enhanced the urban growth both in developed and developing countries. With global urbanization, there have occurred many environment problems causing pollution and environmental degradation. Out of many environmental problems, noise has emerged as one of major urban environmental pollution. Environmental noise pollution has not been an entirely new phenomenon, but rather has been a problem that has grown steadily worse with time.

The word 'Noise' (Latin '*Nausea*') simply means an unpleasant sound that causes discomfort. Noise can be defined as any unwanted, distributing or harmful sound that impairs or interferes with hearing, causing stress, hampers concentration and work efficiently or cause accidents (Miller, 1998).
In these few decades, urban growth is rapidly increasing in Nepal. At the same time, many urban cities like Kathmandu, Lalitpur etc. has begun facing many environmental problems like, solid wastes, sewage, air pollution, noise pollution etc. Community noise and industrial noise represent the leading and significant forms of noise pollution in Nepal.

Noise pollution in urban cities is steadily increasing over the years. Proportion of people exposing to noise is greatly increasing. This has direct and indirect affect to the people that can lead to the health hazard. Some of major health hazard caused by the noise as suggested by experts are permanent hearing loss, high blood pressure, muscle tension, migraine headaches, higher cholesterol levels, gastric ulcers, irritability insomnia, increased aggression and psychological disorder (Miller, 1998).

In Nepal, there were very few researches on noise pollution being carried out. Even such surveys conducted in the past have revealed that noise levels in urban areas are generally much higher than recommended International Standards.

The specific guideline and policies regarding noise pollution prevention and control are still non-existence in Nepal. This research has aimed of monitoring ambient noise level in major cities of Nepal that can play a crucial role in formulating guideline on prevention and control of noise pollution in Nepal.

The initiative taken by NHRC through WHO support in preparing the guideline can assist the responsible authorities for making policies, rules and regulations with an aim to control noise. This publication is principally concerned with the prospective assessment of noise level monitoring in urban cities of Nepal.

1.2 Objectives

The main objectives of the study are:

- To assess the trend of community sound pressure level in different settings of five urban areas or cities.
- To find out noise induced health effect of people in a community within the jurisdiction of survey.
- To predict the risk factor of the noise induced hearing loss.
- To develop fundamental database to assist in the preparation of guideline for Noise pollution prevention and control in Nepal.

1.3 Purpose of Study

The main purpose of this study is to assess the sound pressure level in different settings of Nepal, to analyze noise induced hearing loss, to compile the survey details and to develop fundamental database to assist in preparation of guideline for the noise pollution prevention and control in Nepal. The information is presented through tables, maps and graphical illustrations. The existing noise level in different settings of cities in Nepal are analyzed and compared with International Standards.

1.4 Scope of the Project

The scopes of this project are:

1. Collection, analysis and review of existing data/information on Noise Pollution in Nepal.
2. Conduct a limited field level monitoring based on International criteria for generating primary data on noise pollution in Nepal.
3. Analysis and interpretation of primary data obtained from the field level monitoring.

4. Collection and compilation of available secondary data on noise pollution in traffic, industries of major urban cities.
5. Identification of key areas of pollution, issues in relation to noise pollution, potential health effects.
6. Predictions of risk factor of noise induced hearing loss focusing on hearing impairment.
7. Based on the technical findings of the project, it is aimed to assist in developing proper guideline, policies, and related legislation for the concerned authorities in Nepal.

CHAPTER 2

2. LITERATURE REVIEW

2.1 Review of Previous Studies Related to Noise Pollution in Nepal

In Nepal, there were very few researches on noise pollution being carried out. Shrestha and Shrestha (1985) have made the comprehensive study on Noise Pollution in Kathmandu. They have measured noise levels in various areas of the city associated with transport, industry, and the community. Manandhar *et al.* (1987) have conducted a complementary study of Traffic Noise in Kathmandu . Miyoshi (1987) has examined Industrial Noise in Kathmandu. Sapkota *et al.* (1999) have studied community noise in Kathmandu valley. Pradhananga *et al.* (1999) have conducted Indoor Noise Level Monitoring in different industries of Kathmandu valley. The detail of above studies as reviewed below.

2.1.1 Transportation Noise

Road traffic noise is a major source of noise in urban areas. It produces disturbance and give an impact to more people than any other forms of noise source (Dix, 1981). Shrestha and Shrestha 1985, and Manadhar *et al.* 1987 have measured noise level in high traffic, hospitals, campuses and residential areas. Similarly, Khanal *et al.* 1994, have recorded traffic noise level in different areas of Kathmandu valley. Both of those finding shows that during last one and half decades, 70-100 dBA range of noise level were typically observed in urban Kathmandu roads. It was found that noise levels were much higher than those recommended in the United Kingdom for road traffic near residential areas. They have also observed the distinct traffic peaks in the morning and evening on urban roads as people travel to and through from work. Khanal *et al.*, 1994, however, observed little significant variation of noise level in office and non-office hour throughout the day.

Table 2.1 Road Traffic Noise Level in Kathmandu

Location	Noise Level (dBA)
Tri-chandra campus	80-90
Bir Hospital	90-95
Teku	85-100
Lazimpat	80-99
Putali Sadak	82-98

Source: *Shrestha and Shrestha(1985) and Manandhar et al. (1987)*

Table 2.2 Road Traffic Noise Level in Kathmandu Valley

Location	Noise Level in dBA (Office Hour)	Noise Level in dBA (Non-office Hour)
Maitighar	91-96	80-89
Putalisadak	78-83	80-85
Thamel	85-90	78-84
Chabahil	82-90	83-90
Kalimati	82-86	73-79
Sundhara	84-90	75-80
Kupondol	92-95	83-87
Lagankhel	87-91	88-91
Thimi	75-79	58-64
Suryabinayak Buspark	71-76	52-56

Source: *Khanal et al., (1994)*

Similarly, Sapkota *et al.*, (1999) have measured noise level in different location of Kathmandu valley. They have also found that observed noise level in Kathmandu city were higher than other developed mega-cities of the world. They have calculated that the level of traffic noise in Kathmandu valley is 14.76% and 11.23% higher than USA and Japan respectively.

Table 2.3 Road Traffic Noise in Kathmandu Valley

Location	Noise Level in dBA (Leq)	Lmax
MinBhavan	75.4	89.8
Putalisadak	62.9	78.4
Sahidgate	78.3	92.10
kalimati	64.6	88.4
Thamel	70.3	80.3
Mangal Bazar	68.10	73.00

Source: *Sapkota et al., 1999*

Those studies have revealed that vehicle engines, horns, road-tier friction, gear box and exhaust system major sources responsible for rising traffic noise. They have even predicted that the significant factors responsible for increasing noise level were traffic flow rate, the proportion of heavy vehicles and nature of road surface. According to their studies, old vehicle like heavy buses; three wheeler tempos were contributing sources in raising the traffic noise level. They have even added that due to lack of vehicle maintenance regulation in Nepal, old vehicles like heavy buses; three -wheeler tempos etc. were freely running in urban cities that were responsible for high traffic noise.

2.1.2 Industrial Noise

Industrial machines and processes produce industrial noise. The noise may contain predominantly low or high frequencies, total components, are impulsive or have unpleasant and disruptive temporal sound patterns. The mechanical processes like weaving, blasting, pressing, drilling, cutting, metal chipping and riveting etc. can possess a significant occupational health hazard. The industrial workers are predominantly exposed to industrial noise that can seriously give the impact on health (Bergland and Lindvall, 1995).

Shrestha and Shrestha, (1985) and Miyoshi, (1987) have measured the levels of noise produced by various machines and processes in different industries within Kathmandu valley and outside. They have found that noise levels were high in textile industries, metal works, cement industries and flour-mills. The highest recorded noise level was 120 dBA at Balaju Kapada Udyog (Textile Mill).

Table 2.4 Industrial Noise Level (Indoor) in Nepal

S.No.	Industry and Location	Noise Level (dBA)
1	Balaju Textile Ltd. (BID)	82-120
2	Hetauda textile Mills (Hetauda)	90-95
3	Balaju Auto Works Pvt. Ltd (BID)	86-109
4	Hulas steel industries Pvt. Ltd. (Simra ,Bara)	95-105
5	Nepal Biscuit Co. (Nebico) Pvt. Ltd. (BID)	60-70
6	Khadya udyog Pvt. Ltd (flourmill) (Hetauda)	90-100
7	Asian paints (Nepal) Pvt. Ltd. (Hetauda)	80-90
8	Hetauda cement ind.ltd. (Hetauda)	80-106
9	Nepal polythene and plastic Ind. Pvt. ltd. (BID)	60-75

Source: *Shrestha and Shrestha (1985) and Miyoshi (1987)*

Pradhanaga *et al.* (1999) have measured indoor noise in various industries of industrial estates like Balaju Industrial District, Patan Industrial District and Bhaktapur Industrial District of Kathmandu Valley.

Table 2.5 Industrial Noise Level in Kathmandu Valley

S.No.	Industry	Noise level (Leq-dBA)
1	Textile	92-100
2	Plastic	80-92
3	Iron and steel	85-95
4	Food	79-91
5	Cement pipe	87-94

Source: *Pradhanaga et.al. (1999), RONAST*

From their studies, it was concluded that there were higher noise levels in textile industries. All the workers in these industries were continuously exposed above the OSHA threshold value (90 dBA) and were prone to hazard of noise.

Similarly, the Occupational Safety and Health Project of HMG/Nepal (OSHP) has monitored indoor noise level in different industries of Nepal in the fiscal year of 2000/ 2001 and 2001/2002. It was observed that indoor equivalent noise levels were in a range between 90 - 110 dBA. They have even observed higher noise level in the textile, metal, and plastic industries. These levels were comparatively higher than OSHA standard.

Table 2.6 Industrial Noise Level in Nepal

S. No.	Type of Industry	Activity	Noise level (Leq-dBA)
1	Balaju Aluminium Industries, BID	Spinning	90-98
2	Reliable Plastic, BID	Molding	99-112
3	Plastic Industries, BID	Molding	97
4	Nebico Biscuit, BID	Grinding	100-104
5	Balaju Yantra Shala, BID	Cutting	104
6	Bottlers Nepal, BID	Filling	96
7	Nepal Feed Ind., BID	Grinning	90-95
8	Him plastic, BID	Cutting	100-103
9	Eastern textile Pvt. Ltd, Birgunj	Loom	102
10	Brigung sugar Mill, Birgung	Turbine	105
11	Hulas Steel Ind. Pvt. Ltd, Bara	Galvanizing	94

Source: *Occupational Safety and Health Project HMG/Nepal, 2000/2001& 2001/2002*

2.2 Review of Legislation, Plan and Policies related to Noise Pollution Control in Nepal

In Nepal, there are no specific policies, legislation or guidelines related to noise pollution control. However, the need for policies, plan and legislation of Noise Pollution was clearly spelled out in Nepal Environment Policies and Action Plan (NEPAP) in 1993.

NEPAP was based on Agenda-21 that has addressed most of the principals relevant to Nepal. Agenda-21 refers to the declaration of principals by United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, in June 1992. Principals; 11, 13; and17 of Agenda-21 followed by the NEPAP are relevant to noise pollution control, which states that:

"Nation shall enact effective environmental laws and developmental law regarding liability and compensation for the victims of pollution and other environmental damage. Nation shall undertake the environmental impact assessment, as a national instrument for proposed activities that are likely to have a significant adverse impact on the environment."

It was for the first time in the Sixth five-year Plan (1980-1985) that environment problem was recognized as national issue. Environment was regarded as an integral part of development in the Seventh Five-year Plan (1985-1990). Following the political changes in 1990, the constitution of Kingdom of Nepal (1991) recognized environment protection as an issue of national priority for the country. Eighth five-year Plan (1990-1995) has strongly emphasized on the importance of EIA in development sector for investigating development-related pollution and to adopt proper technology to minimize such pollution. Subsequently, the Environmental Protection Act, EPA (1997) and Environmental Protection Rules, EPR (1997) were enacted. Similarly, Ninth five-year plan (1995-2000) has laid more emphasis on Pollution Prevention Strategy.

2.2.1 Related Legislation

2.2.1.1 The Constitution of Kingdom of Nepal, 1990

Article 26 (4) embodies following policy mandates:
"The state shall give priority to protection of the environment and also to the prevention of its further damage due to physical development activities by increasing the awareness of the general public about environmental cleanliness and the state shall also make arrangements for the special protection of the rare wildlife, the forest and vegetation."

Article 11-15 proclaims:
"The freedom of association and freedom of opinion and expression".
This provision provides the right for any victim to protest against environmental impact causing developmental activities. This right emphasis the people participation in making environmental policies.

Article 64(8) stipulates:
"The House of Representatives may, by rules, regulate the constitution and management of committee on Natural resources and protection of the environment."

This provision has emphasis in formation of high-level committee on environment protection and conservation and has empowered the committee to take necessary decision on implementation of environmental policies and legislation.

2.2.1.2 The Environment Protection Act, 1997

Environmental Protection Act, 1997 and Environment Protection Rules 1997 have made provision dealing with Initial Environmental Examination (IEE), Environment Impact Assessment (EIA), Prevention and Control of Pollution and Protection of National Heritage and Environmental Protection Area.

Section -7 (1) of the Act refers to "Prevention and Control of Pollution" which state;
"Nobody shall create pollution or allow pollution to be caused in such a manner which is likely to have significant adverse impact on the environment or likely to be hazardous to human life

and health, or shall not emits sound, heat radioactive rays, wastes from any mechanical devices, industrial enterprises or any other places contrary to the prescribed standard"

Sub-section 2-3 of the section-7 of the Act has given full authority to the concerned agency to immediately penalize or prohibit activities violating to section-7 (1).

The chapter 3 of Act has provided various provisions under rules 15-20 for prevention and control of pollution.

Rule -15 refers to prohibition of emitting waste states that:
"A person shall not emit or cause the emission of noise, heat, radio-active material and wastes from any mechanical means, industrial establishment or any other place in contravention of the standard prescribed by the Ministry through notification published in the Gazette."

Rule-16 has enforced the industries like chemical, food processing, textile etc. listed in Annex-7 of the Act to install equipment to reduce the pollution under prescribed standard and to take provisional or permanent pollution certificate from the concerned body (MOPE).

Rule 17-20 has given provision of lodging complained against pollution and empowered the concerned body to issue notice to control pollution and to carry out sanitation and cleanliness activities.

2.2.1.3 The Labour Act, 1991

The labor Act 1991, which is administrated by the Ministry of Labour, is the main regulation that0 regulate the working environment. Chapter-5 of the Act deals with occupational health and safety. Section-27 of chapter-5 requires the management to make certain arrangements such as reduction of noise pollution that would adversely affect health of workers. Section-28 and -29 requires for management to provide protective clothing or devices to workers handling excessive noise producing equipment.

2.2.1.4 Industrial Enterprises Act, 1992

As provided in industrial policy, these act mandates to take license for the industries listed in the Annex-2 of the Act if it causes significantly adverse effect on defense, public health and environment. Section-11 clearly provides that licenses or registration certificate shall contain provision regarding concession, exception, facilities that will be given to enterprise and prescribed condition to be fulfilled by them. Section-13 mandates the Industrial Promotion Board established under the Act, section-12 to direct the industries to make arrangements for controlling environment pollution. Section -15 (k) provides permission to grant up to 50% of taxable income for the investment of an industry on process or equipment with the objective of controlling pollution or environment. Section-25 (1) empowers HMG/Nepal to punish any person for establishing any industry without complying the condition mentioned in the license or certificate of registration.

2.2.1.5 Motor Vehicle and Transportation Management Act, 1993

Section-23 of the Act empowers the HMG/Nepal to fix necessary standard to examine pollution that vehicle may cause and also to determine whether or not the vehicle is road worthy. Section-17 (1) enforces the vehicle owner to examine the vehicle under the measures prescribed in section-23, before registration and for taking owner roadworthiness certificate.

Section-118 of the Act mandates the traffic police department to put restriction to drive any vehicle at any public place for public security and welfare of the common people. Under this Act, Traffic Police Department has recently declared Horn Restriction Zone from Shahid Gate to Jamal in Kathmandu City. For violation of this law, under the section-164 of the Act, traffic police can impose fine immediately from Rs 25 to Rs 200.

2.2.1.6 Local Self-Governance Act, 1999

Section-28 (h) of chapter-4, Part-2, of this Act empowers the Village Development Committee to take executive decision and direction to make various programs related to environmental protection. Similar empowerments are given to District Development committee and Municipality in Section-189 (g) and Section-96(c) of Chapter-1, Part-3 respectively. Section -70 (h) of this chapter-8 of this Act clearly mandated the Village Development Committee to punish any person that carry out such activity as to disturb peace in the neighboring place or society by way of installing or through any equipment or means of entertainment. A similar mandate was also given to Municipality under section-165 (g).

2.2.1.7 The Town Development Act, 1999

Clause- 9 of this Act empowers the Town Development Committee to regulate, control or to prohibit any act or activity that has an adverse effect on public health or the aesthetic of the town, or in any way pollutes the environment. It contains penalty provision in the form of fines for the violation of the Act.

2.3 Effect of Noise on Human Health

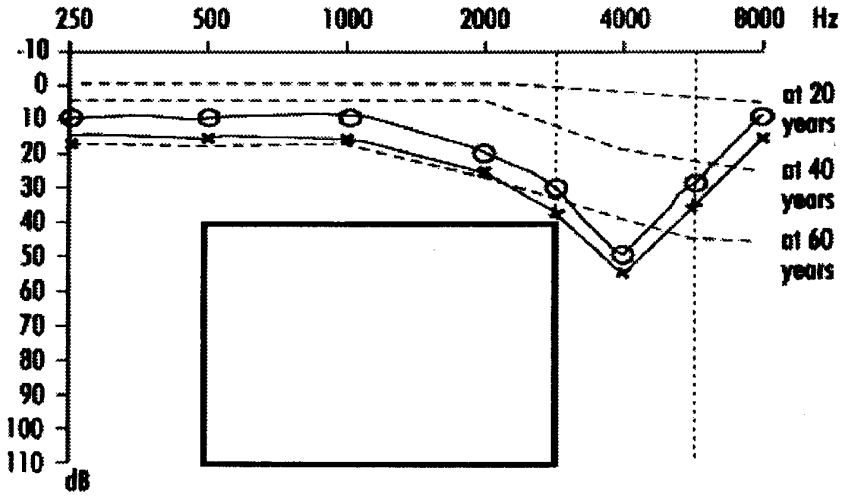
2.3.1 Noise Induced Hearing Loss

Noise induced hearing loss is of a sensory neural type involving injury to the inner ear. Hearing loss usually refers to hearing impairment that is causing difficulties or to a hearing threshold level that has deteriorated (King *et al*; 1992). Hearing loss can be caused in number of ways due to breaking of the bones of the middle ear. Prolong noise exposure to high intensity sound can damage the hearing cells of the inner ear leading to permanent hearing loss. Over a period of a lifetime progressive deafness occurs as hear cells die off. This condition is known as *Presbycusis*

(Glorig and Nixon, 1962). Some audiologists have adopted term, as, a *Sociacusis*, eventual hearing loss due to the cumulative effect of noise exposure in every day life.

The audiogram observed in cases of noise induced hearing loss is characterized by an onset of hearing loss at 4000 Hz, visible as a dip in the audiogram. As exposure to excessive noise levels continues, neighboring frequencies are progressively affected and the dip broadens, encroaching at approximately 3000 Hz. Noise induced hearing loss is usually bilateral and shows a similar pattern in both ears. Hearing thresholds progressively increase with age, with higher frequencies more affected. The characteristic 4000 Hz dip observed in noise induced hearings loss is not seen with *Presbycusis* cases (Mohapatra, 2002).

Chart 1: The Audiogram showing Bilateral Noise Induced Hearing Loss



The circles represent the right ear, the crosses the left ear.
The central square represents the region of speech comprehension.
The dashed line illustrates the effect of age on hearing.

Countries like America, UK, Poland etc. has defined fence for hearing impairment as 26- 30 dBA or more at 1000-4000 Hz. Hearing-loss at high frequencies is usually greater than loss at 500 Hz (Berglund and Lindvall, 1995). Studies carried out by many scientists (Robinson 1971, Burns 1973) reveals the long term hazard of noise are related to occupational noise exposure and that workers exposed to intense noise daily, for several years shown noise induced hearing loss. The considerable hearing loss was frequent at higher frequency. Similarly, many studies have predicated that risk of hearing damage associated with prolonged exposure to sound level is above 85 dBA.

2.3.2 Interference with Speech Communication

Speech is the most important signal of communication that might be interfered by the noise. Speech interference is basically a masking process in which simultaneous interfering noise renders speech incapable of being understood. Noise interference with speech discrimination results in a great proportion of person disabilities and handicaps such as problems with concentration, fatigue, uncertainty and lack of self confidence, irritation, misunderstanding, decreased working capacity, problems in human relation and number of reaction to stress (Berglund and Lindvall, 1995).

Most of the acoustical energy of speech is in the frequency range of 100-6000 Hz with the most important cue-bearing energy between 300- 3000 Hz. Some studies indicate that during the relaxed conversation in the home, the speech level is approximately 55 dBA and as the sound pressure levels of the noise increase, people tend to raise their voice to overcome the masking effect.

Environment noise may also mask other acoustical signals that are important for daily life such as telephone signal, doorbell, alarm clocks, fire alarms, other warning signal and music. The masking effect of noise in speech discrimination is more pronounced in the hearing impaired than in the person with normal hearing. This may also be the case for the elderly and for children in the process of language acquisition (Hygge *et al.*, 1992). For full sentence intelligibility in listeners with normal hearing, the signal to noise ratio (i.e. the difference between the speech level and the sound level of the interfering noise) should be at least 15 dBA (Berglund, Lindvall, Shcwela, 1997).

2.3.3 Sleep Disturbance

It is a major effect of environment noise. It may cause primary effects during sleep and secondary effects that can be assessed the day after nighttime noise exposure.

For the good night sleep the equivalent sound level should not exceed 30 dBA for continuous background noise and individual noise event exceeding 45 dBA (Berglund and Lindvall, 1995). Exposure to noise can induce disturbance of sleep in terms of difficulty to fall asleep, alternation of sleep pattern or depth and awakenings (e.g. Eberhardt, 1987 and Griefahn 1989). These effects are referred to primary sleep disturbance effects. Other primary physiological effects that can be induced by noise during sleep are vegetative reactions such as increased blood pressure (Muzet and Ehrhart, 1980), increased heart rate (Ohrstrom, 1989) increased finger pulse amplitude, vasoconstriction and change in respiration and cardiac arrhythmia (Carter and Hunyor 1991) and increased body movements (Muzet, Naitoh, and Johnson, 1974).

Secondary or after effects of noise disturbed sleep are reduced perceived sleep quality, increased fatigue, depressed mood or well being and decreased performance (Berglund and Lindvall, 1995).

Some studies have indicated that the sleep of children and young person is less affected by noise than that of middle aged or older person (Nixon1972). It has also been reported that babies who have hard gastric difficulties or have suffered brain injury may be particularly sensitive to noise (Murphy, 1969). Certain data indicate that women may be more sensitive to noise during sleep than men (Lukas, 1972).

2.3.4 Physiological Effect

A sudden change in the acoustic surrounding may activate several physiological systems leading to changes such as increase in heart rate, increase in blood pressure, vascular constriction and may even initiate alarm reactions (Anderson.1982).

Studies in animal have demonstrated that prolonged exposures to high level of noise can cause a persistent increase in blood pressure (Rosecrans, Wetyman and Buchley, 1966). Sound level of 62-65 L_{max} during sleep may be laid to increase in heart rate (Valet *et al.*, 1983).

A higher incidence of circulatory problem, peripheral blood flow disturbance and irregularities of heart rate have been reported among workers exposed to a SPL of noise at 95 dBA (Jansen, 1961). In workers exposed to continuous noise and in people living near airports, industries and noisy streets, noise exposure may have a temporary as well as permanent impact on physiological functions.

2.3.5 Performance Effect

It has been seen that noise can adversely effect on performance of cognitive tasks such as reading, attention, problem solving and memorization. Noise induced arousal may produce better performance in simple tasks in the short term. However, cognitive performance substantially deteriorates for more complex tasks (Berglund and Lindvall, 1995).

It has observed that children performance is poor in comprehensive tasks whose school are situated in busy areas of city and suffer from noise pollution (Evan, 1990). Noise, because of lacking rhythm, causes irritation that result in learning disabilities.

Adaptation to noise exposure may also affect performance. In school around airports, children chronically exposed to aircraft noise under perform in proof reading, in persistence or challenging puzzles, in test of reading acquisition and in motivational capabilities (Evan *et al.*, 1994).

Noise may also produce impairment and increase in error at work. Some accident may be an indicator of performance deficits.

2.3.6 Psychological Effect

It is still not believed that environment noise can cause any mental psychological illness, but it is assumed that it could give rise to psychological and psychosomatic symptoms in the form of headaches, fatigue irritability and annoyance.

Abey *et al.*, (1969) described an increased admission rate to psychiatric hospitals among a population living in an area exposed to high levels of aircraft noise. Tarnopolsky *et al.* (1980) investigated 6000 persons living in areas with different level of aircraft noise exposure. The survey covered four areas in London with different level of aircraft noise exposure. They found that depression, irritability, awakening and difficulty in falling asleep were significantly more frequent in the high noise area and also included that prevalence of symptoms was significantly higher among persons who exposed that they were annoyed by the noise.

Shrestha, (2001) has investigated 90 traffic police working in different places of Kathmandu valley. Her result shows that about 70 percent of respondents were having lack of concentration, irritation, depression and disturbance from noise.

In Gausala, Kathmandu/Nepal, it was reported that cow's milking capacity was greatly reduced due to heavy traffic noise in that vicinity. Similarly a 3-year-old child was fainted and later died in Panchthar district in Eastern Development Region of Nepal when a chopper flied above him close to ground (National daily Newspapers).

The results available so far, do not indicate that environment noise provokes psychiatric disease. Noise may, however, act as stressor, including psychiatric symptoms among sensitive individuals.

CHAPTER 3

3. METHODOLOGY

This study is basically carried out with the help of both the primary and secondary data. Primary data is collected directly from the field through monitoring, questionnaire, whereas secondary data is collected from already published materials.

3.1 Primary data collection

Primary data collection is obtained from field level monitoring of sound pressure level. The detail of monitoring protocol followed for the collection of monitoring data is highlighted below.

3.2 Secondary data and information

Secondary data and information is collected from related entities/office such as IUCN, ICIMOD, RONAST, MOPE etc. Environment and other related reports produced by different donor assisted programs; reports produced by WHO, reports of regional and international organizations, and noise abatement regulations of different countries like UK, Japan, India, US. In addition national, regional and international experiences in conducting noise assessment were studied in detail.

The existing policies of Nepal in relation to noise pollution police, strategies, legal provision, and management practices in Nepal were studies. This was supplemented by discussion with related authorities at various levels of His Majesty Government of Nepal. An interaction was held with agencies/ parties with past working experience in noise pollution sector. Literatures on the best management practices of the developed nations have been reviewed in the context of Nepal to assist in formulation applicable policy, strategy and institutional arrangement for administration, monitoring, prevention and control of noise pollution.

3.3 Sampling site

Based on settlement density, traffic flow and crowd of people, five major urban cities of Nepal were chosen for monitoring ambient noise. They were

Kathmandu Valley
1) Kathmandu city
2) Lalitpur city
3) Bhaktapur city
4) Kirtipur city

Out of Kathmandu Valley
5) Janakpur city

These cities were categorized into five major areas based on international criteria. They were

1) High traffic Area
2) Commercial cum residential Area
3) Commercial cum tourist Area
4) New residential Area
5) Old residential Area

Two or more than two samples sites were chosen for each settings mentioned above. Similarly, an ambient noise level was monitored in the industrial area like Balaju Industrial State and Patan Industrial State. There were altogether 169 samples monitored in 38 sample sites. Details of sample sites were shown in the table and were located in the map of cities.

A. High Traffic Area

1. Kalanki, Kathmandu
2. Shahidgate, Kathmandu
3. Putalisadak, Kathmandu
4. Maitghar, Kathmandu
5. TU-Gate, Kirtipur
6. Lagankhel, Lalitpur
7. Satdobato, Lalitpur
8. Kupandole, Lalitpur
9. Suryabinayak, Bhaktapur
10. Thimi Bus Stop, Bhaktapur
11. Ramanada Chowk, Janakpur

B. Commercial cum Residential Area

1. Ason Chowk, Kathmandu
2. Naya Bazaar, Kirtipur
3. Manbhawan, Lalitpur
4. Bhanu Chowk, Janakpur

C. Commercial cum Tourist Area

1. Thamel chowk, Kathmandu
2. Darbar Square, Kathmandu
3. Mangal Bazar, Lalitpur
4. Janaki Mandir, Janakpur

D. Old Residential Area

1. Lagan, Kathmandu
2. Panga, Kirtipur

3. Bhatkepati, Kirtipur
4. Pimbhal, Lalitpur
5. Katunje, Bhaktapur
6. Bhairab Mandir, Bhaktapur
7. Yatri Niwas, Janakpur

E. New Residential Area

1. Samakhushi, Kathmandu
2. Sano Thimi, Bhaktapur
3. Sanitar, Bhaktapur
4. Sainbu, Lalitpur
5. Khumaltar, Lalitpur

F. Industrial Area

1. Balaju Training Institute, Balaju Industrial District
2. Balaju Yantra Shala, Balaju Industrial District
3. Chirag Foam Ind. PVt. Ltd., Balaju Industrial District
4. Balaju Industrial Gate, Balaju Industrial District
5. Supreme Textile, Patan Industrial District
6. Himal Tents Pvt. Ltd, Patan Industrial District
7. Patan Industrial Gate, Patan Industrial District

3.4. Assessment and Measurement of Noise

The quantification of sound levels for the purpose of determining whether they have been hazardous to health and welfare or exceed local legally adopted limits (if any), is a complex task. Depending upon both the purpose of the measurement, objectives stipulated in TOR and to obtain the desired accuracy of the result, the specific noise monitoring methods were selected based on Japanese Industrial Standard (JIS c1512/1985 and JIS z 8731/1983).

3.5 Noise Meter

Noise Level Meter (NA-09, Range: 35 -130dBA) was used for ambient sound pressure level monitoring in concerned zones. The recorder (LR-04) recorded the perceived sound signals on the graph paper. Similarly, for the ambient noise monitoring in industrial area, Noise Dose Meter GA -255 and 701B, which is equivalent to BS 6402/1994 Personal Sound Exposure Meter, was used. Details of instruments and its calibration process are shown in the annex-2 and 3

3.6 Measuring time

The survey was performed on working days. The measurement was carried out for ten minutes interval at each station in different time zones i.e. early morning hour, early office (peak) hour, early non-official (non-peak) hour, late office hour and late non-office hour altogether about 1

hour monitoring in aim each spot. In industrial area, the measurement was carried out for eight hours interval in a working day and night. The categorization of time is followed as per the cited literature of specification of instruments. US Department of Transportation & American National Standard Institute (ANSI) refer 7:00 Hrs to 22:00 Hrs as daytime and 22:00 Hrs to 7:00 Hrs as nighttime. On this regard, five time zones were selected for monitoring sound pressure level at each location.

The noise meter was mounted on a stand set at a height of 1.5 m. It was placed by taking reference distance from the site and was kept as far as possible from reflecting surface.

3.7 Measurement

The sound pressures level of traffic, residential, commercial, and industrial zone was measured by A-weighting. The A-weighted sound pressure levels (L_{min}, L_{max}, L_{eq}, L_{dn}, L_{95}, L_{90}, L_{50}, L_{10} and $L_{5)}$ were calculated from the recorded curves as mentioned in annex- 5.

3.8 Environmental Noise Pollution Survey

In order to obtain public opinion upon environmental noise and its effect in human health, noise pollution survey questionnaire was set. The sampling was taken randomly in five cities covering five different environmental settings. Altogether, 150 questionnaires were taken for the study. Questionnarie were prepared in both English and Nepalese language. The survey was conducted directly through household visits and indirectly through email request in Kathmandu, Lalitpur and Bhaktapur cities and requested them to send filled up questionnaire in the corresponding address. The survey questionnaire in both Nepalese and English language can be viewed in annex-8.

3.9 Audiometric Test

The audiometric test was applied in order to determine the auditory sensitivity of the individual who is continuously exposed to high noise level in cities of Nepal. For a case study, sampling site for audiometric test was selected in the Kopundole, Lalitpur City. There were two reasons on its selection. Firstly; it was observed as one of the highest noise level during Noise Pollution Monitoring and secondly, people of different environmental settings are found living in that area.

For the test, two different groups namely exposed and non-exposed group were categorized. Exposed group were those residing or having regular activity near the main road where sound pressure level exceeds 70 dBA. Non-exposure group are those reside who lives or use to perform their activity away from noisy areas where sound pressure level do not exceeds 55 dBA. Voluntary participation to perform above test was called in both the communities. 61 samples were collected in total. 25 samples from the non-exposure area and 36 samples from the exposed area were collected for the above test. The manual audiometers were applied for the test. The screening as well as diagnostic audiometric examinations were performed. The site for audiometric testing was selected in most quite area as far as possible excluding all the extrinsic noise factors like road, commercial, households noise etc. The audiometric threshold data was

recorded in an audiogram form as recommended by ASHA (American Speech Language Hearing Association) in 1974 and as adopted by ANSI (American National Standard Institute) in 1978. The medical doctor was recommended for executing the diagnostic examination of the samples.

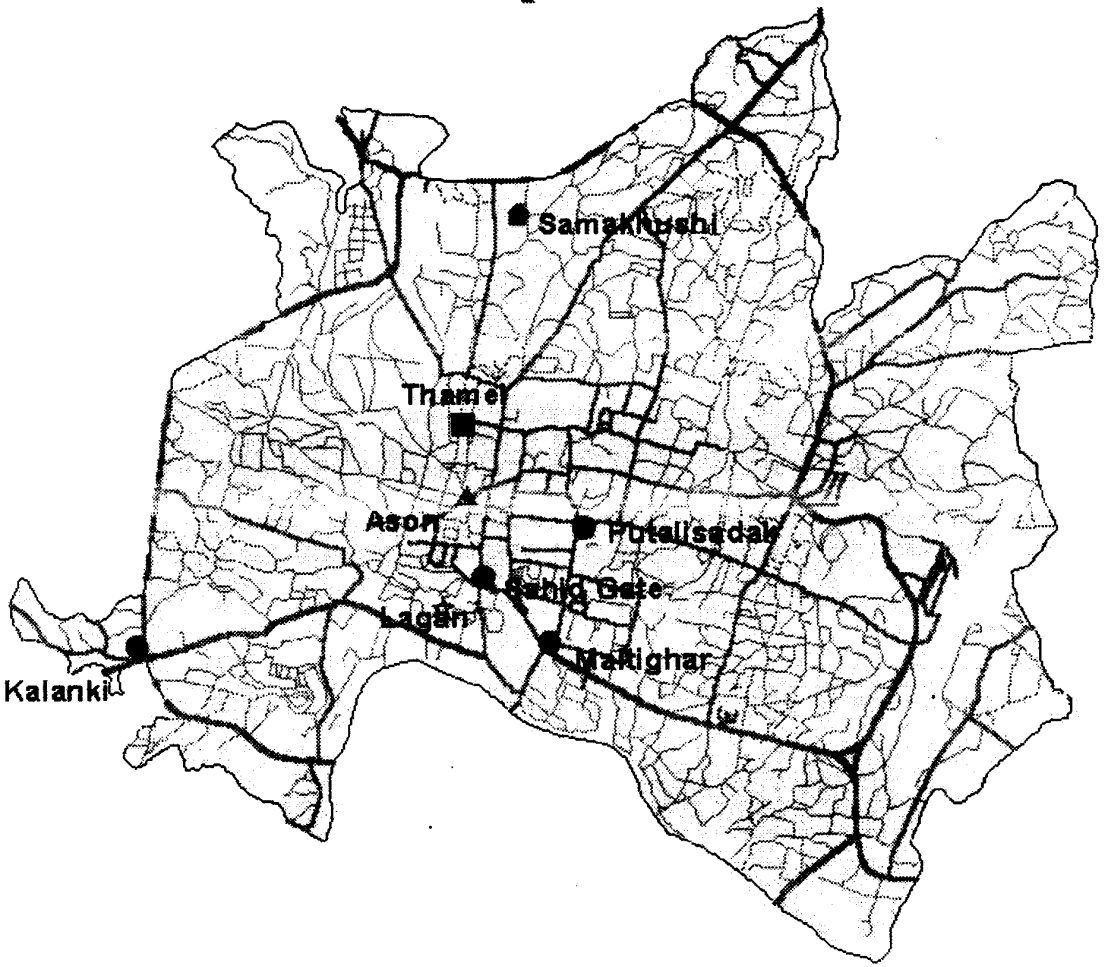
3.8 Study Limitation

The survey was conducted as per requirement mentioned in ' Term of Reference' provided by Nepal Health Research Council. The noise monitoring was carried out in the five cities according to TOR. The environmental settings like hospital, parks, schools and colleges, airport have not included in this study and they are also beyond the scope of TOR. Very limited survey on noise pollution has been conducted in Nepal. They were very confined to specific areas, covering very limited scope of work. Selected monitoring carried out in the cities couldn't provide overall database and analyze the overall noise pollution status in a country as a whole.

3.9 Location of the Sampling Sites in Maps

Find the attached sampling site maps ..

Map1: Kathmandu City



N

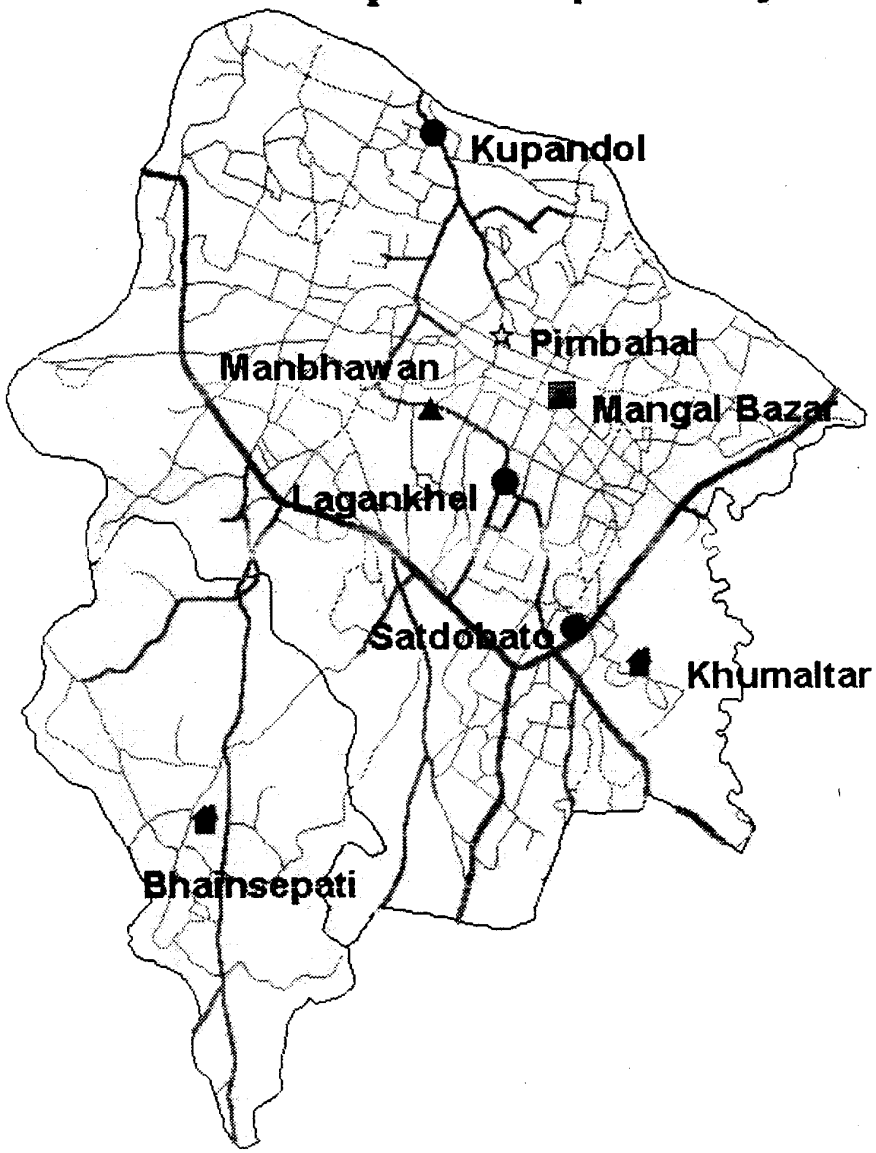
Legend

- High Traffic
- Commercial Cum Residential
- Old Residential
- New Residential
- Commercial Cum Tourist

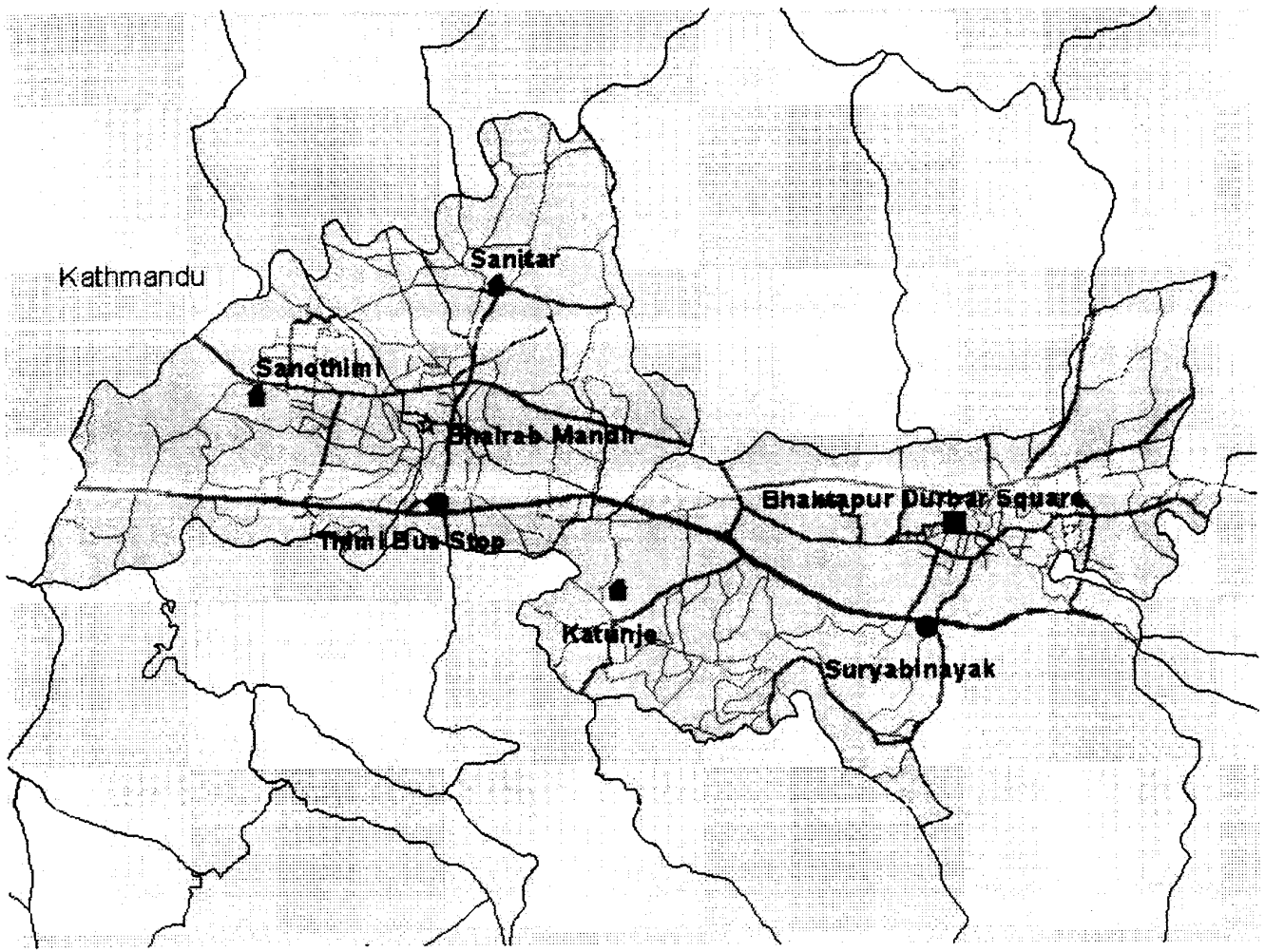
0 0.8 1.6 2.4 Kilometers

NHRC, 2003

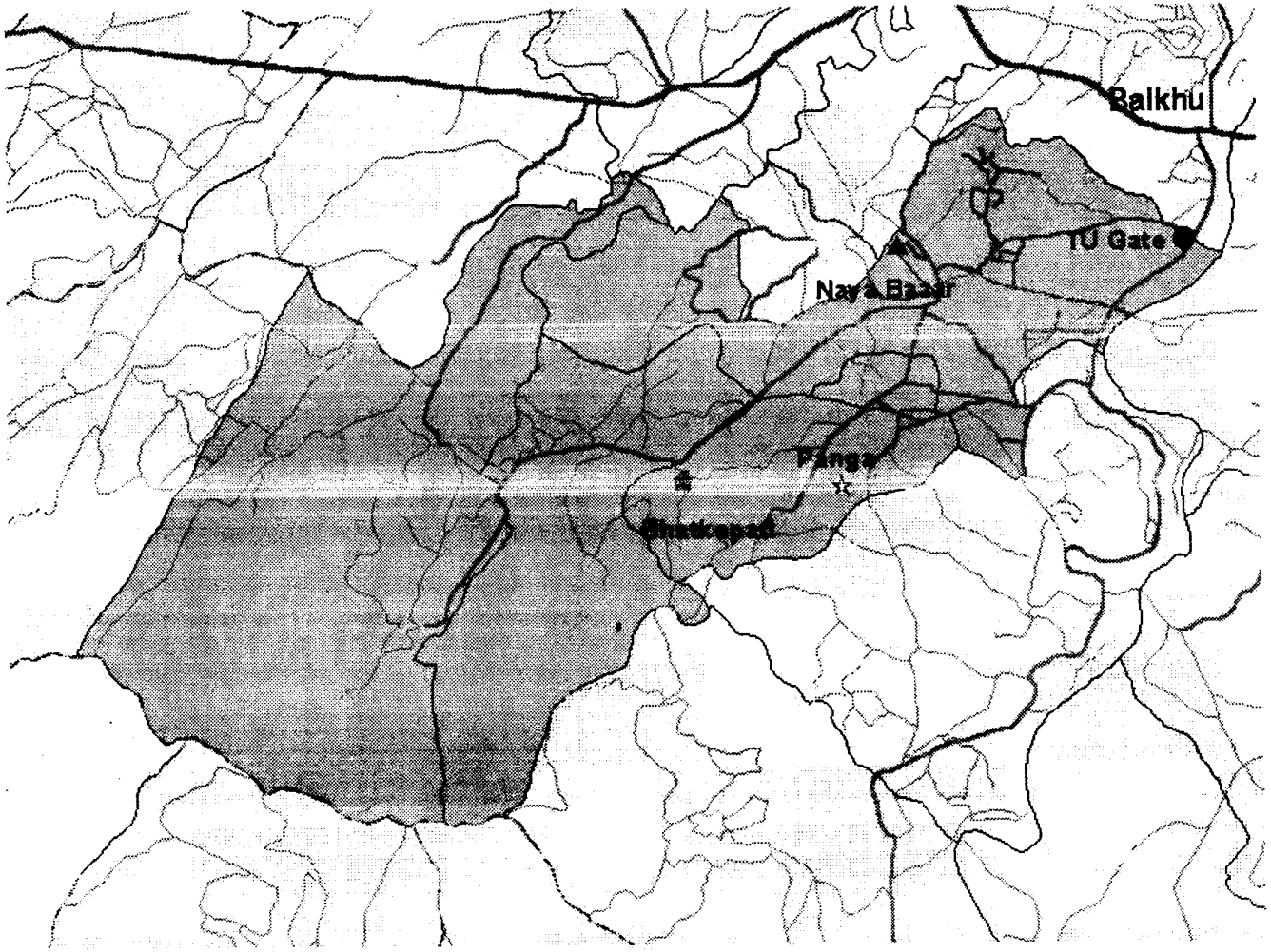
Map2: Lalitpur City



Map3: Bhaktapur City



Map4: Kirtipur City



N

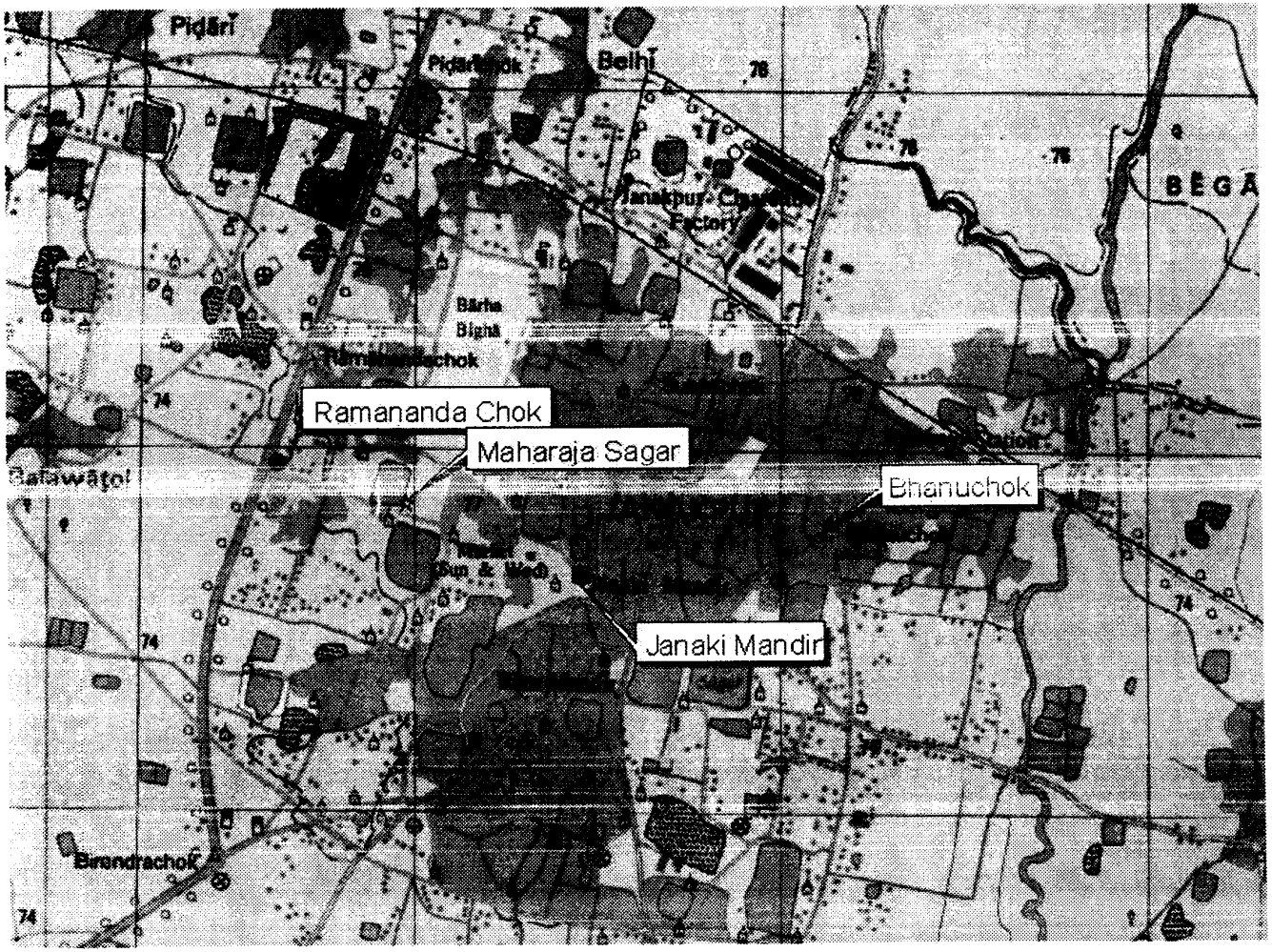
Legend

- New Residential
- Commercial Cum Residential
- Old Residential
- High Traffic

0 1 2 3 Kilometers

NHRC, 2003

Map 5: Janakpur City



NHRC, 2003

Map 6: BALAJU INDUSTRIAL DISTRICT