TRIBHUVAN UNIVERSITY

AMBIENT AIR QUALITY OF KATHMANDU VALLEY

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Submitted By
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AMBIENT AIR QUALITY OF KATHMANDU VALLEY

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ABBREVIATIONS & ACRONYMS

COPD	Chronic Obstructive Pulmonary Disease
CO	Carbon monoxide
DANIDA	Danish International Development Agency
ENPHO	Environment and Public Health Organization
ESPS	Environment Sector Programme Support
GIS	Geographic Information System
HMG	His Majesty's Government
HSU	Hartridge Smoke Unit
ICIMOD	International Centre for Integrated Mountain Development
IUCN	International Union for Conservation of Nature and Natural
Leaders Nepal	Society for Legal and Environmental Analysis and Development Research
MOPE	Ministry of Population and Environment
$\mu g/m^3$	microgram per cubic meter
μm	micrometer
NO_2	Nitrogen Dioxide
N_2O	Nitrous Oxide
NO	Nitric Oxide
NEPAP	Nepal Environmental Policy and Action Plan
NEFEJ	Nepal Forum of Environmental Journalist
NAAQS	National Ambient Air Quality Standards
PM	Particle Matter
$PM_{2.5}$	Particle Matter less than 2.5 microns
$PM_{7.07}$	Particle Matter less than 7.07 microns
PM_{10}	Particle Matter less than 10 microns

ppm	Parts per million
RONAST	Royal Nepal Academy of Science and Technology
SPM	Suspended Particulate Matter
SO_2	Sulphur Dioxide
TSP	Total Suspended Particles
T.U.	Tribhuwan University
TUTH	Tribhuwan University Teaching Hospital
USEPA	United States Environment Protection Agency
VDC	Village Development Committee
WHO	World Health Organization

EXECUTIVE SUMMARY

Air pollution is the presence of undesirable materials in quantities large enough to produce harmful effects. It has become the burning issue of the world. Therefore, there is an urgent need for global initiative to control pollution level. For this reason, International Organization like United Nations Organization has held various conferences aiming at safeguarding the environment. So on 22nd April 1970, United Nations General Assembly passed the resolution which declared 5th June as the World Environmental Day.

Nepal also has taken initiative regarding the safeguard of the environment. There are various Acts, Legislation and Laws introduced in the country regarding this matter. In October 2002, MOPE has established six monitoring stations within the Kathmandu valley to monitor the six classic air pollutants namely SO_2, NO_2, CO, lead, benzene and particulate matter.

Particulate Matter is a collective term used to denote a broad array of finely divided solid or liquid materials dispersed in the air. Among the six classic pollutants, particulate matter, less than 10μm (PM_{10}) has become a major problem in Kathmandu's air.

Kathmandu, the capital city of Nepal is the centre foci for all major facets of the country. This results in rapid urban growth and population inflow. The valley is especially vulnerable to air pollution due to an exploding population inflow, rapid urbanization, valley centric industrialization and significant increase of vehicular transport in the narrow streets. Furthermore, the bowl like topography of the valley restricts the wind movements and retains the pollutants in the atmosphere.

To survive in this polluted environment it is very important to widen our knowledge of the environment. So this study highlights the basic idea of the status of the PM_{10} of the ambient air quality of the Kathmandu valley.

The annual average of the PM_{10} in Kathmandu's air from November 2002 to October 2004 was calculated to be 139.75$\mu g/m^3$. The most polluted monitoring site was found out to be Putalisadak (the most traffic flow area) with the annual PM_{10} concentration of 210.38$\mu g/m^3$. The least polluted site was Matsyagoan (traffic free area) with an annual average PM_{10} concentration of 53.66$\mu g/m^3$. It is seen that there is a significant amount of seasonal variation in the level of PM_{10}. During the monsoon season PM_{10} level goes down below the NAAQS level (120$\mu g/m^3$). This is because the rain flushes down the particles in the air and significantly reduces the pollutants level. During the dry winter season the PM_{10} level is much higher than the NAAQS level.

Air pollution has emerged as the most visible component of environmental degradation in Kathmandu. Therefore HMG has set the National Standard for the ambient level of six classic air pollutants. The government has set a target to meet the standard value by the year 2005.

CHAPTER – I

1. INTRODUCTION

1.1 Background of study

Pollution basically is of two types – man-made and natural. Man made pollution is as old as human civilization itself. It is considered as lowering the quality of environment caused exclusively by human activities. While tropical cyclones, volcanic eruption, earthquake floods, drought etc causes natural pollution. [1]

Talking of man-made pollution, the rapid development of science and technology has no doubt myriad positive effects. However, it has led to increase in the pollutant level in the atmosphere, water etc. Therefore it can be said that it is the by-product of all the development and infact, a price for progress.

Furthermore, pollution has no fixed localized boundary. Therefore, there is an urgent need for global initiative to control pollution level. For this reason, International Organization like United Nations Organization has held numerous conferences regarding this matter. For example, Stockholm Conference 1972, Rio Conference 1972 in Brazil etc. All these conferences aim at safe guarding the environment. So on 22nd April 1970, United Nations General Assembly passed the resolution which declared 5th June as The World Environmental Day. From this day onwards, air or atmosphere has been advocated as the life force.[2]

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[1] Savindra Singh, ***ENVIRONMENTAL GEOGRAPHY***, Allahabad, India: Prayag Pustak Bhawan, 2000, p323.

[2] Sita Maiya Singh Thapa (Dr),"Air or Atmosphere as Life Force: Legal Remedies for Living Beings from the Polluted Air in Nepal." ***NEPAL LAW REVIEW,*** Vol.15, No1&2, July 2002, p100.

Even Nepal has taken initiative regarding the safeguard of the environment. So in 1990, The Constitution of the Kingdom of Nepal too made a mandatory policy for the state to incorporate environmental matters into its process. Under Part IV Directive Principles and Policies of the state, it is clearly stated in the Article 26(4) that "The state shall give priority to the protection of the environment also to the prevention of its future damage due to physical developmental 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 the vegetation".

Today, if we look into the situation of Kathmandu valley, it has been facing a number of serious environmental and ecological challenges. The ecological degradation in the hills and the rapid deteriorating quality of the urban environment including the riverine ecology has raised concerned both at home and abroad. Rapid environmental degradation of the valley is/one of the important environmental issues which is addressed by the Nepal Environmental Policy and Action Plan (NEPAP), which was endorsed by the Environmental Protection Council, HMG of Nepal in September 1993.[3]

1.1.1 Definition of Pollution

According to the report of Restorting the Quality of our Environment, President's Science Advisory Committee, Washington, USA, pollution may be defined as "unfavourable alteration of our surroundings wholly or largely as a by-product of man's actions through direct or indirect effects of changes

[3] Krishna Prasad Oli et. al., ***ENVIRONMENTAL PLANNING AND MANAGEMENT OF THE KATHMANDU VALLEY***. Documentation preparation managed and co-ordinated by IUCN under the supervision of HMG/MOPE, Kathmandu, Nepal, 1991, p 1

in energy patterns, radiation levels, chemical and physical constitution and the abundance of organism."[4]

There are various types of pollution. Some of them are like:

(i) Air Pollution

(ii) Sound / Noise Pollution

(iii) Water Pollution

(iv) Soil Pollution

Although there are different types of pollution but the study shall focus on the ambient air pollution of Kathmandu valley.

Ambient air is a mixture of gases containing about 78.09 percent nitrogen, 21.95 percent of oxygen, 0.93 percent argon, 0.03 percent carbon dioxide and some other gases like neon, helium, methane, krypton etc. in very low proportion. Water vapour is also present ranging from 1 to 3 percent on volume bases. In addition to these components certain constituent known to be pollutants are also present in low background level. The importance and significance of air can be judged from the fact that we can live without food for few weeks, without water for about few days but cannot survive more than few minutes without air.[5]

Some specific definition of air pollution is as follows:

According to WHO, air pollution is defined as " limited to situation in which the outdoor ambient atmosphere contains materials in concentration, which are harmful to man and his surrounding environment." WHO has identified the selected air pollutants that affect the human health, which is presented in the following Table 1. Box 1 also reveals that air pollutants do affect the human health.

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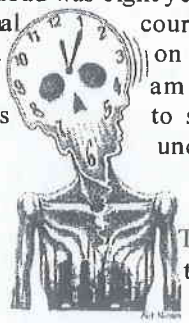
[4] Savindra, op. cit., f.n. 1, p 415.
[5] Savindra, op. cit., f.n. 1, p 420

Box 1

GHOST OF 1984 STILL HAUNTS BHOPAL GIRLS

BY SUCHANDANA GUPTA/TNN

BHOPAL: Fatima Begum of Jahangirabad was eight years old when the gas tragedy struck. At 28, Fatima should have been, in the normal course of things, married. But Bhopal is no normal place, not after what happened on December 3, 1984. Why should any man marry me? I am a gas victim. I'm unhealthy and poor," says Fatima. "Boys come with their families to see me. My mother has not given up hope yet. But the moment they know I am undergoing treatment, they go away. I don't dream of marriage any more," she says.



Fatima is not the only one of her kind. There are no exact numbers, but in Bhopal's gas-affected areas, women born soon after that terrible night just don't figure in the marriage market.

Balkrishna Namdeo, president of Gas Peedit Nirashit Pension Bhogi Sangharsh Morcha, says, "People fear that marrying off a boy to a gas-victim might result in deformed children. Fatima is suffering moderate after-effects. There were hundreds of baby girls then who have now reached marriageable ages. This problem is concentrated in girls between 20 and 30."

Source: THE TIMES OF INDIA, New Delhi, Friday, December 3, 2004

Table 1: Effects of Selected Air Pollutants on Human Health

Pollutant	Major Health Impacts
Particulate Matter	Acute respiratory infection, especially in children. Damages lung's defense mechanisms and causes COPD, cardiovascular disease and lung cancer. Triggers asthma. Irritation in the eye. Low birth weight.
Sulphur Dioxide	Acute mucus membrane irritant. Exacerbates asthma and COPD. WHO guideline: 125μg/m^3 (24hr.average) and 50μg/m^3 (annual mean).
Nitrogen Dioxide	Irritation of respiratory tract. Severe exposure can result in death from pulmonary oedema can increase susceptibility to viral infections. WHO guideline: 40 μg/m^3 (annual mean).
Carbon Monoxide	Fatal in large doses. Aggravates heart disorders. Effects the central nervous system. Impairs oxygen carrying capacity of blood. WHO guideline: 100 mg/m^3 or 90ppm for 15 minutes.

Pollutant	Major Health Impacts
Ozone	Reduced lung function; airways inflammation; bronchoconstrictions; exacerbation of asthma. Eye irritation. WHO guideline: 120μg/m^3 for 8 hours.
Lead	Extremely toxic: affects nervous system and blood; can impair mental development of children; causes hypertension. WHO guideline: 0.5μg/m^3 (1 year average).
Benzene	Carcinogenic to human; long-term exposure can result in bone marrow depression expressed in leucopenia and anemia; high concentration can result to structural and numerical chromosome aberrations. WHO guideline: No safe limit.

Source: WHO 2001

Air pollution is defined as " the presence in the outdoor atmosphere of one or more contaminants, such as dust, fumes, gas, mist, odour, smoke, or vapour, in quantities, with characteristics, and of duration such as to be injurious to human, plant, or animal life or to property, or which unreasonably interfere with the comfortable enjoyment of life and property."[6]

The American Medical Association, states that air pollution is "the excessive concentration of foreign matter in the air which adversely affects the well being of the individual or causes damage to property."[7]

1.1.2 Brief Introduction of the Principal Air Pollutants

Particulate Matter (PM_{10}), Sulphur Dioxide (SO_2), Oxides of Nitrogen, Carbon Monoxide (CO), Ozone, lead, benzene are some of the pollutants present in the ambient air.

(i) Sulphur Dioxide

Sulphur Dioxide in the atmosphere arises from both natural and human activities. Natural processes, which release sulphur compounds,

[6] Savindra, op. cit., f.n. 1, p 420.
[7] M N Rao et. al, ***AIR POLLUTION***, 7 West Patel Nagar, New Delhi , Tata McGraw-Hill, 1999, p2.

include decomposition and combustion of organic matter; spray from the sea and volcanic eruptions. The main human activities producing sulphur dioxide are the smelting of mineral ores containing sulphur and the combustion of fossil fuel. SO_2 dissolves in the water forming sulphuric acid, which is highly corrosive in nature, and this helps in damaging materials and also plant and animals tissues. (http://www.epa.nsw.gov.au/envirom/princairpol.htm).

(ii) Oxides of Nitrogen

The main oxides of nitrogen present in the atmosphere are Nitric Oxide (NO), Nitrogen Dioxide (NO_2) and Nitrous Oxide (N_2O). Nitrous Oxide occurs in much smaller quantities than the other two, but is of interest as it is a powerful greenhouse gas and thus contributes to global warming.

The major human activity, which generates oxides of nitrogen, is fuel combustion, especially in motor vehicles. Oxides of nitrogen form in the air when fuel is burnt at high temperatures. This is mostly in the form of nitric oxide with usually less than 10 percent as nitrogen dioxide. Once emitted, nitric oxide combines with oxygen ('oxidizes') to form nitrogen dioxide, especially in warm sunny conditions.

These oxides of nitrogen may remain in the atmosphere for several days and during this time chemical processes may generate nitric acid, and nitrates and nitrites as particles. These oxides of nitrogen play a major role in the chemical reactions that generate photochemical smog.

Nitrogen dioxide is also a respiratory irritant, which may worsen the symptoms of existing respiratory illness. (http://www.epa.nsw.gov.au/envirom/princairpol.htm).

(iii) Carbon Monoxide

It is an odourless and colourless gas produced by incomplete oxidation (burning). As well as wildfires, carbon monoxide is also produced naturally by oxidation in the oceans and air of methane produced from

organic decomposition. In cities, the motor vehicle is by far the largest human source, although any combustion process may produce it.

Carbon monoxide usually remains in the atmosphere for a month or two. It is removed by oxidation to form carbon dioxide, absorption by some plants and microorganisms, and rain.

When inhaled, carbon monoxide binds to the oxygen-carrying site on the blood's hemoglobin, which reduces oxygen transport in the body. At high concentrations it is very toxic, causing headaches, dizziness, reduced ability to think, and nausea. (http://www.epa.nsw.gov.au/envirom/princairpol.htm).

(iv) Ozone

Near the ground, ozone is a colourless, gaseous secondary pollutant. It is formed by chemical reactions between reactive organic gases and oxides of nitrogen in the presence of sunlight. Ozone is one of the irritant secondary pollutants in photochemical smog. Ozone is strongly oxidizing and can irritate the eyes and the respiratory tract. It also damages plants.

The formation of ozone in the upper levels of the atmosphere or 'stratosphere' is by a different process. Ozone is not regarded as a pollutant because it is produced naturally. It is important in absorbing harmful ultraviolet radiation and preventing it from reaching the earth. (http://www.epa.nsw.gov.au/envirom/princairpol.htm).

Among the major principal of air pollutants researcher's study is basically based on one of the parameters that is only particulate matter.

(v) Particulate Matter

Particulate Matter is a collective term used to denote a broad array of finely divided solid or liquid dispersed in air.[8] Particulate matter may

[8] Jerermy Colls, ***AIR POLLUTION***, 11 New Fetter Lane, London Ec4P 4EE, Spon Press, 2002, p 60

include living organism like bacteria, virus, molds, algae, pollen grains etc. The non-viable particulate in atmosphere is mist, smokes, fumes, dusk etc.

Particulate matter of responsible size may be emitted from a number of sources like volcanoes and dust storms, power plants, industrial processed, and incinerators. The size of particulate matter ranges from less than 0.1 micrometer (μm) to hundreds of micrometers. Particles that have an aerodynamic diameter of less than 10 μm are referred to as PM_{10}. As these particles are small enough to enter the human respiratory system, they are also called as respirable particulate matter (Fig 1).

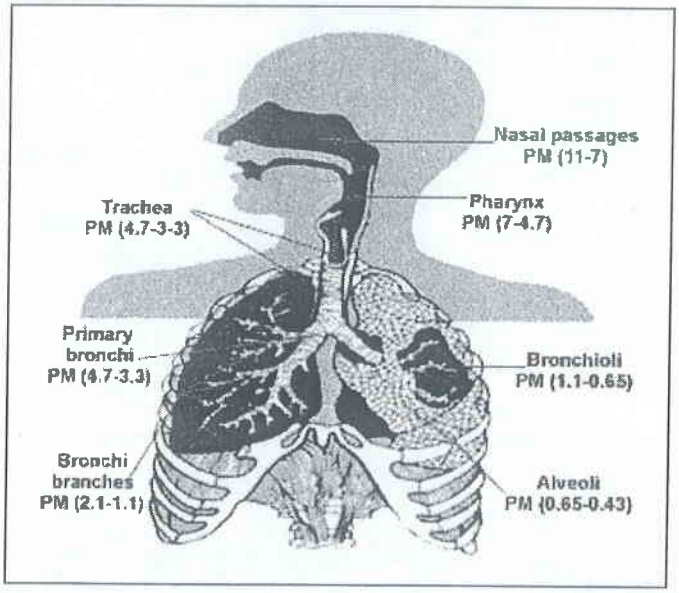


Fig 1: Penetration of Particles in Human Body

(Source: http://www.cpcb.delhi.nic.in/sept2001air2.htm)

Similarly, particles that are smaller than 2.5 μm are referred to as fine particles or $PM_{2.5}$. Coarser particles generally refer to particles with an aerodynamic diameter greater than 2.5 μm when particles in the air are inhaled by the human beings they are deposited in various regions of the respiratory system depending on the size of the particles. Particles that are greater than 10 mircons are normally retained by the cilia in the nose and do

not enter the respiratory tract. Therefore, particles larger than 10 microns do not cause much harm except some irritation in the nose or eye.[9]

1.2 Statement of the Problem

Kathmandu, the capital city of Nepal is the focus of all the major facets of the country, namely economy, tourism, culture, politics, administration and natural environment.

Due to the above reasons, the population of Kathmandu valley is increasing day by day. Not only this, the infrastructure development has never been able to catch up with the unplanned and accelerating growth. As a result this has led to increase in slums, inadequate and polluted drinking water supply, polluted air to breathe, haphazard manner of dumping the solid waste in the neighbourhoods.

Increase in population, vehicular fleet, energy consumption, and industries mainly brick sectors have contributed to air quality degradation in the Kathmandu valley. Furthermore, the bowl like topography of the valley restricts the wind movements and retains the pollutants in the atmosphere. People have every right that the air they breathe in is clean and healthy. Therefore while undertaking the study about the ambient air quality of Kathmandu valley, the researcher has raised the following questions:

(i) Are the people of Kathmandu valley aware of the state of ambient air quality, which they are breathing?

(ii) Is the level of air pollution same throughout the Kathmandu valley?

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[9] Bhusan Tuladhar et. al., A report on ***HEALTH IMPACTS OF KATHMANDU'S AIR POLLUTION***, submitted to Kathmandu Electric Vehicle Alliance, Kathmandu, September 2003.

(iii) Is the legal provision regarding the control of the Air pollution sufficient?

1.3 Objective of the Study

The main objectives of this study are as follow:

(i) To analyze the concentration of the particulate matter (PM_{10}) in the ambient air at different spots within the Kathmandu valley.

(ii) To compare the air pollution level between the busy traffic flow and the traffic free area of Kathmandu valley.

(iii) To analyze the major hospital records to identify annual and seasonal variations and trend in respiration illness and its relation to pollution level.

(iv) To review the existing Legislation and Action Plan related to air pollution.

1.4 Significance of the Study

The significance of the study is as follows:

The study will provide the available temporal and spatial information about the air pollution level of the Kathmandu valley. The study expects to raise awareness about the risk of the pollution level and would provide the information base and guidelines to the stakeholders and policy makers for the control of the pollution level in Kathmandu's air.

1.5 Limitation of the Study

Some of the limitations of this study are as follow:

(i) Basically, data collected for this study is based on the secondary data. Therefore the validity of the study would

depend upon the reliability of the collected information and data.

(ii) Only PM_{10} parameter of the ambient air is studied. The data of PM_{10} parameter is from November 2002 to October 2004.

(iii) Impact of the meteorological factors for example, wind velocity, temperature inversion etc has not been considered which might have significant role in the dispersal of air pollutants.

(iv) In this study only PM_{10} parameter has been taken as the pollution indicator. However, other parameters may be contributing significantly for polluting the air, but these parameters have not been included in this study.

(v) Only major public hospitals COPD (Chronic Obstructive Pulmonary Disease) data are studied and the obtained data is from 1994/95-2003/04. These days, many well-to do people of Kathmandu prefer to visit private clinics or nursing homes. Therefore the data collected from the major public hospital may not give the complete perspective of respiratory disease of the Kathmandu valley.

(vi) Hospital records at public hospitals in Kathmandu valley are usually poorly managed and are often difficult to obtain. Although this study has obtained data directly from the Medical Record Section of the respective hospitals, it was not possible to obtain some data and sometimes the data may not reflect the actual situation. For example there are many respiratory diseases and if one patient may be suffering from more than one disease but the hospital only records the final "primary

diagnosis" which refers to the principal acute reason for admission. So there may be a slight variation in COPD categorization from hospital to hospital.

(vii) This study only analyzes the records of the COPD patient who has been admitted to the hospital whereas records of the other patients (outdoor and emergency patients) were not available.

(viii) This study just gives an indication of the impact of Kathmandu's pollution on public health on the bases of some of the literature reviewed concerning the respiratory disease. Medical study concerning the respiratory diseases has not been conducted.

1.6 Organization of the Study

The study comprises of six chapters. They are as follow:

The first chapter contains the introductory part of the study. It gives a brief idea about the air pollution. It also includes the knowledge gap, research problem, objectives of the study, limitations of the study and significance of the study. The second chapter contains the review of literature. The third chapter explains the methodologies adopted for the study. The fourth chapter gives us the geographical location and its general characteristic of the study area. The fifth chapter presents the results of air pollution level of Kathmandu valley. The last chapter covers the conclusion and recommendations.

CHAPTER – II

2. LITERATURE REVIEW

Of the available literature, some of the relevant ones have been studied as follow:

In 1980, Bhattarai and Shrestha studied on dust pollution in Kathmandu. Dust samples were collected from 18 different spots. The result showed that lead content was far in excess of the reasonably acceptance level of 0.6 ppm. It was found between 544ppm (Maitighar) to 153 ppm (Tripureshwar).[10]

Sharma et. al., (1992), studied the Total Suspended Particles (TSP) in the different streets of Kathmandu city. It was performed in June, October, and November 1992 by using matched weight monitors. The samples were collected in the daytime in between 9:00 am to 5:00 pm. The average value of the particulate matter for the 16 samples collected was 309 $\mu g/m^3$. In some places the value found were as high as 700- 775 $\mu g/m^3$. The particulate matter was in the range from 197- 461 ug/m^3. The value found was higher especially in the streets having heavy traffics.[11]

Devkota (1992) conducted an inventory study in energy utilization and air pollution in Kathmandu valley. According to Devkota, vehicles were the main contributors of air pollution in Kathmandu. Devkota estimated that the peak hour exhaust emission distribution in 63 percent of CO, 13 percent of volatile organic compounds, 13 percent of total hydrocarbons, 8 percent

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[10] D R. Bhattarai and P R. Shrestha, "Lead Contents in the Dust of Kathmandu City Roads." ***PROCEEDINGS OF NEPAL CHEMICAL SOCIETY***, pp.47-50.

[11] U Sharma et. al., "Atmospheric Pollution in Kathmandu city: Particulate Matter in the Kathmandu City and study of Mycoflora in it." ***JOURNAL OF NEPAL CHEMICAL SOCIETY***, Vol. II, 1992, pp 1-8.

of NO_2, 0.75 percent of SO_2, 2.2 percent of particulate matter and 0.27 percent of Benzene. Daily emission of polycyclic aromatic hydrocarbons from public transportation services in 6.6 gm. Devkota also concluded that out of total imported liquid fuel in Nepal, 79 percent gasoline, and 27 percent diesels oil is consumed only in Kathmandu. The pollution load in the ambient air of Kathmandu valley has been estimated to about 550 tons of CO, 14 tons of NO_2 and 3.5 tons of SO_2.[12]

A study conducted by ENPHO (NGO) in 1993 under the Department of Housing and Urban Development was carried in two phases. In the first phase of the study, the samples were collected from the different heights and different distances from the roads for 24 hours. This study reflected that the concentration of gaseous pollutant were within WHO standard. However, TSP and most PM_{10} values exceeded the standard. In the second phase, the samples were collected from breathing height and almost from same distance very close to road for 9 hours in the daytime that included traffic peak hours. The concentrations of the pollutants were found out to be higher in the second phase than in the first phase. This shows that the pollutants were in greater concentrations in the daytime and nearby where they were released i.e. roads. In the farther places and in the nights they get dispersed. The pollutants were mainly due to vehicles since there are no industries around the area of the study.[13]

The study of Kedar Koirala (1995) has shown the temperature is higher at Sahid Gate bus station (the core area of the Kathmandu valley) than other rural areas. It is due to the concentration of pollutants emitted by

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[12] S R. Devkota, A report on ***AMBIENT AIR MONITORING IN KATHMANDU VALLEY***, submitted to the Kathmandu Valley Vehicular Emission Control Project, 1993, pp 11-19.
[13] ENPHO, A report on ***AIR QUALITY ASSESSMENT IN KATHMANDU CITY***, submitted to Department of Housing & Urban Development, HMG/N, Babarmahal, Kathmandu, Nepal, 1993.

the vehicles.[14]

Otaki et. al., conducted a survey on the respirable air particulate (PM_{10}) over 60 spots in Kathmandu Municipality in the month of October and November, 1993. The study showed nearly 2-6 times higher PM_{10} dust particulate concentration than normally accepted level of $70um/m^3$ set by WHO.[15]

A study carried out by the LEADERS Nepal (Society for Legal and Environmental Analysis and Development Research) 1997,concluded that the height of the valley and the low wind speed is the least favourable for the pollutant dispersion. The 24 hours NO_2 concentration is higher than WHO permissible level in place like Balhku, Balaju, Maharajgung, New Road Gate, City bus park and Putalisadak compared to Thamel which has moderate level of NO_2 concentration. The concentration of PM_{10} at Putalisadak area was maximum during the early morning and the late afternoon during peak traffic hours. As the vehicles being one of the major contributors for the release of pollutants in the urban area, the significant positive correlation was obtain between PM_{10} and vehicles and negative between air temperature and concentration of Suspended Particulate Matter (SPM).[16]

A study reported by the Pulchowk Campus (Kathmandu) during January, February and March 1999 found out that Kathmandu valley was very much polluted. According to the study the average mass loading in

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[14] Kedar Koirala, A Master Thesis on ***EFFECTS ON AIR POLLUTION ON URBAN CLIMATE OF KATHMANDU VALLEY***, submitted to the Central Department of Meteorology, Tribhuvan University, Kathmandu, Nepal, 1995.

[15] Otaki et. al., "Respirable Air Particulate Potential of Kathmandu Municipality", ***RESEARCH ON ENVIRONMENTAL POLLUTION AND MANAGEMENT***, NESS Publication, Thapathali-11, Kathmandu, Nepal , Series-1, July 1995, pp 6-21.

[16] LEADERS Nepal, Report on ***STATUS OF AIR POLLUTION IN KATHMANDU: ENVIRONMENTAL EDUCATION TO DEFEND IT***, Kathmandu, Nepal, 1998.

February (1996) was 285μg/m^3 and 380μg/m^3 in February (1997) which indicates that the pollution level in Kathmandu valley increases by 1.3 times per year. The mass concentrations of particulate measured in different locations of Kathmandu valley were two to six times higher than the World Health Organization set standard (150-230 μg/m^3).[17]

The first citizen's report prepared by LEADERS Nepal gave emphasis on the monitoring of $PM_{7.07}$ using Laser Dust Monitor in different season at various urban sites of Kathmandu. The study also measured the vehicle flow, which was correlated with the $PM_{7.07}$ concentration. Strong relations have been obtained between number of vehicles and $PM_{7.07}$ count. However, an inverse relation was obtained between air temperature and $PM_{7.07}$. It was also found out that the increase precipitation plays an important role to rainout the air-borne particulate. The report also analyzed the hospital records for the respiratory diseases especially on children. It has been found that urban residents exceeded the number of respiratory related cases in the hospital compared to that from the rural area in Kathmandu. The report also covers the study on NO_2 concentration and acid rain.[18].

Raut (2001) states that due to the high concentration of benzene used in the gasoline, the ambient concentration of benzene has been found higher than the safe limit in the high traffic streets of Kathmandu. Benzene, a known carcinogen, found in the air after inhalation causes leukemia. So people living near the high traffic streets and walking along the roadside are

[17] D N. Kafle et. al., "Particulate Mass Loading in Kathmandu Valley", ***TRIBHUVAN UNIVERSITY JOURNAL***, Vol.XXI, No I, June 1998, pp13-27.
[18] LEADERS Nepal, A Citizens Report on Air Pollution: ***CHILDREN'S HEALTH AT RISK***, Kathmandu, Nepal, 1998.

vulnerable to the exposure to high level of benzene and likely to be effected by leukemia and other diseases.[19]

In 2001, ENPHO has conducted the study on ambient air quality monitoring in the Kathmandu valley. It was found that minimum PM_{10} concentration was observed as low as 14 $\mu g/m^3$ at Matsyagoan (valley background site) which is located in the upwind direction and where traffic flow is low. The maximum concentration of particulate matter was 1336 $\mu g/m^3$ at Putalisadak where traffic flow is relatively high.[20]

A study conducted by Pokhrel (2002) has indicated that with the present rate of vehicle increase, PM_{10} concentration in Kathmandu valley will increase by 82 percent within 15 years (from 1996 - 2011) if no control measures are taken. Similarly, PM_{10} concentration at Putalisadak (a core city and high traffic area) will cross the US EPA (United States Environment Protection Agency) standard almost 42 percent of the days in a year and it can cause serious health damage to the urban residents. But control measures such as ban of 20 year old and two strokes vehicles, enforcement of tail pipe emission regulation, technology enhancement and programs to control re-suspension of roadside dust can check this increase level of PM_{10}.[21]

Kamaluddin Sabuj studied about the air pollution state of the Kathmandu valley. He found out that the vehicles; buses, trucks and motorcycles with two stroke engines are probably the most significant contributors to air pollution. Approximately 600 new two wheelers are registered in Kathmandu every week. It is estimated that around 56 tons of

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[19] Anil K Raut, Position Paper on ***BENZENE CONCENTRATION IN KATHMANDU'S AIR***, Clean Energy Nepal, Kathmandu, Nepal, 2001.

[20] ENPHO, A Report on ***AMBIENT AIR QUALITY MONITORING IN THE KATHMANDU VALLEY***, Kathmandu , Nepal, 2001.

[21] Sumit Pokhrel,"PM_{10} Forecast for Kathmandu Valley," ***CLEAN ENERGY NEWS***, Vol.2, NO 9, January 29, 2002.

carbon monoxide, 18 tons of hydrocarbons, 7 tons of nitrogen, 0.4 tons of sulphur dioxide and 0.69 tons of particulate matter are discharged daily through the exhaust pipes of these vehicles in Kathmandu. Industrial emission has also reported to have increased the ambient load air pollutants. It is estimated that 104 tons per day of the TSP load in the Kathmandu valley atmosphere is contributed by the medium and large sizes industries.[22]

Raut (2002), states that industrial situated within the valley, using poorly maintained and old technology, are responsible for air pollution. Most polluting industries are situated at the South and Southwest parts of the valley. Unfortunately, Southwest wind in the valley helps to blow air from remotely situated industries to the urban areas.[23]

M L Hildebrandt and Pokhrel (2002) studied that spatiotemporal variations in PM_{10} concentrations in the Kathmandu area resulted from dynamic human-environmental interactions. The temperature, wind speed and its direction, precipitation and the topography of Kathmandu valley affects the concentration of the PM_{10}.[24]

The study conducted by LEADERS Nepal on air quality monitoring in the Bishnumati corridor area (February 2003 - January 2004) resulted that most of the time, the TSP concentration crossed the guideline value. But the other pollutants such as CO, SO_2 and NO_2 were found well below the guideline values. But the monthly average trend over the year shows that there is substantial decrease in the air pollution during the monsoon season.

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[22] Kamaluddin Sabuj, "Kathmandu: curbing vehicular pollution" ***AIR POLLUTION IN ASIAN CITIES***, 42/1 Kha, Segum Bagicha, Dhaka,1000 Bangladesh, A Publication of Forum of Environment Journalist of Bangladesh, 2002, pp 89-90.

[23] Anil K Raut, "State of Air Pollution in Kathmandu Valley," ***ENVIRONMENT***, Ministry of Population and Environment, Kathmandu, Nepal, Vol.7, No. 8, June 5, pp73-83.

[24] M L Hildebrandt and S Pokhrel.,"Climate and Air Quality: A Case Study of PM_{10} in Kathmandu ,Nepal", ***PROCEEDING OF THE APPLIED GEOGRAPHY CONFERENCE***, Binghamton, New York, October, 2002.

The annual average of the TSP concentration was varied by the location wise. The concentration was found high at Kalimati bridge area where the minimal was found at Shova Bhagawati. Similarly, the annual PM_{10} concentration was also found high at Kalimati Bridge and low at the Shova Bhagawati area. The monthly average of the TSP shows that the TSP concentration has decreased from June till September and then again increased as the winter gets in. Similar is the case with the monthly PM_{10} concentration. The high concentration of PM_{10} and TSP concentration can be seen during the winter months. During the rainy season, the concentration of both of the pollutants was found substantially decreased.[25]

The above literature reviews are some of the earlier studies conducted in Kathmandu valley. The rich information provided by these studies has paved the way for the present study with regards to the researcher's problem. However, in respect to their studies, the researcher has conducted the study in a slightly different way. For instance, the researcher has studied the six permanent ambient air-monitoring stations of the Kathmandu valley of 24 hours for particulate matter (PM_{10}) only.

[25] LEADERS Nepal, Final report on ***AIR QUALITY ALONG BISHNUMATI CORRIDOR***, submitted to Clean Nepal, Kathmandu, Nepal, 2004.

CHAPTER – III

3. METHODOLOGY

This present study is entirely based on secondary data only.

3.1 Selection of the Study Area

The study of Ambient Air Quality is mainly of Kathmandu valley, central region of Nepal. This region was selected in order to know about the air pollution level of Kathmandu valley and its consequences at the backdrop of the growth of the city, increase in population, vehicles etc. Moreover, it is a burning issue.

3.2 Source of Data

(i) The data are basically based on the secondary source and it consists of table work, which is collected from various libraries of NGO's and INGO's like WHO, ICIMOD, IUCN, RONAST, NEJAF etc including the Central Library, T.U. Kirtipur.

(ii) Population Census 2001.

(iii) Ministry of Population and Environment HMG/MOPE.

(iv) Review of Literature.

(v) Major hospitals of Kathmandu.

(vi) Topographical map (Kathmandu, Lalitpur and Bhaktapur) of 1992 at the scale of 1:25,000 prepared by the Survey Department/HMG and Finnade.

(vii) Websites

3.3 Data Analysis

For the analysis of the data, simple quantitative and qualitative techniques are used. Data are shown in the tabular form, figures and maps. Maps are prepared by using a PC based Arc View GIS Version 3.1 software, Vector GIS.

CHAPTER – IV

4. GENERAL BACKGROUND OF THE STUDY AREA

The Kathmandu valley is roughly elliptical in shape, 25 kilometers along its East-West axis having a maximum width of 19 kilometers. It lies in the lesser Himalayas of the Central Nepal. It is located between $28^0 32' 13'' N$ to $28^0 49' 0'' N$ latitude and $85^0 11' 31'' E$ to $85^0 31' 38'' E$ longitude.

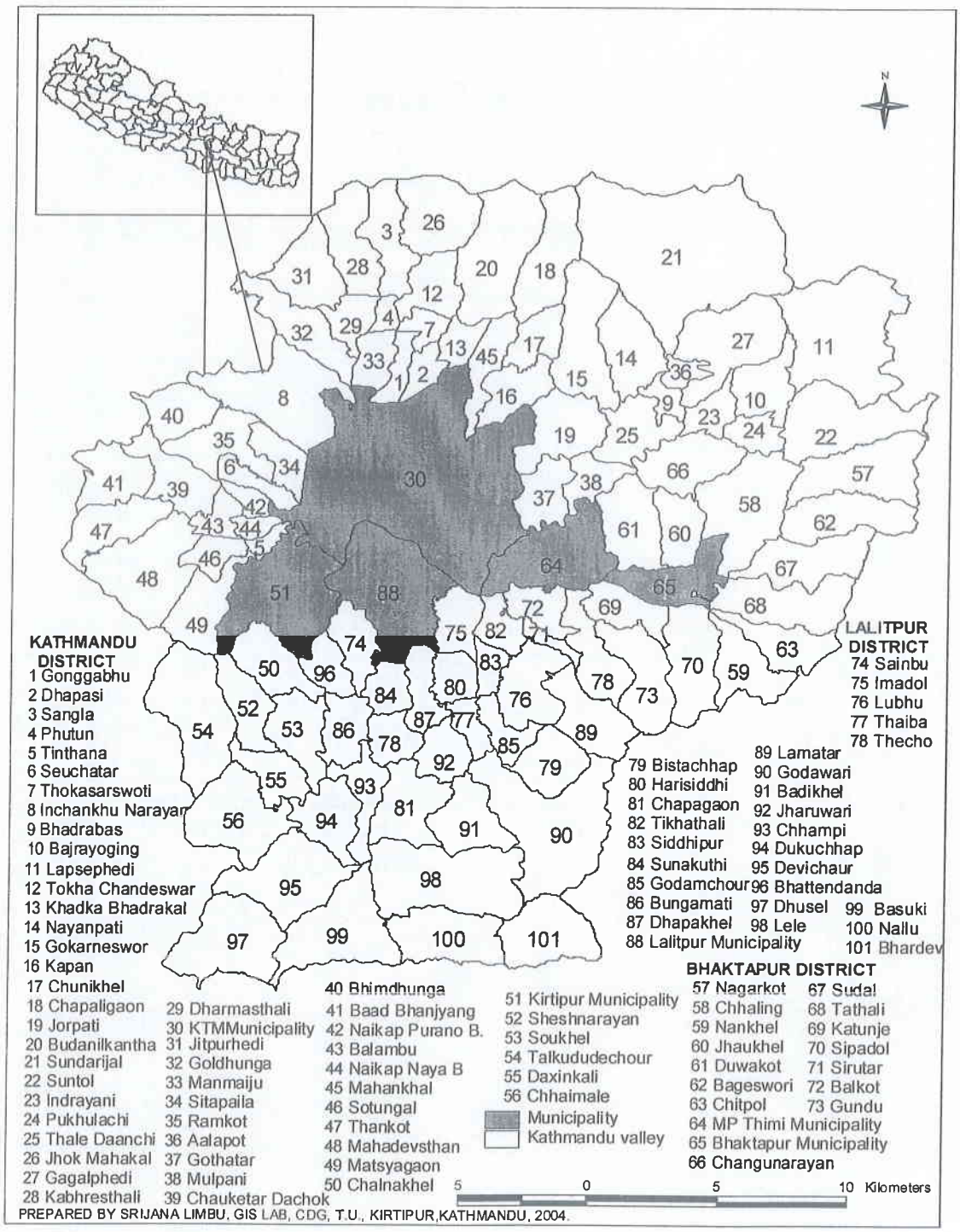
According to the population census data of 2001, it reveals that there are 165695 people residing in three districts of Kathmandu valley (Kathmandu, Lalitpur, and Bhaktapur)

The valley comprises three administrative districts namely, Kathmandu, Bhaktapur and Lalitpur. However, it does not cover the entire area of the three districts. In Kathmandu districts, out of 57 VDCs (Village Development Committees) Nanglebhare VDC falls outside the valley. Similarly in Lalitpur, out of a total 41 VDCs, sixteen lie outside the valley. However, all the sixteen VDCs of Bhaktapur district are within the boundary of Kathmandu valley. Kathmandu valley therefore includes 97 VDCs.

Kathmandu district has two municipalities- Kathmandu and Kirtipur. Lalitpur has one and Bhaktapur has Bhaktapur and Madhyapur Thimi municipality. Excluding the area of the 17 VDCs listed above, the total area of Kathmandu Valley is 701.80 m^2. (Map1)

Mountains having the heights of more than 2000 meters surround the bowl shaped topography of Kathmandu valley on all sides. The valley is surrounded by Shivapuri, Nagarkot, Phulchoki, Nagarjun, Chandragiri range including various passes viz. Bhimdhunga, Sanga and others.

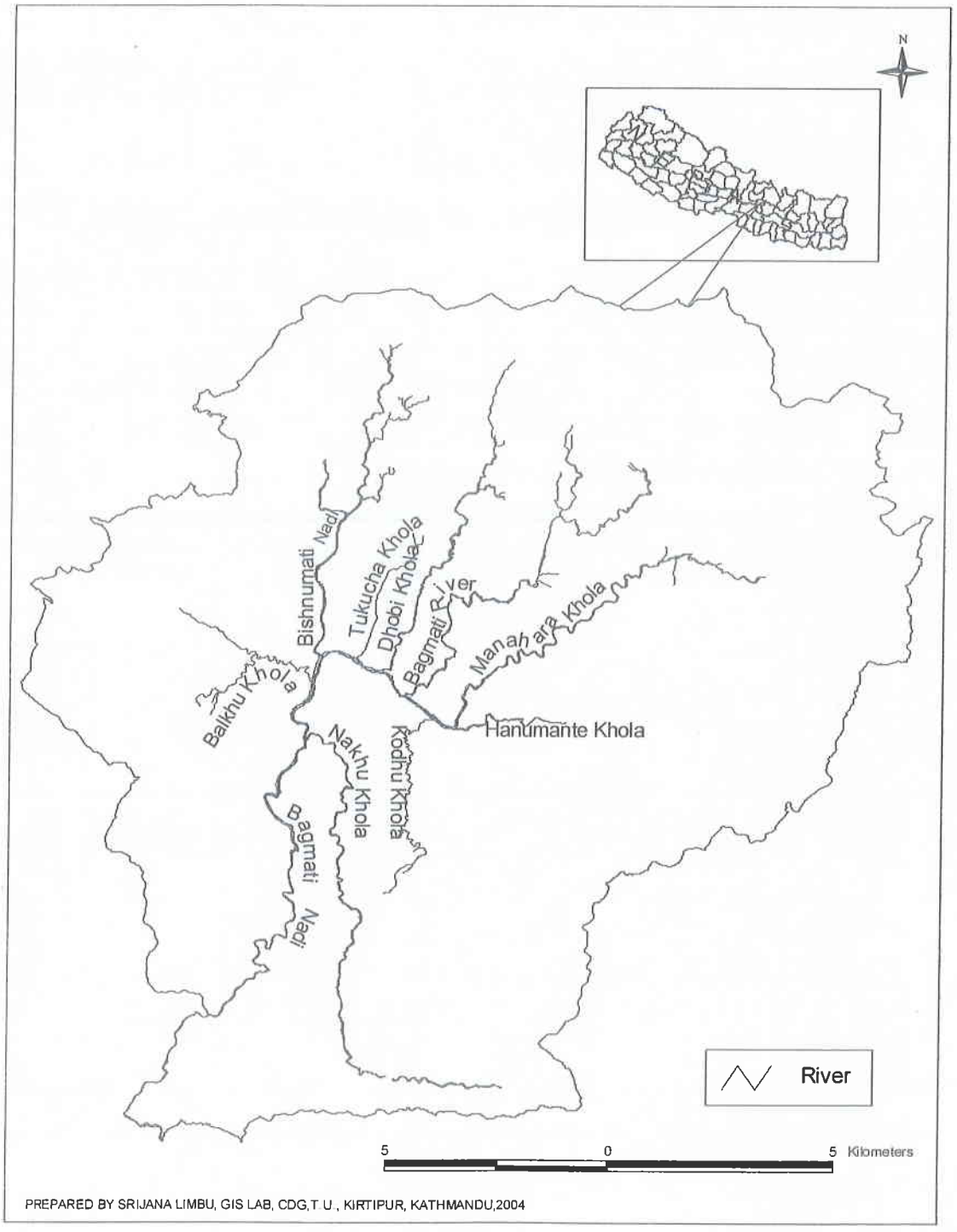
Map 1: KATHMANDU VALLEY



The valley has a centripetal drainage pattern with the drainage towards the centre of basin. Bagmati is the main river, which originates from Shivapuri range of northern part of the valley. Similarly, Nakhu, Kodku and Godavari originate from Phulchoki range, Hanumati and Manohara from Nagarkot, Dhobi Khola from Shivauri, Bishnumati from Shivapuri – Nagarjun and Balkhu and Bosan from Chandragiri having several other tributaries. (Map 2)

In general, the climate of valley is temperate and the mean annual temperate is about 19^0C. The valley experiences three distinct weather conditions. Cold season extends from October to February and January is the coldest month with mean temperature of 11^0C. The period between March to mid June is the summer season. The warm and rainy season extends from mid July to September and July is the warmest month with mean temperature of 25^0C. The valley receives an annual average rainfall of 1400 mm. July is the wettest month with an average rainfall of 125 mm. Except for the monsoon period, the general climate of the valley is usually dry because of its location and topography. The high altitude with extreme diurnal variation in radiation leads to a potentially strong cooling in the night and warming in the day. During dry season, cooling in the night causes formation of deep inversion layer. When the inversion layer is deep enough, the insulation may not break up the inversion. This situation of temperature inversion can last for several days, especially during the winter period. The atmosphere then acts like lid over the city region and the concentration of pollutants may build up considerable due to poor atmospheric dilution mechanism. During summer and early autumn, the prevailing wind regime in the valley is the Southwest monsoon.

Map 2: RIVER SYSTEM OF KATHMANDU VALLEY



whereas in the winter this is mostly westerly. The northern Himalayas prevent the flow of cold Siberian winds from the Northeast. The dispersion conditions of air pollutants are poor because of low wind speed (less than about 5 km/hour in annual average).

Basically, there have not been any significant trends for temperature over the last 20 years. However, slight warming has been observed during the last ten years (1983 -1992) as compared to the earlier 10 years (1976-1985). The average temperature has increased slightly by 1.5^{0}C. This shift can be said to be significant only in that it is indicative of warming trend caused by vehicular emission, urbanization, and loss of green areas in the valley. So is the case for annual rainfall, which varies from year to year. Frosts occur during January and early February, although, number of frost days and the intensity of frost have declined in the last fifteen years.

CHAPTER –V

5. STATUS OF AMBIENT AIR

From November 2002, with the help of DANIDA, MOPE has established six air quality monitoring stations within the Kathmandu valley. The main aim of establishing these air monitoring stations is to create public awareness of air quality in which they breathe in. The locations of these six air monitoring stations are presented in the following Table 2, Map 3 and Plate 1- 6.

Table 2: Locations of Monitoring Stations

Location	Classification
Putalisadak	Urban traffic
Matsyagoan	Valley Background
TU, Kirtipur	Urban Background
Bhaktapur	Urban Background
Patan Hospital	Urban traffic
Thamel	Urban traffic / Residential

Source: www.mope.gov.np

The main problem in the Kathmandu's air is the high concentration of particulate matter. Other pollutants such as CO, NO_2, SO_2 are within the National and International Standards, but the PM_{10} is significantly higher than that of the Standards. At present only PM_{10} has been monitored daily. The monitoring stations automatically collects 24 hour samples through the eight filters mounted three meters above the ground. The samples are collected once a week and analyzed in a local laboratory.

The results of the monitoring stations are published every week at the MOPE's website (www.mope.gov.np) and even in the local newspaper such as The Nepali Times and The Kathmandu Post. It is even displayed on an

electronic board at Basantapur, Kathmandu. MOPE has used different descriptors with colour code to describe the air quality so that it will be easier for the common people to understand it. (Table 3)

Table 3: Air Pollution (PM_{10}) Descriptors for Kathmandu.

Descriptor	Colour	PM_{10} ($\mu g/m^3$)
Good	Green	< 60
Moderately	Yellow	60 – 119
Unhealthy	Orange	120 – 349
Very Unhealthy	Red	350 – 425
Hazardous	Purple	> 425

Source: www.mope.gov.np

MOPE has also developed National Ambient Air Quality Standards (NAAQS) .The standard for PM_{10} is 120$\mu g/m^3$. (Table 4)

Table 4: National Ambient Air Quality Standard for Nepal

Parameters	Units	Averaging time	Concentration in ambient air, maximum	Test methods
TSP	$\mu g/m^3$	Annual	-	
		24 hours*	230	High volume sampling
PM_{10}	$\mu g/m^3$	Annual	-	
		24hours*	120	Low volume sampling
Sulphur Dioxide	$\mu g/m^3$	Annual	50	Diffusive sampling based on weekly averages
		24 hours**	70	To be determined before 2005
Nitrogen Dioxide	$\mu g/m^3$	Annual	40	Diffusive sampling based on weekly averages
		24hours**	80	To be determined before 2005

Parameters	Units	Averaging time	Concentration in ambient air, maximum	Test methods
Carbon Monoxide	$\mu g/m^3$	8 hours**	10,000	To be determined before 2005
Lead	$\mu g/m^3$	Annual	0.5	Absorption spectrometry, analysis of PM_{10} samples****
		24 hours	-	-
Benzene	$\mu g/m^3$	Annual	20*****	Diffusive sampling based on weekly averages
		24 hours	-	-

*Note: 24 hourly values shall be met 95% of the time in a year. 18 days per calendar year the standard may be exceeded but not on two consecutive days.

**Note: 24 hourly standards for NO_2 and SO_2 and 8 hours standard for CO are not to be controlled before MOPE has recommended appropriate test methodologies. This will be done before 2005.

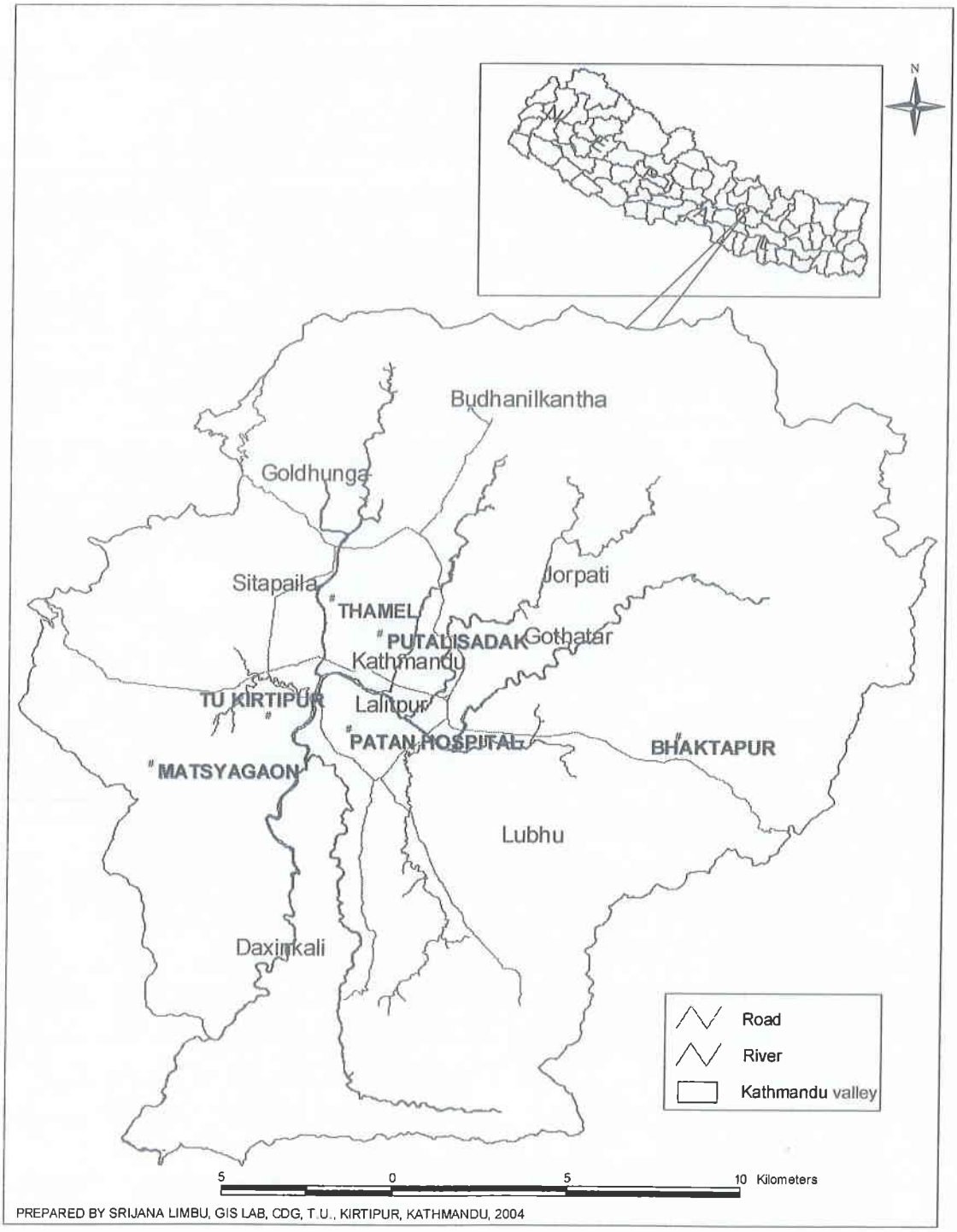
***Note: Control by spot sampling at roadside location: Minimum one sample per week taken over 15 minutes during peak traffic hours, i.e. in the period 8am – 10 am or 3pm – 6 pm on a workday. This test method will be re-evaluated by 2005.

****Note: If representativeness can be proven, yearly averages can be calculated from PM_{10} samples from selected weekdays from each month of the year.

*****Note: To be re-evaluated by 2005.

Source : www.mope.gov.np

Map 3: LOCATION OF THE STUDY AREA AND AIR QUALITY MONITORING STATIONS IN KATHMANDU VALLEY



AIR QUALITY MONITORING STATIONS

Plate 1: Putalisadak (Urban traffic area)

Plate 2: Matsyagaon (Valley background area)

AIR QUALITY MONITORING STATIONS

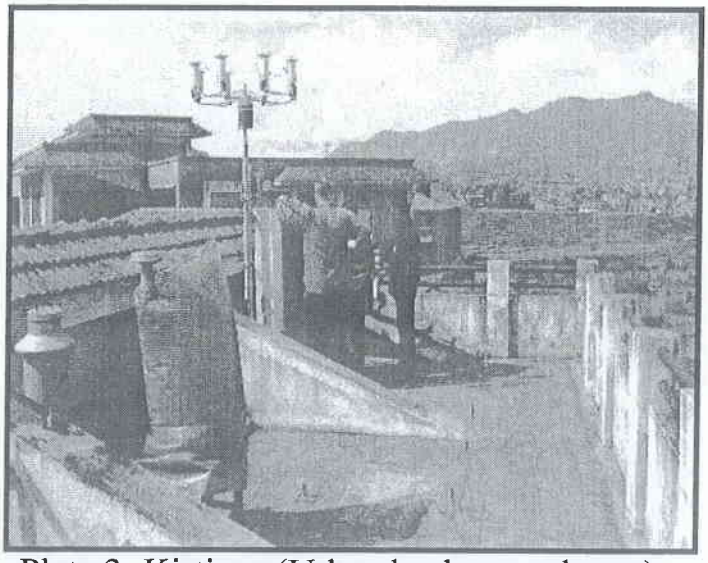


Plate 3: Kirtipur (Urban background area)

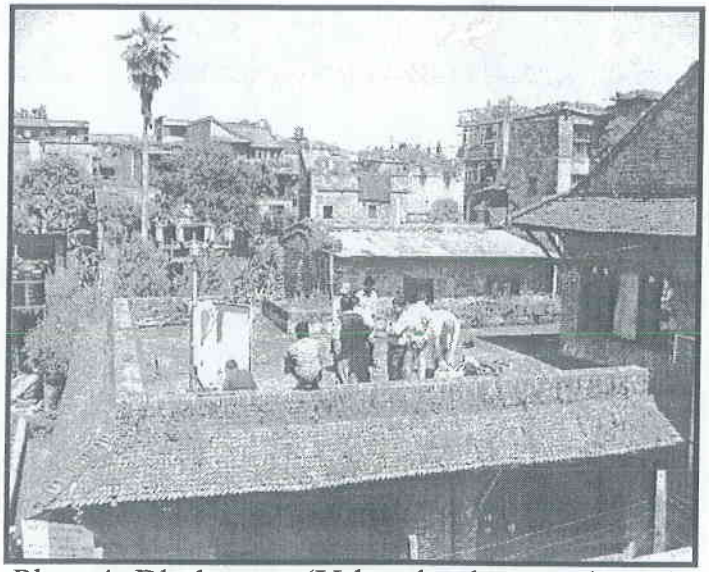


Plate 4: Bhaktapur (Urban background area)

AIR QUALITY MONITORING STATIONS

Plate 5: Patan Hospital (Urban traffic area)

Plate 6: Thamel (Urban traffic/residential area)

5.1 PM_{10} Concentration

PM_{10} data is presented graphically and in tabular form generated from six monitoring stations within the Kathmandu valley. Although the data is of two years (see Annex), following result can be drawn from the analysis of the PM_{10} data:

(i) In comparison with NAAQS and other International Standard, the level of PM_{10} within the Kathmandu valley is comparatively high. (Fig 2)

(ii) The annual monthly average of PM_{10} at six monitoring stations was calculated to be 139.75$\mu g/m^3$ (November 2002– October 2004).

(iii) Calculating location-wise, the result from the six monitoring stations confers that the most polluted site is Putalisadak. Its highest monthly average PM_{10} concentration is 317$\mu g/m^3$. This is probable due to the high traffic density and moreover the tall buildings on either side of the roads tend to have canyon effect, which does not allow the pollutants to disperse easily. (Fig 3)

(iv) After Putalisadak, the second highest polluted area is the Patan Hospital area with a high monthly average PM_{10} concentration of 280$\mu g/m^3$. This is also probably due to Patan Hospital area being one of the highest traffic flow areas compared to other four monitoring stations (Thamel, Bhaktapur, Kirtipur and Matsyagaon). (Fig 4)

(iv) The PM_{10} level of Thamel is also relative high but less polluted than that of Putalisadak and Patan Hospital area. Of the 24 months (November 2002- October 2004) taken into study, the monthly average PM_{10} concentration of 14 months shows 58.3

percent above the NAAQS level, which is 120μg/m^3. This indicates that the air is considered as "Unhealthy." (Fig 5)

(v) In comparison to Bhaktapur (East urban background area of Kathmandu valley), Kirtipur (West urban valley background of Kathmandu valley), has slightly less PM_{10} concentration. The highest monthly average PM_{10} concentration of Bhaktapur is 279μg/m^3 while that of Kirtipur is only 151μg/m^3. (Fig 6)

(vi) Incase of Matsyagaon, a valley background location, the monthly average of PM_{10} are below the National Standard (120 μg/m^3). (Fig 7)

(vii) There is a significant amount of seasonal variation in the level of PM_{10}. The monthly average concentration of PM_{10} is the highest in the month of January, which is the peak of the dry winter season. During the monsoon season the concentration of PM_{10} level goes down below the NAAQS level (120μg/m^3).This is probably due to the rain flushing down the particles in the air and significantly reducing the pollution level. In the month of January 2003, the monthly average PM_{10} concentration was 256μg/m^3 while in the month of July 2004 it was just 65μg/m^3. But in the month of August 2004, it was 63μg/m^3, this is because the PM_{10} of Matsyagoan was recorded only for 17 days. Another additional factor that reduces the pollution level during the monsoon is that the polluting brick kilns in Kathmandu do not operate during the monsoon.[26] (Fig 8)

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[26] IUCN,***URBAN AIR QUALITY CHANGES AND POLICY MEASURES: A REVIEW OF RECENT CONDITIONS IN NEPAL,*** IUCN, Kathmandu, Nepal, 2004, pp 18-19.

(viii) During the winter season, the level of PM_{10} concentration is high in Bhaktapur area. This is probably mainly due two reasons: as stated above that most of Kathmandu's brick kilns, located around the city of Bhaktapur start operating in the month of December and another reason is that the wind in Kathmandu, which flows east towards Bhaktapur, carrying with it a significant amount of particles from Kathmandu. The average PM_{10} level in the month of January 2003 in Bhaktapur was higher (279$\mu g/m^3$) than the levels in Patan Hospital (277$\mu g/m^3$) and Thamel (273$\mu g/m^3$) areas and only slightly lower than Putalisadak (317$\mu g/m^3$).

(ix) Vehicles are one of the major sources of air pollution in Kathmandu. This can be verified by the following three observations:

(a) Areas with heavy traffic flow (Putalisadak and Patan Hospital) are the most polluted areas.

(b) Pollution levels are very low during to Nepal Bandh when there are almost no vehicles plying on the road. When there was Nepal Bandh from May 18th - 20th, 2004, the PM_{10} level of Putalisadak was 119$\mu g/m^3$, 83$\mu g/m^3$, 62$\mu g/m^3$ respectively, but the following next day on May 21, the level of PM_{10} had risen up to 172$\mu g/m^3$. (See Annex)

(c) Pollution level drops during the weekends (Saturdays and Sundays) since there are fewer vehicles plying on the road. As per the calculation, in the case of Putalisadak (July - October 2004), the average level of PM_{10} on 18 weekends was

112.5μg/m^3. However in the same months, the average PM_{10} concentration on weekdays (Monday to Friday) was 127.9μg/m^3, which indicates that the average concentration of PM_{10} on weekdays is higher than weekends. (Fig 9)

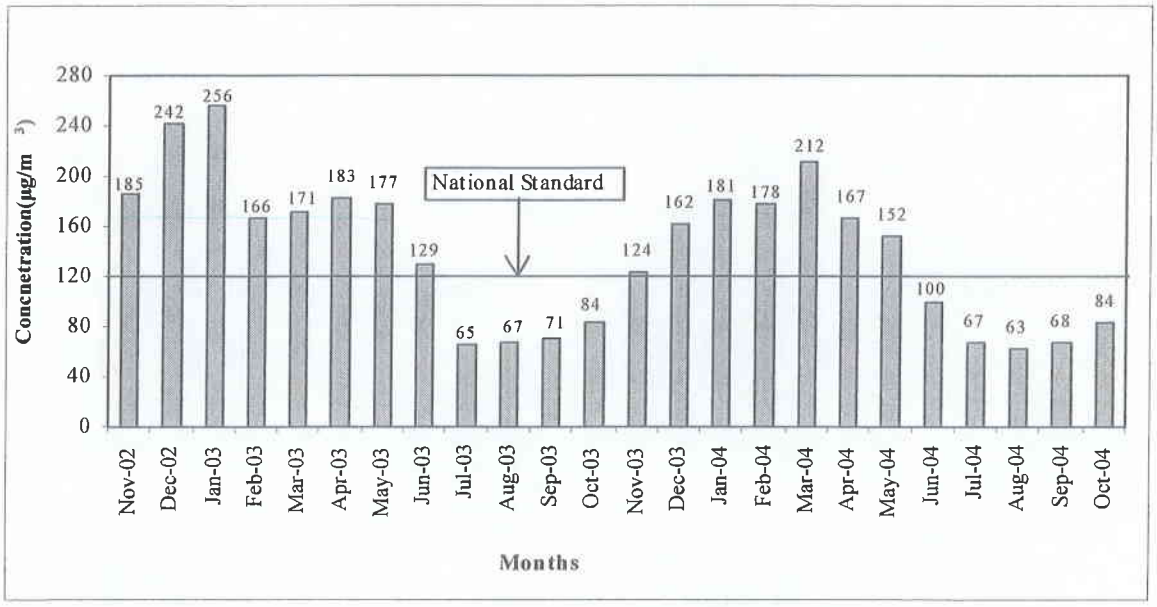

Fig 2: Monthly Average PM_{10} variation in Kathmandu valley

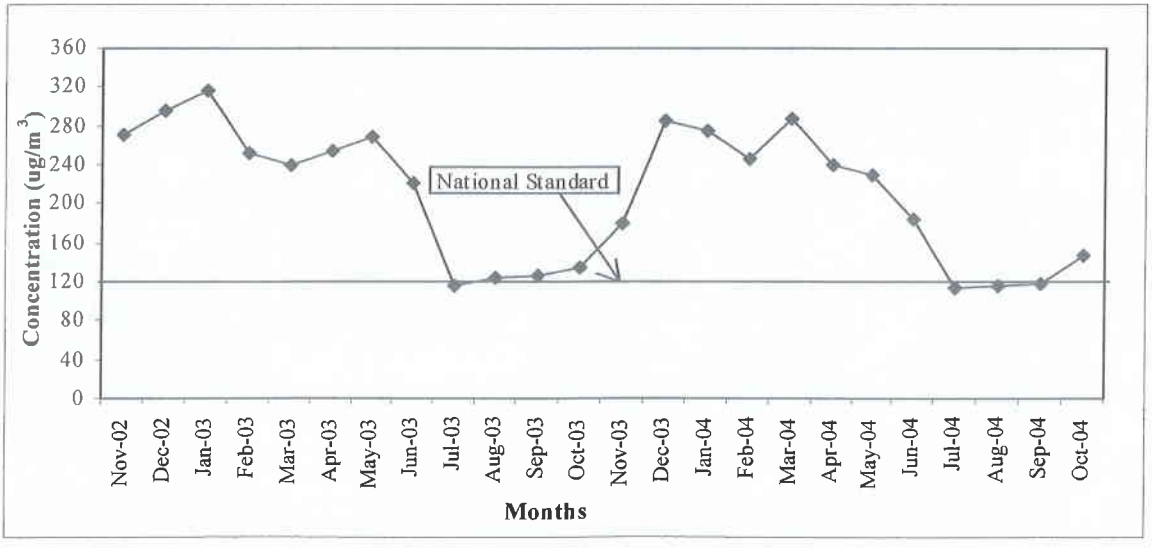

Fig 3: Monthly Average PM_{10} variation at Putalisadak

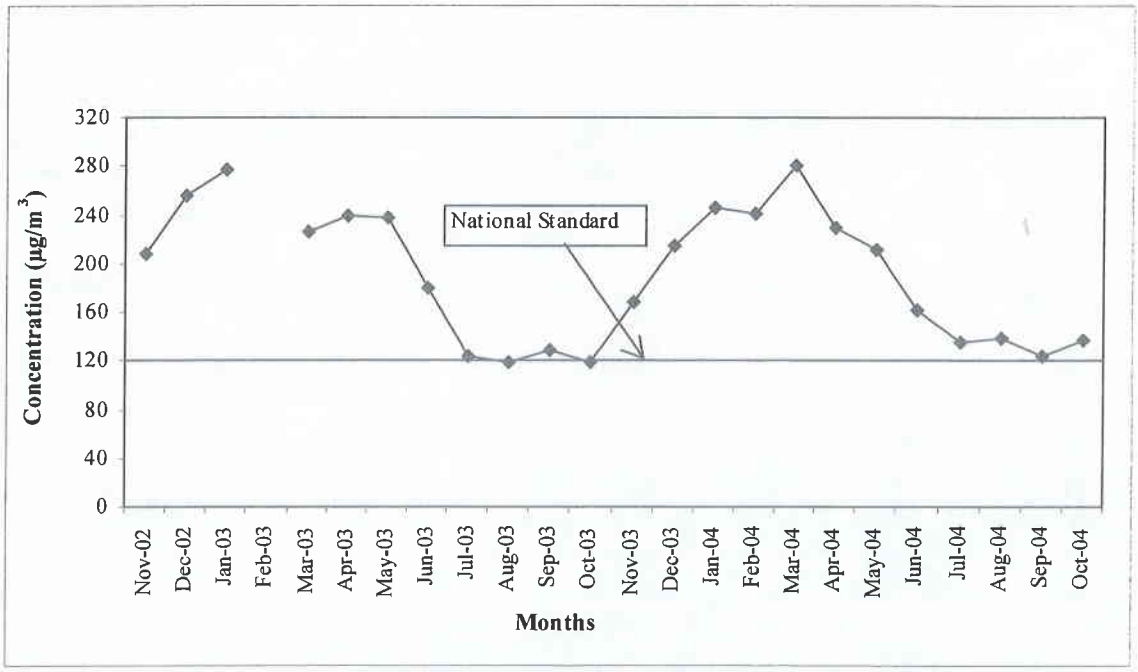

Fig 4: Monthly Average PM_{10} variation at Patan

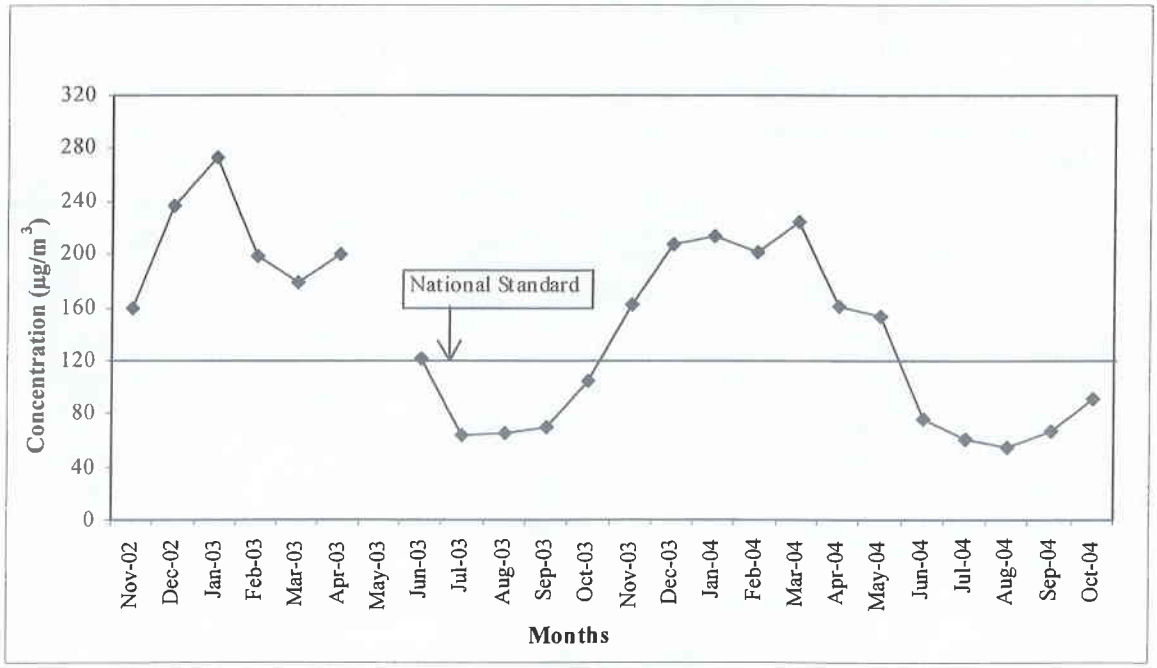

Fig 5: Monthly Average PM_{10} variation at Thamel

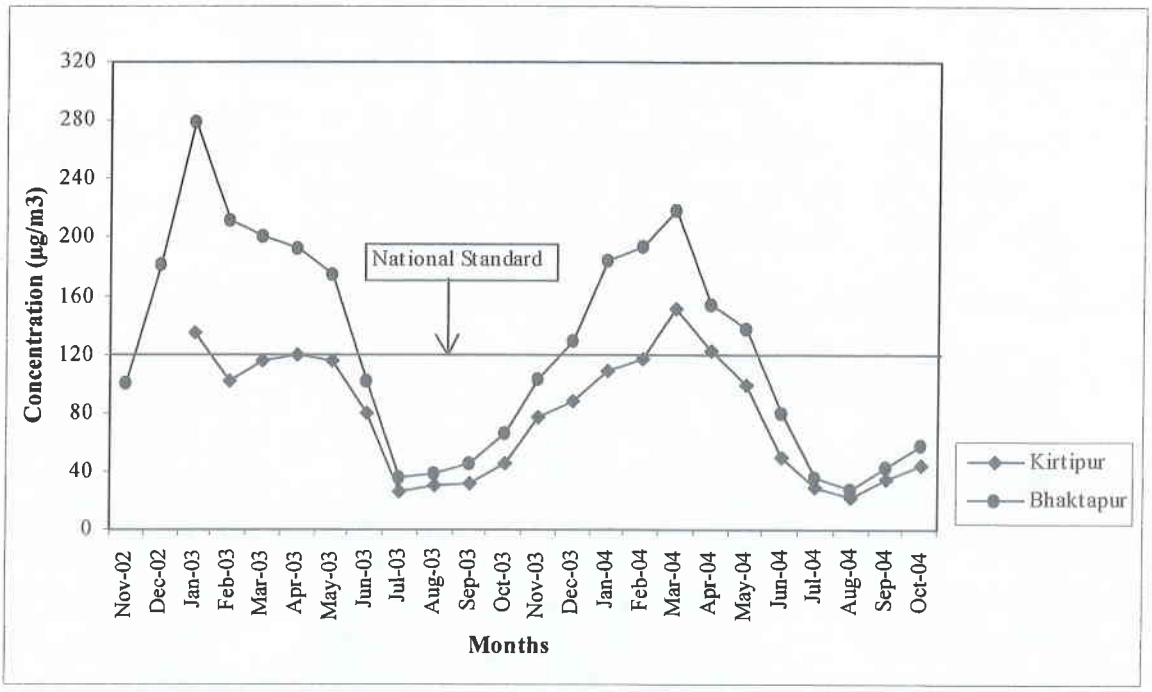

Fig 6: Monthly Average PM_{10} variation at Kirtipur and Bhaktapur

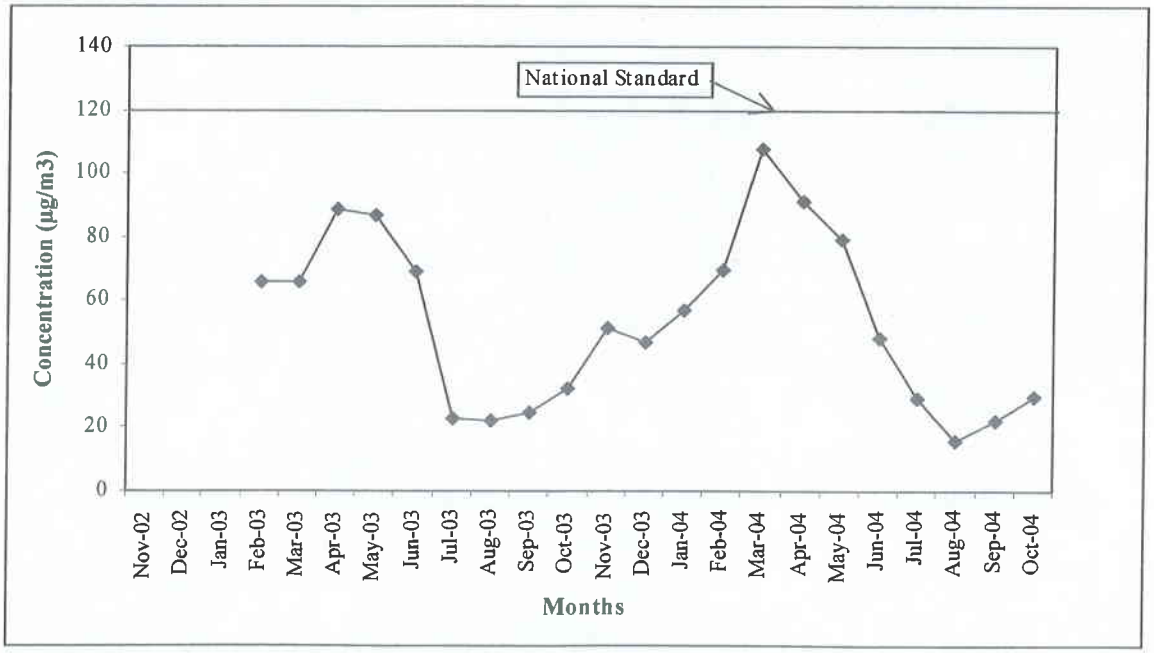

Fig 7: Monthly Average PM_{10} variation at Matsyagoan

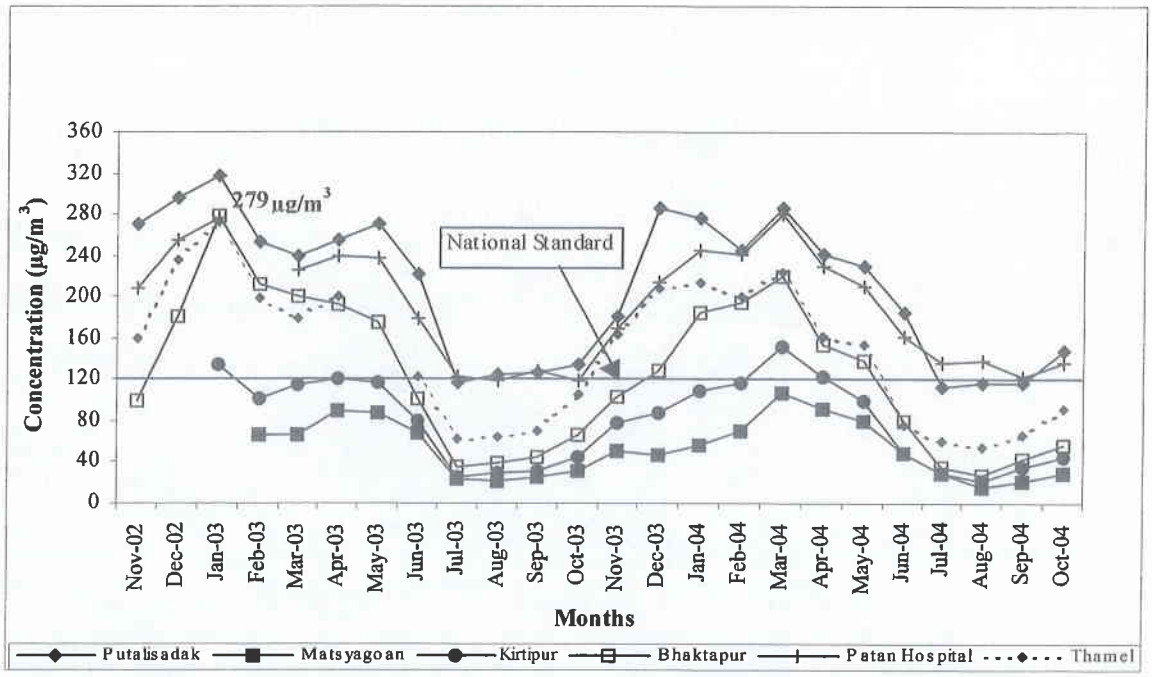

Fig 8: Seasonal Variation of PM_{10} at Different Monitoring Stations of Kathmandu valley

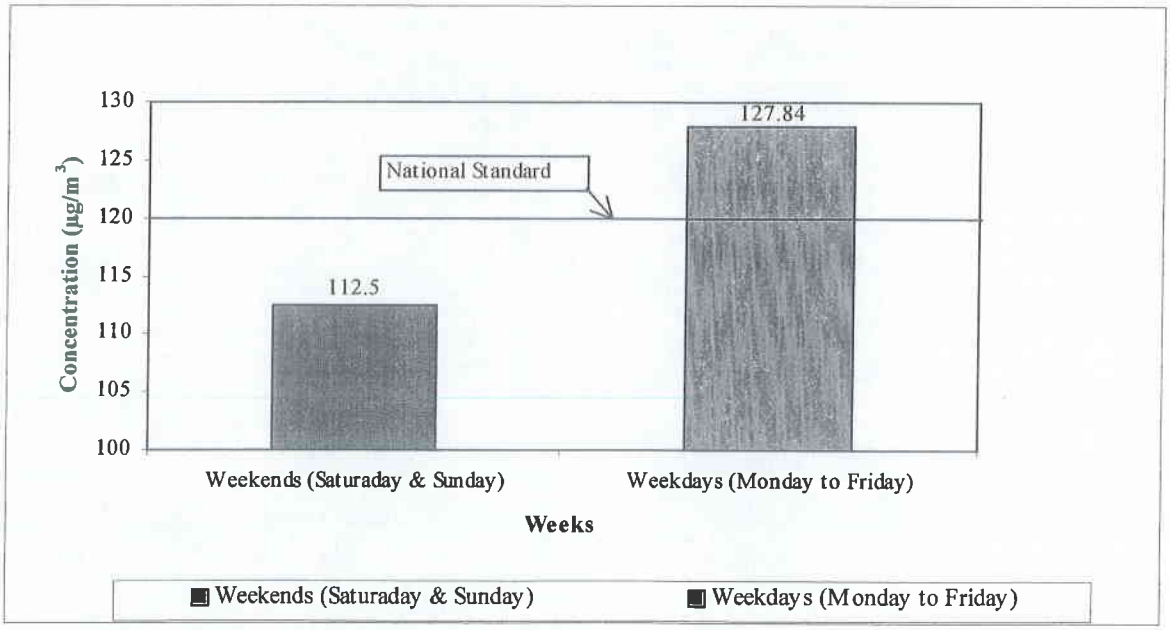

Fig 9: Weekly Average PM_{10} variation at Putalisadak

5.2 Air Pollution and Human Health

Analyzing the records of major hospitals of Kathmandu, it gives an indication of the Kathmandu's pollution impact on public health.

There are four major public hospitals in Kathmandu namely, Patan Hospital, Bir Hospital, Tribhuwan University Teaching Hospital (TUTH), and Kanti Children Hospital. Beside these public hospitals, there are few other hospitals and nursing homes run by private sector to cater the health needs of the richer people of the society.

This study assesses the records of in-patients from the past ten years of the three major hospitals (Patan Hospital, Bir Hospital and TUTH) in Kathmandu. The study obtained records of the in-patients only that suffered from COPD. All the records were directly obtained from the respective hospital's Medical Record Section.

The following Table 5 and Fig 10 just reveals the trend in the number of patients with COPD case in Kathmandu. However, this study does not take into account the number of COPD patients suffered due to the exposure to ambient air pollution. Since the data of air pollution is of two years only (November 2002 – October 2004) correlation between air pollution and COPD patient number could not be studied.

The monthly or seasonal variation of COPD patients somewhat coincide with the PM_{10} concentration in Kathmandu. During the winter season, when the PM_{10} concentration was found higher, the COPD patient number also showed the same trend although this needs to be empirically verified. (Table 6 and Fig 11)

Table 5: Records of COPD Patients in Major Hospitals of Kathmandu valley (1994/95-2003/04)

Year	COPD Patients		
	Patan Hospital	Bir Hospital	TUTH Hospital
1994/95		335	225
1995/96		370	320
1996/97	407	294	381
1997/98	486	221	496
1998/99	611	251	487
1999/2000	817	351	510
2000/01	882	391	576
2001/02	749	388	568
2002/03	849	416	467
2003/04	803	454	575

Source: Medical Record Section of the respective hospitals

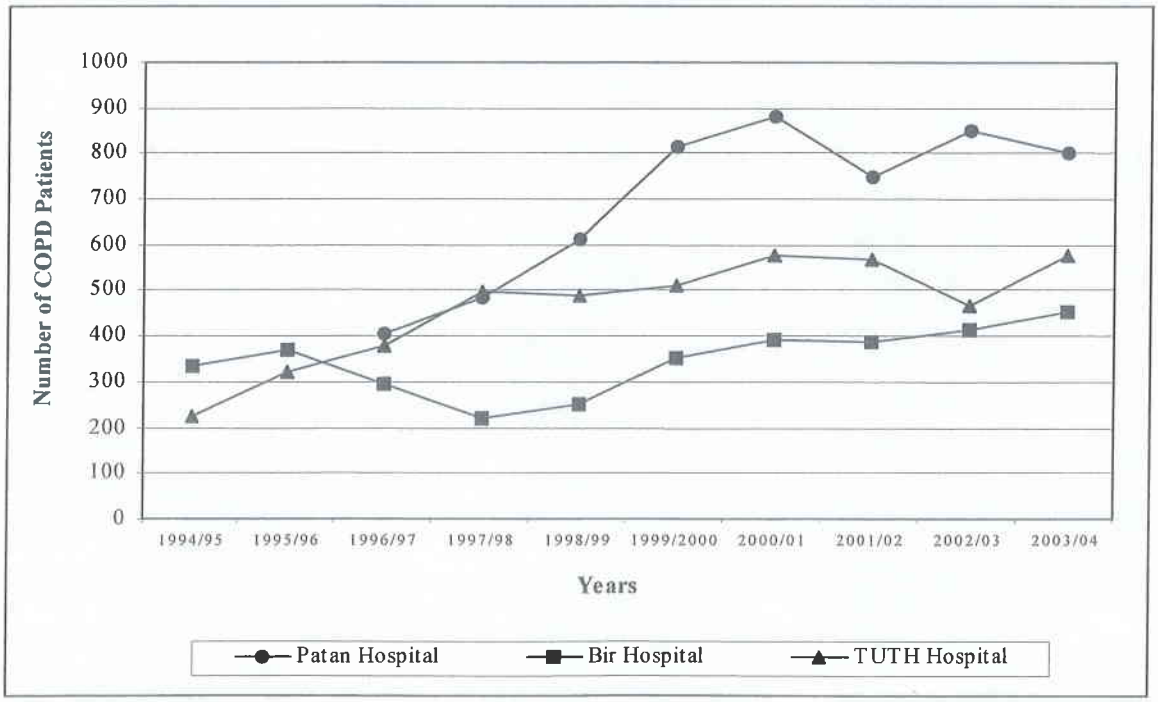

Fig 10: Yearly Trend of COPD Patients of the Major Kathmandu Hospitals (1994/95-2003/04)

Table 6: Monthly variation of COPD Patients (Patan Hospital) and PM_{10} level at Patan Hospital Air Monitoring Station (2003/04)

Months	COPD Patients	Monthly Average PM_{10} Level
mid Apr - mid May	63	248.9
mid May - mid Jun	82	219.7
mid Jun - mid Jul	60	130.3
mid Jul - mid Aug	49	125.4
mid Aug - mid Sept	34	126
mid Sept - mid Oct	34	113.2
mid Oct - mid Nov	52	144.2
mid Nov - mid Dec	63	189.8
mid Dec - mid Jan	104	241.3
mid Jan - mid Feb	85	231.2
mid Feb - mid Mar	80	249.6
mid Mar - mid Apr	97	278.4

Source: COPD data : Medical Record Section of Patan Hospitals
PM_{10} data : MOPE's website (www.mope.gov.np)

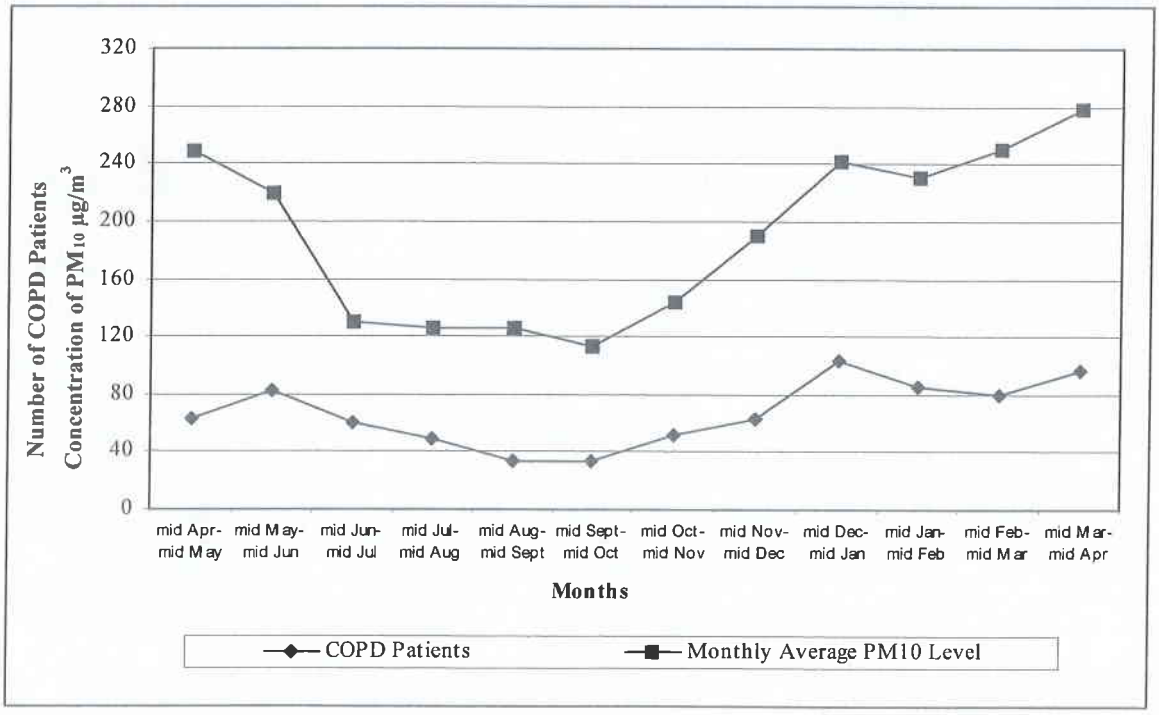

Fig 11: Monthly variation of COPD Patients (Patan Hospital) and PM_{10} level at Patan Hospital Air Monitoring Station (2003/04)

5.3 Review of the existing Legislation and Action Plan

In order to mitigate air pollution problems faced by our country, HMG has adopted various Acts, Legislations and Policies.

Some of these Acts, Legislations and Policies that address the air pollution nationwide are as follow:

(i) The constitution of the Kingdom of Nepal 1990:

The constitution arranges for the duty of the state to incorporate environment matters into its policy process. Under Part IV Directive Principles and policies of the state, it is clearly stated in the Article 26(4) that "The state shall give priority to the protection of the environment also to the prevention of its future damage due to physical developmental 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 the vegetation".

(ii) Industrial Enterprise Act 1992

This Act grants a reduction of up to 50% on the taxable income of any industry invested in pollution minimization equipment or process.

(iii) Vehicles and Transport Management Act 1993

This Act deals with the provision concerning with the means of transport which are to be operated keeping the pollution level under control. Section 14(1) has made compulsory to register any vehicles that is purchased or imported and 14(2) prohibit the use of vehicles without registration. Section 17 authorized

to test the vehicles according to the criteria prescribed under section 23 of he Act. This includes:

(a) Mechanical condition of the vehicles

(b) Amount of pollution discharged by the vehicles

(c) Life span of the vehicles

(d) Make or appearance of the vehicles

According to this section 23, government has set emission standard to check vehicular emission in Kathmandu valley. The government specified; smoke density of diesel engine should not exceed 65 Hartridge Smoke Unit (HSU) and CO emitted by petrol engine vehicles should not exceed 3 percent by volume. However, later this limit has been brought down by 75 HSU and 4.5 percent by volume respectively.

(www.rrcap.uneporg/issues/air/maledec/Baseline/Nepal/NEPCH5.htm)

(iv) Environment Protection Act, 1996

Environment Protection Act 1996 and Environment Protection Rules 1997 has been brought into existence in order to give effect to constitutional provisions. These Act and Rules have made provision dealing with pollution control, initial environment examination and environmental impact assessment, conservation of national heritage, establishment of environment protection fund, declaration of protected zone etc. Pollution control and environment assessments are the main goal of this Act.

5.3.1 Response to curb Air Pollution Problem in Kathmandu

(i) Government Policy

HMG has introduced several policies in order to curb air pollution problems in Kathmandu valley. (See Box 2). In 1991, Government banned on the import of three-wheeler into the valley. Then in 1995, HMG introduced tail pipe emission standard of 65 HSU for diesel vehicles and 3 percent for CO for gasoline vehicles in Kathmandu. But after two and half years, in 1998, HMG relaxed the diesel smoke to 75 HSU for the vehicles manufactured till 1994 and CO limited for gasoline vehicles to 4.5 percent for four wheeler manufactured till 1998.[27] (Table 7)

Table 7: Emission Standard of CO and HSU

For Gasoline Vehicles	Permissible Smoke Unit(CO in percent)
Up to 1980 manufactured four wheeler vehicle 1981 and later manufactured vehicles	4.5 3.0
Up to 1991 manufactured three wheeler vehicle	4.5
For two wheeler vehicle	4.5
For Diesel Vehicles	HSU
Up to 1994 manufactured all types of vehicles	75
1995 and after manufactured vehicles	65

Source: MOPE, 1998

The Table 8 below reveals that only 75% of the total test indicate the compliance with the emission standard of CO and HSU.

Table 8: Vehicle Emission Test Result (CO test for Petrol Engines and HSU for Diesel Engines)

Year	Vehicles Tested	Pass	Fail
1995/96	486	162	324
1996/97	41466	25220	16246
1997/98	31173	22984	8189
1998/99	28018	24240	3778
1999/2000	42826	34255	8571
2000/2001	34543	29034	5509

[27] HMG/MOPE, ***STATE OF THE ENVIRONMENT, NEPAL,*** Kathmandu, Nepal, 1998.

Year	Vehicles Tested	Pass	Fail
2001/2002	33378	24462	8916
2002/2003	32894	23698	9196
Total	244784	184055	60729

Source: Valley Traffic Police, 2003

In 1999, HMG took a bold step by removing 600 diesel three-wheelers from Kathmandu. In 2000, MOPE introduced the Nepal Vehicular Mass Emission for new vehicles. Realizing the effects of the old vehicles in air pollution level in Kathmandu, MOPE in the later part of 2000 announced a ban in all public vehicles older than 20 years and all two-stroke three-wheelers in Kathmandu valley effective from 16th November 2001. (http://www.cen.org.np).

The Constitution of Kingdom of Nepal 1990, Industrial Enterprise Act 1992, Vehicles and Transport Management Act 1993, Environmental Protection Act 1996, emphasized on the need of clean air. Even National Conservation Strategy 1998, Nepal Environmental Policy and Action Plan 1993, The Eight Five Year Plan 1992-1997, The Ninth Five Year Plan 1997-2002, The Tenth Five Year Plan 2002-2007 have made provision for the formulation for the air control management plan.

Recently, in March 2002, HMG has announced to ban on polluting Bull's Trench Kiln from Kathmandu valley and after one and half year, it has already announced to stop registration of these kilns. (http://www.cen.org.np)

Box 2

VALLEY AIR QUALITY SHOWS IMPROVEMENT

BY KIRAN CHAPAGAIN
KATHAMNDU, February 20

At last, there is good news regarding air pollution in the Kathmandu valley. A recent Post study has revealed that air quality in the valley has improved significantly this year." The air quality in the valley this year improved by 16 per cent this year (2003-2004) as compared to last year (2002-2003)," Chiranjibi Gautam, Advisor of the Air Quality Monitoring project of Environment Sector Programme Support (ESPS), told The Kathmandu.

The study shows that concentration of fine dust particles, known as PM_{10}, has come down to 175 micrograms per cubic meter this winter against 210 micrograms last winter. However, the valley air is still

unhealthy as it contains PM_{10} above the safe limit of 120 microgram. Yet, the reduction is a great relief since the concentration of PM_{10} at some places like Putalisadak and Patan Hospital areas had at times crossed even 425 micrograms.

Thanks goes to air joint quality improvement measures initiated by the Ministry of Population and Environment (MOPE) and ESPS, a DANIDA-supported project at the ministry.

The first of its kind since MOPE began regular monitoring of air quality in the valley since November 2002, the study is based on the analysis of pollution data obtained from six valley based air quality monitoring stations set up last year.

The government, in collaboration with ESPS, had started adopted a number of air pollution monitoring and control measures in 2003, and the improvement can largely be attributed to them.

MOPE began vehicular emission-monitoring programme on June 5, 2003 in collaboration with the Valley Traffic Police Office (VTPO). In this programme, a joint team of MOPE and VTPO monitors black smoke belching vehicles and takes necessary actions against them.

Likewise, the Department of Transport Management has installed the latest Four-Gas Tester and Opacity Meter, and has tightened the awarding of green stickers. Vehicles are the major source of PM_{10} in the valley.

Similarly, environment friendly and energy efficient technology has been adopted by replacing traditionally operated brick kilns, which come after vehicles in contributing to the valley's pollution.

Out of the 120 old kinds of brick kilns in the valley, ESPS supported 40, which is less polluting than the traditional ones, to adopt the new technology. The brick kilns, which are a significant source of PM_{10}, usually come into operation during the winter season, which leads to a significant rise in the pollution level of the valley at that time. Over a dozen illegally run brick kilns have already been demolished so far.

An intensive training program conducted by the government also contributed to the improvement in the air quality. Over 400 automobile technicians working in vehicle workshops in the valley were trained under the Vehicles Anti-pollution Training Programme. They were mainly given instructions on the proper maintenance of vehicles from the environmental point of view.

Another major anti-pollution measure taken by the government was the phasing out of as many as 2,400 two-stroke engine three wheelers that was started last year. Two-stroke engines are supposedly 12 times more polluting than four-stroke ones.

PM_{10} is the only air polluting challenge to the valley air. It is the major cause behind growing cases of heart diseases, asthma, respiratory problems and other diseases among the valley residents.

Source: THE KATHMANDU POST, Saturday, February 21, 2004

(ii) Municipalities

Kathmandu valley compromises of five municipalities namely- Kathmandu, Lalitpur, Bhaktapur, Madhyapur Thimi and Kirtipur. In order to control air pollution, few steps have been taken up by the Kathmandu metropolitan. It has environment department and it is also involved in public education through community, groups, schools and weekly radio programmes. It also sees to the building infrastructure required for air pollution control such as construction of roads, overheads bridge etc.

(iii) Non Government Organization

Several Non Government Organization like ENPHO, LEADERS Nepal, Clean Energy Nepal etc have been involved in research, advocacy, public awareness and pilot project demonstration works related to air pollution control.

(iv) International Organization

Some of the International Organization like ESPS/MOPE, IUCN, ICIMOD are working in air pollution monitoring research and information dissemination work. Recently MOPE had established six monitoring stations in Kathmandu valley to collect air pollution data and then plan for its management and improvement. It has also set the National Standard for ambient level of classic air pollutant. Currently PM_{10} has become a major problem in Kathmandu air so the government has set target to meet the standard value within 3 years from the date of Standard Setting.

CHAPTER –VI

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

It is seen that in comparison with NAAQS and other International Standard, the level of PM_{10} within the Kathmandu valley is comparatively high. The total average of PM_{10} at six monitoring stations was calculated to be 139.75μg/m^3 from November 2002 – October 2004. Among the six monitoring stations the most polluted monitoring site was found out to be Putalisadak with a monthly average PM_{10} concentration of 210.36μg/m^3, whereas the least polluted site was Matsyagaon with a monthly average PM_{10} concentration of 53.67 μg/m^3.

The monitoring stations located near the traffic flow area have high PM_{10} concentration crossing the National Standard, whereas the traffic free area has low PM_{10} concentration.

There is a seasonal variation in the PM_{10} concentration in Kathmandu's air. The level of PM_{10} is extremely high especially in dry winter months. In these months the air in the urban Kathmandu especially along the roadsides can be classified as either "Very Unhealthy" or even "Hazardous". In case of monsoon months the PM_{10} concentration is relatively low. This is probably because of the rain flushing down the particles in the air and significantly reducing the pollutant level.

The hospital records reveal that there is an increase in the number of patients being suffered from COPD in Kathmandu's public hospitals. Similarly, the seasonal variation of COPD patients also coincides with the PM_{10} concentration of Kathmandu's air. During the dry winter season when

the PM_{10} concentration was found higher, the COPD patients number also shows the same trend.

Considering the fact that Kathmandu's air is polluted, the government has laid down some laws and regulations dealing with the urban air pollution control. It has also implemented some of the policy measures to curve the urban air pollution with emphasis to Kathmandu valley.

6.2 Recommendations

Based on the conclusion mentioned above, this study recommends the following actions:

(i) From this study it has seen that PM_{10} has become a major problem in Kathmandu's air. Immediate implementation of the action plan should be undertaken seriously in order to bring down the concentration of the fine particles of Kathmandu's air.

(ii) As vehicles are the major cause of air pollution in Kathmandu valley, this study strongly recommends to find out the bottlenecks on the vehicular emission control system and work towards reducing emission from vehicles.

(iii) There is an urgent need to extend the regular air quality monitoring programme also in other urban cities of Nepal too.

(iv) While addressing the problem of air pollution, the cost of human health should be kept in mind by the policy makers.

(v) The government should take drastic initiative to improve road networks and other transportation infrastructure.

(vi) Public awareness campaigns are required in order to impart the knowledge about the air pollution hazards and its preventive methods.

Above all, in order to improve Kathmandu's air pollution, the government should take up an effective action plan in prior consultation with the stakeholders and take strong measures to implement it. As stated in the Box 3 (below), comprehensive plans and policies should be effectively implemented so that the current level of air pollution will be lowered, which will free city residents not only from health hazards, but also from economic burden.

Box 3

Pay what you owe, and you'll know what is your own.
- Benjamin Franklin -

Air Pollution

The pollution levels in Kathmandu, especially during winter, are comparable to some of the most polluted cities in the world. High concentration of fine dust particles in Kathmandu's air is the main problem. Although pollutants such as CO_2, SO_2, NO_2 are within national and international standards, the PM_{10} (particles smaller than 2.5 micron in size that can directly enter lungs) is alarmingly high. As the current level of pollution is still beyond the safe limit, the health of the residents of Kathmandu valley is under assault.

The PM_{10} has increased by more than four times in eight years although the government has phased out smoke-belching diesel-run three wheelers from the valley. The number of vehicles on the streets of Kathmandu has increased at an alarming rate. The pollution from vehicles is mainly because of the large number of vehicles on congested streets. In 2000, the number of vehicles plying on the streets of Kathmandu exceeded the valley's capacity by about 30,000. While the number of vehicles as shot up in recent years, the road infrastructure has remained constant. As a result, road accidents and traffic jams have become a regular phenomenon.

The testing of emission conducted by the government has been ineffective as many drivers manage to hoodwink the authorities concerned. It is reported that 25 percent of the smoke-belching vehicles do not clear the emission test. And there is no mechanism to punish such vehicles, which would have, otherwise, helped lower the air pollution. The quality of fuel and lubricants used in vehicles is another factor that contributes to Kathmandu's air pollution. The use of diesel with high sulfur content increases the emission of fine particles and poor quality lubricants also cause an increase in emission.

Kathmandu is vulnerable to air pollution because of rapid and haphazard urbanization. There is no mechanism that monitors the construction of new buildings. Every institution has become toothless and ineffective, thanks to rampant corruption. Effective emission test and proper distribution of green stickers to those vehicles, which clear the test, will certainly lower the air pollution. Mere ad hoc committees and random implementation of environmental programs will not produce the desired results. The faster expansion of the city's fleet of vehicles poses a serious environmental threat in the form of urban air pollution. Effective implementation of comprehensive plans and policies can only lower the current level of air pollution, which will free city residents not only from health hazards, but also from economic burden.

Source : THE KATHMANDU POST, Wednesday, November 10, 2004.

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(http://www.cen.org.np).

ANNEX
Detail Results

NOVEMBER, 2002						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**PatanHospital**	**Thamel**
1/11/02	N/A	N/A	N/A	119	N/A	170
2/11/02	N/A	N/A	N/A	108	N/A	163
3/11/02	N/A	N/A	N/A	100	N/A	184
4/11/02	N/A	N/A	N/A	105	N/A	190
5/11/02	N/A	N/A	N/A	104	N/A	171
6/11/02	N/A	N/A	N/A	72	N/A	124
7/11/02	N/A	N/A	N/A	78	N/A	128
8/11/02	N/A	N/A	N/A	93	N/A	136
9/11/02	N/A	N/A	N/A	93	N/A	137
10/11/02	N/A	N/A	N/A	100	N/A	150
11/11/02	N/A	N/A	N/A	77	N/A	109
12/11/02	N/A	N/A	N/A	71	N/A	98
13/11/02	N/A	N/A	N/A	46	N/A	57
14/11/02	N/A	N/A	N/A	73	N/A	109
15/11/02	N/A	N/A	N/A	72	N/A	121
16/11/02	N/A	N/A	N/A	83	N/A	126
17/11/02	N/A	N/A	N/A	83	N/A	165
18/11/02	N/A	N/A	N/A	74	N/A	146
19/11/02	N/A	N/A	N/A	95	N/A	158
20/11/02	N/A	N/A	N/A	106	N/A	161
21/11/02	N/A	N/A	N/A	119	N/A	214
22/11/02	N/A	N/A	N/A	126	N/A	185
23/11/02	N/A	N/A	N/A	125	N/A	176
24/11/02	N/A	N/A	N/A	114	N/A	171
25/11/02	N/A	N/A	N/A	150	N/A	231
26/11/02	N/A	N/A	N/A	121	185	196
27/11/02	256	N/A	N/A	115	222	209
28/11/02	287	N/A	N/A	127	217	205
29/11/02	286	N/A	N/A	135	220	221
30/11/02	256	N/A	N/A	124	198	200
Monthly Average	**271**	**N/A**	**N/A**	**100**	**208**	**160**

DECEMBER, 2002						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**PatanHospital**	**Thamel**
1/12/02	257	N/A	N/A	126	200	176
2/12/02	262	N/A	N/A	133	213	179
3/12/02	267	N/A	N/A	151	229	197
4/12/02	304	N/A	N/A	112	240	222
5/12/02	297	N/A	N/A	121	231	213
6/12/02	288	N/A	N/A	120	205	203
7/12/02	254	N/A	N/A	133	286	240
8/12/02	263	N/A	N/A	114	255	177
9/12/02	267	N/A	N/A	111	227	178
10/12/02	284	N/A	N/A	132	206	196
11/12/02	278	N/A	N/A	125	232	205
12/12/02	310	N/A	N/A	129	222	216

DECEMBER, 2002						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**PatanHospital**	**Thamel**
13/12/02	301	N/A	N/A	141	205	210
14/12/02	261	N/A	N/A	146	194	200
15/12/02	291	N/A	N/A	144	205	194
16/12/02	271	N/A	N/A	147	227	209
17/12/02	281	N/A	N/A	177	261	236
18/12/02	277	N/A	N/A	187	262	240
19/12/02	346	N/A	N/A	226	311	273
20/12/02	333	N/A	N/A	215	281	270
21/12/02	284	N/A	N/A	207	245	225
22/12/02	350	N/A	N/A	202	259	286
23/12/02	359	N/A	N/A	212	264	328
24/12/02	367	N/A	N/A	273	365	302
25/12/02	345	N/A	N/A	261	339	308
26/12/02	339	N/A	N/A	256	317	286
27/12/02	342	N/A	N/A	215	320	291
28/12/02	310	N/A	N/A	254	290	247
29/12/02	204	N/A	N/A	265	245	291
30/12/02	N/A	N/A	N/A	284	283	278
31/12/02	N/A	N/A	N/A	278	275	N/A
Monthly Average	**296**	**N/A**	**N/A**	**181**	**255**	**236**
JANUARY, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**PatanHospital**	**Thamel**
1/1/03	N/A	N/A	65	145	157	240
2/1/03	407	N/A	111	210	283	270
3/1/03	435	N/A	133	245	309	348
4/1/03	303	N/A	112	279	296	261
5/1/03	349	N/A	115	261	299	289
6/1/03	340	N/A	114	271	330	305
7/1/03	295	N/A	130	261	299	281
8/1/03	343	N/A	102	248	282	249
9/1/03	290	N/A	114	236	264	247
10/1/03	318	N/A	118	244	297	300
11/1/03	266	N/A	129	248	242	259
12/1/03	301	N/A	138	244	254	291
13/1/03	313	N/A	128	250	303	287
14/1/03	305	N/A	117	254	289	266
15/1/03	328	N/A	128	300	317	309
16/1/03	321	N/A	131	297	356	306
17/1/03	305	N/A	136	298	139	298
18/1/03	319	N/A	129	298	N/A	295
19/1/03	325	N/A	136	347	N/A	302
20/1/03	349	N/A	131	317	N/A	303
21/1/03	307	N/A	124	337	N/A	266
22/1/03	283	N/A	138	292	N/A	257
23/1/03	296	N/A	164	299	N/A	250

JANUARY, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**PatanHospital**	**Thamel**
24/1/03	318	N/A	157	314	N/A	279
25/1/03	317	N/A	172	368	N/A	269
26/1/03	314	N/A	221	323	N/A	310
27/1/03	374	N/A	206	362	N/A	303
28/1/03	416	N/A	269	384	N/A	369
29/1/03	221	N/A	118	270	N/A	85
30/1/03	210	N/A	90	200	N/A	176
31/1/03	237	N/A	98	236	N/A	198
Monthly Average	**317**	**N/A**	**135**	**279**	**277**	**273**
FEBRUARY, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/2/03	132	N/A	55	90	N/A	106
2/2/03	201	N/A	91	166	N/A	156
3/2/03	313	N/A	95	215	N/A	256
4/2/03	464	N/A	146	258	N/A	309
5/2/03	324	N/A	114	259	N/A	234
6/2/03	282	N/A	89	240	N/A	246
7/2/03	260	N/A	101	233	N/A	222
8/2/03	245	N/A	109	230	N/A	212
9/2/03	298	N/A	102	268	N/A	231
10/2/03	278	N/A	96	238	N/A	203
11/2/03	292	N/A	103	252	N/A	241
12/2/03	274	N/A	102	252	N/A	222
13/2/03	259	N/A	121	261	N/A	223
14/2/03	275	N/A	127	288	N/A	243
15/2/03	266	110	159	302	N/A	245
16/2/03	260	104	152	265	N/A	234
17/2/03	291	108	168	284	N/A	245
18/2/03	283	84	137	284	N/A	213
19/2/03	88	24	36	103	N/A	102
20/2/03	213	32	53	148	N/A	127
21/2/03	227	41	82	178	N/A	184
22/2/03	224	50	75	165	N/A	188
23/2/03	232	54	92	186	N/A	181
24/2/03	234	56	81	175	N/A	150
25/2/03	198	72	99	161	N/A	127
26/2/03	167	69	82	109	N/A	112
27/2/03	217	55	90	141	N/A	135
28/2/03	277	N/A	110	173	N/A	197
Monthly Average	**253**	**66**	**102**	**212**	**N/A**	**198**
MARCH, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/3/03	304	55	112	280	157	263
2/3/03	354	75	168	308	154	278

MARCH, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
3/3/03	327	62	124	276	205	217
4/3/03	268	68	130	218	N/A	211
5/3/03	307	86	164	249	N/A	233
6/3/03	306	141	197	280	399	266
7/3/03	253	52	151	240	378	228
8/3/03	224	83	125	234	231	186
9/3/03	234	91	138	218	276	203
10/3/03	N/A	94	143	230	300	214
11/3/03	N/A	72	140	257	272	212
12/3/03	N/A	69	100	202	204	165
13/3/03	260	32	69	119	180	124
14/3/03	216	45	88	189	260	157
15/3/03	205	56	96	176	225	142
16/3/03	220	57	107	199	180	163
17/3/03	145	40	87	163	170	139
18/3/03	235	40	90	164	201	147
19/3/03	275	60	127	180	231	174
20/3/03	242	77	121	226	273	183
21/3/03	250	97	133	211	258	194
22/3/03	222	96	128	222	194	182
23/3/03	194	92	107	198	206	152
24/3/03	145	60	87	142	166	124
25/3/03	155	41	77	104	182	127
26/3/03	188	54	94	165	225	130
27/3/03	172	44	97	140	212	161
28/3/03	332	57	107	185	241	167
29/3/03	201	64	100	178	196	128
30/3/03	208	42	68	108	164	117
31/3/03	270	55	94	144	202	148
Monthly Average	**240**	**66**	**115**	**200**	**256**	**179**
APRIL, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/4/03	224	63	102	158	217	157
2/4/03	216	82	119	171	222	163
3/4/03	282	92	129	178	241	188
4/4/03	202	56	81	129	167	127
5/4/03	165	47	69	139	143	125
6/4/03	239	45	76	168	156	151
7/4/03	272	65	117	200	232	181
8/4/03	329	74	130	236	263	228
9/4/03	350	102	165	261	313	236
10/4/03	307	115	186	289	356	290
11/4/03	366	124	195	309	309	271
12/4/03	316	138	185	250	315	269

APRIL, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
13/4/03	320	134	148	233	286	255
14/4/03	197	72	126	162	227	148
15/4/03	222	58	121	170	260	137
16/4/03	250	73	114	146	354	162
17/4/03	213	50	108	128	243	166
18/4/03	226	87	121	178	N/A	205
19/4/03	277	103	127	206	N/A	228
20/4/03	142	73	87	162	N/A	88
21/4/03	248	100	148	228	N/A	185
22/4/03	332	121	126	241	N/A	235
23/4/03	231	122	121	231	186	248
24/4/03	284	132	114	209	291	334
25/4/03	305	122	108	240	250	324
26/4/03	235	100	121	213	236	266
27/4/03	203	62	127	156	211	37
28/4/03	157	71	60	100	91	N/A
29/4/03	N/A	N/A	80	117	145	N/A
30/4/03	N/A	N/A	100	148	285	N/A
Monthly Average	**254**	**89**	**120**	**192**	**240**	**200**
MAY, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/5/03	N/A	N/A	102	126	264	N/A
2/5/03	N/A	N/A	64	134	159	N/A
3/5/03	N/A	N/A	99	148	250	N/A
4/5/03	272	N/A	100	137	181	N/A
5/5/03	364	189	200	241	331	N/A
6/5/03	427	N/A	209	295	378	N/A
7/5/03	415	N/A	227	318	386	N/A
8/5/03	455	298	194	325	395	N/A
9/5/03	251	75	162	208	296	N/A
10/5/03	243	83	100	161	187	N/A
11/5/03	221	71	87	124	213	N/A
12/5/03	176	54	73	105	220	N/A
13/5/03	192	60	96	124	196	N/A
14/5/03	251	62	109	157	237	N/A
15/5/03	241	63	103	159	210	N/A
16/5/03	253	64	92	143	235	N/A
17/5/03	160	61	86	133	177	N/A
18/5/03	213	50	91	140	183	N/A
19/5/03	200	63	N/A	133	220	N/A
20/5/03	245	73	N/A	155	225	N/A
21/5/03	268	80	109	164	210	N/A
22/5/03	172	45	52	106	152	N/A
23/5/03	204	47	70	125	227	N/A
24/5/03	187	64	73	108	148	N/A

MAY, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
25/5/03	164	80	88	135	178	N/A
26/5/03	305	100	129	184	229	N/A
27/5/03	348	136	166	208	256	N/A
28/5/03	332	N/A	145	190	227	N/A
29/5/03	324	N/A	N/A	243	252	N/A
30/5/03	385	N/A	N/A	298	299	N/A
31/5/03	295	N/A	N/A	208	232	N/A
Monthly Average	**270**	**87**	**116**	**175**	**237**	**N/A**
JUNE, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/6/03	285	120	122	188	234	93
2/6/03	208	102	114	156	199	90
3/6/03	264	83	114	147	261	63
4/6/03	137	22	50	69	173	88
5/6/03	241	19	66	88	230	108
6/6/03	295	28	82	113	185	120
7/6/03	218	75	70	105	136	118
8/6/03	225	47	42	93	183	104
9/6/03	250	52	60	103	181	133
10/6/03	244	135	138	174	203	189
11/6/03	381	196	184	236	303	262
12/6/03	450	226	228	219	330	312
13/6/03	461	243	245	258	350	312
14/6/03	203	88	110	143	183	177
15/6/03	283	82	91	119	226	164
16/6/03	160	67	77	74	209	114
17/6/03	244	55	67	83	220	131
18/6/03	162	45	61	79	180	108
19/6/03	201	28	31	68	129	82
20/6/03	156	30	37	49	120	69
21/6/03	165	30	38	46	94	72
22/6/03	82	27	28	42	131	65
23/6/03	117	31	34	43	87	67
24/6/03	78	30	38	46	108	59
25/6/03	144	35	34	44	111	79
26/6/03	129	34	44	50	116	87
27/6/03	N/A	33	53	53	135	90
28/6/03	N/A	27	31	39	100	110
29/6/03	226	35	45	47	107	96
30/6/03	165	56	68	74	172	105
Monthly Average	**221**	**69**	**80**	**102**	**180**	**122**
JULY, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/7/03	115	37	43	61	124	69

JULY, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
2/7/03	133	43	44	55	137	75
3/7/03	149	28	28	37	131	54
4/7/03	40	25	32	36	85	44
5/7/03	117	29	35	37	121	61
6/7/03	149	21	23	32	107	59
7/7/03	226	21	19	33	95	80
8/7/03	90	17	17	27	57	45
9/7/03	36	21	19	28	87	38
10/7/03	126	19	26	38	158	64
11/7/03	170	20	19	33	194	73
12/7/03	98	22	23	36	155	58
13/7/03	148	27	33	34	97	62
14/7/03	113	22	25	32	81	59
15/7/03	189	30	28	35	116	70
16/7/03	108	31	38	71	181	66
17/7/03	84	28	28	31	117	53
18/7/03	63	25	33	33	130	50
19/7/03	81	28	32	35	78	71
20/7/03	104	20	24	31	106	88
21/7/03	134	20	25	36	153	63
22/7/03	118	19	32	39	197	61
23/7/03	167	17	19	35	113	65
24/7/03	129	35	28	46	112	84
25/7/03	136	24	23	36	151	98
26/7/03	87	13	17	26	77	55
27/7/03	98	18	24	41	159	58
28/7/03	102	21	30	33	190	72
29/7/03	122	20	20	32	134	57
30/7/03	77	11	16	24	98	42
31/7/03	88	13	16	23	57	48
Monthly Average	**116**	**23**	**26**	**36**	**123**	**63**
AUGUST, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/8/03	126	16	21	33	112	60
2/8/03	65	21	22	30	55	47
3/8/03	139	22	27	34	118	68
4/8/03	156	22	33	40	188	85
5/8/03	92	27	34	43	170	66
6/8/03	118	22	28	38	114	74
7/8/03	123	26	30	33	130	75
8/8/03	276	17	25	29	88	64
9/8/03	193	21	29	39	110	73
10/8/03	155	25	31	38	119	67
11/8/03	123	23	37	48	103	63
12/8/03	116	23	28	79	87	56

AUGUST, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
13/8/03	126	22	28	46	135	74
14/8/03	155	33	37	51	202	82
15/8/03	203	30	34	48	165	71
16/8/03	131	30	35	43	126	73
17/8/03	94	24	35	30	118	57
18/8/03	40	12	17	33	49	42
19/8/03	36	14	15	29	59	39
20/8/03	80	22	28	42	74	58
21/8/03	130	18	39	48	181	93
22/8/03	133	22	32	46	211	79
23/8/03	102	17	16	31	124	58
24/8/03	130	20	29	31	148	72
25/8/03	107	26	33	36	107	62
26/8/03	138	24	31	39	91	71
27/8/03	144	22	36	40	92	61
28/8/03	153	22	25	32	117	67
29/8/03	117	27	51	35	108	58
30/8/03	114	22	N/A	41	82	58
31/8/03	60	19	33	28	71	46
Monthly Average	**125**	**22**	**30**	**39**	**118**	**65**
SEPTEMBER, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/9/03	125	23	32	31	105	56
2/9/03	93	20	24	34	79	54
3/9/03	140	21	24	36	122	69
4/9/03	167	25	29	34	110	64
5/9/03	142	20	26	39	131	54
6/9/03	97	25	34	43	139	60
7/9/03	158	22	26	39	117	65
8/9/03	146	22	29	47	145	73
9/9/03	139	25	34	49	117	82
10/9/03	102	26	38	48	161	72
11/9/03	121	32	35	49	178	68
12/9/03	150	34	34	45	140	79
13/9/03	81	24	27	42	123	54
14/9/03	91	28	34	44	166	55
15/9/03	132	24	32	36	188	56
16/9/03	142	24	38	41	216	81
17/9/03	152	25	34	46	156	88
18/9/03	46	21	22	33	52	42
19/9/03	67	24	26	40	60	63
20/9/03	57	22	24	34	72	56
21/9/03	97	21	22	38	74	57
22/9/03	142	29	35	52	172	86
23/9/03	112	27	33	47	86	60

SEPTEMBER, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
24/9/03	72	23	36	54	69	65
25/9/03	197	29	51	71	140	87
26/9/03	220	26	47	61	163	104
27/9/03	196	21	26	55	111	95
28/9/03	157	26	40	46	159	93
29/9/03	161	33	46	63	182	90
30/9/03	83	23	30	42	96	63
Monthly Average	**126**	**25**	**32**	**45**	**128**	**70**
OCTOBER, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/10/03	168	22	34	54	126	95
2/10/03	147	19	33	47	148	93
3/10/03	121	28	40	61	113	89
4/10/03	106	32	41	56	114	87
5/10/03	108	27	34	47	78	87
6/10/03	91	31	34	45	101	88
7/10/03	97	32	35	46	101	94
8/10/03	99	30	34	42	103	77
9/10/03	92	25	28	37	83	61
10/10/03	107	22	28	40	97	64
11/10/03	109	27	40	49	98	91
12/10/03	143	30	46	61	125	106
13/10/03	148	29	44	68	135	114
14/10/03	143	36	54	74	148	121
15/10/03	156	42	55	77	150	122
16/10/03	155	38	54	82	129	122
17/10/03	159	34	48	78	111	115
18/10/03	127	38	46	68	109	115
19/10/03	151	32	51	86	115	116
20/10/03	189	35	63	92	138	140
21/10/03	185	32	57	86	116	142
22/10/03	173	45	65	105	138	142
23/10/03	186	45	66	102	175	139
24/10/03	205	58	90	109	182	160
25/10/03	172	57	66	87	123	129
26/10/03	114	36	39	78	111	98
27/10/03	93	20	24	43	76	74
28/10/03	91	20	31	38	94	68
29/10/03	108	20	32	59	102	85
30/10/03	124	25	49	67	120	102
31/10/03	130	26	43	75	131	108

OCTOBER, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
Monthly Average	**135**	**32**	**45**	**66**	**119**	**105**
NOVEMBER, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/11/03	121	42	63	91	146	114
2/11/03	172	66	86	112	181	157
3/11/03	190	69	102	124	209	196
4/11/03	189	58	84	124	186	183
5/11/03	195	61	90	116	161	180
6/11/03	191	71	96	131	174	198
7/11/03	197	74	105	117	214	190
8/11/03	186	64	85	114	152	174
9/11/03	171	56	81	99	170	172
10/11/03	N/A	N/A	N/A	N/A	N/A	N/A
11/11/03	167	56	70	96	180	146
12/11/03	174	50	78	91	178	165
13/11/03	232	45	85	102	163	175
14/11/03	192	45	66	103	163	186
15/11/03	175	44	72	93	140	173
16/11/03	166	65	63	77	179	145
17/11/03	192	41	72	99	159	156
18/11/03	189	46	68	105	168	143
19/11/03	192	37	71	104	167	182
20/11/03	220	40	73	112	170	210
21/11/03	193	53	87	106	193	157
22/11/03	176	56	79	108	153	157
23/11/03	180	49	72	99	187	149
24/11/03	200	44	66	108	187	185
25/11/03	189	47	69	117	189	167
26/11/03	191	50	71	91	193	132
27/11/03	217	52	81	108	186	176
28/11/03	192	48	75	103	149	157
29/11/03	184	55	79	105	169	165
30/11/03	209	56	80	121	199	192
Monthly Average	**187**	**53**	**78**	**106**	**175**	**192**
DECEMBER, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/12/03	235	62	104	121	215	215
2/12/03	248	62	96	114	224	218
3/12/03	278	52	91	110	201	180
4/12/03	200	48	67	98	182	151
5/12/03	243	56	92	117	208	190
6/12/03	276	70	114	134	202	225
7/12/03	227	76	95	134	211	173

DECEMBER, 2003						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
8/12/03	245	68	85	124	194	179
9/12/03	231	37	60	97	159	162
10/12/03	251	32	63	96	181	159
11/12/03	226	36	66	106	201	181
12/12/03	265	36	70	104	211	186
13/12/03	336	36	77	126	218	214
14/12/03	N/A	32	80	128	206	232
15/12/03	N/A	44	96	136	223	238
16/12/03	474	82	121	155	304	287
17/12/03	356	47	112	115	238	259
18/12/03	338	42	84	124	231	217
19/12/03	303	34	81	162	232	233
20/12/03	285	41	92	149	238	198
21/12/03	297	42	82	159	244	208
22/12/03	278	36	74	132	217	217
23/12/03	N/A	36	90	127	257	213
24/12/03	N/A	39	84	135	224	210
25/12/03	323	32	83	160	231	260
26/12/03	322	49	96	140	251	215
27/12/03	245	54	110	156	208	195
28/12/03	239	26	56	75	101	118
29/12/03	282	43	90	124	198	204
30/12/03	360	54	92	157	193	236
31/12/03	347	49	114	195	256	271
Monthly Average	**286**	**47**	**88**	**129**	**215**	**208**
JANUARY, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/1/04	340	44	90	183	236	263
2/1/04	314	51	87	156	292	220
3/1/04	260	42	102	169	234	224
4/1/04	262	55	103	177	234	226
5/1/04	280	57	105	164	264	195
6/1/04	330	47	106	169	249	231
7/1/04	326	45	97	200	242	241
8/1/04	366	49	116	232	298	255
9/1/04	349	50	107	205	299	248
10/1/04	295	51	110	202	273	237
11/1/04	316	60	125	172	271	256
12/1/04	279	57	112	207	271	264
13/1/04	277	56	104	206	260	212
14/1/04	N/A	45	105	184	192	196
15/1/04	182	51	101	151	198	183
16/1/04	320	81	130	197	229	204
17/1/04	287	65	113	184	226	223

JANUARY, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
18/1/04	313	69	123	227	330	234
19/1/04	285	63	133	214	265	216
20/1/04	270	69	124	221	271	221
21/1/04	244	67	119	195	199	180
22/1/04	251	59	102	179	212	137
23/1/04	195	65	140	219	204	170
24/1/04	139	33	66	100	118	104
25/1/04	343	34	77	153	217	190
26/1/04	309	61	89	149	267	233
27/1/04	254	57	81	143	229	177
28/1/04	248	57	106	149	261	208
29/1/04	294	81	126	175	220	215
30/1/04	297	66	113	167	236	227
31/1/04	317	71	168	247	300	256
Monthly Average	**285**	**57**	**109**	**184**	**245**	**214**
FEBRUARY, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/2/04	365	49	136	202	290	234
2/2/04	186	45	93	160	187	151
3/2/04	222	43	86	167	225	185
4/2/04	173	64	81	127	210	162
5/2/04	187	64	83	109	172	137
6/2/04	227	62	90	151	221	168
7/2/04	223	67	108	182	207	180
8/2/04	255	73	115	206	251	219
9/2/04	263	58	122	240	274	225
10/2/04	308	62	112	203	251	219
11/2/04	279	48	114	223	249	N/A
12/2/04	192	46	92	168	187	N/A
13/2/04	286	52	123	203	299	N/A
14/2/04	217	66	114	171	265	N/A
15/2/04	280	66	128	174	256	194
16/2/04	311	64	110	210	261	256
17/2/04	217	69	120	210	213	216
18/2/04	288	81	146	295	333	265
19/2/04	318	83	157	244	291	301
20/2/04	239	69	114	188	273	195
21/2/04	231	92	131	213	256	190
22/2/04	232	70	115	172	192	175
23/2/04	260	93	131	200	277	197
24/2/04	238	110	135	190	214	204
25/2/04	196	98	143	206	175	192
26/2/04	220	93	129	213	N/A	186
27/2/04	222	97	129	207	N/A	182
28/2/04	245	77	118	180	N/A	188

FEBRUARY, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
29/2/04	248	68	122	205	233	205
Monthly Average	**246**	**70**	**117**	**194**	**241**	**201**
MARCH, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/3/04	256	68	109	200	241	200
2/3/04	277	70	125	203	295	201
3/3/04	276	96	141	208	255	212
4/3/04	208	121	154	218	202	185
5/3/04	283	103	120	260	288	202
6/3/04	226	86	134	214	269	202
7/3/04	230	81	117	176	259	176
8/3/04	165	69	131	156	183	148
9/3/04	302	79	144	219	297	232
10/3/04	331	110	175	295	339	242
11/3/04	219	81	111	161	173	148
12/3/04	230	90	126	174	201	170
13/3/04	224	91	115	197	200	186
14/3/04	324	118	160	248	276	248
15/3/04	247	125	164	236	295	206
16/3/04	230	97	149	172	270	186
17/3/04	305	120	160	204	281	225
18/3/04	276	126	162	223	262	230
19/3/04	262	127	169	203	233	231
20/3/04	240	154	178	209	269	238
21/3/04	168	83	71	108	156	135
22/3/04	297	84	106	175	196	167
23/3/04	307	121	140	209	284	264
24/3/04	334	134	185	256	335	274
25/3/04	380	126	164	239	370	260
26/3/04	344	112	168	300	396	296
27/3/04	399	117	188	305	366	325
28/3/04	324	111	206	N/A	308	272
29/3/04	428	164	169	309	402	320
30/3/04	446	146	213	247	382	281
31/3/04	354	146	219	253	405	290
Monthly Average	**287**	**108**	**151**	**219**	**280**	**224**
APRIL, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/4/04	353	162	257	309	387	309
2/4/04	332	163	216	337	304	254
3/4/04	163	85	121	N/A	170	126
4/4/04	275	84	116	N/A	193	149
5/4/04	260	93	130	N/A	219	178

APRIL, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
6/4/04	213	99	92	N/A	208	174
7/4/04	256	128	156	N/A	243	163
8/4/04	175	N/A	103	N/A	208	121
9/4/04	194	N/A	76	144	275	136
10/4/04	184	N/A	78	108	176	120
11/4/04	228	86	101	158	247	165
12/4/04	207	95	128	169	236	156
13/4/04	216	89	137	162	253	168
14/4/04	311	130	120	197	273	222
15/4/04	228	112	143	174	260	183
16/4/04	399	118	159	177	315	219
17/4/04	356	135	186	200	283	223
18/4/04	261	109	139	166	257	163
19/4/04	353	144	175	200	325	249
20/4/04	237	101	125	141	190	175
21/4/04	252	96	134	159	223	188
22/4/04	220	96	75	154	203	153
23/4/04	217	30	42	59	117	82
24/4/04	179	46	137	63	146	90
25/4/04	200	36	N/A	120	203	118
26/4/04	182	41	N/A	93	182	102
27/4/04	172	62	N/A	123	279	126
28/4/04	151	42	78	75	166	100
29/4/04	210	26	46	95	123	110
30/4/04	257	38	55	103	237	116
Monthly Average	**241**	**91**	**122**	**154**	**230**	**161**
MAY, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/5/04	258	21	44	75	137	83
2/5/04	260	55	143	122	209	143
3/5/04	219	71	101	N/A	281	162
4/5/04	290	88	112	N/A	225	153
5/5/04	240	76	106	N/A	217	158
6/5/04	245	101	147	N/A	244	327
7/5/04	294	91	138	224	238	284
8/5/04	257	91	82	223	220	207
9/5/04	339	102	140	187	250	197
10/5/04	282	120	141	179	283	206
11/5/04	189	100	126	176	184	165
12/5/04	184	93	118	150	171	148
13/5/04	272	115	129	193	236	190
14/5/04	263	129	162	206	239	221
15/5/04	256	129	160	191	260	213
16/5/04	263	124	90	187	244	204
17/5/04	267	53	56	91	165	90

MAY, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
18/5/04	119	64	60	77	126	90
19/5/04	83	60	51	110	70	69
20/5/04	62	37	39	59	171	57
21/5/04	172	78	85	94	239	117
22/5/04	191	95	107	115	269	152
23/5/04	198	82	106	116	186	132
24/5/04	240	69	65	141	278	132
25/5/04	254	74	91	123	240	146
26/5/04	146	49	56	87	209	85
27/5/04	378	56	70	123	223	129
28/5/04	282	47	75	113	176	119
29/5/04	158	53	79	112	170	121
30/5/04	224	50	83	112	167	109
31/5/04	245	64	100	129	228	143
Monthly Average	**230**	**79**	**99**	**138**	**211**	**153**
JUNE, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/6/04	123	50	56	85	121	91
2/6/04	182	49	70	92	121	103
3/6/04	128	41	48	80	103	75
4/6/04	200	62	76	109	259	108
5/6/04	149	53	71	100	214	100
6/6/04	226	14	65	96	175	113
7/6/04	125	34	50	69	178	89
8/6/04	209	40	65	100	171	40
9/6/04	178	35	34	74	119	71
10/6/04	196	37	54	73	127	104
11/6/04	191	32	41	50	154	78
12/6/04	131	26	35	54	156	85
13/6/04	136	24	43	56	152	80
14/6/04	209	22	32	44	179	60
15/6/04	213	19	23	71	144	37
16/6/04	118	20	21	N/A	78	30
17/6/04	139	15	15	N/A	113	N/A
18/6/04	189	16	17	N/A	116	N/A
19/6/04	152	19	20	N/A	83	32
20/6/04	164	38	28	20	172	N/A
21/6/04	137	22	27	25	139	N/A
22/6/04	206	57	52	62	181	N/A
23/6/04	201	77	74	84	211	N/A
24/6/04	253	160	N/A	145	273	N/A
25/6/04	302	97	87	160	276	N/A
26/6/04	296	108	N/A	84	175	N/A
27/6/04	204	66	N/A	84	158	N/A
28/6/04	194	63	73	93	169	N/A

JUNE, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
29/6/04	227	64	73	91	167	N/A
30/6/04	180	71	84	85	168	N/A
Monthly Average	**185**	**48**	**49**	**80**	**162**	**76**
JULY, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/7/04	166	68	73	76	140	137
2/7/04	165	57	N/A	62	129	92
3/7/04	133	29	N/A	43	111	64
4/7/04	215	20	N/A	32	108	58
5/7/04	151	16	19	27	140	54
6/7/04	109	17	23	32	137	46
7/7/04	48	14	19	26	87	37
8/7/04	27	12	15	20	52	29
9/7/04	64	20	24	45	48	55
10/7/04	46	21	67	34	54	49
11/7/04	81	46	22	53	139	76
12/7/04	109	35	34	38	152	61
13/7/04	110	37	38	44	206	79
14/7/04	161	46	42	59	229	99
15/7/04	141	49	48	55	186	77
16/7/04	158	21	20	33	134	63
17/7/04	64	18	22	24	75	38
18/7/04	78	16	19	22	69	34
19/7/04	136	22	17	29	179	59
20/7/04	126	45	41	40	183	74
21/7/04	100	36	47	52	194	68
22/7/04	186	40	42	50	127	83
23/7/04	157	30	37	48	270	88
24/7/04	66	15	19	24	166	42
25/7/04	76	16	16	28	87	45
26/7/04	106	15	20	24	139	48
27/7/04	122	17	14	24	163	51
28/7/04	78	N/A	17	15	133	41
29/7/04	75	N/A	19	20	119	42
30/7/04	108	N/A	12	26	126	59
31/7/04	151	N/A	20	24	133	52
Monthly Average	**113**	**29**	**29**	**36**	**136**	**61**
AUGUST, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/8/04	112	23	18	21	141	53
2/8/04	193	22	33	25	179	53
3/8/04	151	19	27	33	166	59
4/8/04	182	15	15	N/A	136	43
5/8/04	194	18	23	26	186	54

AUGUST, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
6/8/04	132	22	20	27	181	59
7/8/04	79	15	18	26	55	38
8/8/04	130	17	23	26	120	47
9/8/04	103	12	22	32	158	49
10/8/04	91	7	20	26	98	47
11/8/04	119	11	25	24	145	57
12/8/04	146	17	23	32	214	65
13/8/04	95	20	24	19	174	72
14/8/04	100	21	23	26	179	51
15/8/04	129	15	22	27	183	61
16/8/04	120	11	20	11	128	47
17/8/04	86	N/A	22	21	221	50
18/8/04	69	N/A	17	18	126	41
19/8/04	96	N/A	22	21	141	52
20/8/04	79	N/A	10	24	79	47
21/8/04	113	9	16	24	105	55
22/8/04	92	N/A	14	29	162	54
23/8/04	94	N/A	26	42	186	52
24/8/04	137	N/A	28	31	177	55
25/8/04	108	N/A	23	35	98	60
26/8/04	154	N/A	23	34	80	65
27/8/04	124	N/A	32	42	128	75
28/8/04	114	N/A	17	40	98	63
29/8/04	60	N/A	17	18	72	43
30/8/04	145	N/A	22	34	113	76
31/8/04	64	N/A	31	31	77	51
Monthly Average	**116**	**16**	**22**	**28**	**139**	**55**
SEPTEMBER, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/9/04	80	N/A	37	44	75	65
2/9/04	83	N/A	44	55	88	71
3/9/04	82	N/A	43	57	83	71
4/9/04	73	N/A	27	41	84	52
5/9/04	117	N/A	26	45	168	71
6/9/04	128	N/A	58	55	212	91
7/9/04	136	N/A	50	46	124	76
8/9/04	151	N/A	44	58	130	82
9/9/04	156	N/A	60	58	180	85
10/9/04	126	N/A	36	39	185	68
11/9/04	80	N/A	24	31	79	51
12/9/04	114	0	18	23	75	43
13/9/04	141	25	13	25	51	45
14/9/04	104	17	16	22	111	48
15/9/04	104	16	27	22	152	53
16/9/04	116	23	38	41	143	58

SEPTEMBER, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
17/9/04	102	26	32	36	157	52
18/9/04	96	16	26	36	86	57
19/9/04	99	0	18	28	108	55
20/9/04	106	22	28	33	109	47
21/9/04	137	19	11	38	141	59
22/9/04	149	22	25	34	141	73
23/9/04	174	18	23	41	146	72
24/9/04	157	20	30	50	172	83
25/9/04	132	23	85	42	109	68
26/9/04	136	35	38	53	139	94
27/9/04	124	37	49	51	153	93
28/9/04	76	36	40	48	81	74
29/9/04	73	28	29	41	67	61
30/9/04	147	28	45	53	139	92
Monthly Average	**117**	**22**	**35**	**42**	**123**	**67**
OCTOBER, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/10/04	134	35	45	54	118	79
2/10/04	120	33	39	55	108	65
3/10/04	140	31	32	41	105	61
4/10/04	127	36	38	54	198	82
5/10/04	145	36	43	55	138	76
6/10/04	135	33	42	47	151	74
7/10/04	132	19	16	38	67	50
8/10/04	130	27	29	34	126	58
OCTOBER, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
9/10/04	158	48	48	73	155	103
10/10/04	140	42	53	65	187	100
11/10/04	162	35	46	58	133	97
12/10/04	132	30	40	54	116	83
13/10/04	201	26	46	56	173	108
14/10/04	207	29	69	65	181	118
15/10/04	177	27	36	54	197	110
16/10/04	141	32	50	59	142	112
17/10/04	153	36	48	52	160	97
18/10/04	151	29	48	73	177	114
19/10/04	185	24	47	59	146	108
20/10/04	129	28	40	74	158	111
21/10/04	155	25	42	65	101	98
22/10/04	87	21	38	58	96	75
23/10/04	97	25	26	60	86	77
24/10/04	106	26	40	34	116	69
25/10/04	93	27	50	46	112	64
26/10/04	154	27	57	58	144	93

OCTOBER, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
27/10/04	167	23	61	62	149	106
28/10/04	174	24	53	59	119	106
29/10/04	220	27	56	63	142	124
30/10/04	160	27	53	71	103	101
31/10/04	150	29	40	68	135	101
Monthly Average	**147**	**30**	**44**	**57**	**137**	**91**

Note: The unit for all the data is $\mu g/m^3$.
Averages have been calculated using available data only.
Monthly Average: Monthly average value for each monitoring station.
N/A: Not available.
Source: www.mope.gov.np

MAY, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
18/5/04	119	64	60	77	126	90
19/5/04	83	60	51	110	70	69
20/5/04	62	37	39	59	171	57
21/5/04	172	78	85	94	239	117
22/5/04	191	95	107	115	269	152
23/5/04	198	82	106	116	186	132
24/5/04	240	69	65	141	278	132
25/5/04	254	74	91	123	240	146
26/5/04	146	49	56	87	209	85
27/5/04	378	56	70	123	223	129
28/5/04	282	47	75	113	176	119
29/5/04	158	53	79	112	170	121
30/5/04	224	50	83	112	167	109
31/5/04	245	64	100	129	228	143
Monthly Average	**230**	**79**	**99**	**138**	**211**	**153**
JUNE, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/6/04	123	50	56	85	121	91
2/6/04	182	49	70	92	121	103
3/6/04	128	41	48	80	103	75
4/6/04	200	62	76	109	259	108
5/6/04	149	53	71	100	214	100
6/6/04	226	14	65	96	175	113
7/6/04	125	34	50	69	178	89
8/6/04	209	40	65	100	171	40
9/6/04	178	35	34	74	119	71
10/6/04	196	37	54	73	127	104
11/6/04	191	32	41	50	154	78
12/6/04	131	26	35	54	156	85
13/6/04	136	24	43	56	152	80
14/6/04	209	22	32	44	179	60
15/6/04	213	19	23	71	144	37
16/6/04	118	20	21	N/A	78	30
17/6/04	139	15	15	N/A	113	N/A
18/6/04	189	16	17	N/A	116	N/A
19/6/04	152	19	20	N/A	83	32
20/6/04	164	38	28	20	172	N/A
21/6/04	137	22	27	25	139	N/A
22/6/04	206	57	52	62	181	N/A
23/6/04	201	77	74	84	211	N/A
24/6/04	253	160	N/A	145	273	N/A
25/6/04	302	97	87	160	276	N/A
26/6/04	296	108	N/A	84	175	N/A
27/6/04	204	66	N/A	84	158	N/A
28/6/04	194	63	73	93	169	N/A

JUNE, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
29/6/04	227	64	73	91	167	N/A
30/6/04	180	71	84	85	168	N/A
Monthly Average	**185**	**48**	**49**	**80**	**162**	**76**
JULY, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/7/04	166	68	73	76	140	137
2/7/04	165	57	N/A	62	129	92
3/7/04	133	29	N/A	43	111	64
4/7/04	215	20	N/A	32	108	58
5/7/04	151	16	19	27	140	54
6/7/04	109	17	23	32	137	46
7/7/04	48	14	19	26	87	37
8/7/04	27	12	15	20	52	29
9/7/04	64	20	24	45	48	55
10/7/04	46	21	67	34	54	49
11/7/04	81	46	22	53	139	76
12/7/04	109	35	34	38	152	61
13/7/04	110	37	38	44	206	79
14/7/04	161	46	42	59	229	99
15/7/04	141	49	48	55	186	77
16/7/04	158	21	20	33	134	63
17/7/04	64	18	22	24	75	38
18/7/04	78	16	19	22	69	34
19/7/04	136	22	17	29	179	59
20/7/04	126	45	41	40	183	74
21/7/04	100	36	47	52	194	68
22/7/04	186	40	42	50	127	83
23/7/04	157	30	37	48	270	88
24/7/04	66	15	19	24	166	42
25/7/04	76	16	16	28	87	45
26/7/04	106	15	20	24	139	48
27/7/04	122	17	14	24	163	51
28/7/04	78	N/A	17	15	133	41
29/7/04	75	N/A	19	20	119	42
30/7/04	108	N/A	12	26	126	59
31/7/04	151	N/A	20	24	133	52
Monthly Average	**113**	**29**	**29**	**36**	**136**	**61**
AUGUST, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/8/04	112	23	18	21	141	53
2/8/04	193	22	33	25	179	53
3/8/04	151	19	27	33	166	59
4/8/04	182	15	15	N/A	136	43
5/8/04	194	18	23	26	186	54

AUGUST, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
6/8/04	132	22	20	27	181	59
7/8/04	79	15	18	26	55	38
8/8/04	130	17	23	26	120	47
9/8/04	103	12	22	32	158	49
10/8/04	91	7	20	26	98	47
11/8/04	119	11	25	24	145	57
12/8/04	146	17	23	32	214	65
13/8/04	95	20	24	19	174	72
14/8/04	100	21	23	26	179	51
15/8/04	129	15	22	27	183	61
16/8/04	120	11	20	11	128	47
17/8/04	86	N/A	22	21	221	50
18/8/04	69	N/A	17	18	126	41
19/8/04	96	N/A	22	21	141	52
20/8/04	79	N/A	10	24	79	47
21/8/04	113	9	16	24	105	55
22/8/04	92	N/A	14	29	162	54
23/8/04	94	N/A	26	42	186	52
24/8/04	137	N/A	28	31	177	55
25/8/04	108	N/A	23	35	98	60
26/8/04	154	N/A	23	34	80	65
27/8/04	124	N/A	32	42	128	75
28/8/04	114	N/A	17	40	98	63
29/8/04	60	N/A	17	18	72	43
30/8/04	145	N/A	22	34	113	76
31/8/04	64	N/A	31	31	77	51
Monthly Average	**116**	**16**	**22**	**28**	**139**	**55**
SEPTEMBER, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/9/04	80	N/A	37	44	75	65
2/9/04	83	N/A	44	55	88	71
3/9/04	82	N/A	43	57	83	71
4/9/04	73	N/A	27	41	84	52
5/9/04	117	N/A	26	45	168	71
6/9/04	128	N/A	58	55	212	91
7/9/04	136	N/A	50	46	124	76
8/9/04	151	N/A	44	58	130	82
9/9/04	156	N/A	60	58	180	85
10/9/04	126	N/A	36	39	185	68
11/9/04	80	N/A	24	31	79	51
12/9/04	114	0	18	23	75	43
13/9/04	141	25	13	25	51	45
14/9/04	104	17	16	22	111	48
15/9/04	104	16	27	22	152	53
16/9/04	116	23	38	41	143	58

SEPTEMBER, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
17/9/04	102	26	32	36	157	52
18/9/04	96	16	26	36	86	57
19/9/04	99	0	18	28	108	55
20/9/04	106	22	28	33	109	47
21/9/04	137	19	11	38	141	59
22/9/04	149	22	25	34	141	73
23/9/04	174	18	23	41	146	72
24/9/04	157	20	30	50	172	83
25/9/04	132	23	85	42	109	68
26/9/04	136	35	38	53	139	94
27/9/04	124	37	49	51	153	93
28/9/04	76	36	40	48	81	74
29/9/04	73	28	29	41	67	61
30/9/04	147	28	45	53	139	92
Monthly Average	**117**	**22**	**35**	**42**	**123**	**67**
OCTOBER, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
1/10/04	134	35	45	54	118	79
2/10/04	120	33	39	55	108	65
3/10/04	140	31	32	41	105	61
4/10/04	127	36	38	54	198	82
5/10/04	145	36	43	55	138	76
6/10/04	135	33	42	47	151	74
7/10/04	132	19	16	38	67	50
8/10/04	130	27	29	34	126	58
OCTOBER, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
9/10/04	158	48	48	73	155	103
10/10/04	140	42	53	65	187	100
11/10/04	162	35	46	58	133	97
12/10/04	132	30	40	54	116	83
13/10/04	201	26	46	56	173	108
14/10/04	207	29	69	65	181	118
15/10/04	177	27	36	54	197	110
16/10/04	141	32	50	59	142	112
17/10/04	153	36	48	52	160	97
18/10/04	151	29	48	73	177	114
19/10/04	185	24	47	59	146	108
20/10/04	129	28	40	74	158	111
21/10/04	155	25	42	65	101	98
22/10/04	87	21	38	58	96	75
23/10/04	97	25	26	60	86	77
24/10/04	106	26	40	34	116	69
25/10/04	93	27	50	46	112	64
26/10/04	154	27	57	58	144	93

OCTOBER, 2004						
Date	**Putalisadak**	**Matsyagoan**	**Kirtipur**	**Bhaktapur**	**Patan Hospital**	**Thamel**
27/10/04	167	23	61	62	149	106
28/10/04	174	24	53	59	119	106
29/10/04	220	27	56	63	142	124
30/10/04	160	27	53	71	103	101
31/10/04	150	29	40	68	135	101
Monthly Average	**147**	**30**	**44**	**57**	**137**	**91**

Note: The unit for all the data is $\mu g/m^3$.
Averages have been calculated using available data only.
Monthly Average: Monthly average value for each monitoring station.
N/A: Not available.
Source: www.mope.gov.np

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