SITUATION ANALYSIS OF ENVIRONMENTAL HEALTH IN NEPAL 2009

Research Advisor

Dr. Chop Lal Bhusal

Study Team

Mr. Meghnath Dhimal, Principal Investigator

Ms. Lila Bhattarai, Research Assistant

World Health Organization

Nepal Health Research Council

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Meghnath Dhimal
Research Officer/ Principal Investigator, NHRC

Preface

The first major international response to environmental degradation came in 1972 with the UN Conference on the Human Environment in Stockholm, Sweden. This UN conference was on the Human Environment focused world-wide attention on the pollution of planet and global environment that threatens all human beings. After 20 years of this Conference, in June 1992, the United Nations Conference on Environment and Development (UNCED) also known as "Earth Summit" was held in Rio de Janeiro where five major agreements on global environmental issues were signed as formal treaties. The outputs of the conference also included a Declaration of Principles on Environment and development and an agenda for change during the 21st century, referred to as Agenda 21. Agenda 21 acknowledges the dependence of human health on a healthy environment by assessing through social and economic development. It requires all countries to have programs to identify environmental health hazards and to reduce the risks. UN formal treaties on environmental issues have been used as a priority-setting tool for the policies of many international agencies and countries. In response to Agenda 21, Government of Nepal has also prepared the Nepal Environmental Policy and Action Plan (NEPAP) in1993.

Since health and environment issues are largely interdependent, problems related to drinking water and sanitation, air quality control, hazardous waste management, food safety, chemical safety, noise reduction, road safety, accident prevention and hygiene promotion need to be addressed in an integrated manner. An Environmental Protection Act came into existence in 1996 in Nepal. The Environmental Protection Act 1996 and Environmental Protection Rules 1997 (First amendment 1999) which is the umbrella Legislation of Nepal for Environmental sector. This facilitated the formulation of many policies, guidelines and standards covering different aspects of environment.

The aspects of environmental health need to be addressed properly as they focus on the relationship between human health and environmental risk factors. As Environmental Health is the vital component of the preventive measure of Health service, the significance seems most essential in the present situation of the country. Finding these issues as one of essential components, Ministry of Health (Now Ministry of Health and Population) incorporated environmental health in the National Health Policy (1991). Taking this into consideration, Nepal Health Research Council formed Environmental Health Research Unit as the first designated office working in the field of Environmental Health issues in Nepal with close coordination with Ministry of Health and World Health Organization in January 12, 2001. NHRC carried out the first situation analysis of Environmental health in Nepal in 2001and this prepared document is the update for that. This report has collected and compiled facts and figures as well as important information scattered in various published and grey literature in a single document. I sincerely hope that this document will be useful for researcher for further researches and program managers for reducing the environmental degradation and prompting the health of Nepalese people.

Dr. Chop Lal Bhusal
Executive Chairman, NHRC

Executive Summary

The environment is all the physical, chemical and biological factors external to a person and all the related behaviours. The key to man's health largely lies in his environment. There are various environmental risk factors causing premature deaths and diseases, especially among the poor and vulnerable groups and has increased health costs. Already, the aggregate environmental health costs associated with poor environmental management are estimated to reach close to 3.5% of gross domestic product (GDP), representing a significant burden of Nepal's economy (World Bank, 2008). Poor quality of drinking water, low coverage of sanitary facilities, heavy use of solid biomass fuel for cooking, lack of waste management systems are some of the factors increasing the burden of disease on Nepal's population of both rural and urban areas. Haphazard and rapid urbanization is increasing in the county resulting environmental deterioration and associated economic problems with it. Different types of vulnerable communities are increasing in the urban areas such as squatter, slum, street children, rag pickers, internally displaced population. Their numbers are growing with miserable living conditions, crowded poor quality housing, and minimal access to water and sanitation.

With an increase in the urban population, the demand for environmental services such as drinking water, sanitation, and proper sewerage management can not be met. Contaminated water sources, inadequate sanitation, inadequate management of household and municipal waste, continue to affect human health. Urban air pollution in Kathmandu valley is coming up as a serious problem which exceeds both the national and international standards. And so is the problem of solid waste management. Similarly, indoor air pollution is a threatening issue both in urban and rural areas alike.

Health indicators of Nepal show a progress in infant mortality, maternal mortality, and average life expectancy attributable to the increase in the health services rather than an improvement in the environmental conditions. In other words, health care services are focused on curative services rather than on preventive aspects which could have long term impacts on the human health.

In the last decades Nepal has adopted a rather comprehensive set of environmental policies and laws that cover a broad range of environmental and other sector issues. There are some gaps and inconsistencies in policies though it has helped during the implementation of the environmental program. The main challenge lies in the effective implementation of the set environmental laws and policies .There is very little emphasis on enforcement and monitoring of the existing laws and by laws. Intersectoral coordination between the perceived responsible bodies like the Ministry of Environment, Ministry of Health and Population, Ministry of Local development, Department of Water Supply and Sewerage, Ministry of Physical Planning and Works and Municipalities are also seen weak.

This study in its attempt to analyze the present situation of environmental impact on health has intended to a) determine the status of health and environment b) identify the impacts of changing environment on health and c) identify the existing policies, standards and other responses regarding environmental health in Nepal. Secondary data was collected for the study.

This study has attempted to present the current environment situation of key environmental problems like Air pollution, Water pollution, Solid waste management and climate change. It has also incorporated the policy and legislative responses from the governmental and non governmental organizations including public. The

study has made relevant recommendations with a belief that it will be well taken, implemented and enforced by all the responsible bodies. The problems wise recommendations are as follows: .

Air Quality

- Promotion of cleaner/safer and environmentally friendly vehicles
- Enforcement of environmental laws and by laws
- Scientific traffic management with incorporated vehicle monitoring
- Promotion of non-motorized vehicles and public transport through better services and discouraging use of fossil fuels
- Cleaner production and energy efficiency in industries
- Separate residential areas and away from industrial areas
- Promotion of Safer Kitchens with proper ventilation
- Awareness, education and advocacy on health impact of air pollution
- Need to conduct routine Air Quality Monitoring in Kathmandu Valley and in other major urban areas for time series data
- Need to enforce Indoor Air Quality Standards and Guideline 2009
- Need to conduct epidemiological studies on health impact of air pollution in both urban and rural areas.

Water Quality

- Meeting the demand of drinking water in terms of both quantity and quality
- Wider sanitation coverage for both rural and urban areas
- Promote rainwater harvesting
- Promote awareness, water conservation and use of water saving equipments
- Enforcement of Water Quality Surveillance as per National Drinking Water Quality Standard 2006

Solid Waste Management

- Decrease ambiguity of laws and policies and define roles and mandates for responsible authorities
- Waste collection following certain categorization and respective disposal models.
- Promote reusing, recycling and composting of wastes
- Need of clear & specific strategy and legislation for industrial and medical wastes manangement
- Strategies to reduce wastes at source level (households, hospitals, industries)

Climate Change

- Need to conduct more research on climate change and health in Nepal in term of impact, vulnerability and adaptation
- Need to mainstream climate change issue in development plans
- Adaptation programs for health sector need to be identified while preparing NAPA
- Need integrated diseases surveillance system in the country

Acronyms and Abbreviations

ADB	Asian Development Bank
AQM	Air quality management
CBS	Central Bureau of Statistics
CEN	Clean Energy Nepal
CKV	Clean Kathmandu Valley
COPD	Chronic Obstructive Pulmonary disease
DDC	District Development Committee
DoHS	Department of Health Services
DoTM	Department of Transport Management
DHM	Department of Hydrology and Meteorology
PSIR	Pressure-State-Impact-Response
DWSS	Department of Water Supply and Sewerage
ECOSAN	Ecological Sanitation
EIA	Environmental Impact Assessment
ENPHO	Environment and Public Health Organization
EPA	Environment Protection Act
EPC	Environment Protection Council
EPR	Environment Protection Regulations
ESPS	Environment Sector Programme Support
GTZ	German Agency for Technical Cooperation
HCI	Health Care Institution
ICIMOD	International Centre for Integrated Mountain Development
IUCN	World Conservation Union
JICA	Japan International Cooperation Agency
KMC	Kathmandu Metropolitan City
MDG	Millennium Development Goals
MPPW	Ministry of Physical Planning and Works
MoE	Ministry of Environment
MoEST	Ministry of Environment, Science and Technology
MoF	Ministry of Finance
MoFSC	Ministry of Forest and Soil Conservation
MoI	Ministry of Industry

MoLD	Ministry of Local Development
MoPE	Ministry of Population and Environment
MoWR	Ministry of Water Resources
MOHP	Ministry of Population and Health
MuAN	Municipal Association of Nepal
NEPAP	Nepal Environment Policy and Action Plan
NESS	Nepal Environmental and Scientific Services
NHRC	Nepal Health Research Council
NPC	National Planning Commission
NWP	National Water Plan
NWRS	National Water Resources Strategy
NWSC	Nepal Water Supply Corporation
SWC	Social Welfare Council
SWMRMC	Solid Waste Management and Resource Mobilization Centre
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
VDC	Village development committee
WB	World Bank
WECS	Water and Energy Commission Secretariat
WHO	World Health Organization

Scientific measurements

μg	Microgram
$\mu g/m^3$	Microgram per cubic meter
B.C.	Before Christ
B.S.	Bikram Sambat (era used in Nepal)
BOD	Biological Oxygen Demand
CO	Carbon monoxide
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
HC	Hydrocarbon
NAAQS	National Ambient Air Quality Standards

NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
PAH	Polycyclic Aromatic Hydrocarbon
$PM_{2.5}$	Particulate matter of diameter 2.5 microns or less
PM_{10}	Particulate matter of diameter 10 microns or less
POPs	Persistent Organic Pollutants
SODIS	Solar Disinfection
SO_x	Sulphur Oxides
SO_2	Sulphur Dioxide
TDS	Total Dissolved Solids
TSP	Total Suspended Particles
TSS	Total Suspended Solids

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1 Introduction

1.1 Background

Environment is composed of living and non-living entities of a particular area, where each component of the system interacts with each other. The sum total of bio-physical and socio-cultural factors which influence the survival, growth, development and reproduction of an organism(s) is referred to as environment. When one component of this relationship is changed or disturbed, the influence is manifested in other part of the environment. Thus the environmental problems can be caused by natural or man made decisions with the utilization of natural resources. Environmental problems caused by human activities however can be usually avoided through proper planning and consideration of environmental impacts.

In general, the environmental problems have emanated from unsustainable use of natural resources, and inadequate integration of environmental planning into development programs and their implementation. Major environmental problems have emerged from land degradation, depletion of forest resources, unplanned urban development and mismanagement of industrial effluents and domestic wastes causing pollution of water, air and soil. The over concentration of economic opportunities in urban centers further aggravate the environmental problems. The pollution in the environmental directly affects the human health in terms of mortality and morbidity.

Since health and environment issues are largely interdependent, problems related to water and sanitation, air quality control, hazardous waste management, food safety, chemical safety, noise reduction, road safety, accident prevention and hygiene promotion need to be addressed in an integrated manner. The ever increasing population, uncontrolled urbanization, centralization of opportunities and people in the capital and major cities, haphazard urbanization and settlement has severely affected the environment and caused environmental problems. There has not only been an increase in environmental pollution but also the level of certain pollutants has exceeded the national and international standards affecting public health.

The key to man's health largely lies in his environment. In fact, much of man's ill -health can be traced to adverse environmental factors such as water pollution, air pollution, soil pollution, poor housing conditions, presence of animal reservoirs and insect vectors of diseases which pose a constant threat to man's health. The demographic growth and fast urbanization all over the world are bringing profound social and environmental changes. Therefore, the attainment of a healthy environment is becoming more and more complex. The term environmental sanitation is now being replaced by environmental health. Environmental health covers the assessment, correction, control and prevention of environmental factors that can adversely affect health as well as the enhancement of those aspects of the environment that can improve human health. Environment health is focusing on protection from diseases through the provisions of clean water, waste disposal, safe food, clean air, safe living and working conditions etc. The purpose of environmental health is to create and maintain ecological conditions that will promote health and environment.

The main drawback in environment health however, is the lack of coordinated, integrated approach in addressing the problems. There are many rooms where the Ministry of Environment(MoE) and the Ministry of Health & Population(MoHP) have to work together and develop common strategy towards developing

policies, guidelines and standards for promoting environmental health in Nepal. Many issues like food safety, chemical safety, hospital waste management, excreta disposal, air quality, water quality, noise pollution come under domain of both environment and health.

Thought the progress is being made in interventions, the environmental health implications of poor water supply and sanitation as well as indoor and urban air pollution dramatically may impact Nepal's ability to achieve targets for reducing child mortality, improving maternal health, combating diseases and other Millennium Development Goals.

Reducing the disease burden of environmental risk factors will contribute significantly to the Millennium Development Goals. Many Millennium Development Goals (MDGs) have an environmental health component; key elements are highlighted below.

Goal 1 ERADICATE EXTREME POVERTY AND HUNGER

Minimizing exposures to environmental risk factors indirectly contributes to poverty reduction, because many environmentally mediated diseases result in lost earnings. Also, disability or death of one productive household member can affect an entire household.

Goal 2 ACHIEVE UNIVERSAL PRIMARY EDUCATION

Providing safe drinking-water and latrines at school (particularly latrines for girls) will encourage primary school attendance. Interventions that provide households with access to improved sources of drinking-water and cleaner household energy sources also improve student attendance, saving time that children would otherwise spend collecting water and/or fuel. The same interventions can save children from missing school as a result of illness or injury.

Goal 3 PROMOTE GENDER EQUALITY AND EMPOWER WOMEN

Particularly in developing countries, access to improved drinking-water sources, cleaner household energy sources, and more generally, reduction of environmentally-attributable burden of childhood diseases, can save time women now spend in collection of fuel, water, and care for children who become sick. Time thus saved also can be invested by women in income-generating activities and education, thus contributing to the MDG goal of empowering women and promoting gender equality.

Goal 4 REDUCE CHILD MORTALITY

The mortality rate in children under five years of age from environmentally-mediated disease conditions is 180 times higher in the poorest performing region, as compared with the rate in the best performing region. In terms of just diarrhoea and lower respiratory infections, two of the most significant childhood killers, environmental interventions could prevent the deaths of over 2 million children under the age of five every year, and thus help achieve a key target of this MDG – a two-thirds reduction in the rate of mortality among children in that age category.

Goal 5 IMPROVE MATERNAL HEALTH

Environmental interventions can contribute to this MDG by providing a safe home environment, which is of great importance to the health of children and pregnant mothers. Conversely, a contaminated home environment is a threat to the mother and her unborn child. Childbirth, for example, requires safe water and sanitary conditions.

Goal 6 COMBAT HIV/AIDS, MALARIA AND OTHER DISEASES

Results of WHO analysis indicate that over half a million people die every year from malaria,and over a quarter of a million people die from HIV/AIDS, as a result of environmental and occupational causes. A large proportion of malaria, in particular, may be attributable to readily modifiable environmental factors, such as land use, irrigation and agricultural practices.

Goal 7 ENSURE ENVIRONMENTAL SUSTAINABILITY

Diarrhoeal diseases associated with a lack of access to safe drinking-water and inadequate sanitation result in nearly 1.7 million deaths annually. Household use of biomass fuels and coal by over one-half of the world's population, results in 1.5 million deaths a year from pollution-related respiratory diseases. Enhancing access to improved sources of drinking water, sanitation, and clean energy are therefore key environmental interventions that can reduce pressures on ecosystems from water and air-borne contamination, and also improve health. Residents in fast-growing cities of the developing world may be exposed to the combined health hazards of unsafe drinking-water, inadequate sanitation, and indoor and outdoor air pollution. Reductions in such environmental exposures will both improve the health and the lives of urban slum dwellers – one of the key targets of MDG-7.

Goal 8 DEVELOP A GLOBAL PARTNERSHIP FOR DEVELOPMENT

The study shows that both the health sector and non-health sector actors can, and need, to take joint action to effectively address environmentally-mediated causes of disease. To do this global partnerships are essential. Many such alliances already exist in the field of children's environmental health; occupational health; in joint health sector and environment sector linkages; and in actions in the water, chemical and air pollution sectors. Such global partnerships need to be strengthened and reinforced, harnessing the full range of policy tools, strategies and technologies that are already available – to achieve the interrelated goals of health, environmental sustainability, and development.

Source: Pruss-Ustun, and Corvalan, 2006

In the recent years though, a significant effort has been put in by the government, NGOs, INGOs in the environmental sector and there is increasing awareness of the need for reliable environmental information to inform policy and planning for sustainable development. Environmental data is still inadequate and scattered in Nepal. To discover what data is available and to gain access to them is both a difficult task. Relevant data are scattered among many institutions, and are often unpublished. There are many gaps and inconsistencies, problems in data quality, lack of clear information about methods and definitions used, lack of time series, and lack of comparability between different data sets. Nevertheless, an effort has been made by the NHRC in this publication to summarize, integrate and update the major achievements and drawbacks so far in the environmental health sector in Nepal.

1.2 Study Objectives

1. To review the causes of major environmental health problems
2. To review the status of health and environment in Nepal
3. To identify the impacts of the changing environment on health and
4. To identify the existing policies, standards and guidelines regarding environmental health.

1.3 Methodology

Formation of Study Team

In order to conduct the study, a study team consisting of environmentalist, public health specialist and public health graduate was formed.

Data Collection

In order to achieve the objectives and obtain the major outcomes of the study, both the primary and secondary sources have been used for data collection. Data was collected mainly from secondary source. All relevant data were collected by visiting relevant organizations or institutions or experts and browsing from the websites of all concerned organizations. The data were collected from Nepal Health Research Council, Ministry of Environment, Department of Transport Management, Department of Industry, Practical Action Nepal, Alternative Energy Promotion Centre, Biogas Support Program Nepal, ICIMOD, NGO Forum Nepal, Department of Health Services, Kathmandu Metropolitan City, WWF Nepal, ADB, WB, Environment and Public Health Organization Nepal (ENPHO), Ministry of Local Development, Department of Hydrology & Meteorology and Melamchi Water supply Development Board. The primary data were collected from the key informant using the method of interview.

Data Analysis

Data regarding the environment and health status was collected between 2000 to date and was compared with available data before 2000 A.D. The data were presented in tables, graphs and figures as per the need.

Stakeholder Meeting

One stakeholder meeting was organized to discuss about the findings of the study and important data missed in the draft report were incorporated after receiving the comments and suggestions from the experts and stakeholders.

1.4 Limitations of the Study

The study attempts to bring out situation analysis of environmental health at the national level. Yet, most of the data related to environmental health sector address the problems of Kathmandu and a few urban centers of Nepal only. Data on environmental health sector in the rural and other areas are inadequate. The study, therefore, is more urban biased. Though, there are many environmental health risk factors, the present study has taken only four environmental factors for analyzing the situation of Environmental health due to the limitation of time and resource. There was also a problem in establishing co-relation between environment and health aspect as most of the studies conducted separately in environment and health sector.

2 P-S-I-R Framework of Key Environmental Health Problems in Nepal

Environment is one such domain without whose perfect functioning hampers the environmental resources, overall health of the people, and the development of the country. It draws upon the interest and response from all facets of life, from different disciplines and sectors. Due to increased and unbalanced human activities, the natural and man-made entities have been greatly influenced, giving rise to different environmental problems. The P-S-I-R (Pressure-State-Impact-Response) framework of environmental problems provides a causal link between the causes, state, impact and actions taken to tackle any environmental problem. Such module helps to identify the gaps and facilitate for the decision making decision making process. In 2001, Ministry of Population and Environment (MOPE) published a comprehensive State of Environment report in collaboration with UNEP and ICIMOD in PSIR framework.

NHRC in 2002 prepared the Situation Analysis of Environment Health, on which this study is based. This study aims at updating and analyzing the status of Environment health using the Pressure, State, Impact and Response (PSIR) framework.

Nepal Health Research Council prioritizes the environmental health research priority areas for Nepal in 2006. It includes ten broad areas (See Annex I). In this report, PSIR Framework is used to address the following four key environmental problems in Nepal:

- Air pollution
- Water Pollution
- Solid waste management
- Climate Change

3 Air Pollution

The quality of the air we breathe is fundamental to the quality of life. However, air pollution is a major environmental health problem affecting both developed and developing countries as well as urban and rural areas. Concentration of air pollutants is primarily the function of source emissions, topographic and meteorological conditions. In Nepal, air in both urban and rural areas is polluted by mainly pollutants emitted from anthropogenic activities. Rapid urbanization and migration of rural people to urban areas coupled with increasing number of vehicles running in poorly maintained roads, concentration of industries in urban areas, uncontrolled waste management practices are the major source of air pollution in urban areas. In rural areas, the use of solid biomass fuels such as woods, cow-dung, and agriculture residues as source of energy for cooking and heating purposes particularly in the poorly ventilated houses is the main concern of indoor air pollution. The polluted air quality in major cities and indoor air pollution in rural areas is adversely affecting the health of people. Air pollution and its effect on health is a very complex subject since there are many different pollutants and their individual effects on health are difficult to discern. But it is known that air pollution impacts heavily on exposed population.

3.1 Pressure

3.1.1 Pressure of Ambient Air Pollution

Urbanization and Industrialization

Urban air pollution is the major contributor to the deteriorating ambient air quality. As urbanization is rapidly increasing, the sources of air pollution are added up resulting in more air pollution and the urban people particularly getting more exposed to the polluted air. Back in 1961, the percent of people living in urban areas was 3.6 increasing to 4.1 in 1971, 6.3 in 1981, 9.2 in 1991 and 15 in 2001. It is estimated that by 2020 the urban population will be 33.7 percent of the total estimated population of 34.7 million people. Concentration of population and economic activities in major urban areas has created imbalance in the demand and supply of infrastructure and services.

Exposure to air pollution has become an inescapable part of urban life. Millions of people today are at risk to various health problems due to harmful emissions from motor vehicles, industries, construction activities, fossil fuel combustion and tyre burning.

According to Department of Industry, the number of industries registered from 1960 to 2009 is 3915. Industries registered in manufacturing sector constitute 50 percent. According to Department of Cottage and Small Industries, there are 111 brick kilns, 89 stone crushing industries, 70 industries with boilers; most of these industries have no pollution control device.

Fossil Fuel Consumption and Biomass Burning

The increasing demand for more fuel due to increased population and life style create pressure on the atmosphere.

Table 1 Energy Supply (Consumption pattern by sector and types)

('000 Tones of Oil Equivalent)

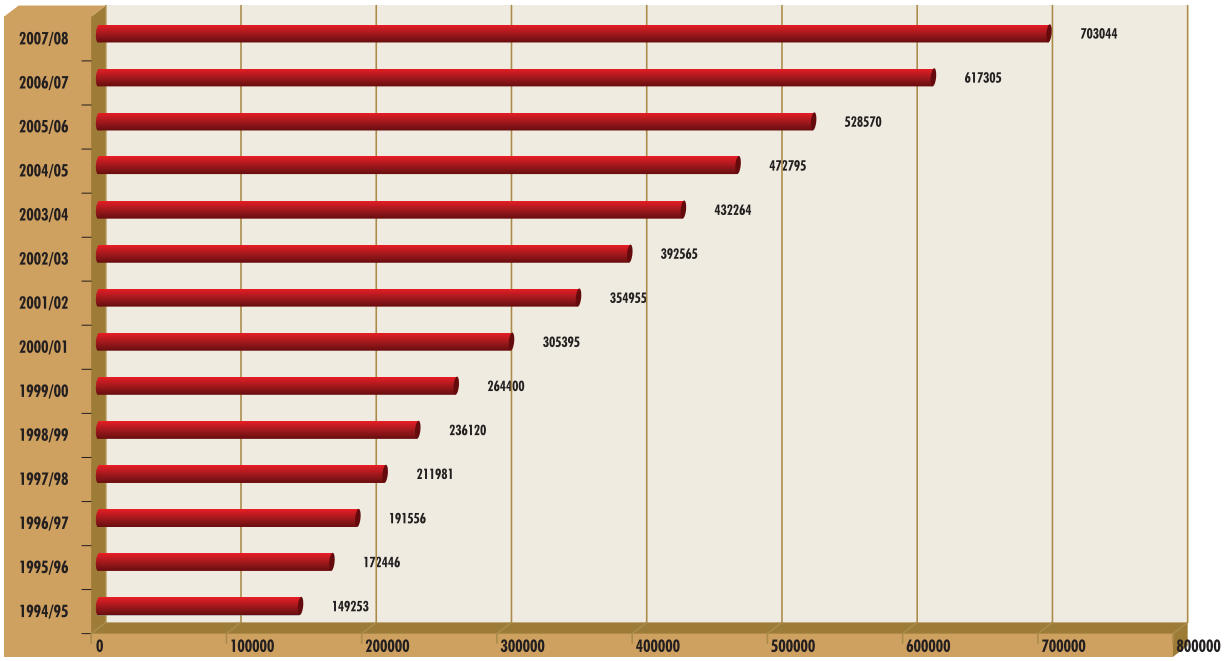
Fuel Supply by Type	2001	2002	2003	2004	2005	2006
Traditional	6824	7088	7241	7397	7558	7721
Fuel Wood	6068	6315	6451	6590	6733	6878
Agri. Residue	299	306	313	320	328	336
Animal Dung	457	467	477	487	497	507
Commercial	921	910	887.5	912.5	858.9	964.9
Petroleum	734	758	754.5	741.5	707.08	724.09
LPG	46	56	65	77	90	1063
Motor Spirit	47	50	53	53	59	62
Air Turbine Fuel	54	401	45	54	57	64
Kerosene	269	329	297	264	203	198
High Speed Diesel	290	255	267	267	279	276
Light Diesel Oil	3	2	0.5	0.5	0.08	0.09
Fuel Oil	14	14	13	10	1	1
Others	11	12	14	16	18	20
Coal	175	152	134	172	152	241

Source: Water and Energy Commission Secretariat

Above table shows that the petroleum and other vehicular fuels consumption has decreased. This may be due to the import of energy efficient vehicles, increased price of fuel, low economic activities and decreased supply in itself. But the fuel demand that is met by fuel wood and other agricultural and traditional types are in the increasing trend.

Transport Sector Growth

There has been a significant rise in the number of vehicles in the country with increased population, mobility, industrialization and economic activities. The total number of vehicles in 1994/1995 was 1, 49,253 that increased to 703044, 72,795 in 2007/2008. This figure shows that there has been an increase in the number of vehicles by more than 37 percent.



Source: Department of Transport Management

Figure 1 Vehicles Growth

3.1.2 Pressure of Indoor Air Pollution

Biomass smoke

About 83.3 percent households of Nepal (Urban 39.1% and rural 92.3%) use solid fuel as primary source of energy (NDHS 2006). So, it can be assumed that there is substantial burden of disease attributable to indoor air pollution. Solid bio-fuels like animal dung, crop residues, wood and coal for cooking daily meals and heating homes are the primary cause of biomass smoke and results in indoor air pollution. This problem is more pronounced in the rural parts of Nepal because they are poor and cannot afford to adopt cleaner fuels. It seems that the poor will continue using bio fuels seeing the tempo of development of our country. Women and children are particularly more exposed to indoor smoke due to limited ventilation and also because women and children spend long periods of time indoors. Most of the households (87%) use biomass fuel (dung, charcoal, wood, or crop residues) / coal followed by clean fuel such as kerosene/ LPG/ Bio-gas/ Electric Heater in Dhading district (NHRC/WHO 2009).

Factors that influence Indoor Air Quality(IAQ) include the following:

- Inadequate supply of outside air
- Contamination arising from sources within the building (e.g. combustion products including CO and environmental tobacco smoke; volatile organic compounds from building materials, fabric furnishings, carpet, adhesive, fresh paint, new paneling and cleaning products; ozone from office equipment).
- Contamination from outside the building (e.g. ozone, CO, and PM) through air intakes, infiltration, open doors and windows.
- Microbial contamination of ventilation systems or building interiors.

3.2 State

3.2.1 State of Ambient Air Pollution

In March 2001, the Government of Nepal initiated the establishment of the first permanent ambient air quality monitoring system in Kathmandu Valley.

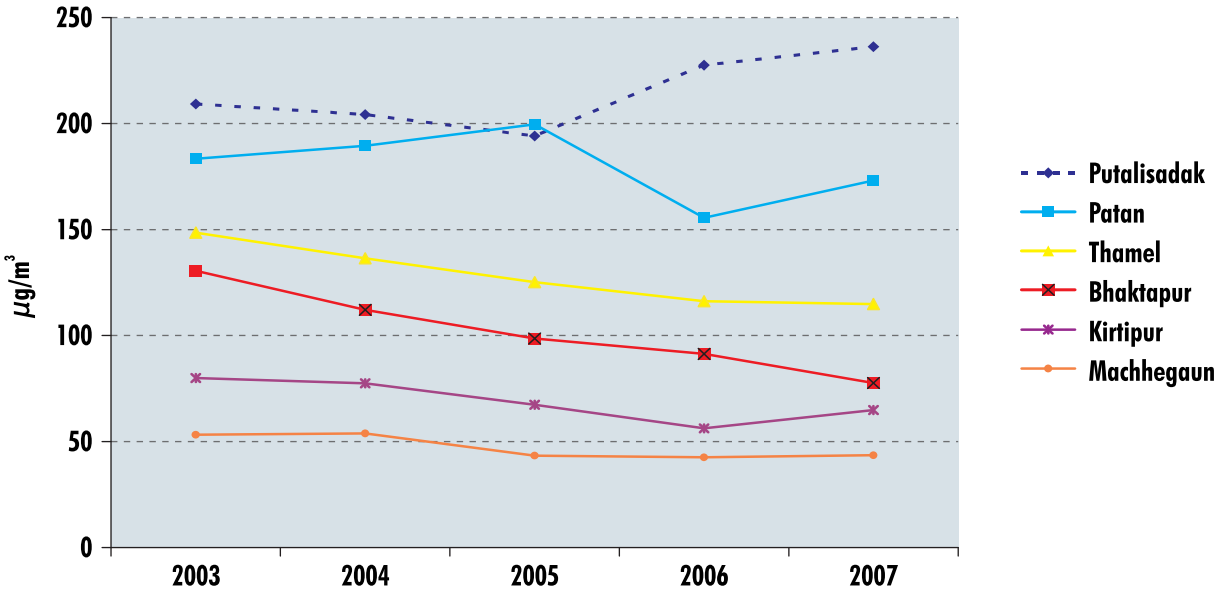
The monitoring systems, initiated by the Government of Nepal in 2001, are located at six different stations; each station represents the exposure levels at different types of locations: two road side traffic stations, one residential area, two urban backgrounds and one valley background stations. Putalisadak and Patan, Thamel, Bhaktapur and Tribhuvan University, and Matsyagaon being the six stations respectively. The results of the air quality monitoring program have shown that the main problem of concern regarding the outdoor air quality is the very high level of suspended particulate matter. In particular, the high concentration of PM10 and PM2.5 observed are known to cause serious health problems and excess mortality.

The overall average for PM10 of Kathmandu Valley has been reduced by 12% from 2003 to 2007. PM10 is decreasing steadily from 2003-2006. From 2006 to 2007, there is practically no change in the annual valley average PM10 concentration. The reduction found in 2003-2006 is observed in spite of an increasing number of vehicles registered in the valley. Numbers of registered 2- and 4-wheelers have been reported to increase by more than 10% per year. This general decrease in PM10 concentrations is the result of the actions taken by the government in 2000-2007, especially with respect to the implementation of the Euro I standard in 2003, and with the ban of Moving Chimney Bull's Trench Kiln.

The 2007 results of the air quality monitoring activities show that air pollution levels in Kathmandu Valley follows the same annual patterns as in 2003-2006. The levels of PM10 are still very high, especially during the dry period. However, the measured levels of PM10 have generally reduced at residential and urban background areas since 2003, and this positive trend is continued in 2007 (MOEST 2007). It is clear that the number of days with non-compliance for PM10 is still far too high. Of special concern are the high numbers of days with non-compliance at the urban residential (Thamel), as this station represents an outdoor air quality that a large part of the population in the Valley is exposed to. For Bhaktapur, there is a very positive reduction in the number of days with non-compliance for PM10, and this reduction is attributed to the ban of brick kilns based on traditional technology in 2004. The number of brick kilns in the Bhaktapur area is specifically high, and the ban introduced seems to have a very positive effect on the air quality particularly in the Bhaktapur area (MOEST 2007).

The measured levels of lead in PM10 were below the NAAQS for lead (0.5 $\mu g/m^3$) at all times and at all stations in 2007. PM2.5 levels at the residential station (Thamel) concentrations were reduced by 30% from 2005 to 2007. This is a very positive trend, especially as the fine particles that are contained in the PM2.5 fraction are particularly harmful to human health (MOEST 2007). The challenge of managing the air quality of Kathmandu Valley is immense and requires strong commitment from the government and participation of public to bring it down to the national target.

The annual average concentration of PM10 from 2003 to 2007 in six different stations of Kathmandu Valley is shown in following graph. All the stations except Putalisadak show a reduction in PM10 concentration. The Putalisadak station has been affected by frequent burning of litter very close to the station, especially during night in the winter seasons in 2006 and 2007.



Source: Status on ambient air quality of Kathmandu Valley, 2007, MoEST

Figure 2 Annual Average PM10 concentration: Results from 2003- 2007, station by station

The air quality deteriorates drastically during the dry period (December-May), and improves during the wet period (June-November). During December, January and February, the 24 hour average concentrations of PM10 exceed the NAAQS of 120 $\mu g/m^3$ almost everyday at the urban area stations (Putalisadak, Patan and Thamel) (MOEST 2007).

Outside the valley, a study done by NHRC in 2004 showed that the average level of TSP and PM10 in Birjung were almost double than that of Pokhara. The PM10 and TSP level in three sites Bhanuchowk, Ranighat and Adarshanagar of Birjung were found to be 380 $\mu g/m^3$, 358 $\mu g/m^3$ and 220 $\mu g/m^3$ and 1282 $\mu g/m^3$, 1432 $\mu g/m^3$ and 547 $\mu g/m^3$ respectively. The study also showed that the average TSP level and PM10 level in different urban settings of Pokhara city i.e. high traffic, industrial and commercial zones were found 529 $\mu g/m^3$, 394 $\mu g/m^3$and 309 $\mu g/m^3$and 165.1$\mu g/m^3$, 130.15 $\mu g/m^3$ and 109.1$\mu g/m^3$ respectively.

Bossi in November 2003 collected two samples of total polyaromatic hydrocarbons (PAH) from five different monitoring stations in Kathmandu and analyzed them in Denmark. The samples taken from sites at Patan Hospital, Putalisadak, Thamel and Bhaktapur had PAH concentrations of 2.32, 3.16, 3.23 and 4.30 $\mu g/m^3$ respectively which are three times higher than the European Union recommended level (1$\mu g/m^3$). Only in Matsyagaon, the benzene concentration was below the European Union level (ADB and ICIMOD 2006)).

3.2.2 Status on Indoor Air Pollution

A study conducted by NHRC in 2004 reveals that the indoor PM10 concentration is 2418 $\mu g/m^3$ (average of 62 readings)in houses with traditional clay stoves using solid bio-fuel. Whereas, the PM10 concentration level in kitchens using cleaner fuels (gas, kerosene) was found to be 792 $\mu g/m^3$ (average26 readings), which is about three times low (NHRC/WHO 2004). There are very limited data available on status of indoor air pollution in Nepal.

3.3 Impacts

3.3.1 Impacts on human Health

Although air pollution has become a visible environmental problem in the last decade, only limited data are available to evaluate its magnitude and impact. The health impact of air pollution depends on the pollutant type, its concentration in the air, length of exposure, other pollutants in the air and individual susceptibility. Different people are affected by pollution in different ways. Among them, the more vulnerable are the poor, undernourished, very old, very young, and people with pre-existing respiratory disease and ill health.

Indoor air pollution from household energy ranks as the fourth leading health risk in poor developing countries. The smoke from biomass fuels is a complex mixture of aerosols containing significant amounts of carbon monoxide (CO), suspended particulate matter, hydrocarbons, and NOX (Naeher et al.2005).Exposure to indoor air pollution poses severe threats to ones health. Exposure to the smoke from a day's cooking is equivalent to smoking two packets of cigarettes (Warwick et.al, 2004), directly affecting lungs and chest and posing risks for chronic respiratory disorders, acute respiratory infections (ARI) including, pneumonia and bronchitis, chronic obstructive pulmonary disease (COPD), lung cancer, and other problems.

PM10 and PM2.5 are of major concern of particulate pollutants in terms of their impact on human health. These particles pose the greatest problems because they can get deep into the lungs and some even finer particles get deeper into the bloodstream. Long-term exposure to particulate matter shows decreased lung function, chronic bronchitis, premature deaths, and heart attacks. Long term epidemiological studies have not been conducted in Nepal so far, but a few cross-sectional studies have undertaken taking one-time medical examination of an exposed population or have used dose-response relationships to indicate that the health impacts of air pollution.

A study done by NHRC/WHO in 2008 reveled that the about 50% cases of acute lower respiratory infections (ALRI) were attributed by indoor smoke in Dhading district and total Disability Adjusted Life Years (DALYs) was1284 due to ARI.

Eight kinds of respiratory ailments and related symptoms; COPD, bronchial asthma, ENT, eye problem and cough, phlegm, breathlessness, wheezing were found in adult respondents due to indoor smoke at rural Mountain Village in Far-Western Nepal. The study showed a significant positive association between prevalence of respiratory-disorder due to indoor air pollution, among both smokers and non smokers (Joshi et al., 2009).

An epidemiological study conducted in a rural community in the hilly region of Nepal revealed a significant positive correlation between the prevalence of chronic bronchitis and average amount of time of exposure to indoor are pollution both amongst smokers and non – smokers. The increasing trend of the prevalence rates as the level of exposure is increased, even after elimination of age effect, established a fact that domestic smoke pollution is an important contributing factor in chronic bronchitis (Pandey, 1984).

NHRC (2004) study also shows that persons exposed to solid bio-fuel smoke show higher prevalence of respiratory abnormalities as compared to clean fuel users and ARI prevalence is found to be 16.8% as compared to processed fuel which is 7%.

CBS (2002) census report shows that 80% of the households use animal dung and wood as solid fuels for cooking purposes. The total death from pneumonia alone was reported to be 4429 during the last 12 months preceding 2001 census (4.15 % of the total deaths). Similarly, the total death from Asthma / Bronchitis is reported to be 7170 (6.71 %). According to Nepal Demographic and Health Survey, 2001, the prevalence of ARI for children below 5 years, was found to be 23 % (NDHS 2001) and prevalence of ARI among under five children was 5% in 2006 (NDHS 2006)

A study conducted by World Bank in 1997 estimated 85 cases of excess mortality and 1.5 million respiratory symptom days due to PM10 exposure. In 2002, Clean Energy Nepal surveyed schoolchildren around brick kilns and found that brick kilns had a significant impact on the health of these children. Yet another study conducted by CEN/ENPHO in 2003 showed that a reduction in PM10 in Kathmandu valley would reduce 2117 cases of Respiratory Hospital admissions, 41,454 emergency room visits, 5.2 million restricted activity days, 1,35,475 acute bronchitis in children , 0.5 million asthma attacks, 32 million days with respiratory symptoms and 4304 chronic bronchitis. NHRC/WHO (2006) study using Environmental Burden of Disease (EBD) approach estimated that attributable burden due to PM10 concentration in Kathmandu valley against the baseline concentration of 10$\mu g/m^3$ was 1,926 cases of premature mortality per year.

World Bank (2008) study estimated that the total cost of indoor air pollution is US4 147.3 million which is almost 2% of Nepal's GDP. Similarly, the total economic cost of urban air pollution in Nepal are estimated at about US$ 21 million (0.29 %) of Nepal's GDP.

3.4 Response

It was the National conservation Strategy 1988 that focused on needs to establish policies in response to air pollution and emphasized to develop standards and establish the monitoring and evaluation system. Environmental Protection Council in 1993 brought the Nepal environmental Policy and Action Plan focusing on integrating development efforts and environmental conservation for sustainable fulfillment of the basic need of the people by mitigating the adverse environmental effects of development activities.

Sectoral policies have been important in reducing the air pollution problems. National Transport Policy 2002 has shown its commitment to promote zero emission vehicles and expanding the solar, electric vehicles throughout the country which directly affects the health of the people. Industrial Development Perspective Plan 2002, (updated in 2004) gives emphasis to enhanced productivity in the Nepalese industrial sector, with the incorporation of the Cleaner Production/Energy Efficiency/Environmental Management System (CP/EE/EMS) as well.

The strategies of the Tenth Plan has affirmed that a well equipped inspection and monitoring system can reduce the road accidents and implement vehicle pollution control standards. The Sustainable Development Agenda for Nepal (SDAN), 2003 has included the following objectives for air pollution.

- Setting strictly enforced ambient air quality standards
- Encourage the shift towards zero-emission vehicles, especially in dense urban areas
- Shift towards clean sources of industrial energy

- Create conditions that foster the growth of institutions that increase domestic research and monitoring capability of air quality including capacity for tracking the trans-boundary transport of air pollution
- Promote use of cleaner stove technology and alternative cooking fuel sources to reduce indoor air pollution.

3.4.1 Legislative Response

Transport management Act 1992 and Regulation 1997, empowers the Government of Nepal to determine standards in mechanical conditions of the vehicle, the amount of pollution discharged by vehicles and the lifespan of vehicles. Environmental Protection Act and Rules brought by the Government in 1997 provides authority to MOEST to formulate standards and enforce them. All pollution prone industries and establishments need to undergo the EIA procedures.

The Industrial Enterprises Act, 1992, has given privilege to those environmental friendly industries with reduction of up to 50% in the taxable income for the investment in industrial process or equipment with very minimum effect on the environment. Local Self Governance Act 1997 provides authority to local bodies to introduce measures to reduce air pollution with the objective of safeguarding health of citizen.

As per the provisions of EPA and EPR, Nepal Government has introduced National Ambient Air Quality Standard for Nepal (NAAQS) in 2003 (See Annex II) as target to reduce air pollution through various preventive and control measures. Other main measures taken by government are as follows:

- Introduction of Nepal Vehicle Mass Emission Standard, 2056 (only vehicles complying with these standards can be imported to the country).
- Ban on import of second-hand and reconditioned vehicles, two-stroke engine vehicles (1999)
- Phased out three wheeler diesel tempos (1999), three wheeler two-stroke engine vehicles, and 20 years old taxis from Kathmandu Valley (2004).
- Introduction of Vehicle Emission Standards for in-use vehicles to ply in the streets of Kathmandu Valley inside ring-road (1997) and reviewed this standard as national requirement in 2001.
- On-road tailpipe emission monitoring of polluting vehicles (2003)
- Ban on trucks and other heavy goods carrying vehicles entering inside ring-road from 7 am to 8pm (1999/2000).
- Ban on the new registration of Bull's Trench Kiln brick manufacturing industries in the valley and all those already in operation to be changed to cleaner technology by the end of 2004.
- Emission standards for brick kilns of 900 mg/m^3 by Industrial Promotion Board in 2004.

Recently, the government of Nepal has set the National Indoor Air Quality Standard and Implementation Guidelines 2009 which were Gazetted on April 4, 2009(See Annex III). These documents were prepared through a multi-stakeholders committee comprising of the Ministry of Health and Population, Ministry of Environment, Science and Technology, Kathmandu University, Practical Action and WHO. This reflects the initiation of good coordination among the stakeholders to resolve the problem of indoor air pollution and health. The government has also implemented Polluter Pay Principal in Kathmandu valley by placing Rs.0.5 per liter petrol and dissel to reduce the air pollution Kathmandu valley.

3.4.2 Promotion of Alternative Energy Technologies

Alternative Energy Promotion Center (AEPC) was established in 1996 under the Ministry of Environment, Science and Technology (MOEST) with an aim to popularize and promote the use of renewable energy technology, to meet the energy needs in the rural areas of Nepal, and raise the living standards of rural people, to protect the environment and to foster commercially feasible alternative energy industries in the country. AEPC works closely with various donors, INGOs, NGOs, and other organizations. DANIDA and Government of Norway have been assisting in the Energy Sector Assistance Programme. Achievements made by the AEPC are summarized below:

- Biogas support program was started in 1992, and until December 2004, there were 135311 biogas plants installed. Fourteen biogas appliances manufacturing workshops and 57 biogas manufacturing companies are involved in the promotion of biogas plant in the country.
- Till July 2005, a total of 150,000 Improved Cooking Stoves (ICS) were installed throughout the country with the objective of smokeless environment in the rural kitchen or reduction in the volume of smoke produced during cooking against the traditional stoves.
- Solar Home System (SHS) promotion program has been started since 1992 and until December 2006, the total no. of SHS was reached to 96, 673 with total installed capacity of about 3.1 MWp.
- Various types of micro-hydro (MH) plants ranging from 1kW to 100kW are based on technologies like propeller turbine, cross flow turbine, pelton turbine, multipurpose power unit (MPPU), peltric set, and improved ghatta. Around 2,200 such schemes have been developed and installed in the past decades totaling about 14,600 kW power output till mid-July 2003 benefiting about 146,000 rural households in Nepal.

3.5 Gaps

- No regular monitoring of ambient air quality in Kathmandu valley. Air quality monitoring stations of the Kathmandu valley are not operated since March 2009.
- No air quality monitoring stations in urban areas outside the Kathmandu valley.
- No availability of indoor air quality data.
- Very few epidemiological studies on health impact of air pollution in Nepal.
- The concentration of PM10 is very high compared to national standard in most of the urban areas of Nepal.

4 Water Pollution

Nepal ranks as the second richest country in the world in water resources. The major sources of water are glaciers, rivers, lakes, ponds, and now rainfall. There are about 6,000 rivers in Nepal with estimated total length of 45,000 kilometers (DHM 1998). The major rivers originating from high Himalayan region and flowing down to flat southern plane with span of few hundred kilometers posses very high head difference that leads to the potential of generation of over 83,000 MW of electricity, however only 527.5 MW has been generated so far (10th Plan-NPC). 40% of the urban people have access to electricity and 5% to the rural people (SDAN 2003). The country has 660 lakes of more than 1 hectares surface area. Big lakes are used for irrigation, hydropower generation, fisheries and others. Small lakes and rivers provide perennial supply of water for life support system and other activities. Monsoon rain recharges all the water sources and reservoirs. Annual rainfall of Nepal being 1,700mm most of the water is received during the monsoon period (June – September) (ICIMOD 2006). Groundwater is an important source of water for people particularly in Kathmandu and the Terai region.

Use of water resources can be considered as a measure of development, since it is directly related to agricultural activities, environmental conservation, and human health. With increasing population and development activities, pressure on water resources is increasing. However, the source of water resources is diversified. Since water is a basic element in different types of activities, it is used by tapping most of the available sources and its use is being intensified in order to meet the growing demand for water.

Human health is directly and indirectly related to the availability of quantity and quality of water, and also indicates the affluence and sanitation of any society. Normally, the daily water requirement for basic physiological processes of a person according to WHO is 2 liters per day. Water quality refers to the suitability of water to sustain living organisms. For humans, it is used for drinking, bathing, washing, irrigation, and industry. Changes in water quality are reflected in its physical, biological, and chemical conditions, and these in turn are influenced by natural and anthropogenic activities.

4.1 Pressure

4.1.1 Water Quantity

The present day civilization is mostly based on energy and fuel oil rules the major politics. As important oil is for development, water is much more important for human existence. There are substitutes for oil, but not for water. People have lived millions of years without oil but they would live for a matter of days without water. At a personal level, a man drinks roughly four liters of water a day (nearly four quarts), either directly or indirectly in various beverages. But it takes 2,000 liters of water which is 500 times as much to produce the food for people to consume each day(Jaco-b.W. K,1979).

The population is ever increasing and so is the demand for food. Since food is such an extraordinarily water-demanding product, it is not surprising that 70% of world water use is for the agricultural purposes. Our economy being agriculture based economy, to increase the output of agriculture, irrigation is a must technology. The estimated total annual water requirement for irrigation in cultivated area is 67km^3, which makes up nearly

30% of the total water potential of 224km^3. Irrigation in Nepal is almost river-based. The Koshi, Gandaki, Karnali, and Mahakali are the major rivers which have been used for irrigation.

In addition to these, there is increased pressure on water resources to generate hydropower and meet the raising demand of electricity of the people. The country has 83,000MW of potential hydropower generation, of which 42,000MW are economically viable. At present, total electricity generation of the country is 559MW (WECS 2004). Additionally, there are micro hydropower plants being operated in different parts of hills and mountains which contribute 1.2% of total hydropower generation of the country. Furthermore, there is increase in demand for electricity which rose from 300MW in 1996 to 426MW in 2002(10th Plan).

Despite Industrial consumption of water being relatively small yet has tremendous pressure due to waste discharge into the rivers and streams. Industrial cooling, heating (boilers), water processing, cleaning and sanitary use consume significant quantity of water most of which are supplied by on site abstraction of ground water. In absence of user charge and permit system in ground water abstraction the judicial use of resource is often ignored. This is particularly true in case of carpet washing industries.

Climate change is currently taking place at an unprecedented rate and is projected to pose a great risk on natural resources and environment. It will potentially have profound and widespread effects on the availability of, and access to water resources. Seasonal shift has been observed and experienced lately with monsoon not being timely and disproportionately. Extreme weather events have occurred lately, e.g Koshi Floods which damaged a large property and lives of thousands. Studies have shown that there is increase in the annual temperature at a rate of 0.06°C/year (Shrestha et.al 1999). This will potentially have an impact on the Himalayan glacier retreat and water availability.

4.1.2 Water Quality

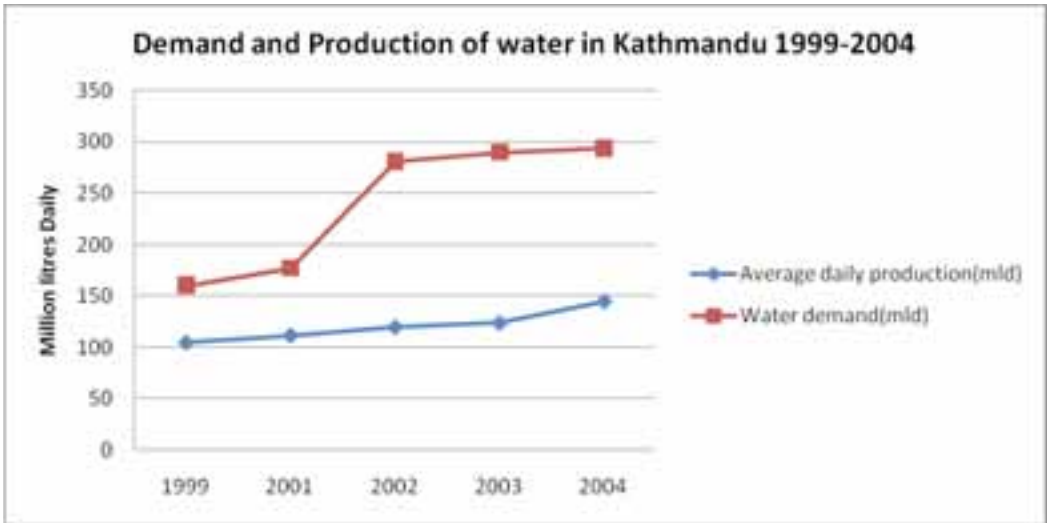
Despite the abundant water resources in Nepal, it has the poorest drinking water and sanitation coverage in South Asia. The quality of drinking water from surface as well as ground water sources is of growing concern in urban Nepal. Water quality mainly that of the accessible water bodies to the urban centers and dense human settlement are extremely polluted. Depending upon the volume of water flowing in the rivers and also the season of the year, the degree of pollution of such water depends. Water quality of all the rivers and streams of Kathmandu valley near to that of the densely populated areas exhibit characteristics similar to that of raw sewage. Bishnumati, and Dhobikhola also show similar characteristics to that of Bagmati. Sewerage is directly discharged into the rivers as if they were waste drainage. Water quality of Seti river at Kaski, budhi khola at Biratnagar and Phewa lake at Pokhara are polluted too. There is a close link between environmental sanitation, hygiene and water supply. And this being the scenario of the water quality of Kathmandu and other major cities, one cannot be positive about the health of the people.

Water pollution maybe because of physical, chemical or biological factors. The dissolved and suspended chemicals are the dominant factors of pollution. The river water pollution in Kathmandu is mainly of anthropogenic type which is due to the generation of sewage and wastewater from domestic, agricultural or industrial use.

4.2 State

4.2.1 Urban Water Supply

Water demand of the urban areas of Kathmandu valley is 170 million liter per day of which only 50% is met during dry season and 80% during monsoon (NPC 2002). The pressure on water quantity in Kathmandu has been increasing day by day due to the rapid urbanization it has been facing. There is an influx of people from other parts into the capital which has aggravated the situation. In such a case, in order to fulfill the gap of water supply, often the water quality aspect has been ignored. In Kathmandu, most of the surface water has been tapped for water supply and much of the groundwater has been used.



Source: NWSC 2004

Figure 3 Demand and production of water in Kathmandu valley

Another important source of water supply in Kathmandu are the age-old stone spouts or 'Dhungedhara'. Stone spouts are natural springs that were developed as sites for public water consumption several hundred years ago. In Kathmandu valley there are 389 stone spouts. Apart from 68 sources that have gone dry and 43 that have been connected to City Supply(KUKL) 233 stone spouts still serve as independent water sources catering approximately 10 percentage of Kathmandu's population today. The naturally working stone spouts are supplying water about 2,946,542 liters per day in dry season (March-May) and about 7,696,091 liters per day in wet season (July-September) (NGO Forum for Urban Water and Sanitation, 2008).

The quality of stone spouts' water is not satisfactory. All the samples tested have shown positive test result in coliform test. In about 90% of samples showed excess ammonia concentration, 60 percentage samples showed nitrate concentration and phosphate concentration in 50 percentage of samples was found to be above WHO permissible value. The water quality of the different stone spouts showed that they are not far from the anthropogenic pollution. (NGO Forum for Urban Water and Sanitation, 2008) Stone spouts have important traditional and aesthetic value so the local people consider it as pure and drink it directly from the source without any treatment posing them at risk to various water related diseases.

280 water samples were collected from seventeen municipalities for studying the Urban Water Quality. Out of them 66 samples from sources, 34 samples from reservoirs and remaining 172 samples from taps were

collected and tested. The values for physiochemical parameters in majority of tested samples from source, reservoirs and all tap were found to lie within the National Drinking Water Quality Standard of Nepal 2062. Water testing results showed high proportion of water samples (sources, reservoirs and taps) were faecally contaminated. Out of total 66 sampled sources, 53 (80.3%) were contaminated with E. coli. Similarly, out of 34 sampled reservoirs, presence of E.coli was found in water samples from 24 reservoirs (70.6%). Out of 180 taps samples, 113 (62.8%) were contaminated with E.coli (ENPHO, 2007).

Arsenic is also reported from ground water of Kathmandu valley too. The distribution patterns of arsenic contamination in tested samples were found almost similar. However, Deep tube wells were found more vulnerable than Shallow dug well and shallow tube wells. Result also showed Arsenic concentrations were higher in pre-monsoon as compared to monsoon as shown in table.

Table 4 Groundwater Quality surveillance for Arsenic in Kathmandu and Lalitpur Municipality

Well Types	Monsoon			Pre-monsoon		
	Total tested Sample	Above WHO Guideline (10ppb)	Above Nepal Standard (50ppb)	Total tested	Above WHO Guideline (10ppb)	Above Nepal Standard (50ppb)
Deep tube wells	56	50.5%	12.5%	51	68.6%	9.8%
Shallow tube wells	160	6.3%	-	149	11.4%	-
Shallow dug wells	91	14.3%	1.1%	87	11.5%	-

Source: ENPHO and JICA, 2005

Water supply in other towns and cities is not any good either. Butwal, Biratnagar, Pokhra, Bhairahawa, Palpa and other major cities and towns too face the problem of inadequate water supply. Water supply system in other towns mainly uses groundwater as the only source and there is virtually no treatment system associated with such water supply. However except Arsenic, potential fecal contamination there is no serious water quality problem. Water quantity is still the problem in urban water supply system even outside Kathmandu valley. Rainwater harvesting has come up as an important alternative to meet the gap in water demand.

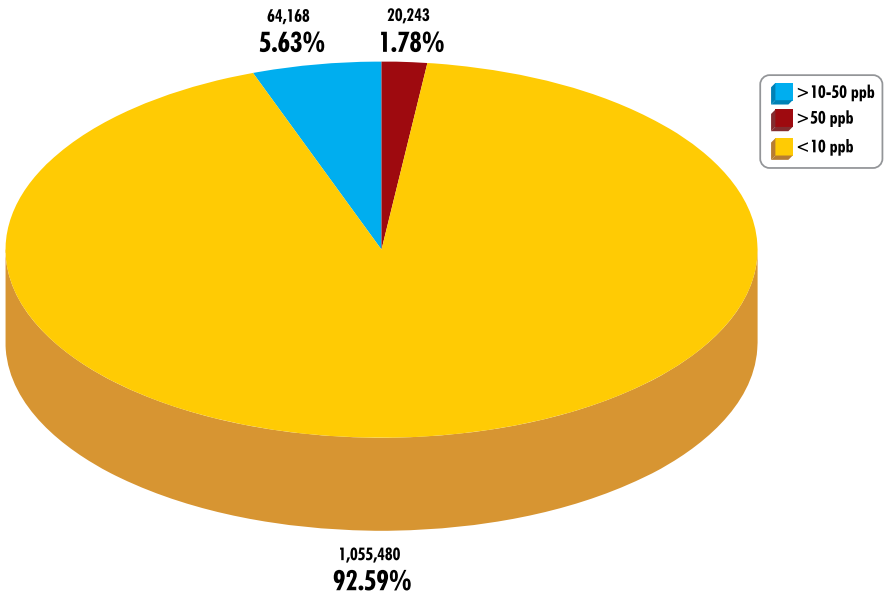
4.2.2 Rural Water Supply

About 39% of total rural households have access to piped water compared with 68% in urban areas. Access to piped water is lowest in Terai, 75% of terai households have access to covered wells (tube well), whereas 62% of the households in the Mountain have access to piped water outside the house (Community tap). Rivers, streams, ponds are also another important source of water for the rural people. Water thus collected is used directly without any treatment, which is highly loaded with fecal contaminants. This poses great risk on the health of the people. The case of remote Jajarkot where hundreds died due to diarrhea epidemic in 2009 is just an example which illustrates the poor supply and availability of clean drinking water in the rural areas. Experts have pointed that this epidemic could be due to fecal contamination in drinking water source. Recently arsenic contamination of groundwater, which is the main source of drinking water in Terai, has cropped as a serious water supply in the Terai.

Arsenic problem in Terai

The Department of Water Supply and Sanitation conducted the first study on arsenic contamination in the eastern terai region of Nepal in 1999, results of which indicated the possibility for arsenic contamination in groundwater of terai (Sharma, 1999). Findings of another preliminary study on arsenic contamination in tube well water in eight terai districts conducted jointly by the Nepal Red Cross Society (NRCS) and the Environment and Public Health Organization (ENPHO) in 2000 revealed the need for a comprehensive study on arsenic contamination in tube well water to find out the extent of arsenic distribution in southern Nepal. Since then, governmental and non-governmental organizations and some researchers have tested several thousand samples of tube well water to identify levels of arsenic contamination and have found that 7.4% of tubewells had arsenic concentrations more than the maximum permissible limit (50 μg/L) for Nepal (Shrestha BR, Whitney JW, Shrestha KB,2004).

According to DWSS, in 20 districts of Terai total 1,139,891 samples were tested for arsenic till June 2008. Out of that, 1, 055, 480 (92.59%) samples had arsenic 0-10 ppb, 64,168 (5.62%) sample had 10-50 ppb and 20,243 had arsenic content >50 ppb (DWSS Official Record).



Source: DWSS

Figure 4 Arsenic Concentration of Total Tube wells As of June 2008

The Nationals Standard of Nepal for Arsenci in drinking water is 50 ppb. The Nepal government set this standard in 2006 setting National Drinking Water Quality Standard 2006. A detailed and a clearer picture of arsenic concentration in terai region of Nepal is given in Figure 4 above.

4.2.3 Groundwater quality in urban areas

Groundwater is abundant in the aquifers of the Terai and the Kathmandu Valley. About 50% of the water used in the city of Kathmandu is derived from groundwater (Water Aid, 2001). Owing to the water supply situation in Kathmandu valley, a large proportion of people tend to have their own dug well and tube wells. This water is mainly used for washing and cleaning purposes and even for drinking purposes. Nepal Water Supply Corporation is also using several of its deep wells for water supply. There is an overall lack of water-

quality data for Nepal and hence assessment of the main quality problems is difficult. The water quality of these shallow and deep wells is not satisfactory.

Shallow groundwater is also at risk of contamination by pathogenic bacteria, pesticides, nitrate, and industrial discharges. In Kathmandu valley, these shallow groundwater are particularly, reported to have been contaminated by domestic and industrial effluents. The nature of these elements is not known in detail, but the greatest sources are likely to be from the textiles and carpet-manufacturing industries. These may introduce effluents with high salinity and containing organic chemicals and some trace metals from dyes and finishing treatments ((Jacobson, 1996).

Shallow tube wells are the major water supply modes in most of the Terai towns. Information about the quality of such water is very limited. Some sporadic studies and studies for Arsenic assessment have shown that some of these tube wells are contaminated with arsenic, many samples contained high ammonia level, iron level and the fecal coliform contamination is rampant (SEAM-N 2005).

Waste water discharges of major cities are directly connected to the nearby areas and so are the solid wastes which are haphazardly dumped in the river banks. If we see in Kathmandu, the situation is degrading day by day. The slum area spread all along the Baghmati and Bishnumati area are more at risk to water contamination. They don't have proper and clean water supply system and are bound to use the same polluted water. The municipal waste dumped along the river corridor increases the risk. Recently, the Bagmati bank area in Balkhu has been improved into the UN Park.

4.2.4 Surface Water Quality In and Near the Urban areas

Natural water bodies like river and ponds near the dense settlements are degrading day by day since they are becoming a potential wastewater sink. They are in the state of anoxic conditions and undergoing anaerobic degradation of the sewage releasing hydrogen sulfide and several other volatile organic gases. This is true with low flow river with excessive waste receiving such as Bagmati, Bishnumati in Kathmandu. However there is some improvement in the condition during monsoon due to higher water volume. The rivers nearby the industrial areas are excessively polluted due to the direct discharge of untreated effluents into the river. This poses risk to the aquatic ecosystem as well as the people downstream.

4.2.5 Sanitation in Urban areas

Sanitation can be measured in terms of availability of sewerage and toilet facilities. Urban sanitation, including access to toilets, wastewater management, and drainage, is a major problem in all municipalities in Nepal. According to Municipal Association of Nepal, 76% of the urban population has access to toilets, while 24% uses open spaces such as riverbanks and fields for defecation. Even among people who have toilets, many practice open defecation for convenience and maintenance cost reasons. In terms of feces disposal, it is estimated that 35% of the toilets are linked to drainage or sewerage systems, 55% discharge into septic tanks, and the remaining 10% into open drains and ditches. There are five municipal wastewater treatment plants in the valley to treat a small portion of the wastewater generated within the valley, but among these, four are either not functioning or only partially functioning.

According to CBS (2002), only 81%, 90% and 92% of households in Lalitpur, Bhaktapur and Kathmandu have toilets in their homes. Those households without toilet practice open defecation. There are public toilets made in the core city areas. But they are not in a good condition. In public places we can see banners, posters and wall writing discouraging people to urinate in public. Even then, people urinating just below those signs are not less. Even walls of government offices are found to be wet with urine.

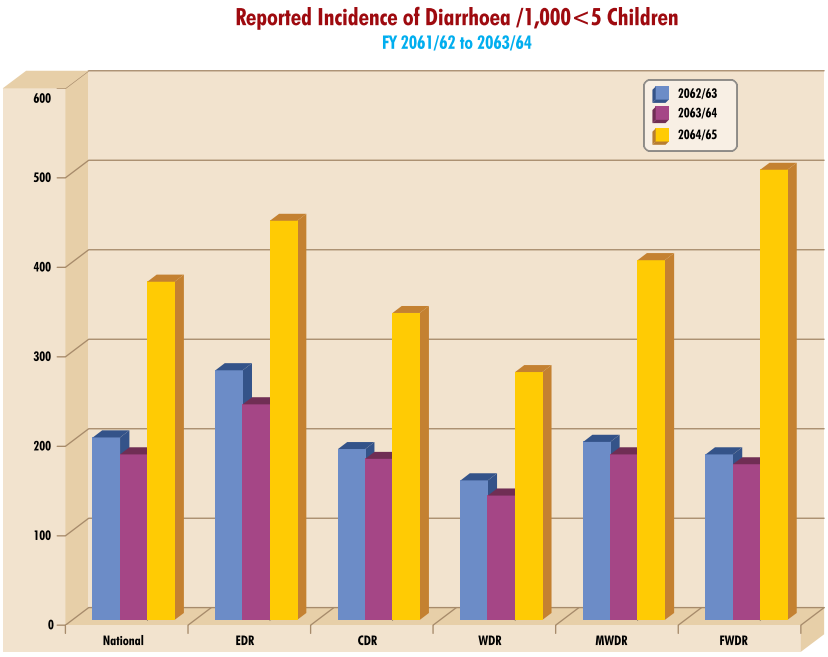
Most of the households in the valley do not have septic tanks; rather they are directly connected to the rivers nearby. The Municipality does provide the service of emptying the septic tanks. But the septage is pumped and disposed eventually in the rivers, in the knowledge of the concerned authority.

4.3 Impacts

4.3.1 Impacts on Public health

One of the major impacts of unsafe water is on public health. An important fraction of the total burden of disease worldwide—around 10%—could be prevented by improvements related to drinking-water, sanitation, and hygiene and water resource management (WHO, 2008). Water pollution and its impacts on health have emerged as a serious public health issue recently. Nepal is facing the double burden of diseases; communicable diseases have not yet decreased and we are witnessing the major outbreaks of diseases like diarrhea and a large fraction of the population are already suffering from non communicable diseases. It is commonly recognized fact that use of contaminated water poses risk on human health causing diseases like diarrhea, cholera, hepatitis. In Nepal, morbidity and mortality rates from water borne diseases are considered high particularly among children below the age of five.

Figure 8 shows the three-year trend of reported diarrhoeal incidence per 1,000 under-five children. At the national level during FY 2064/65, incidence of diarrhoea increased significantly (378 per 1,000) compared to FY 2062/63 and 2063/64. At regional level also diarrhoeal incidence has increased significantly in all regions in FY 2064/65 in comparison to FY 2062/63 and 2063/64. This may be either due to increasing case detection rate or due to poor quality of drinking water.



Source: HMIS/MD, DoHS

Figure 5 Reported Incidence of Diarrhea of <5 year children

Not only that, consumption of poor quality water is associated with various types of intestinal worms and parasites, which is seen all the year round, and increases mainly during the monsoon season. Diseases relating to water management such as Malaria and Japanese Encephalitis take a big toll every year. In the table below we can see that in (n=460) 460 samples of stool tested for intestinal worms in 37% some form of worm was present.

Table 2 Result of Stool sample tests

Parasites	Number	Percentage
Ascarias lumbricoides	48	28.4
Entameoba histolytica	64	38.8
Hookworm	40	23.7
Giardia Lamblia	10	6
Trichuris trichura	6	3.6
Hymenolepis nana	1	0.59
Total Positive samples	169	100

Source: Teku Hospital, Kathmandu, (Data from mid July to mid August 2004)

The tools and waste water from hospital are directly discharge into sewerage and rivers. Other issues of water quality which have negative impacts on public health are arsenic contamination in groundwater. Accoring to the latest report of blanket testing of Arsenic as of June 2008, about 1.80 percent tube wells of terai regions have arsenic concentration above the national standard of Nepal (50ppb). According to the community based prevalence survey conducted by NHRC in high arsenic concentrated area Bardiya, Kailai and Nawalparasi, the average prevalence of arsenicosis is 2 to 3%.

4.3.2 Impacts on water ecology

Human activities have solely been responsible for altering the immaculate water bodies mainly the rivers. The rivers in the valley and in the major cities and towns have been widely used as a sewerage for dumping collected solid waste, households waste, industrial effluents and even slaughtering animals in river banks like in the Bhaisikatan area of Kalimati is an example of just how water bodies have been polluted. The state of rivers and ponds and their appearance is undoubtedly like that of sewerage. Degradation of water quality of the lakes and ponds has expedited the plant succession process. Disappearance of several lakes in Pokhara valley and blooming of water hyacinth in Phewa Lake, shrinking of Tau Daha in Kathmandu Valley, drying up of Kamal Pokhari at the center of Kathmandu city are some of the most notable examples of impact of water quality degradation. Excessively polluted Bagmati, Bishnumati, Dhobikhola, Tukucha, Manahara, Hanumante Rivers in Kathmandu valley no longer house any fresh water aquatic lives as these water courses are rightly termed as dead rivers. Similarly industrial wastes, from pulp industries, distillery, and carpet factories are also directly connected to the rivers and streams. Being this the situation, the aquatic biodiversity has been seriously affected, with loss of aquatic plants and animals. This very water when used in the downstream, can cause health havocs and also affect the agriculture, fisheries and other areas.

4.4 Responses

4.4.1 Policy responses

The Water Resources Act formulated in 1993 confers the ownership of all water resources to the state. The Act has appropriately recognized drinking water as the priority in terms of order of use, followed by irrigation, farming enterprises such as animal husbandry and fisheries, hydroelectric power, cottage industries, water transport, and others. The National Water Resources Strategy 2002 aims at developing and managing water resources in a holistic and systemic manner with emphasis on conservation and protection to the environment. The National Water Resources Strategy declares the commitment of the Nepal government to provide safe, convenient and adequate water to its people. The Tenth Plan document mentions that 85% of the total water demands will be met by the end of the plan period (2008) with gradual improvements in service levels; appropriate sanitation services in rural and urban areas will be provided through community awareness programs; and infant mortality will be reduced by bringing about a reduction in water-related diseases. The government has undertaken the following actions to meet the water demand of the people:

- Rainwater harvesting in feasible areas, mainly the hilly regions where water shortage is maximum during dry season.
- Community-based water supply and sanitation sector projects, particularly in the mid and far west hills
- Rural water supply projects in collaboration with different NGOs and INGOs
- Water quality improvement projects
- Awareness and education about sanitation and hygiene promotion.

The Water Resources Strategy (WRS) formulated in 2005 has set its goal as ' Living conditions of Nepali people significantly improved in a sustainable manner' and which is planned to be achieved through three periodic plans:

- Short-term (5years) – for implementing a comprehensive water resource strategy;
- Medium-term (15years) – for provision of substantial benefits to the people;
- Long-term (25 years) – to maximize benefits accrued from water resources in a sustainable manner

Sustainable Development Agenda for Nepal (SDAN) has also identified the water quality issue as the discharge of the untreated water to the receiving water bodies and to adequately treat the source water for drinking water supply and has policy to prohibit such untreated discharges. Government of Nepal has recently (2006) prescribed drinking water quality standards for the supply pipeline. It also specifies the magnitude of pollutant and other components of water according to the drinking water quality standards. According to this standards, mandate has been given to MoHP for water quality surveillance.

4.4.2 Legislative Responses

The government has in its efforts to conserve the water resources formulated various acts and regulations which are important steps in water resource conservation and protection. They are as follows:

1. Environment Protection Act, 1997 and Environment Protection Rules, 1997 serve as a lead legislation to protect the water qualities of both surface and ground water.
2. Local Self Governance Act (2000)
3. Water Resources Act (1992)
4. Water Resources Regulations (1993)
5. Solid Waste Act (1987) and Regulations (1989)
6. Soil and Water Conservation Act (1982) etc. too have provisions for protecting water qualities.

Millennium Development Goal

The Millennium Development Goal (MDG) also addresses the water and sanitation issue and has accordingly set activities to meet theses goals by 2015.

Government Initiative in Water quality Improvement

Water quality improvement of Kathmandu valley is indeed an intricate work to do. High Powered Committee for Implementation and Monitoring of the Bagmati Area Sewerage

Construction/Rehabilitation Project has been able to successfully commission the Waste Water

Treatment Plant at Guheshwori that is able to cater the wastewater treatment services for upstream area for both domestic and industrial wastewater. Some biological treatment effort with the use of constructed wetland at the bank of Bishnumati River and Dhulikhel Hospital is example of local initiatives to address the underlying problem.

Involvement of other water quality related projects

Multilateral and bilateral organizations have assisted the government to promote cleaner industrial development in the country. Industrial Pollution Control and Management (IPCM) Project 1996, Environment Sector Program Support 1999-05 (ESPS), Eco-labeling in export oriented industries 2000 and Strengthening Environmental Administration and Management in Nepal (SEAM-N) Project are some of the projects which envisaged environment promotion demonstration through cleaner production and energy efficiency, awareness raising among entrepreneurs, local people and policy makers and strengthening of regulatory mechanisms for environment protection, which eventually aims at improving and maintaining the water quality.

Similarly, The Ministry of Physical Planning and Works (MPPW) have collaborated with different NGOs, INGOs and local bodies to undertake the following activities to improve the water quality of Bagmati River;

- ENPHO/ADB/UN-HABITAT/WAN have introduced community wastewater treatment in Madhyapur-Thimi by artificial wetland treatment for 200 households. About 50,000 liters of wastewater have been treated and reused, and an awareness program is being implemented in the communities and schools.
- Kathmandu municipality has been operating a small-scale, localized wastewater treatment plant at Teku since 1998. The treatment system is based on a constructed wetland management system. KMC is collecting the sludge of 10-15 truckloads (each load with $6m^3$) from the septic tanks of private houses and treating it before discharging it into the river.
- Ecological sanitation (ECONSAN) – as per 2005, the number of Ecosan units in the Kathmandu Valley has reached 124.
- The solar disinfection (SODIS) method for drinking water has been introduced by KMC and EDWAG /SANDEC particularly in squatter settlements and schools; it has targeted over 50,000 households for awareness raising). There are about 12,000 SODIS producers in Kathmandu Valley.
- The UN-HABITAT Water for Asian Cities (WAC) Programme Nepal has recently prepared terms of reference for cleaning the Bagmati River. The activities include (i) preparation of a comprehensive local catchment management strategy in one watershed area in the upstream reaches of the Bagmati River System for the Bagmati Area Sewerage Project (BASP), and (ii) preparation of a comprehensive faecal sludge management strategy for Kathmandu Valley for BASP. Likewise, to achieve one of the goals to improve water and sanitation under the MDGs, MPPW, in collaboration with WAC, has introduced programs to improve water and sanitation in peri-urban centers in the Kathmandu Valley, e.g., Khokana, Bungamati, Siddhipur, and Lubhu.

WHO Country Office Nepal is supporting NHRC for capacity building to respond the arsenic issue with the aim of human resource development and conducting research to provide evidence. NHRC conducted the first study on Detection, Management and Surveillance of Arsenicosis in the Selected Local Communities of two Terai districts Bara and Rauthat of Nepal in 2005. The study revealed that Health Worker's Knowledge and Skills about Arsenic and Arsenicosis was almost nil, and they were not familiar with Preventive Measures, Primary Treatment and Referral Mechanism. The study concluded that Detection, Management and Surveillance of Arsenicosis cases was not possible without massive trainings to health staffs. WHO SEARO published Field Guide, Facilitator Guide and Participant Handbook on Detection, Management, and Surveillance of Arsenicosis Cases in South East Asia Region in 2005 for maintaining the uniformity in case detection, management and reporting as well as for training purpose. NHRC translated these WHO Publications in Nepali for the training purposes on detection, management and surveillance of Arsenicosis Cases in Nepal and pre-tested the developed modules in Nepali organizing Training of Trainers on Arsenicosis case Detection, Management and Surveillance in lalitpur in 2006. During the year 2007 -2008, NHRC conducted four district level trainings in Bharatpur, Birtanagar, Dhangadhi and Hetauda covering eleven districts of terai regions Morang, Sunsari, Saptahari, Siraha, Rautahat, Bara, Parsa, Nawalparasi, Rupendehi, Kailali and Kanchanpur. Total 72 person were trained which consists of Paramedics (Health Assistant, Senior Auxiliary Health Worker, Nurses), Public Health Officers, Medical Officers, Dermatologists, Senior Divisional Engineers of respective district and social worker of Nepal red Cross Society. The recommendation form the training workshop was that there should be referral system and even Dermatologists are not enough aware about the cases of Arsenicosis. The prevalence survey conducted by Nepal Health Research Council in Nawalparasi,

Kailali and Bardiya district demonstrated that the prevalence of arsenicosisi is 2-3 percent. Based on these lessons learnt, NHRC with support of WHO Country Office Nepal conducted the study entitled

Development of Sentinel Sites for Arsenicosis Surveillance and Assessment of Prevalence of Arsenicosis in Nepal. For this, the program was divided into two components; organization of Consultative Workshop on Detection, Management and surveillance of Arsenicosis Cases with the major involvement of Dermatologist and high level officers of Ministry of Health and population and development of Sentinel sites in Medical College in Hot spot areas of Arsenic in Nepal. For this, four sentinel sites were developed in Parsa and Rupandehi based on Regional Hospital, Zonal Hospital and Medical Colleges.

4.5 Gaps

- No institutional setup under MoHP for water quality surveillance as per national standard of Nepal.
- Very few data on water quality and sanitation in Nepal.
- Lack of coordination among the stakeholders working in water, sanitation & health.
- Very few distribution & sharing of national drinking water quality standards among the stakeholders.

5 Solid Waste

With the increasing haphazard urbanization and the population influx to Kathmandu valley, the problem of solid waste management has become an urgent task. Solid waste and waste water are the two most noticeable environmental nuisances and the major cause of pollution in Kathmandu. The rivers of Kathmandu, the Bagmati and Bishnumati have literally turned into sewer systems. In Nepal the process is just the reverse; first houses and settlements are made then only people think about other infrastructure. This lack of planning creates pressure on the existing infrastructure making them disorganized, and inefficient.

In earlier days, waste and wastewater generated in Kathmandu valley were recycled and used for agricultural purposes in fields. The waste generated was also mostly organic which made it easier. But With changing lifestyle particularly in urban areas, the increase in inorganic packaging material and broken appliances has in recent decades created solid waste management problem .Today garbage litters streets, open spaces, and polluted rivers around many settlements of Nepal and the seriousness of the problem have mounted tremendously over the years directly affecting the health of citizen, polluting environmental resources and having impact on economy. The problem is acute, particularly in large cities like Kathmandu, Lalitpur, Biratnagar, Pokhara , and Birgunj where significant amount of hazardous waste coming from industries and hospitals is generated which is mixed with domestic waste.

5.1 Pressure

People coming into Kathmandu valley is increasing day by day. Urban areas continue to grow haphazardly and without proper planning and infrastructure such as water supply and sewerage systems, solid waste management facilities, and other services. Properly planned urbanization can play a positive role in promoting economic activities, as well as in promoting conservation of resources to reduce pressure on land resources. However, haphazard and unplanned urbanization leads to many environmental problems such as those posed by solid waste and wastewater management.

The living standards and consumption pattern of the urban population of Kathmandu in the recent years has changed. Availability and use of modern facilities and the changing lifestyles has compelled in more waste and wastewater generation, composition of waste has changed with more plastics and other inorganic materials being the prime composition of waste.

Kathmandu is the epicenter for opportunity, wealth, services, infrastructure, and the activities and power is so centralized in Kathmandu that people are compelled to Kathmandu. And it comes as no surprise that about 51% of the total industries in Nepal with employment of more than 10 persons are located in Kathmandu Valley (IUCN 1999). There are three industrial estates in Kathmandu: Balaju, Patan and Bhaktapur and one outside valley, the Hetauda industrial estate. There are total 3,446 industrial establishments in the country out of which 2,174 industries are centered in Kathmandu of which only 202 industries are located inside the industrial estate. The industries located in Kathmandu are mostly found in the less urbanized or sparsely residential areas like Ring road area; Satdobato-Godavari, Kalanki-Thankot, Koteshwor-Bhaktapur areas. And a variety of industries are found in the valley ranging from carpet, distillery, dairy, bakeries, sweets and confectioneries, snacks, meat and meat products and etc. And these industries generate a lot different and hazardous waste than domestic waste and its management is a daunting task to the responsible authority.

5.2 State

5.2.1 Municipal Solid waste generation

Wastes generated from the households are the main source of solid waste in Nepal. The composition and the amount of waste generated vary according to the living standard, changing lifestyle, and consumption pattern. There is a change in the wastes generated from traditional organic wastes in the past to papers, plastics and glass, metals and packaging materials. And although almost of the waste generated in Kathmandu can be recycled and the governments policy is to recycle, very little of Kathmandu's waste is actually being recycled.

There are total 58 municipalities in Nepal which generates 1,369 tons solid waste per day. Of which Kathmandu alone generates 383.5 tons/day which is 28% of total waste. Existing waste generation and collection in five municipalities in the valley are shown in the table below.

Table 3 Existing waste generation and collection-2004

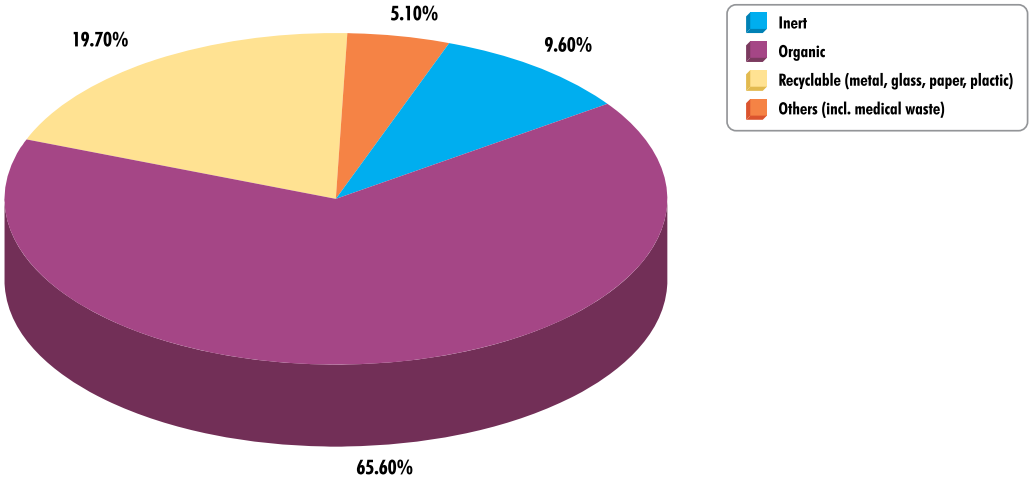
Existing Waste Generation and collection					Projected waste generation
S. N.	Municipality	Per Capita Waste generation		Total municipal waste generation tons/d	Estimated total waste generation tons/d
		Household kg/ person/d	Municipal kg/ person/d		
1.	Kathmandu	0.39	0.52	383.55	512.2
2.	Lalitpur	0.54	0.72	125.64	167.79
3.	Bhaktapur	0.39	0.52	39	52.08
4.	Madhyapur thimi	0.11	0.15	7.59	10.13
5.	Kirtipur	0.34	0.45	19.52	27.07

Source: SWRMC 2004

Amongst the metropolitan and sub-metropolitan cities of Nepal, Birgang's per capita waste generation of 0.93 kg/cap/d is the maximum while Pokhara with 0.19 kg/cap/d is the minimum (source SWRMC 2004). The per capita waste generation in KMC, Lalitpur and Biratnagar is 0.52 kg/cap/day, 0.72kg/cap/day, and 0.23/cap/day respectively. The average per capita waste generation of these five big cities of Nepal is approximately 0.50kg/cap/d and contribute nearly 50% of the total municipal waste generation in Nepal. The average per capita waste generation of other 53 municipalities of Nepal is 0.32kg/cap/day. According to SWMRC 2004 report 58 municipalities of Nepal are generating approximately 500,000 tons of municipal waste annually.

5.2.2 Physical composition of Municipal waste

The physical composition of waste generated from 58 municipalities of Nepal is broadly categorized into four components: inert, organic, and recyclable and others.



Source: SWRMC 2004

Figure 6 Physical composition of household waste (2003)
Average value (by wet weight %) of municipalities

We can see from the above figure that that more than half 65% of the waste generated as municipal waste is organic in nature. And which can be recycled. Since recycling is economically driven, recycling is low for those materials with those having low market value. Organic waste recycling has not been given due importance due to its difficulty in handling and the low market value for its finished product. Since organic waste makes the almost bulk of the waste generated, organic composting could significantly reduce the cost and environmental impacts of waste management. Organic waste can be recycled even with use of simple technologies.

5.2.3 Medical and Hazardous Waste

Health care institutions in the recent times have expanded tremendously in number and capacity with increasing number of hospital beds, there is an increasing load of biomedical waste, especially owing to the increased use of disposable materials, lack of onsite separation practices, lack of proper treatment, it is posing risk to the health of those who handle them and those living at the proximity thus polluting the environment. There is lack of proper system, rules and regulations or implementation of those when it comes to management of biomedical waste. Most of the healthcare institutions both small and large alike, have promoted either open burning, use of incineration which are not in practice with set quality and standard, and largely dumping these wastes in the city garbage and eventually end up either by the bank of the river , roadside or landfill site. We can see very hazardous and infectious waste being dumped just outside the hospital building which includes swabs, used cottons and appliances and even amputated body parts.

A study by ENPHO (2000) found the composition of hospital waste generated from health care facilities in Kathmandu valley includes 62% non-infectious waste, 23% infectious waste, 3% sharps and 12% saline bottles. The most hazardous form of waste is medical waste which comes from hospitals and nursing homes. Study by ENPHO (2000) estimates that there are 2347 beds in government hospitals and 1558 beds in private hospitals and nursing homes, which generates about 1184 kg of infectious waste per day. Most of the medical waste is discarded along with the normal municipal waste. Updated figures in composition of health care waste was not available.

There is no proper system of disposing these medical wastes. Some large health institutions do segregate the waste but treating them separately is not seen. In some health institutions, incinerators are used, better called as small brick kilns because they do no even meet the common international standards, which are operated at low temperatures and have low stack height.

A rapid study on the assessment of healthcare waste management was conducted by NHRC (2007) in 24HCIs of Nepal covering 4 development regions. Particularly striking was the fact that there was no practice of waste quantification in the visited HCIs. And only 33.4% of the HCIs were found to follow the National Health Care Waste Management Guideline or the WHO Guideline, which was circulated in all HCIs for its implementation 5 years ago, and almost two-thirds didn't use it. The study showed the poor management of healthcare waste and highlighted that occupational health of waste handlers was a neglected issue. In conclusion the study showed that waste management among guideline users was better than among the non users.

Occupational health is still a neglected area for healthcare workers. This has been supported by a study by DoHS (2007). This study was carried out in 162 HCIs, and only 39.5% health workers said they used full sleeve gown, 77.2% used gloves, 34.6% used gumboots, and 50.6% used caps/goggles/masks.

5.2.4 Municipal Wastewater

There are many factors influencing the volume of wastewater generated: water availability for domestic and commercial purposes, living standard of consumers, types of commercial establishments like hotels, restaurants, offices, schools. etc. Potential domestic wastewater generation in Kathmandu's urban areas in 200 was estimated to be 124 million liters per day of which only about 47 Mld (about 38%) was collected through sewerage system (Metcalf and Eddy), 2000). The number of sewers constructed in the valley is both inadequate and small sized. Also, maintenance of existing sewers is very poor: most of the sewers are clogged /jammed. Street waste and littered garbage thrown haphazardly which are then washed during rain is the main reason for sewer clogging.

Wastewater, in our context is then directly connected to the nearby rivers (Bagmati and Bishnumati in Kathmandu). Residential wastewater mainly consisting of discharge from toilets (urine, feces, soap, detergents) and from the kitchen (containing foodstuffs, fats, oils, etc). The wastewater generated from industrial and commercial establishments is different in terms of chemical composition and its potential hazard. Waste water from health facilities is also directly mixed into the sewerage and rivers which is highly pathogenic and pollute the down stream water resources.

5.2.5 Industrial Waste

The most water polluting industries in Kathmandu valley are (carpets and garments) washing and dyeing, paper and pulp industries, distilleries, pharmaceuticals etc. 72% of the country's water polluting industries are located in Kathmandu. The wastewater generated from theses industrial establishments are discharged directly into municipal sewers without any treatment which eventually goes into rivers or directly into rivers.

Though the proportion of industrial effluents is only about 7% of the total wastewater, its potential of pollution and hazardity is higher than other wastewater sources because it contains chemicals and toxic substances (Devkota & Neupane 1994, cited in UNEP 2001).

5.3 Impacts

No studies have yet been carried out on the impacts of municipal waste on human health and the surrounding environment in Nepal. But obviously there are visible impacts (both direct and indirect) on health and well being, pollution of water and air, impacts on aquatic life and the ecosystem and others.

5.3.1 Impacts on Health

People who come into direct contact with wastes are more affected. The most vulnerable include the street children who are seen picking plastics from the dumped municipal waste ignorant of its health hazard. Such children not only put themselves at risk but also carry the pathogens and transmit to others. Others like waste management workers, waste collectors, people living near dumping sites, users of polluted water are also continuously at risk of health hazards.

5.3.2 Impacts on Air and Water Pollution

The wastes dumped in open spaces and riverbanks contaminate the surface and groundwater affecting the people who drink this water without any treatment. These wastes are very smelly and cause irritation and nuisance to the passerby. Open burning of waste is also quite common in Nepal especially plastics which sends particulate pollutants and toxic elements into the air people inhale. Uncollected and dumped waste on streets and riverbanks is a long-term source of pollution of both air and water. Also wastewater discharged into rivers is in a state that cannot be used for any purposes like fishing and agriculture.

5.4 Response

5.4.1 Related Policies

There were no specific national policies on the waste management till 1996. Earlier policies were encompassing all kinds of environmental pollution including solid waste but were not effective to deal the matters of solid waste management as desired. The adopted policy for the waste management in Nepal had following activities

- To make solid waste management system simple and effective
- To minimize the adverse effect of solid waste on the environmental and public health
- To mobilize the solid waste as a resources
- To promote public awareness for greater public participation on the solid waste management

The important measures related to solid waste were considered in Eighth, Ninth Plan and Tenth Plan of Nepal Government. According to the Eighth Plan, causes for air, water, and land related pollution was supposed to be investigated through on-the spot observation and management mitigation plans. In this regard emphasis

was laid on adopting technology required for minimizing waste. However pollution control program launched during this period included limited assessment studies of existing situations in the areas of solid waste along with other sectors; air, water, noise etc. Utilization of appropriate technology still needs to be developed in the areas of solid waste including health care waste. Management work plans to control pollution caused by solid waste needs to be implemented. The solid waste aspect has also been mentioned in the Ninth Plan. The Plan includes consideration for engagement of NGOs and private sector for the management of solid waste, emphasis for composting for municipal wastes, setting of norms and standards in this field and its strict implementation in every municipality, and capacity building of local municipalities for handling solid waste related issues. The Tenth Plan has emphasized upon the Public Private Partnership for Solid Waste Management and implementation of Pollution Pay Principle. However, these policies are silent regarding health care waste management. The three year Interim Plan of Nepal Government (2064/65- 2066/67) has clearly mentioned the programs for Health Care Waste Management. It states that necessary programs for the proper disposal of health care waste management will be conducted. This plan has also mentioned Urban Health Promotion Programme and according to which coordination with private and non-governmental organization and concerned ministries will made for providing the necessary facilities of health services, toilets management and sanitation.

5.4.2 Related Legislation

The Interim Constitution of Nepal, 2007

The Interim Constitution of Nepal, 2007 has enshrined environment and health rights as fundamental rights of Nepali citizens. Article 16 (1) states that every person shall have the right to live in clean environment and Article 16 (2) states every citizen shall have the right to get basic health service free of cost from the State as provided for in the law.

Article 35(5) embodies following policy mandates:

> "The state shall make necessary arrangements to maintain clean environment. The state shall give priority to protection of the environment and also to the prevention of its further damage due to physical development activities by increasing the awareness of the general public about environmental cleanliness and the state shall make the special protection of the environment and the rare wildlife"

With the above provisions, some constitutional responsibilities and duties have been vested upon the state for safeguarding the environment.

The Environment Protection Act, 1997

Environmental Protection Act 1997, have made provisions dealing with pollution control, Initial Environmental Examination (IEE), Environmental Impact Assessment (EIA), conservation of national heritage etc. Section 7 of Act refers to pollution control, which states "A person shall not cause pollution or allow pollution to be caused in a manner which is likely to have significant adverse impact on the environment or harm human life or public health or shall not emits, discharge sound, heat, radioactive matter from any machine, industrial enterprises or any other place above the prescribed standard."

The Chapter 3 of Regulation has provided various provisions under rules 15 to 29 for preventing and controlling pollution. These provisions include stopping emission and discharging solid waste against the standards (rule 15) to install and maintain properly the equipment or treatment plants (rule 16). EIA is also mandatory for the establishment of facilities, including treatment plant, recycling plant, storage and landfill for management of hazardous waste Rule 3, annex- 2 of the Regulation states that an EIA is necessary prior to the development of any health care facility with 25 or more beds (Now with100 or more beds as per the notification published in Gazette 3rd Bhadra, 2064 B.S). Safe disposal of Health Care waste is also made mandatory for this category of health care facility.

Solid Waste Management and Resource Mobilization Act, 1987

This Act is one of the key legislation in Nepal for the management of solid waste. The main objectives of this Act are:

- To manage the solid waste and to mobilize the resources
- To minimize the adverse effect of the solid waste on the public health and environment

For the execution of the objectives of the Act, Solid Waste Management and Resource Mobilization Center (SWMRMC) Rule was formulated in 1989. These Rules laid down procedures for the management of solid waste. The Act and Rules empower the Solid Waste Management and Resource Mobilization Center in the matter of the solid waste management.

The Labor Act, 1991

The Labor Act 1991, which is administrated by the Ministry of Labor, is the main regulation regulating the working environment. Chapter 5 of this Act deals with occupational health and safety. Section 27 of Chapter 5 requires the management to make certain arrangements such as the removal of waste accumulated during production process and prevention of accumulation of dust, fume, vapor, and other impure materials, which would adversely affect health of workers. Section 28 and 29 require management to provide protective clothing and devices to workers handling chemical substances and other hazardous and explosives substances.

Industrial Enterprise Act, 1992

This Act provides that industrial license is required if it is related with defense, public health and environment. Section 11 clearly provides that license or registration certificate shall contain provisions regarding concessions, exceptions, facilities that will be given to enterprise and prescribed conditions to be fulfilled by them. Section 13 also provides that the industrial promotion board establishment under the Act can direct the industries to make arrangements for controlling environmental pollution. The Act gives priority to industry based on waste products and industry manufacturing pollution control devices. Similarly, section 25 (2) empowers GON to punish those who don't comply with the conditions mentioned in the license or registration certificate.

The Town Development Act, 1988

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

The Local Self- Governance Act, 1999

The Local Self-Governance Act, 1999 makes municipalities responsible for managing domestic solid waste. Municipalities are also supported to preserve water bodies such as lakes and rivers, assist in controlling water, air, and noise pollution and prevent the spread of infectious disease. The Act does not require the local governments to manage hazardous waste but empowers them to fine anyone up to Rs. 15000.00 for haphazard dumping of solid waste.

5.4.3 Guidelines

National Health Care Waste Management Guidelines 2002

These Guidelines were prepared by Nepal Health Research Council and World Health Organization in 2002 and circular was made by the Minister Level decisions to implement in all levels of health facilities. This guideline has made the provisions of waste management policy, waste management committee, waste management plan, waste minimization, waste segregation, handling, labeling, containment, transport, storage, waste treatment/disposal, occupational health and safety, training, monitoring system, and enforcement instruments for implementation of health care waste management guidelines. The WHO has classified health care waste into eight categories and this Guideline has categorized in to three groups namely sharps, hazardous waste and general waste.

Medical Waste Management Guidelines 2004

These guidelines were developed by Kathmandu Metropolitan City (KMC) with the support from Kathmandu Valley Mapping Programme in 2004. These guidelines were primarily produced to assist in the management of medical waste that are generated in the course of medical treatment in Kathmandu's hospitals, nursing homes, clinics, pathological labs and drugstores. These guidelines have also included classification of medical waste, its sources and amount, in-source management of medical waste, technologies for treatment and disposal of medical waste, health and safety for health care personnel and waste handlers, and responsibilities for medical waste management In contrary to the National Health Care Waste Management Guidelines 2002, it has classified the waste into five categories; ordinary medical waste, ordinary inorganic waste, hazardous waste suitable for incineration, hazardous sharp waste and non-burnable hazardous waste.

Guidelines on Health Care Waste Management 2065

Guidelines on Health Care Waste Management (Swastha Sansthajanya Phor Maila Sammbandhi Nirdasika 2065) has been developed by Management Division, Department of Health Services of Ministry of Health and Population. These Guidelines has also classified the waste into five categories; ordinary medical waste, ordinary inorganic waste, hazardous waste suitable for incineration, hazardous sharp waste and non-burnable hazardous waste. It has includes the process of health care waste management, responsibilities for health care waste management. One of the very important aspects of this guideline is that it has mentioned the waste management options at different levels of health care institutes indicating the type of waste generation, methods of disposal/treatment and responsible persons.

Since 2007 Ministry of Health and Population through the Management Division, Department of Health Services with support from WHO have been building on earlier efforts to promote health care waste

management. The focus of the last few years has been on assessments, capacity building, awareness raising and the development and application of suitable and affordable technologies. Non-burn technologies are promoted with autoclaving the preferred option as it does not generate air pollution and makes the waste safe for recycling.

Management Division is trying to strengthen its regulatory role in HCWM through providing guidance and follow-up. Government financing for elimination of Mercury-based equipment inthe health sector is also being sought. A capacity building programme is being rolled out covering 35 districts so far. Health Care Waste Management is an integral part of patient safety, infection control (through hand hygiene) and occupational health (reduction of needle stick injuries). Efforts need to be undertaken to further strengthen and sustain efforts in HCWM for efficient management, and to be able to negotiate proper final disposal through a sanitary landfill or a central treatment facility in consultation with local authorities, according to relevant acts.

5.5 Gaps

- Lack of specific legislation on health care waste management in Nepal.
- Lack of standard for waste water generated from health facilities.
- Lack of standard and guidelines about the final disposal techniques as per ecological regions.
- Less emphasis on waste reduction and recycling and more focus on disposal.
- No focal unit/section under MoHP to look after health care waste management.

6 Climate Change

Nowadays the term "climate change" is generally used when referring to changes in our climate which have been identified as occurring since the beginning of the mid-19th century. Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC 2007). Human interactions with the natural environment have grown tremendously in the recent centuries. Environmentally significant greenhouse gases are increasing due to both natural and anthropogenic activities and contributing to global warming. The Earth's average surface temperature has risen by about 0.74 degrees Celsius in the past 100 years and it could even rise by up to 5 degree Celsius by 2080 if the emission of such gases are not decisively reduced (IPCC 2007). It is now universally acknowledged that the climate change we are witnessing will continue for a long time. This obviously has serious implications for human health. Clearly Nepal is facing climate change-induced consequences in many spheres of society and development. While some have been studied, data are still scarce and it is difficult to draw clear conclusions for future adaptation measures. Climate change is an emerging risk factor for human health. Human beings are exposed to climate change through changing weather patterns (temperature, precipitation, sea-level rise and more frequent extreme events) and indirectly through changes in water, air and food quality and changes in ecosystems, agriculture, industry and settlements and the economy. The IPCC (2007) report which concluded that "Climate change currently contributes to the global burden of disease and premature deaths…At this early stage the effects are small, but are projected to progressively increase in all countries and regions" (IPCC 2007).

6.1 Pressure

The major mechanism behind climate change is the increased "greenhouse effect" by which the earth 's atmosphere traps energy from the sun just like a greenhouse. The natural greenhouse effect which warms our planet to support life-is being heavily disturbed. The energy from the sun warms land, water, and air. In turn, the warmed-up land , water, and air give off heat which rises up towards the sky. Gases, such as water vapour, present in the earth's atmosphere capture some of that heat and prevent it from escaping into space. This heat trap keeps the earth warm, and like a warm blanket makes our planet a habitable world for all the various flora and fauna species to survive. Without this heat trapping system, the Earth's surface would be about 15 degrees Celsius colder than it is now. This process is known as the greenhouse effect. The greenhouse gases are increased heavily by anthropogenic activities. Human-induced climate change is due primarily to accumulation of "green house gases (GHGs)" in the atmosphere resulting from activities such as combustion of fossil fuels, large scale deforestation and the rapid expansion of irrigated agriculture. The principal HGHs are carbon dioxide (Co2), methane (CH4), nitrous oxide (N2O), ozone (O3) and chlorofluorocarbons (CFCs). The share of Nepal in the global emission of GHGs is negligible (0.025%). Though the country does not emit much greenhouse gases, it has to face the consequences of global warming. The warming has been observed more in Polar Regions than Equatorial Regions. Such warming is raising temperature in the Nepalese sky.

6.2 Status

It is quite amazing that within the span of 200km from north to south, the climate of Nepal varies from arctic to tropical. In Nepal, the elevation generally increases from south to north and is accompanied by decreasing

temperature. Analyses of maximum temperature data from 49 stations in Nepal for the period 1971–94 reveal warming trends after 1977 ranging from 0.06°C to 0.12°C per year in most of the Middle Mountain and Himalayan regions, while the Siwalik and Terai (southern plains) regions show warming trends less than 0.03°C per year (Shrestha et.al 1999). Nepal is highly vulnerable to the adverse impacts of climate change. Rises in temperature related to global warming are associated with changes to rainfall patterns (such as less frequent but more intense rainfall events), increasing frequency and intensity of floods, changes in monsoon on-and offser, longer dry spells and drought events, increasing storms, and a growing threat from Glacial Lake Outburst Floods (GLOF). Significant glacial retreat as well as significant expansion of several glacial has also been documented in recent decades, with an extremely high likelihood that such impacts are linked to rising temperatures. The result of a temperature trend analysis for the period of 1973 to 2007 in Nepal shown.

Very recently in 2008, Practical Action Nepal has compiled the monthly rainfall and temperature data of last 30 years (1976-2005) from Department of Hydrology and Meteorology (DHM) and data were analyzed. They have taken the data of 166 rainfall stations and 45 temperature stations.

Mean Annual Rainfall Analysis

The country receives highest precipitation in the month of July and lowest in the month of November. Similarly the country receives 79.6%, 4.2%, 3.5% and 12.7% during Monsoon, Post-monsoon, Winter and Pre-monsoon seasons respectively. Highest annual precipitation is recorded at Lumle at an elevation of 1740 m.a.s.l., windward side of Annapurna range and lowest annual precipitation is observed at Lomanthang, Mustang at an elevation of 3705 m.a.s.l. leeward side of Annapurna range. It was observed three highest rainfall pocket areas, one at Southern slope of Makalu range in the Eastern Development Region, second Jugal range in the Central Development Region and third Annapurna in the Western Development Region. Whereas, two lowest rainfall pocket areas were observed at the leeward part of High Mountain: Manang and Mustang areas.

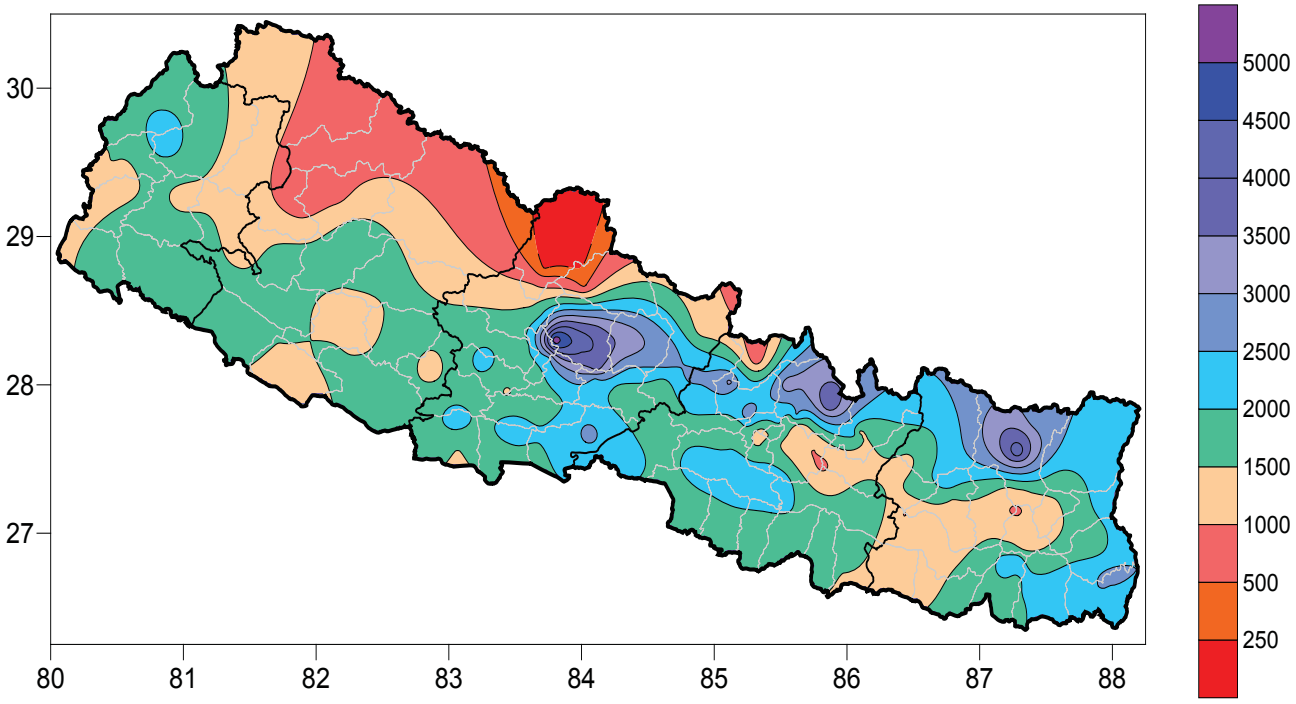


Figure 7 Annual Rainfall Analysis (1976-2005)

Analysis of Mean Annual temperature

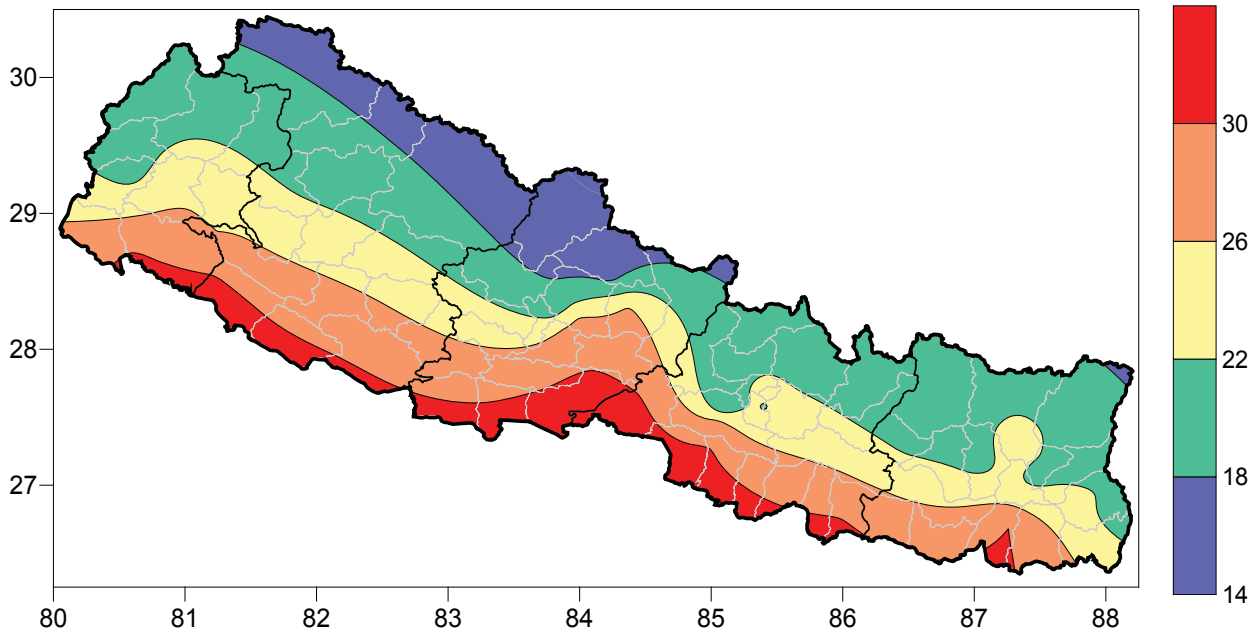


Figure 8 Mean annual temperature

Temperature is directly related with season and altitude of the location. Therefore, the spatial variations in temperature are influenced by altitude. The hottest part of the country is in the southern Terai belt and the coldest part lies in the high Himalayas in the North. Mean Monthly temperature varied between above 22°C in the Terai and Siwalk to less than 12°C in the north-western parts.

A study carried out by MOPE and UNEP for the Initial National Communication to the Conference of the parties of the UNFCCC using models: Canadian Climate Change Model(CCCM), Geophysical Fluid Dynamic Model (GFD3) and Regional Climate Model and their projections showed a projected 2 to 4 degree Celsius rise in average annual temperature over Nepal when CO2 is doubled (MOPE and UNEP 2004).

6.3 Impact

In the early 1990s there was little awareness of the health risks posed by global climate change (IPCC 1990). The IPCC Second Assessment Report devoted a full chapter to the potential risks of climate change to health (IPCC 1996). In the Third Assessment Report (IPCC 2001) the IPCC concluded that: "Overall, climate change is projected to increase threats to human health, particularly in lower income populations, predominantly within tropical/subtropical countries." The IPCC latest assessment report of 2007 concluded that: "Climate change currently contributes to the global burden of disease and premature death. At this early stage the effects are small, but are projected to progressively increase in all countries and regions" (IPCC 2007). Nepal's low level of development and complex topography leaves it quite vulnerable to climate change. The visible impacts of climate change have been observed in Agriculture, Forestry and Biodiversity, Water Resources and Human Health in Nepal.

Climate Change has direct and indirect impacts on human health. The latest IPCC Assessment report (IPCC 2007) has summarized the main health outcomes attributed to climate change as follows:

- Human-induced climate change significantly amplifies the likelihood of heat waves, increasing the possibility of heat strokes, cardiovascular and respiratory disorders.
- More variable precipitation patterns are likely to compromise the supply of freshwater, increasing risks of water-borne diseases like cholera, and outbreaks of diarrhoeal diseases.
- Rising temperatures and variable precipitation are likely to decrease the production of staple foods in many of the poorest regions, increasing risks of malnutrition.
- Meeting increasing energy demands by greater use of fossil fuels will add to the number of respiratory disorders, such as asthma.
- The increase in frequency and intensity of extreme weather events will translate into loss of life, injuries and disability.
- Changes in climate are likely to lengthen the transmission season of important vector-borne diseases (like dengue and malaria) and to alter their geographic range, potentially reaching regions that lack either population immunity or a strong public health infrastructure.
- Rising sea levels increase the risk of coastal flooding, and may lead to displacements of population.
- Loss of livelihood will increase psychosocial stress in the affected populations.

The health impact of climate change in the context of Nepal is obvious. There is a need of research in national context to understand the actual health problems induced by climate change and formulate the evidenced based adaption strategies. However, there are a lot of research challenges in vulnerable mountainous countries like Nepal to conduct research on climate change and health (Dhimal 2008).

The first outbreak of dengue occurred in Nepal in 2006. The cross- sectional entomological survey conducted in 2006, identified the presence of Aedes aegypti in 5 major urban areas of terai regions bordering with india i.e Biratnagar (Morang), Birgunj (Parsa), Bharatpur (Chitwan), Tulsipur(Dang) and Nepalganj (Banke). Similarly, entomological survey conducted in Kathmandu valley in 2009 has revelaed the presence of Aedes aegypti in Kathmandu(Gautam et.al 2009). Previously no Aedes aegypti was recorded in Nepal. The presence of Aedes aegypti in these districts may be attributed by climate change. The outbreak of dirrhoea and cholera in mid-western development region of Nepal in 2009 may be partially blamed for climate change. However, every thing can not be blamed for climate change and need in- depth study in our context. The crops plantation and harvesting seasons has been changed due to shifting monsoon season and the frequency of extreme events such as floods and droughts has increased in recent years which may reduce the crop yields and aggravate the problems of hunger and malnutrition. Hotter days (Heat stress) have increased in terai regions affecting working hours in agriculture and health. The community people have felt that the mosquitoes are shifting in higher altitudes where there was no occurrence of mosquitoes previously (NHRC 2009). Vector-borne diseases have been a public health problem in terms of their mortality morbidity and the subsequent overall impact on the national economy of Nepal. Vectorborne diseases that have important public health implications in the national context include malaria, kala-azar, lymphatic filariasis, Japanese encephalitis and — more recently — dengue. Malaria, once believed to be confined to the forest and forest-fringe areas of the terai and inner terai regions is now distributed over almost 65 districts of the country. Japanese encephalitis, first identified in 1978, is now present in 24 districts. Kala-azar was not

a problem up to 1980 but is now present in 12 districts of eastern and central terai regions. One of the reasons for increasing the disease and geographical spread might be because of climate change The increased temperatures due to climate change may create conducive environment to mosquitoes breeding. More research is certainly needed to discern the attribution of climate change.

6.4 Response

Nepal signed the United Nations Framework Convention on Climate Change on 12 June 1992 during the UN conference on Environment and Development in Rio De Jenerio, Brazil. In order to implement the conclusion effectively, Nepal adopted the Kyoto Protocol on 11 December 1997. The protocol has entered into force in Nepal on 14 December 2005. Major initiatives taken by the GoN to address he climate change problems are summarized below:

- Nepal conducted an inventory of GHGs for energy sector based on 1990 data under US Country Studies Program in October 1994.
- The then MoPE (Ministry of Population and Environment) prepared two separate studies on implementation strategy on environment related conventions formulated in 1999, and identified potential linkages between UNCCD, CBD and UNFCCC in 2000.
- The then MoPE organized a workshop on UNFCCC and Institutional Design of the Cooperative Implementation Mechanism of KP in August 2000 in collaboration with UNEP/ROAP and Asian Development Bank (ADB).
- With the assistance of the ADB, the then MoPE implemented Promotion of Renewable Energy, Energy Efficiency and GHG Abatement (PREGA) project which contributed to establish Designated National Authority (DNA) and prepare PINs and PDDs for some CDM projects.
- The then MoPE with the assistance of GEF/UNEP prepared the first initial national communication report with the Parties to UNFCCC and shared with the Parties in 2004. This report has been the building block to initiate climate change activities in Nepal in the spirit of the UNFCCC and KP.
- From 2006 onwards, MoEST in collaboration with a number of national NGOs organized pubic awareness activities including workshops on: (i) capacity building on Clean Development Mechanism (CDM); (ii) capacity building to respond to climate change; (iii) negotiation skills; (iv) pre- and post-Bali conference on climate change; and (v) CDM/DNA.
- In early 2007, the Government of Nepal also prepared a funding proposal for National Adaptation Programme of Action (NAPA) and submitted to GEF/UNDP for funding. The MoEST has entered into an agreement with UNDP Nepal to implement the Project.
- The Government and Asian Development Bank have entered into an agreement to implement the Strengthening Climate Change and the Environment Project.
- MoEST has completed the implementation of the National Capacity Needs Self Assessment (NCSA) Project by December 2008 with the assistance of the GEF/UNDP where climate change is one of the major components.
- The MoEST has also initiated climate change policy formulation process in collaboration with the WWF Nepal program and has completed 6 stakeholder consultations as of April 2009. The fourth meeting of the Climate Change Policy Coordination Committee has decided to conduct studies on:

(a) vulnerability and adaptation, (b) GHG emission inventory, (c) carbon sinks and mitigation, and (d) policy and legal provisions.

- The Ministry has constituted a 23-member Climate Change Network (CCN) to coordinate activities and share information. The CCN has been constituted to: (i) identify working areas on climate change amongst the government, NGOs, private and donor organizations; (ii) conduct policy/field level research and studies and implement activities based on the capacity and expertise; (iii) promote CDM related activities, and launch public awareness and capacity building programs; (iv) develop position papers for the Parties meeting and enhance negotiation capacity; and (v) also develop Climate Change Clearing House for easy information sharing. The second meeting of the CCN has identified thematic areas for collaborative works on: (a) carbon financing, (b) adaptation and mitigation, (c) carbon sinks, (d) financial mechanism, (e) knowledge management.
- The MoEST has completed the stocktaking exercise and stakeholder consultations to initiate activities for the preparation of the second national communication (SNC) report. This GEF/UNEP and GoN will shortly enter into an agreement to implement the Project to prepare the Second National Communication under UNFCCC.
- The Government has joined the Pilot Programme Climate Resilience (PPCR) which is under implementation with WB assistance. Nepal has been selected as the eligible country for this PPCR. This program might bring up to USD 50 million to implement climate change program in Nepal.
- The Government has also joined the Japan launched Cool Earth Programme recently. Several projects could be developed under this program.

(Source: www.most.gov.np)

On September 1, 2007 the Health Ministers from 11 Member States of WHO's South East Asia Region 25th Health Ministers Meeting in Thimpu, Bhutan adopted the "Thimphu Declaration on International Health Security in the South-East Asia Region". The Thimphu Declaration recognizes natural and manmade health emergencies, emerging infectious diseases and climate change as threats to international health security. The Declaration calls on countries to develop national mitigation and adaptation plans to address the health impact of global warming and climate change. As a follow up of the declaration, Nepal Health Research Council (NHRC) constituted the 13 members steering committee on Climate Change and Health with wider participation of government sectors, UN organization, International Non-Government Organization and Academic sectors and organized National Workshop on Climate Change and Human Health: Potential Impact, Vulnerability and Adaptation in Nepal (19-21 December, 2007) with the support of WHO Country office Nepal. From the workshop, it was known that Very little knowledge exist on Health impact of Climate Change and fair participation of health sector in climate change issues in Nepal. The workshop identified many uncertainties for health impact of climate change in National Context and identified few research areas for study. NHRC with support of WHO country office Nepal has conducted few review studies and retrospective study on climate change and vector borne diseases which show that health impacts of climate change are obvious. There is some degree of association between climatic elements and vector borne and diarrheal diseases in Nepal. There are a lot of constraints and limitation for research on climate change and health in Nepal mainly about availability of data and quality of available data (Dhimal 2008). On September 9, 2008 the Health Ministers from 11 Member States of WHO's South East Asia Region adopted "New Delhi Declaration on the impacts of climate change on human health" in which members states were committed

for accelerating actions to reduce health impacts from climate change in the region. The 27th Health Ministers Meeting of South East Asia Region Member States held in Kathmandu in September 7-9 also prioritized the actions for protecting the health from climate change.

The Ministry of Environment has been preparing the National Adaptation Plan of Action (NAPA). NAPA has three components

1. Preparation and dissemination of a NAPA document
2. Development and maintenance of a climate change Knowledge Management and Learning Platform for Nepal and
3. Development of Multi-stakeholder Framework of Action for Climate Change in Nepal

Six thematic working group (TWG) has been formed and one of them is Public Health Group. The TWGs has been working for preparing the NAPA in Nepal which is expected to be completed by April 2010. Nepal Health Sector Implementation Plan II is under preparation in which Climate Change component has tried to be incorporated by Cross Cutting Thematic Working Group.

6.5 Gaps

- Lack of research on health impact of climate change in Nepal.
- Lack of awareness among health staffs about the health impact of climate change
- No national policy on climate change in Nepal.

7 Conclusion and Recommendations

There are various environmental risk factors causing premature deaths and diseases, especially among the poor and vulnerable groups and increased health costs. The environmental changes are taking place rapidly and are deteriorating day by day. A lot more needs to be made before things get out of control to maintain and improve the ever deteriorating environment of Nepal. Evidence based planning must be done then only can programs or interventions be sustainable. This study puts forth some recommendations for the key issues discussed in the previous chapters.

Air Quality

- Promotion of cleaner/safer and environmentally friendly vehicles
- Enforcement of environmental laws and by laws
- Scientific traffic management with incorporated vehicle monitoring
- Promotion of non-motorized vehicles and public transport through better services and discouraging use of fossil fuels
- Cleaner production and energy efficiency in industries
- Separate residential areas and away from industrial areas
- Promotion of Safer Kitchens with proper ventilation
- Awareness, education and advocacy on health impact of air pollution
- Need to regularly conduct Air Quality Monitoring in Kathmandy Valley and in other major urban areas for time series data
- Need to conduct longitudinal health impact assessment study in Kathmandu valley using the air quality monitoring data of Kathmandu valley
- Need to enforce Indoor Air Quality Standards and Implementation Guidelines 2009

Water Quality

- Meeting the demand of drinking water in terms of both quantity and quality
- Wider sanitation coverage for both rural and urban areas
- Promote rainwater harvesting to meet the increasing demand of water
- Promote awareness, water conservation and use of water saving equipments
- Enforcement of Water Quality Surveillance as per National Drinking Water Quality Standard 2006

Solid Waste Management

- Decrease ambiguity of laws and policies and define roles and mandates for responsible authorities on waste management
- Waste collection following certain categorization and respective disposal models.

- Promote reusing, recycling and composting of wastes
- Need of clear strategy and legislation for industrial and medical wastes management
- Strategies to reduce wastes at source level (households, hospitals, industries)
- Need to practice mercury free health care waste management

Climate Change

- Need to conduct more research on climate change and health in Nepal in term of impact, vulnerability and adaptation
- Need to mainstream climate change issue in development plans of health sector
- Adaptation programs for health sector need to be identified while preparing NAPA
- Need to develop integrated diseases surveillance system in the country
- Need to strengthen rapid response team and early warning system

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ANNEX 1 Environmental Health Research Priority Areas for Nepal 2006

S.N	Broad Research Areas	Sub-Research Areas	Specific Research Areas
1	Water	Microbiological Contamination	Effectiveness of water treatment technologies such as filters, mineral water, tanker water, tap water, ground water, spring water and their quality, trend analysis of drinking water quality of various sources, alternative options of drinking water at the time of emergency such as disaster
		Chemical contamination	Arsenic, Iron, Ammonia, Fluoride, Pesticides etc and their health impact
		Sanitation	Coverage, operational research and health impact
		Water quantity	Per capita requirement and water consumption pattern
2	Air	Indoor Air Pollution (IAP)	Fuel types and health impact (Improved Cooking Stoves and Biogas Installation and health outcomes etc)
		Outdoor Air Pollution (OAP)	Mobile and Stationary sources and health impact
3	Waste	• Health Care Waste • Domestic Waste • Industrial Waste • Industrial Waste	Situational Analysis, Disposal Options and Health Impact
4	Pesticides	Biological Contamination	Linkages with sanitation and waste disposal
		Chemical Contamination	Situational Analysis and health impact with reference to pesticide use
5	Industrial Occupational Safety	Exposure Status and health outcomes	
		Agricultural Safety	Pesticide impact, Neurological and Muscula disorder, accident etc
		Safety at Construction Site (Situational Analysis, Accidents and injuries etc)	Situational Analysis, Accidents and injuries etc
6.	Food Safety/Security	• Biological contamination • Chemical Contamination • Adulteration • Additives and Preservatives • Quantity • Cereals, Vegetables, Oils, Animal Products, • Packed Food	
7.	Climate Change	Land use change	Existing Pattern and Trend/Impact Situation Analysis
8	Road Traffic Accident (RTA)		Situational Analysis Impact (Morbidity, Disability and Mortality)
9	Noise	• Status of Noise Pollution • Health Impact • Standardization Situation Analysis	
10.	Cross Cutting Issues	Policy, Economy, KAP, Resources	

ANNEX 2

National Ambient Air Quality Standards for Nepal 2003

Parameter	Averaging Time	Concentration in Ambient Air, maximum ($\mu g/m^3$)
TSP (total suspended particulates)	Annual	-
	24-hours*	230
PM10	Annual	-
	24-hours*	120
Sulfur Dioxide	Annual	50
	24-hours**	70
Nitrogen Dioxide	Annual	40
	24-hours**	80
Carbon Monoxide	8 hours**	10,000
	15 minute	100,000
Lead	Annual	0.5
	24-hours	-
Benzene	Annual	20****
	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 NO2 and SO2 and 8 hours standard for CO are not to be controlled before MOPE has recommended appropriate test methodologies.

*** Note: If representativeness can be proven, yearly averages can be calculated from PM10 samples from selected weekdays from each month of the year.

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

ANNEX 3 National Indoor Air Quality Standards, 2009

In exercise of the power conferred by Rule 15 of the Environment Protection Rules, 1997, the Government of Nepal has set the following National Indoor Air Quality Standards, 2009. These Standards shall commence on such date, as the Ministry may, by a notification published in the Nepal Gazette, appoint.

Pollutant	Maximum Concentration	
	Level	Averaging Time
Particulate Matter (PM10)	120 $\mu g/m^3$	24-hour
	200 $\mu g/m^3$	1-hour
Particulate Matter (PM2.5)	60 $\mu g/m^3$	24-hour
	100 $\mu g/m^3$	1-hour
Carbon Monoxide (CO)	9 ppm (10 mg/m^3)	8-hour
	35 ppm (40 mg/m^3)	1-hour
Carbon dioxide (Co2)	1000 ppm (1800 mg/m^3)	8-hour

Note

1. Units of measure for the standards are parts per million (ppm) by volume, milligrams per cubic meter of air (mg/m^3), and micrograms per cubic meter of air ($\mu g/m^3$).
2. The use of PM2.5 value is preferred.
3. No need to monitor/measure both Particulate Matter (PM10) and Particulate Matter (PM2.5). In accordance with the World Health Organization (WHO) Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide, 2005, the PM2.5 values can be converted to the corresponding PM 10 values by application of a PM 2.5/MP 10 ratio of 0.5.
4. Averaging time can be fixed as per convenience.
5. When 1 hr. averaging time is chosen, monitoring should be done during cooking time.
6. When 8 hr averaging time is taken, monitoring should cover cooking time too.
7. Monitoring of Carbon dioxide is to ensure the adequacy of the ventilation of monitoring sites.

(Source: Nepal Gazzete April 4, 2009)

ANNEX 4

National Drinking Water Quality Standard 2006

Group	Parameter	Unit	Maximum Concentration Limits	Remarks
Physical	Turbidity	NTU	5(10)	
	pH	TCU	6.5-8.5*	
	Color		5(15)	
	Taste & Odor		No objectionable	
	Total Dissolved Solids	Milligram/Liter		
	Electrical Conductivity	Micro-Siemens /Centimeter	1000	
			1500	
Chemical	Iron	Milligram/Liter	0.3(3)	
	Manganese	Milligram/Liter	0.2	
	Arsenic	Milligram/Liter	0.05	
	Cadmium	Milligram/Liter	0.003	
	Chromium	Milligram/Liter	0.05	
	Cyanide	Milligram/Liter	0.07	
	Fluoride	Milligram/Liter	0.5-1.5*	
	Lead	Milligram/Liter	0.01	
	Ammonia	Milligram/Liter	1.5	
	Chloride	Milligram/Liter	250	
	Sulphate	Milligram/Liter	250	
	Nitrate	Milligram/Liter	50	
	Copper	Milligram/Liter	1	
	Total Hardness	Milligram/Liter	500	
	Calcium	Milligram/Liter	200	
	Zinc	Milligram/Liter	3	
	Mercury	Milligram/Liter	0.001	
	Aluminium	Milligram/Liter	0.2	
	Residual Chlorine	Milligram/Liter	0.1-0.2*	In chlorination system only
Microscopic	E.coli	MPN/100ml	0	
Organism	Total coliform	MPN/100ml	0 (In 95% Sample)	

Note: ( ) Value given in the bracket is applicable only if no alternative is available

* Indicates minimum and maximum limits

Source Nepal Gazzette Ashad 12, 2063 B.S