Action-Oriented Study on
Water Quality and Water Borne Diseases
in Bungamati VDC, Lalitpur District
Nepal

LIBRARY

Submitted to

Nepal Health Research Council (NHRC)
Kathmandu, Nepal

Bandana Kayastha Pradhan, PhD
Department of Community Medicine & Family Health
Institute of Medicine, Tribhuvan University

May 2003

Action-Oriented Study on Water Quality and Water-Borne Diseases in Bungamati VDC, Lalitpur District

May 2003

The Study Team

Bandana Pradhan, PhD   Principal Investigator
Pushkar K Pradhan, PhD   Co-Investigator
Sadhana Pradhanang   Co-Investigator
Birendra K Kayastha   Co-Investigator

Co-operation from Researchers

Name	Institution	Purpose
Prof. Dr. Ramesh Kant Adhikari	IOM	Overall comment
Prof. Dr. Mathura Shrestha		Overall comment
Prof. Dr. Bimala Shrestha	IOM	Overall comment
Prof. Chitra Kumar Gurung	IOM	Method of Analysis

LIBRARY

Acknowledgements

Executive Summary

This is an action oriented research study on water quality and water-related diseases in Bungamati VDC of Lalitpur district, Kathmandu Valley. The VDC is one of the 41 VDCs of Lalitpur district. The VDC with extending over an area of 3.8 km^2 has a total population of 5,667. The density of population is 1,491 persons per square kilometre.

The VDC has three settlement localities such as Bungamati, Chundevi and Phasidol with households of 724, 234 and 152 respectively. The total sample size was 110 households constituting 72, 23 and 15 for Bungamati, Chundevi and Phasidol respectively. Bungamati is the Newars dominated compact settlement; Chundevi is characterized by dispersed settlements consisting of mainly Bahun and Chhetri; and Phasidol comprises mainly the Tamangs in agglomeration form. This study has sought to investigate the quality of drinking water used by the communities and their knowledge towards water borne disease. Dissemination of the findings and demonstration of an appropriate disinfection method among the communities of the study area have also been sought.

This study has primarily been based on primary data. However secondary data have also been used as ancillary source. The sample households as identified consist of three classes such as low, medium and high in terms of the households owning below 5 ropani, 5-10 ropani, and over 10 ropani of landholding respectively. The study region comprises different water sources such as wells, stone spouts, ponds, public taps and rivers with their respective number of 5, 2, 5, 6 and 2. Few households particularly in Bungamati have private connections of piped water. The quality of the drinking water has been tested for 20 sample sites. The result of the drinking water quality is that all physical and chemical parameters of the sample water sources are found lying within the WHO guideline, whereas the values of the bacteriological parameters such as coliform bacteria and E.coli are above the WHO guidelines. So, the water of all sources is found not potable in terms of bacteriological point of view.

The findings show that the majority of the households found to have cleaned their drinking water sources once a year and that the water used by the communities found to be contaminated either at source or consumption points. As a result, incidence of diarrhoea is appeared the common health problem among the sample households in the study region. It is found more serious during the dry summer. Yet, majority of the households found to be unaware with the real cause of diarrhoea. For instance, eating more food found to be the most important, whereas contaminated water has got the least, among the reasons. This means that local communities were not fully aware of the quality of drinking water. Eating in restaurant means foods served there are contaminated.

The communities' perception toward environmental sanitation and personal hygiene is very poor. Not all households do have latrine in their houses and therefore the people of the households with no toilets use nearby field or the riverbank as open defecation. The reasons for not having toilets include preferring open field, bad smell of toilet and lack of money. Two-thirds of the sample households have used proper hand-washing practices after defecation. Not all households have used slipper or shoes while go out including toilet. The sharing of the findings and dissemination of solar disinfection (SODIS) method among the small groups of the community has been accomplished.

iv

Towards improving health and sanitation of the local communities, the following recommendations are suggested. Regular monitoring of water quality at frequent intervals and awareness programmes toward conservation of surrounding environment and personal hygiene to the local communities should be made more effective in the study region by the concerned agencies. Open defecation habit must be controlled through making available affordable toilet scheme to the communities. SODIS appears to be appropriate as well as effective method of water disinfection in the study region.

Table of Contents

List of Tables

List of Figures and Photos

Acronyms

ADB	=	Asian Development Bank
CBS	=	Central Bureau of Statistics
CD	=	Compact Disc
CEN	=	Clean Energy Nepal
DOHS	=	Department of Health Services
DWSS	=	Department of Water Supply and Sewerage
ENPHO	=	Environment & Public Health Organization
HMG	=	His Majesty's Government
IOM	=	Institute of Medicine
IUCN	=	International Union for Conservation of Nature
MOF	=	Ministry of Finance
MOPE	=	Ministry of Population and Environment
NPC	=	National Planning Commission
NWSSP	=	National Water Supply Sector Policy
PET	=	Polyethylene Terephtalate
SODIS	=	Solar Disinfection
SPSS	=	Statistical Package for Social Sciences
UNESCO	=	United Nations Educational Scientific and Cultural Organization
UNICEF	=	United Nations Children's Fund
VDC	=	Village Development Committee
WHO	=	World Health Organisation
WSSS	=	Water Supply and Sanitation Sector

Chapter 1

Introduction

1.1   Background

Nepal is predominantly a rural country. Over 85% of the total population is rural. The rural population has literacy rate below 40% (CBS 2001). The country has high incidence of mortality rates, such as 102 and 165 for infant and child respectively (MOF 2001). Sixty-six percent of the rural population has access to the piped drinking water and the remaining has to depend on spring source, stream and tube well for drinking and other household uses. The per capita water consumption in the rural area is far less than that in the urban area, which is 45 liter and 60 liter respectively.

The water related disease in the rural region of Nepal is a serious issue. The rural people often get suffering from it. Though water is essential for life and other daily activities, the government is not being able to provide enough water to the people. The people particularly in the rural hills have to spend much time for fetching water from the sources managed by the people themselves.

Surface configuration, dispersed settlement locations, lack of roads, poverty, etc. are some of the factors of limited supply of water for drinking and household uses in the rural region. The hills and mountains are rugged that together makes up 77 per cent of the total area. The topography consists of river valleys, ridges and steep slopes with elevation ranging from 300 masl (meter average sea level) to over 8800 masl. There is close relationship between population distribution and area and hill terrain, which indicates that the settlement pattern particularly in the hills is tiny and scattered. The main guiding factor of dispersed pattern of rural settlements in the hills is limited cultivated land resource. Drudgery of movement for fetching drinking water is major hindering factor in the hills, as there is limited piped drinking water supply to cover dispersedly located village settlements. In such situation, the amount of water fetched by the rural households every day from the locally available water sources is just to meet drinking and cooking purposes. In most cases, the natural drinking water sources also do not provide the same amount of water throughout the year, as the water volume depends on the seasonal pattern of monsoonic rainfall. During dry season, there is limited supply of water from such sources, whereas during summer rainfall, most of the sources are often not accessible despite they have large quantity of water. Quality of water even from the natural sources during both seasons is a serious problem. Limited water supply is itself related to health problem while large quantity of water available at these sources during rainy season is often turbid due to flooding and landslides, and contaminated as well due to open defecation. It is known that the people in the hills and mountains are often being suffered from the diseases related to water during both dry and rainy seasons. As this situation has occurred particularly among the rural communities of the hills and mountains since several years back, what practices that local people have used to combat with the problem would be interesting to know, despite there are efforts on the part of the government agencies to this regard.

1.2 Statement of the Problem

Water pollution is one of the serious public health issues in rural Nepal. It is estimated that one third of total deaths of children under five years of age in rural area is due to water borne diseases including cholera, typhoid, dysentery and gastro-entities. The water related diseases lie among the top ten diseases in the country. This situation suggests that the efforts being undertaken on the part of government and other agencies appear to be inadequate to reduce and eventually eliminate bacteriological contamination at different sources of drinking water in the rural region. Yet, the vital connection between water and health is given little emphasis in government policy (UNICEF 1987).

There is a widespread absence of piped drinking water in the rural region and therefore the rural inhabitants have poor access to the safe drinking water. As a result, they have to depend on the most convenient sources of water locally available in their areas irrespective of the quality (ADB 1985).

Drinking water may be contaminated due to several reasons. Of many, lack of proper conservation of the water sources may be an important factor. The contamination of drinking water may occur from sources to consumption at home due to ignorance or improper practice of storing water. The findings of the studies on drinking water quality carried out in several parts of the country indicate that there is widespread lack of public awareness towards conservation or improving water quality. Even if the drinking water sources are biologically clean, the collected water for domestic use may contaminate both outside and within the house environment through poor hygiene and sanitation practices. In general, the pollution in the headstream water in rural region might not yet reach at threshold concentration level. The industries that are located elsewhere in the rural areas might have accelerated to deteriorate the quality of water at sources. While the demand for water consumption is increasing due to increase of population, change in life style and living environment, intensification of agricultural activity, etc. So, if necessary measures are not taken now the magnitude of water pollution may grow seriously in near future as more and more activities depending on the water increases. It can also be assumed that the water contamination may occur due to lack of general awareness of community towards conserving it. It appears that the government efforts are not being adequate to conserve the water quality through providing awareness programmes to the communities. There is lacking of policy measures and programmes towards improving the practice of water quality.

1.3 Rationale

Studies on different aspects of the drinking water and the measures to reduce the pollution level are limited in the country. Few studies carried out in rural Nepal indicate that the sources of drinking water have been contaminated with an unacceptable level of faecal coliform bacteria (DISVI 1990). Statistics indicate that the water related diseases are increasing every year. The diseases have occupied a major proportion of the total patient visits at the health service centres in the country. Until now, much emphasis is given to curative measures such as medical treatment to the problem. This measure is essential, but it is an immediate and a short-term measure. Likewise, physical treatment is a normal practice to clean the drinking water. But mere

this treatment is not effective to solve the deteriorated problem of water quality. In other words, it is not a permanent or sustainable solution.

Indeed, the rural communities require rather long-term solutions to the ever-increasing problem of water related diseases. The increasing trend of the patients having water related diseases can also be minimized if emphasis is given to preventive measures such as imparting awareness of the people at both community and government levels about how to conserve and protect the water both at sources and home. This measure is considered to be manageable at community level and assumed to be remained for a longer time in a sustainable way. However, this requires to assessing the existing practice and knowledge of the local communities towards water quality conservation and maintenance. The results of the study would be helpful in formulating appropriate awareness program for better management of the drinking water sources, if there exist inappropriate practices. Conversely, if the rural communities have better practices, they then can be replicated in other areas.

1.4   Objectives

This study seeks to investigate the quality of drinking water used by the communities and their perception towards the quality of the water, water borne disease and sanitation. The study has the following specific objectives:

o   Assess the bacteriological and physio-chemical quality of the water used by communities

o   Determine the factors responsible for contamination of the drinking water

o   Ascertain the perception of the rural communities towards water quality and practices of
    managing the water sources and water borne disease

o   Share the findings of the results among the communities of the study area

o   Disseminate the appropriate methods of cleaning water among the communities

o   Suggest measures of drinking water and sanitation services suitable to the local communities

1.5   Research Questions

The followings research questions have been formulated in this study.

o   What is the state of water quality available at community level?

o   What are the factors responsible for deteriorating the quality of drinking water?

o   What are the major sources of water for the local communities?

o   What are the efforts undertaken by the related agencies towards improving the water quality?

o   Is there any indigenous practice of protecting water at source and home?

1.6 Research Hypotheses

This study intends to examine the following research hypotheses[1].

o   There is relationship between education level of the respondents and quality of drinking water.

o   Households' income level is directly related with the quality of drinking water.

o   There is relationship between the households' landholding size and means of hand washing practices after defecation.

---

[1] Two of the hypotheses formulated in the proposal, such as drinking water supply system versus water quality and quantity of drinking water and health and sanitation have been removed due to unavailability of data from the respondents.

Chapter 2

Literature Review

An understanding of water pollution and its causes, magnitude and impacts on human health is important to formulate policies and programmes for improving water quality. Human health is greatly dependent on the quality of water the people are using it for different purposes.

2.1 Water and Sanitation Studies

Distance of drinking water sources is major factor in determining water quality and sanitation of rural localities. Generally, as the distance of water sources from living areas increases, the amount of water required for use decreases and thus the health condition of people deteriorates. Studies carried out in rural areas of Nepal by ADB (1985), IUCN (1991), Pradhan (2000), and MOPE (2001) show that rural people have used the most convenient sources of water in their areas irrespective of quality due to lack of piped water. Another important issue is the diseases due to lack of adequate and potable water, The studies of CEMAT (2000), ENPHO (1999), DOIIS (2001) and CBS (1999) indicate that about one third of the total death of children under five years of age in rural region of Nepal is due to water borne diseases, such as cholera, typhoid, dysentery and gastro-entities. Yet, the vital connection between water and health is given little emphasis in the government policy (UNICEF 1987, NPC 1998, and MOPE 2001).

Drinking water sources using by local communities may not be clean due to several reasons. One basic reason may be the lack of proper conservation of water sources from human activities, animal grazing etc. Drinking water contamination of Kathmandu valley has been studied since three decades ago from different sources (Sharma 1978, Adhikari et al. 1986, ENPHO/DISVI 1990). The contamination may occur from sources to consumption in house due to ignorance or improper practice of storing water. Even if the drinking water sources are biologically clean, the collected water for domestic use may contaminate both outside and within the house environment through poor hygiene and sanitation practices. Studies carried out by Pradhan (1995 and 1998) show that there is lack of general public awareness towards conserving or improving water quality at sources. In most cases, the pollution of water in the headstream located in rural region has not yet reach at the threshold concentration level for chemical parameters but not free from fecal contamination (ENPHO 1996, Pradhan 1998, CEMAT 1999, Pradhan 2000 and 2001). The study of IUCN (1991) has also indicated that the drinking water sources in rural region have been contaminated with an unacceptable level of faecal coliform bacteria. It is argued that if necessary measures are not taken now, the rate of pollution may grow even larger in near future as more and more activities depending on water increasing (Devkota and Neupane 1994, Palikhe 1999 and Poudel 1998).

2.2 National Water and Sanitation Policies and Measures

Water Resources Act-1993 of Nepal is an Act of greater significance, which vest ownership of all water resources on the State and private ownership is disregarded. The Act also appropriately recognizes the drinking water as the first priority in terms of its use, which is followed by

irrigation, farming enterprises like animal husbandry and fisheries, hydroelectric power, cottage industry, water transport, and others in order of priority of use.

Drinking water is the basic minimum need of all human beings and provision of convenient, safe and adequate drinking water is the declared commitment of His Majesty's Government of Nepal. It has been realized that the development of water supply and sanitation sector (WSSS) brings in enhanced socio-economic benefits and public health improvements. A large mass of population is still deprived of safe, convenient and adequate drinking water supply and sanitation facilities. The rural population in hills and midlands still obtain their water from springs, ponds, canals, streams and rivers, which are in most cases, grossly contaminated. The water has to be fetched from a long distance involving heavy ups and downs and thus the quantity of water used is minimum and just enough to sustain life. The condition in Tarai area is also not better despite availability of enough groundwater. Very often, shallow tube-wells and dug wells are polluted. Due to fecal contamination, water borne diseases such as cholera, diarrhoea, dysentery, and infectious hepatitis are the major causes of mortality and morbidity amongst children.

Yet, the water supply coverage achieved so far by the end of 1996 has been estimated to be 61% of the total population. The sanitation coverage measured in terms of latrine access was about 20%. Compared to the targeted coverage of 100% piped water supply and 50% sanitation coverage of the total population as mentioned in the Ninth Plan (1997-2002), the water supply coverage is estimated to be 66% and the sanitation coverage is estimated to be 40% by the end of 2002. The Ninth Plan has formulated the following objectives related to the water and sanitation:

(a) To classify the service level based on quantity & quality of water supplied, which should be accessibility and reliability throughout the year.

(b) To mobilize optimally the local resources for the supply of safe water in adequate quantity.

(c) To protect and conserve the existing resources both in Tarai and Hills.

(d) Priority shall be given to implement W/S Project benefiting the under privileged, minority groups and, poorer communities with active involvement of the user groups.

(e) To integrate sanitation programs with water supply activities as an equal component of the project for the improvement of the environmental hygiene and level of public health.

(f) To develop simple, low cost technologies that are within the capabilities of the users to manage, operate and afford to pay for the services and to replicate such technologies at the national level.

(g) To redefine the roles and responsibilities of the existing institution for effective and efficient service delivery and facilitate decentralized operational modalities.

(h) To develop the Non-government organization, community based organization and the private sector organization as a partner agency for the overall development of the sector.

(i) To develop technical and institutional capabilities for lowering the high level of present leakages and wastages to the appropriate level in the urban areas.

A National Policy on Sanitation has been prepared in 1994, whereas the National Water Supply Sector Policy has been formulated in 1998. The National Water Supply Sector Policy (NWSSP) - 1998 has aimed at achieving the following principal objectives.

(a) To provide and ensure safe, convenient and adequate water supply to all Nepalese people with sanitation as its integral component with specific focus on the disadvantaged groups.

(b) To reduce incidence of water related diseases extensively prevalent in the country.

(c) To lessen sufferings and drudgeries of women and children who are traditionally involved with collecting water and taking care of domestic sanitation and hygiene.

Some of the **planning** and **program** given below are directed to attain the objectives set above.

(a) To extend the national coverage of water supply to all by the year 2002.

(b) To classify the level of services based on the quantity and quality of water supplied accessibility, reliability and continuity of the system.

(c) To adopt measures to improve/better the levels of service through rehabilitation, expansion and extension of existing WSS programmes.

(d) To promote community education and awareness programme for enhancing capabilities of the communities and empowering them to act/participate and benefit effectively from WSS program.

(e) To make hygiene education and sanitation promotion programme an integral part of water supply programmes.

(f) To install sewerage or on-site sanitation system in urban and peri-urban areas as appropriate.

(g) To minimize adverse environmental impact while executing WSS programmes.

(h) To safeguard the microbiological, chemical and physical laity of drinking water.

(i) To institute necessary changes and improvements in the existing legal regime and formulate appropriate acts, rules, and regulations for preserving and protecting water sources against pollution, up keeping environmental sanitation, maintaining appropriate standard of water quality and promoting private sector involvement.

The followings are some of the **strategic objectives** to attain the above said policy statements:

(a) Increasing water supply coverage to 100% by 2002 in commensurate with the philosophy "Some for all rather than more for some".

(b) Recognizing fresh water as a limited and finite resource and priority to be given to demand management and reduction of unaccounted for water in preference to the traditional "new source" approach.

To fulfil the basic strategic objectives mentioned above the following are some of the **principal strategies**.

(a) Harnessing streams springs and wells carrying water of acceptable quality in rural areas and developing a simple mechanism of sanitary inspection or regular monitoring/surveillance of water supply projects.

(b) Promoting appropriate disinfections methods for domestic use. Extending treatment facilities gradually in urban and semi-urban areas, district centres and other densely populated areas.

(c) Setting up National Drinking Water Quality Standard and enforcing the same.

(d) Establishing and managing water testing laboratories and other institutional framework and developing technical and managerial capabilities to monitor ground water quality surveillance at national, regional, district and community levels.

(e) Identifying and strengthening Water Quality Surveillance Agency and instituting effective surveillance programme to maintain a good quality of drinking water at a national, regional, district and community levels.

(f) Developing a regular water quality monitoring and assessment system of surface and ground water for control of water pollution.

The NWSSP has for the first time elaborately described objectives, policies and programs for the development of drinking water and sanitation facilities for the people. However, it seems that they are too ambitious if we look back into the practice of the previous attempts, which are often being far behind than what have been said in the documents. Expected that majority of the country people will get the water and sanitation services, provided that all these activities are translated into the real field. Yet, they lack some of the policies and programs for better availability of the facilities. First, mere emphasizing onto enlarging the drinking water coverage will not adequate unless quality (potable) and quantity (how much per capita) aspects of drinking water are considered. Besides coverage, these two are vital in terms of health and sanitation. Despite WHO guideline for drinking water is there, the sector policy has not explicitly defined Nepalese potable water standard. Secondly, the health and sanitation education program alone does not reduce water related diseases. Living standard of the rural communities needs to be raised through providing income-generating activities to them. They are to be made capable of paying water and sanitation tariffs. However this issue is interlinked among many agencies related to the water and sanitation sector. It requires that an agency be established so that all concerned stakeholders can be brought into one umbrella. The coordination should be made at national, sub-national and local levels. For instance, a close coordination between water and sanitation and health departments is essential, as water related diseases relate to both of them. Thirdly, the policy measures lack in identifying parameters of water quality and sanitation. No monitoring of water quality and sanitation can be performed unless the parameters are identified and defined. Above all, establishment of database system is essential at district and central levels for planning formulation, decision-making, implementation and monitoring and evaluation. The document has not dealt with it, which is very much vital and essential for drinking water and sanitation facilities.

Chapter 3

Research Methodology

3.1 Study Area and Its Justification

The present research is a case study. Indeed, the rural settlements of the Kathmandu Valley are relatively better position in drinking water coverage and sanitation sector than other rural parts of the country, since the valley has the nation's capital city and many historically important traditional Newari settlements, which are quite peculiar in terms of architect, art and culture and housing pattern. However, there are problems of drinking water supply, quality and sanitation particularly in the rural region of the valley. Therefore, Bungamati VDC (Village Development Committee) of Lalitpur district, Kathmandu Valley has been chosen as a case study. Of many traditional Newar settlements, Bungmati is one of the important settlements, which is close to Lalitpur city. There are other rural settlements within Bungamati VDC, which are quite different from Bungamati. All these different settlement localities represent both Newar and non-Newar features. The rural communities have accessed to a variety of sources of drinking water such as well, tap, stone sprout, streams, etc. The results and the policy measures to be formulated may be replicated in other parts of the valley and the country.

3.2 Research Methods and Sample Design

3.2.1 Data sources

This study has been based primarily on primary source. The field survey has been used to collect data for the study. However, secondary sources such as population census report, health bulletins and published and unpublished reports related to drinking water and sanitation have been used wherever feasible in the study.

3.2.2 Tools and techniques for data collection

The primary data for this study was gathered through using the following tools and techniques:

o   The structured questionnaire sheets containing both open- and close-ended questions were prepared and administered to the sample household heads for gathering information (annex 3). Responses of the sample households were filled in the questionnaire sheets by the principal and other researchers themselves.
o   Water samples from the drinking water sources were collected and analysed in the laboratory for bacteriological and physico-chemical parameters (annex1).
o   Observation checklist was used to record the environment and sanitation conditions of the water sources, living area and toilets (annex 4).
o   Besides, household sample survey, focus group discussion was performed with the local people at common places such as teashop and Chautara. The discussion was made through participatory approach.

However, the questionnaire sheets were finalized after pre-testing, which was accomplished in Budhanilkantha area.

3.2.3 Sampling methods and sample size

Prior to the field survey, the reconnaissance survey was carried out in the study area that provided the basis to select sample villages and to determine the sample size. Three settlement localities such as Bungamati, Chundevi and Phasidol were selected based on the relatively greater concentrations of the caste and ethnic groups contained in each of them. The household number of the three settlement localities obtained from the VDC record was 724, 234 and 152 respectively. The total sample size has been determined at 110, which has been obtained by using the following formula (Hanushek and Jackson 1977)[2].

$$ n = \bar{x} \pm 2 \frac{s}{\sqrt{N}} $$

Where,

n	= size of sample
$\bar{x}$	= mean of the distribution of households by ward
2	= standard error (i.e. 95% probability)
s	= standard deviation of the distribution of households by ward
N	= Number of wards

The 110 total sample units represent 10 per cent of the total households of 1,110 of the VDC. With this percent, the sample units for each of the three localities have been obtained, which were as follow: Bungamati – 72, Chundevi – 23 and Phasidol - 15. This sample size as determined on the basis of mean and standard deviation of the distribution of households by ward lies within the range given by the equation. The sample households from each locality were selected randomly for questionnaire survey[3].

For questionnaire survey, the household head of the sample household was considered as the sample unit. The sample household heads included man and woman, different age groups, ethnic groups and socio-cultural status. This was performed in order to represent a wide view regarding the use and management of the drinking water sources.

In addition, observation and group discussion were also used to get further information.

---

[2] $\bar{x}$ = 123; s = 23.4; N = 9 and n = sample size that lies within the standard error of the mean at 95% probability is $n = 123 \pm 14.1$.

[3] The households were selected on contact basis by visiting each of the localities, and the questionnaire was administered to them. However, household was selected carefully so that no repetition of the same occurred.

Study Design

Study area	→	**Bungamati VDC**

Sample localities	→	**Bungamati** (Wards: 1-6)	**Chundevi** (Wards: 7-8)	**Phasidol** (Ward: 9)

Sample/total households	→	**Households** (72 out of 724)	**Households** (23 out of 234)	**Households** (15 out of 152)

Methods of analysis

Water quality –Lab analysis
Questionnaire
Observation check-list

Findings and action

Finding Dissemination
Action – SODIS Disinfection
Awareness

3.2.4 Validity and reliability of the research

The reliability of the research is confirmed by using the following processes and considerations:

o The test instruments, equipment and pre-testing of methodology were standardized
o Data collection was performed by the skilled and well experience personnel
o Sorting and editing of the data in the filled up questionnaire forms was performed
o Water sample analysis especially for the chemical parameter was performed using ENPHO field test kit in the field, and 50% of the water samples sources were analysed in the community medicine laboratory.
o Bacteriological water quality analysis was carried out in the Community Health Laboratory, Institute of Medicine, Maharajganj.
o Questions were asked to the selected sample household heads in simple Nepali language.
o Sample size was determined with the equation given above, which is based on mean and standard deviation of the households in the VDC wards.
o The result was supported by the information gathered through group discussion and observation.

3.2.5 Methods of analysis

This study is primarily of descriptive type that is used to describe different aspects of the drinking water in qualitative and contextual manners. To a greater extent, the description has dealt with objective judgment, comparison and critical evaluation of the factors related to the quality, quantity and management of the drinking water sources.

Two types of variables have been identified. In 'dependent variable' water quality, water quantity, and practice and perception of the sample households have been included, whereas parameters like education status, economic status and occupation have been included in "independent variable". Descriptive statistics such as mean, standard deviation, variance, standard error, indices, etc. and visual aids including maps, graphs, charts and photographs have been used in the text wherever feasible. Hypothesis testing has been performed through using the non-parametric test such as χ^2-test.

3.2.6 Limitation of the study

o This is a case study and therefore the generalizations of the findings apply to the study region only.
o The study has primarily concentrated on the selected parameters of water quality (stated above) and water related diseases.
o Water quality analysis has been assessed in terms of bacteriological, biological, physico-chemical parameters.
o The assessment of the water quality signifies the point of time during which the samples were chosen.

3.2.7 Plan for supervision and monitoring

Prior to the data collection, a one-day discussion program was held among the investigators and field surveyors.

Two research assistants were hired for data collection and given training to them about how to get proper responses from the respondents. However, they were supervised and monitored by one of the investigators during the field survey.

Verification of the data collection was made whether the collected data was adequate or not. In case of incomplete and unclear information, the field surveyors were sent next day for the data collection.

3.2.8 Data management and processing

o Each question was given identification number and all information was transferred on to the well-prepared datasheet format.
o All data have been entered into and processed to generate desirable tables, charts and flows through using the SPSS (Statistical Package for Social Sciences) program.
o Database has been made in relational database system.
o A copy of the data was stored onto CD and floppy diskettes.

3.2.9 Expected outcome of the research

o To be known different status of the water quality.
o To be understood the knowledge and practice of the communities of the water sources and sanitation.
o To be known of different sources of water.

Chapter 4

The Profile of Bungamati

4.1 Spatial Setting

Bungamati VDC (Village Development Committee) is one of the 41 VDCs of Lalitpur district. The VDC extends over an area of 3.8 km². This lies in the southwest of the district. It has four adjoining VDCs, such as Khokana on the north, Sunakothi and Thecho on the east and Chhampi on the south. On the west is the Bagmati river (*Figure 1*).

4.2 Social Setting

In 2001, the total population of Bungamati VDC was 5,667 as compared to 4,818 in 1991. This shows an increase of 17.6% population between 2001 and 1991. The VDC has density of 1,491 persons per square kilometre. The females slightly outnumbered the males (*Table 1*). The average household size is 5.1. The proportion of the active population in VDC total population is 63%, whereas the proportion of the dependent population is 37%. Of the dependent population, the population with below 15 years of age accounts for 29% and the population with over 59 years of age is 8% (*Table 2*). The proportion of dependent population is quite large.

Table 1: Population by age group and sex, Bungamati VDC

Ward No.	House holds	Male		Female		Total	
		No.	%	No.	%	No.	%
1	137	441	7.8	414	7.3	855	15.1
2	128	333	5.9	366	6.5	699	12.3
3	110	252	4.4	224	4.0	476	8.4
4	153	387	6.8	366	6.5	753	13.3
5	85	212	3.7	199	3.5	411	7.3
6	111	255	4.5	266	4.7	521	9.2
7	100	302	5.3	293	5.2	595	10.5
8	134	330	5.8	385	6.8	715	12.6
9	152	319	5.6	323	5.7	642	11.3
Total	1110	2831	50.0	2836	50.0	5667	100.0

Source: CBS (2001)

The population structure in terms of age and sex as shown in Figure 2 is that the proportion of old age population with 60 years of age and over is thin and likewise child population below 5 years of age is also very small proportion in both sexes. In the latter case, either the birth rate is declined or the child mortality rate is high. Thinning old age population may be due to poor health facility or poor dietary system. In other words, the large proportion of the productive population of Bungamati VDC means there is high potential of growth of population in future.

Figure 1

Bungamati VDC

Legend

▨ Bungamati VDC

☐ District boundary

N
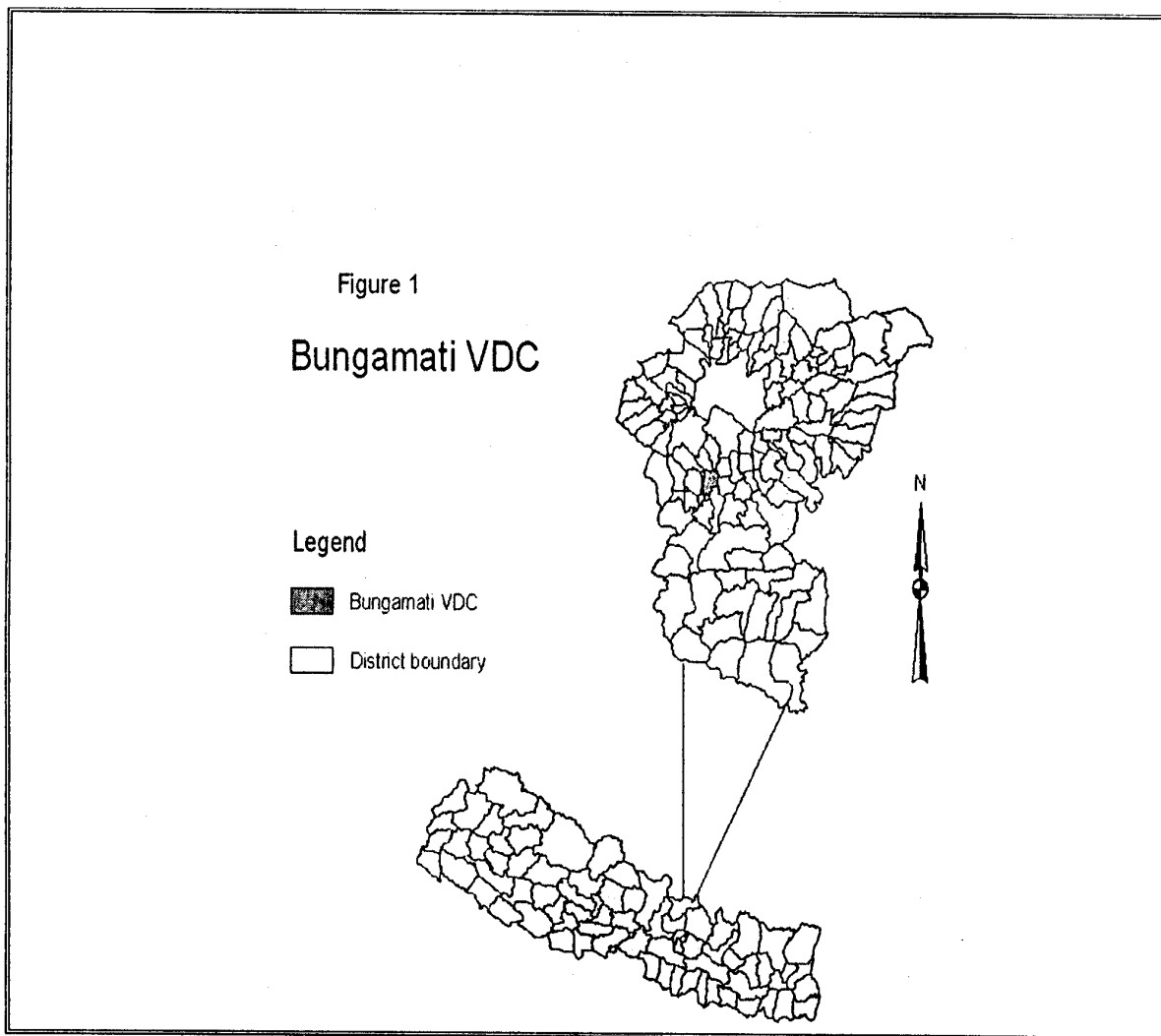
Table 3 shows the population distribution by castes and ethnic groups in each ward of Bungamati VDC. The 2001 population census has provided 7 major castes, ethnic groups and religious group. It seems that the VDC has multi-ethnic populations. However, the Newar is the largest with slightly over 64 percent among the other population groups. It has occurred in all but ward 7. The second and third largest groups include Bahun and Chhetri, and the hill ethnic (Tibeto-Burman) groups, which are found in few wards. Having

Table 2: Population by age group

Age groups	Total	
	Number	%
Below 15	1655	29.3
15 – 59	3545	62.5
Over 59	467	8.3
Total	5667	100

Fig.2 : **Population Pyramid of Bungamati VDC**
(Population% by age group)
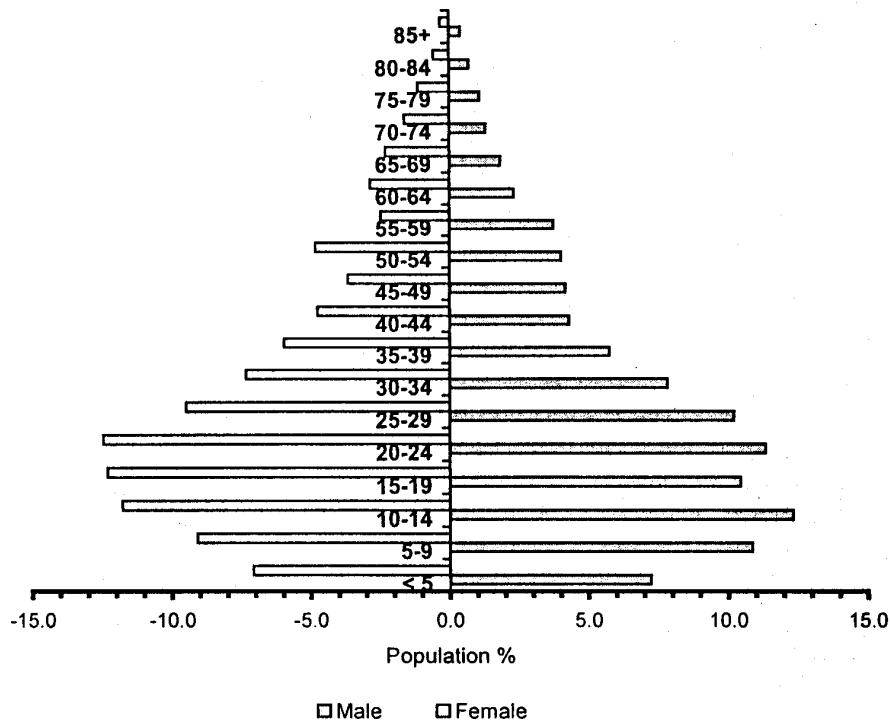
population of other castes and ethnic groups including some of the castes from the Tarai, the Dalits (untouchable), Tharu and Chepang, etc, the communities of Bungamati VDC is said to be a quite mixed character. Once only Newar resided Bungamati locality is now having other castes and ethnic groups. For instance, three wards of Bungamati locality (1, 4 & 6) are composed of diverse castes and ethnic groups and yet Newar has dominated in the community composition.

Table 3. Bungamati VDC Population by caste & ethnic groups

Caste & ethnic groups	Ward number									Total	
	1	2	3	4	5	6	7	8	9	No.	%
B_Chhetri	25			40		27	485	664	6	1247	22.0
Newar	782	694	473	593	409	483		4	211	3649	64.4
Hill ethnic groups	8		1	73		9	97	23	414	625	10.9
Tribal groups				15			1		9	25	0.5
Tarai groups	1	3	1			1	3		1	10	0.2
Dalit groups	32			32			8	16		88	1.6
Muslim	5								1	6	0.1
Unidentified castes	2	2	1		2	1	1			9	0.2
Total	855	699	476	753	411	521	595	715	642	5667	100
%	15.1	12.3	8.4	13	7.3	9.2	10.5	12.6	11.3	100	

Source: CBS (2001).
Note: B_Chhetri = Bahun, Chhetri & Thakuri; Hill ethnic groups = Magar, Tamang, Rai, Gurung, Limbu, Sherpa, Sunuwar; Tribal groups = Tharu & Chepang (Praja); Tarai groups = Yadav & Mallah; Dalit groups = Kami, Damai/Dholi, Sarki & others dalits.

4.2.1 Population and settlement

Bungamati VDC consists of three major village localities such as Bungamati, Chunikhel and Phasidol. Of these, Bungamati is the largest locality in terms of population size, which alone consists of six (1 to 6) out of nine wards. The total population of Bungamati locality is 3,715, making up two-thirds of its VDC total population. The other two localities comprise the rest three wards, which lie in outlying part of the Bungamati. It is one of the historically important compactly built traditional Newar settlements[4] of the Kathmandu valley, which lies about 6 km in the southwest of Patan city. It is situated on the plateau or elevated plain at about 1,352 masl (meter average sea level) in between two rivers: the Bagmati river in the west and the Nakhu khola in the east. The latter is a tributary of the former river. The elevation of the points through which they are flowing is 1,255 and 1,326 masl respectively. Bungamati is connected with Patan city by road.

Photo 1: **Machhindranath Temple**

---

[4] Bungamati is said to be originated in 16th century where Machhindra, a Rain God of India was invited to settle with his subjects during the time of a big draught. Later, the shrine of Machhendra was established at the site where the settlement of Bungamati now lies. Bungamati is famous as the winter home of the Red Machhendra god of Patan who resides every winter in a powerful, Shikhara-style temple. The Kathmanduties celebrate festival on the day of shifting of the Machhindra from Bungamati to Patan.

Bungamati was among the ten important market settlements in rural Lalitpur identified by the government (HMG/UNESCO 1975). By that year, it had 2000 inhabitants, 10 shops and 5 other services. By the early 1990s, it served as service centre. In 1994, Bungamati expanded its size with 43 different commercial and service units (Pradhan 1997). Historically, Bungamati was one of the important market towns along the traditional trade route leading to Bhimphedi in Makawanpur district. Its importance has been reinforced by the location of public facilities, industries and public transport service. The rapid urbanization of both Kathmandu and Patan cities in the recent past appears to have enormously affected in the development pattern of traditional market settlements including Bungamati in the valley. Its adjoining locality 'Sainbu' along the Patan-Bungamati corridor has come under the direct influence of the urbanisation of Patan city.

The Bungamati built-up area consists of densely built typical ancient Newari houses, made up of brick and mud. The houses are mostly of three storeys with narrow footpaths paved with bricks and stones. The ground floor is used for storing of agricultural residues, pet animals (sheep and goat), chicken and toilet. Other floors are used for living and cooking. There are few spacious courtyards within the built-up area, which are often used for grain drying in the sunny day.

The settlement density in the outlying areas is thin, where houses are surrounded with open fields. Other castes, Bahun and Chhetri, and ethnic groups including Tamang live in the outlying villages. Spatially, the Tamang is found usually residing on the higher mountain slopes, whereas the Bahun, Chhetri, and others have preferred low-lying areas including the foothills for living.

4.3 Economic Setting

Though the agriculture together with animal husbandry was major occupation of the inhabitants of Bungamati, it has now become as an auxiliary to other non-agricultural activities. Yet almost all households in Bungamati locality have landholdings. Major agricultural crops are rice, potatoes, garlic, maize and seasonal vegetables. Except vegetables, the production of other crops is mainly for self-consumption. The low-lying agricultural fields are often used throughout the year.

Particularly the Bungamati bazaar is important for woodcarving and other tourist related activities. According to the village office, there are about 200 or smaller woodcraft business in this village. The woodcarvers have an important role in preserving the unique art of ornamental woodwork. The Bungamati VDC estimates that that around 6,000 tourists visit the Bungamati each year. Machchhendranath temple is the major attractive site for the visitors. Other interesting places to be observed include the communal life around the village's courtyards, ponds and religious temples. Some of the houses exhibit good examples of carved windows, as well as attractive examples of naïve Rana-style plasterwork. A few recently built modern buildings have also maintained a moderate maximum height and
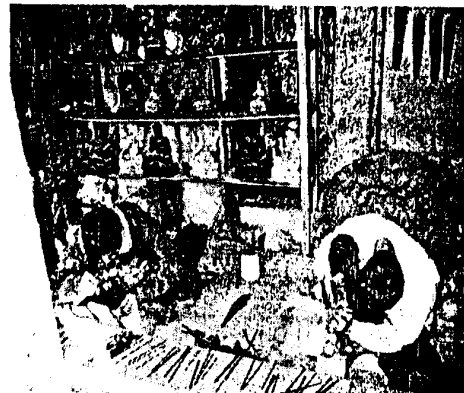
Photo 2: **Wood Carvers, Bungamati**

brick exteriors. However, there is extremely lacking of tourist infrastructure facilities including public toilets, sanitation, conservation of ponds, etc. A few Tibetan carpet factories can be seen in the village; these factories have given employment to the village girls. Most of the educated villagers work in the cities of Patan and Kathmandu as labourers, construction and office workers.

As Bungamati is one of the attractive places of tourists in the Kathmandu Valley, it has to concentrate its development activities on to improving tourism related infrastructure facilities. During the last year, the VDC has however undertaken urban environmental improvement such as repaving of the streets and some parts of the main square with traditional brick and stone patterns. Pavement of streets leading to the Machhindranath square and other temples, re-roofing of traditional Jhingati tiles of some of the houses facing the Machhindranath temple, restoration of the traditional stone water spout, and proper maintenance of the public toilets particularly for the use of tourists are some of the works to be performed immediately. There are other works to be done such as restoration of other ponds, street pavement in other parts of more Bungamati, opening of restaurants and other shops for tourists, etc. This all will help to attract more tourists and spend longer time.

Chapter 5

Analysis of Sample Population

5.1 Characteristics of Sample Population

5.1.1 Social characteristic

The sample units consist of 110 households from the three localities, Bungmati Chundevi and Phasidol of the Bungamati VDC. Table 4 shows the number of sample households by castes and ethnic groups of each sample locality.

Table 4: Distribution of castes & ethnic groups by sample locality

| Name of locality | Castes & Ethnic groups | | | | | | Total | |
| | B_Chhetri | | Newar | | Tibeto-Burman | | | |
	No.	%	No.	%	No.	%	No.	%
Bungamati	9	8	63	57	-	-	72	65
Chundevi	23	21	-	-	-	-	23	21
Phasidol	-	-	5	5	10	9	15	14
Total	32	29	68	62	10	9	110	100

Source: Field Survey (March 2003).

As stated above, the Bungamati locality has a compact settlement with the domination of Newar, which represents the largest share (65%) in the total sample households. Chundevi is characterized by dispersed settlement consisting of mainly Bahun and Chhetri, whereas Phasidol comprises mainly Tamang communities residing in agglomeration settlement pattern. The latter two localities share 35 per cent in the total sample units.

Table 5: Education level by caste & ethnic group

| Education level | Castes & ethnic groups | | | | | | Total | |
| | B_Chhetri | | Newar | | Tibeto-Burman | | | |
	No.	%	No.	%	No.	%	No.	%
Illiterate	16	14	16	14	16	14	46	43
Literate	8	7	16	14	0	0	24	21
1-5 grade	0	0	16	14	0	0	16	14
6 - 10 grade	8	7	16	14	0	0	24	21
Total	31	29	63	57	16	14	110	100

Source: Field Survey (March 2003).

Table 5 shows that the illiterate has a considerable proportion (43%) in the total sample households. All the Tamang sample household heads were illiterate, whereas slightly over half of the Bahun and Chhetri household heads was illiterate. Among the literate, the household heads with just read and write have 21 per cent. The Newar household heads have greater proportion of the literate in the sample households.

Table 6 shows that still there were sample units with illiterate in the young age group. Greater proportion of the illiterate represented the age group 50-65 years in the total sample units.

Table 6. Education level and age group

| Religion types | Age groups | | | | | | | | Total | |
| | <20 | | 20 - 49 | | 50-65 | | <65 | | | |
	No.	%	No.	%	No.	%	No.	%	No.	%
Illiterate	8	7	8	7	24	21	8	7	46	43
Literate	0	0	8	7	8	7	8	7	24	21
1-5 grade	0	0	0	0	8	7	8	7	16	14
6 - 10 grade	0	0	16	14	0	0	8	7	24	21
Total	8	7	31	29	39	36	31	29	110	100

Source: Field Survey (March 2003).

The sample households consist of two religion groups: Hindu and Buddhist. Table 7 shows that all the Bahuns and Chhetris were Hindu and likewise all the Tamangs were Buddhists. The Newars were divided into these both religion types.

Table 7. Religion and ethnic group

| Religion types | Castes and ethnic groups | | | | | | Total | |
| | B_Chhetri | | Newar | | Tibeto-Burman | | | |
	No.	%	No.	%	No.	%	No.	%
Hindu	31	29	31	29		0	63	57
Buddhist		0	31	29	16	14	47	43
Total	31	29	63	57	16	14	110	100

Source: Field Survey (March 2003).

5.1.2 Economic characteristic

The occupation characteristic feature of the sample household heads is that majority of them have taken up agriculture as main economic activity and they all from Bahuns and Chhetris and Tamangs (*Table 8*). The Newars have taken up both trading and agriculture as occupations.

Table 8. Occupation by caste and ethnic group

| Occupation types | Castes and ethnic groups | | | | | | Total | |
| | B_Chhetri | | Newar | | Tibeto-Burman | | | |
	No.	%	No.	%	No.	%	No.	%
Agriculture	31	29	47	43	16	14	94	86
Business	0	0	8	7		0	8	7
Others*	0	0	8	7		0	8	7
Total	31	29	63	57	16	14	110	100

Source: Field Survey (March 2003). * Others include agriculture and business.

In agricultural region, the landholding size is considered a major indicator of social and economic status of the households. Likewise the number of livestock owned by the households also indicates the social and economic status, as this directly relates to landholding size and geographic locations. Tables 9 and 10 show the distribution of landholding size by occupation type and number of livestock units by landholding size.

Majority of the sample households are small farmers with landholding size below 5 ropani, followed by large farmer with landholding size above 10 ropani. However, mere landholding size is not adequate to indicate rich and poor farmers. Spatial location of farmlands is important whether they are *Khet* land or *Bari* land. The former is associated with low-lying areas on the bank of the rivers or valley or tar land with irrigation facility, whereas the latter is associated with the hill slopes, which is often without irrigation facility. So, the Khet is more productive and valuable than the Bari.

Table 9: Landholding size by occupation

Occupation types	Agriculture land (area in ropani)						Total	
	<5		5 - 10		>10			
	No.	%	No.	%	No.	%	No.	%
Agriculture	39	36	24	21	31	29	94	86
Business		0	8	7		0	8	7
Others*	8	7		0		0	8	7
Total	47	43	31	29	31	29	110	100

Source: Field Survey (March 2003). * = Both agriculture and business

Majority of the sample households (86%) take up agriculture as the main occupation, as though it does not provide employment to them over the year round. The households with below 10 ropani of land have taken up business and others (trading and agriculture) activities (*Table 9*). The livestock raised by the households includes cow, buffalo, sheep, etc. The single livestock unit owning households are the largest (*Table 10*).

Table 10: Agriculture land and livestock

Number of livestock units	Agriculture land (area in ropani)						Total	
	<5		5 - 10		>10			
	No.	%	No.	%	No.	%	No.	%
1	39	36	24	21	31	29	94	86
2-5	0	0	8	7		0	8	7
>5	8	7		0		0	8	7
Total	47	43	31	29	31	29	110	100

Source: Field Survey (March 2003).

Based on the area of agriculture land, the sample households have been divided into three classes such as low, medium and high, which are defined as the households owning below 5 ropani, 5-10 ropani, and over 10 ropani respectively. Other parameters such as income, building types, number of livestock units, etc. would also be useful to define economic status of the households, but the data on income was difficult to obtain, and the condition of building types and livestock units were more or less similar and therefore they are not considered here.

Chapter 6

Analysis of Drinking Water

6.1 Sources and Quality of Drinking Water

6.1.1 Drinking water sources

Water sources relate to the location, amount, storage, distribution and access to water. The water sources used by the communities include stone spout, well, pond, stream and tap in the study area. They can be divided into two broad groups, traditional or natural and modern water supply systems. The first four sources fall in the traditional or natural water source system, whereas the last one, i.e. tap lies in the modern system.

Photo 1: A protected well for drinking water

There are 5 wells, locally called as *inaar*, 3 in Bungamati locality and 2 in Chundevi locality. The inhabitants use water of the wells for washing clothes, bathing and even drinking. Using of the well water has diminished in recent years due to coming up of pipe water system. However, the people use them when there is little or no water in pipe water system. Bungamati and Phasidol each have one stone spout. Its water is used for drinking, cooking and other purposes.

Photo 2: A local pond using for washing cloths

There are 5 ponds in Bungamati locality. These ponds are now usually used for ritual and religious purposes and washing clothes. There are two rivers, the Bagmati and the Nakhu for Bungamati locality. The people of Bungamati locality use particularly the Nakhu River for washing clothes and bathing during the dry season when there is inadequate water supply in the pipe water system. In other words, the pipe water system alone does not fulfil the demand of water of all residents.

There are 6 public water taps in the Bungamati locality. About 74 households of Bungamati have also water pipes connection in their houses. Table 10

Photo 3: Public tap: source of drinking water

shows the sample number and type of drinking water sources. Bungamati locality has all three types of drinking water sources, well/stone spout, public tap and private tap. Most of the houses of Phasidol do have private tap provided by the Plan International, but they are now not working due to lack of water supply. The sample households of Chundevi and Phasidol localities use only wells for drinking and other domestic purposes (*Table 11*). Being largest, Bungamati locality has not only the greatest number of drinking water sources, but also has all three types of drinking water sources.

Table 11: Sources of drinking water

Locality	Source types			Total
	Well/stone spout	Public tap	Private tap*	
Bungamati	3	6	14	23
Chundevi	1	-	-	1
Phasidol	1	-	-	1
Total	5	6	14	25

Source: Field Survey (March 2003). * Sample taps

6.1.2 Quality of the Drinking Water Sources

The quality of the drinking water sources has been analysed in terms of physical, bacteriological and chemical parameters as stated in table 12. The analysis has covered 25 water samples from three types of sources as shown in table 11. The physico-chemical parameters include temperature, pH, iron, chlorine, total hardness, chloride, N-NH$_4$ (nitrogen ammonia), PO$_4$-P (phosphate-phosphorus) and floride; the bacteriological parameters comprise E.coli and coliform bacteria.

The results of all physical and chemical parameters of the sample water sources lie within the WHO (World Health Organisation) guideline. The bacteriological parameters such as coliform bacteria and E.coli, indicators of fecal contamination have been measured in terms of presence and absence of bacteria by Hydrogen Sulphide Paper Strip Method (H$_2$S Method) and colony forming unit (cfu) per 100 ml of E.coli by membrane filter technique on Chromocult media. Both indicator bacterial parameters show above the WHO guidelines. The test of presence and absence of coliform bacteria in the water is a qualitative analysis. It is to be noted that three sample sites including 2, 6 and 8 all belong to private tap showed absence (negative) of coliform bacteria at point of source, but the presence (positive) of the coliform bacteria was found at the consumption point (*Annex 4*). This means that both private and public water sources are said to be contaminated with coliform bacteria (*Table 12*). There is a great variation in number of E.coli bacteria - all above zero and the water of all the sources is not potable in terms of bacteriological point of view.

Chlorination is one of the best methods for water disinfection. In our water supply system its effectiveness is measured in terms of the concentration of free residual chlorine (FRC) present in the distribution system. The test result from the table shows that FRC is neither detected in the water samples collected from public nor from private taps.

Table 12. Water quality Analysis of drinking water

Parameter	Water source				WHO Guideline Values
	PVT TW n = 14	P TW n = 6	Well n = 3	ST Spout n = 2	
pH	6.5-8.2	6.5-7.5	7.5	7.5	6.5-8.5
Temp (°C)	13-18	12-15	15-18	15-18	25
Iron (mg/l)	ND-0.3	0.3	0.3	0.3	3
Chlorine mg/l	ND	ND	ND·	ND	0.2
Chloride mg/l	10-30	22-45	26-27	23-45	250
N-NH₄ (mg/l)	ND-0.2	0.2	0.2	0.2	0.04-0.4
PO₄ – P (mg/l)	0.1	0.1	0.1	0.1	0.4-5.0
Coliform bacteria (WS)	+/-	+	+	+	-
Coliform bacteria (CW)	+				-
E. coli cfu/100 ml	10-131	3-20	48-200	58	0

Note: WS = Water Source Points; CW = Consuming water, PVT TW = Private tube well,
P TW= Public tube well, ST Spout = Stone spout.

6.2 Factors of Contamination of Drinking Water

The above results of water quality show that all the water sources used by the communities are contaminated either at source points or at consumption points. Contamination at source points relates to community/public or private, whereas contamination at consumption points relates to private household. The field observation indicates that the factors responsible for contamination of drinking water at source points are lack of protection and proper treatment of source water, leakage in pipe distribution system,

Photo 4: Poor drainage around public tap

intermittent supply of water, poor drainage system and poor environment surroundings of the water sources. However, distance is not a factor of water contamination in the study region, as in other hill areas where people have to travel relatively longer distance to fetch water. All water sources lie within a relatively easy proximity (*Table 13*).

Table 13. Distance of water sources

Drinking water source	Distance of fetching water (in meter)								Total	
	<10		10-100		101-200		>200			
	No.	%	No.	%	No.	%	No.	%	No.	%
Well/spring	16	15	16	15		0	7	6	39	35
Public tap	15	14	26	24	11	10	5	5	57	52
Private tap	14	13		0		0		0	14	13
Total	45	41	42	38	11	10	12	11	110	100

Source: Field Survey (March 2003).

The contamination at consumption point within house is mainly due to lack of proper cleaning of water containers, personal habit, lack of awareness of cleanliness, etc.

6.3 Local Communities Managed Water Quality Sources

6.3.1 Practices of managing the drinking water sources

Information has been obtained from the sample households about the frequency of cleaning of the water sources. This includes the households using the public water sources. The households having private tap have been excluded.

Table 14: Cleaning of water sources

Water sources	Yes		No		Total
	No.	%	No.	%	
Well/spring	31	28	8	7	39
Public tap	57	52			57
Private tap			14	13	14
Total	88	80	22	20	110

When the information on regular cleaning of the water sources such as every month, every six-month and once a year was asked to the sample households, the results obtained show that majority of the households used to clean their water sources once a year, 88 out of 110 households fell into this category. This practice of regular cleaning of the public water sources can be related to the religious functions or occasions, for instance *Sithi Nakh* of the Newar communities. Other households with equal number used to clean their water sources every six-month or every month. A greater proportion of the households are used to clean the public tap (water tanks) than the traditional water sources, wells and stone spout (*Table 14*).

6.3.2 Perception of local communities toward water quality

Incidence of water borne diseases including diarrhoea is one of the basic health problems in the study area. The water pollution as perceived by the local communities is analysed in relation to literacy level. Table 15 lists the reasons of diarrhoea given by the sample households, which indicate that they are pretty aware with other causes of diarrhoea than contaminated water. Among the reasons, eating more food found to be the most important, whereas contaminated water has got the least weightage, 33.6% (*Table 15*). This means that local communities were not fully aware of the quality of drinking water. Eating in restaurant means foods served there are contaminated. While analysed it in relation to education level, there is not clear picture, which means all the households have the same perception. However, traditional belief still found to be one of the reasons of diarrhoea.

Table 15: Communities' perception of diarrhoeal disease

Reasons of diarrhoea disease	Education level perception (%)				Total		
	Illiterate	Literate	1-5 grade	6-10 grade	Of	Mf	CI (%)
Eating more food	73.9	62.5	87.5	83.3	83	110	75.5
Eating stale food	71.7	62.5	62.5	58.3	72	110	65.5
Eating in restaurant	56.5	62.5	87.5	62.5	70	110	63.6
Dirty surrounding	32.6	45.8	75.0	54.2	51	110	46.4
Traditional belief	37.0	66.7	50.0	41.7	51	110	46.4
Polluted air	23.9	62.5	62.5	58.3	50	110	45.5
Contaminated water	10.9	33.3	68.8	54.2	37	110	33.6
Of	141	95	79	99	414	770	53.8
Sample size (n)	46	24	16	24	110		
Mf	322	168	112	168	770		
CI	43.8	56.5	70.5	58.9	53.8		

Note: Of = Observed frequency, Mf = Maximum possible frequency, CI = Cumulative index.

6.3.4 Status of common diseases in Bungamati VDC

The settlement localities of Bungamati VDC are prone to different common diseases related to water and others. The top ten common diseases and their related attendant patients recorded in the Bungamati Health Post for the whole part of Bungamati VDC are shown in table 16. Information of detailed diseases related to each major type is given in *Annex 2*.

Skin disease is the most common disease in Bungamati VDC. Of the total 2,554 out patient visits recorded at the health post, nearly one-fourth of the total patients have been affected by this disease. The second most important disease related to ARI (acute respiratory infection). Although the incidence of diarrhoeal disease, which is directly related to the consumption of contaminated water, occupies the fourth position among the health post visited patients, some of the other diseases listed in the table are indirectly related to water.

Table 16. List of top ten diseases based on patient visit record, Bungamati

CD code	Type of disease	Rank	Patient Number	Per cent
23	Skin disease	I	624	24.4
24	ARI	II	336	13.2
37	Falls/Injuries/fractures	III	313	12.3
14	Diarrhoeal disease	IV	199	7.8
15	Intestine worms	V	188	7.4
34	Gastritis	VI	177	6.9
39	Toothache and other mouth complains	VII	132	5.2
44	Others	VIII	80	3.1
20	Avitaminoses and other nutrition deficiency	IX	75	2.9
25	Ear Infection	X	67	2.6
	Total		2191	85.8

Source: Bungamati Health Post Record 2002/2003.

The pattern of incidence of the common diseases is varied remarkably in different months of a year. On the whole, there is higher incidence of patients' visits during the month of February than other months. In case of diarrhoea disease, May, which is just before beginning of the summer rainfall, is the crucial month. Incidence of diarrhoea disease is the least in the month of October. The pattern of incidence of the common diseases in all months of the year shown in figure 3 has health planning implications.

Fig. 3: Number of Patients' Visits Bungamati VDC 2002
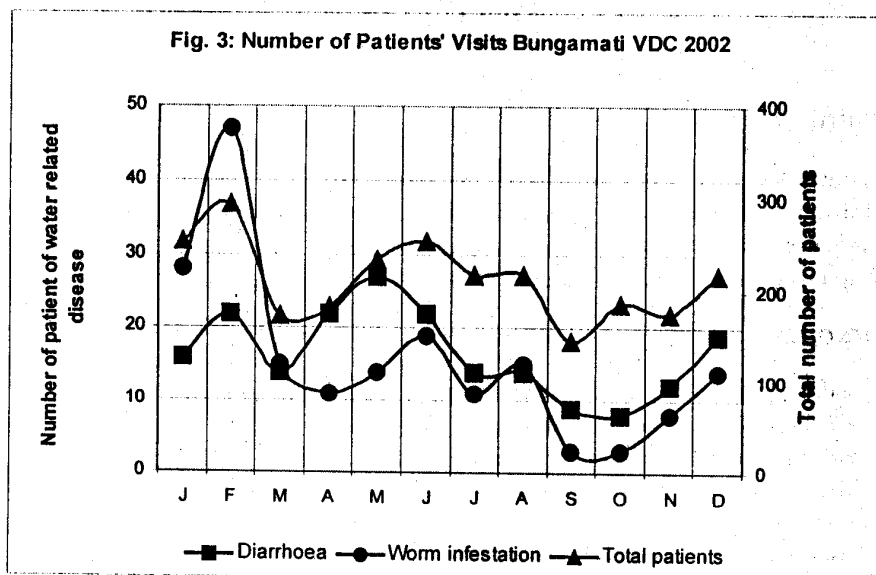
According to the opinion of the sample households, incidence of diarrhoea found to be the highest, 57 percent of the sample households have responded to it (*Table 17*). The second most health problem is the cold and cough related to respiratory disease. Incidence of 6 common diseases as reported by the sample households varies among the three localities.

Table 17: The communities' response of common diseases (in percent)

Diseases	Bungmati (n = 72)	Chundevi (n = 23)	Phasidol (n = 15)	Total	
				No.	%
1. Skin	11.1	-	-	8	7.3
2. Cold and cough	2.8	30.4	40.0	15	13.6
3. Acute respiratory infection	11.1	-	6.7	9	8.2
4. Diarrhoea	65.3	69.6	6.7	64	58.2
5. Worm infection	6.9	-	26.7	9	8.2
6. Anaemia	2.8	-	20.0	5	4.5
Total	100	100	100	110	100

Source: Field survey

Chapter 7

Sanitation Status and Awareness

7.1 Sanitation Status

Environmental sanitation is essential to promote health and prevent diseases. It can be explained in terms of provision of adequate amount of potable water, disposal of wastes, air hygiene, safeguarding of food, etc. In the present study, personal hygiene, toilet facilities and surrounding environment are considered to describe the environmental sanitation.

7.1.1 Personal hygiene

The personal hygiene is explained in terms of frequency of bathing and washing cloths. It is noted above that not all local communities do have potable water and private connection to pipe water. As majority of the households have to depend on the common sources for water, which are also in few locations and the water supply from them is not sufficient all the year round, nearly 79 per cent and 93 per cent of the households found to have practiced bathing and washing cloths once a week respectively (*Table 18*). This means the personal hygiene in terms of bathing and washing cloths is poor, which can be related to skin disease.

Table 18: Households' practices of bathing and washing

Practice	Bathing		Cloths washing	
	No.	%	No.	%
Every day	16	14	8	7.3
One alternate day	8	7	-	0
Once a week	86	79	102	92.7
Total	110	100	110	100

Reasons of skin disease given by the respondents are shown in table 19 The values shown in the table are relative percentiles derived from the number of respondents to each reason with respect to total sample size of each locality. Among the various regions, religious belief found to be the most important cause of skin disease and they were more pronounced in Phasidol and Chundevi (*Table 19*). Other important reasons include personal hygiene and expose to polluted outdoor locale.

Table 19. Communities' perception of skin disease

Reasons of skin disease	Percentile of respondents by locality			Total		
	Bungamati	Chundevi	Phasidol	Of	Mf	CI (%)
Religious belief (snake god)	55.6	87.0	93.3	74	110	67.3
Bathing by dirty water	55.6	60.9	40.0	60	110	54.5
Not regular bathing	41.7	43.5	86.7	53	110	48.2
Dirty surrounding	34.7	60.9	66.7	49	110	44.5
Playing in dust and dirt	27.8	65.2	80.0	47	110	42.7
Swimming in river	41.7	34.8	53.3	46	110	41.8
Not frequent changing clothes	13.9	78.3	-	28	110	25.5
Others *	13.9	21.7	46.7	22	110	20.0
Drinking contaminated water	13.9	17.4	-	14	110	12.7
Bathing by well water	6.9	-	-	5	110	4.5
Of	220	108	70	398		
Sample size (n)	72	23	15	110		-
Mf	720	230	150	1100	1100	36.2
CI	30.6	47.0	46.7	36.2		-

*Working in field in water

7.1.2 Toilets use

Toilet use is an indicator of sanitation condition in rural Nepal. In the study region, 71 out of 110 total sample households (65%) have accessed to latrine facilities *(Table 20)* There are two types of latrine, viz. pit and water seal. The maintenance of toilets can be related to the supply of water, housing density and space, practice, etc. The sanitation condition of the toilets is on the whole poor. First, not all sample households do have toilets and those, who do not have toilets, have to go to nearby open field. The condition of toilets is also not so clean and hygienic due to shortage of water.

Table 21 shows that majority of small landholding households do not have toilets.

Table 20 Latrine types by household

Types of latrine	Number	Per cent
1. Pit	21	29.6
2. Water seal	50	70.4
Total	71	100

Table 21: Household types with latrine

Agriculture land	House with latrine		Total
	Yes	No	
Low	24	24	48
Medium	24	7	31
High	23	8	31
Total	71	39	110

Source: Field Survey

7.1.3 Waste disposal

As already noted above, Bungamati locality has its major streets being paved with bricks and there are garbage collection baskets at major streets with the initiation of local effort. Being agricultural villages, collection and management of waste disposals are indeed not a serious problem, as the organic wastes are being used as manure in the farm fields. Table 22 shows that 94 out of 110 households have used manure pit for the disposal of their wastes. The rest households have used containers (particularly in Bungamati locality) and nearby open places for the wastes. There is no significant relationship between the households with landholding size and practice of waster disposal. This

Photo 5: Condition of water seal toilet

has been examined with the chi-square test such as χ^2_{tv} (table value) = 5.99; P (probability) =0.05; χ^2_{cv} (calculated value) = 0.08; df (degree of freedom) = 2.

Table 22 Places of household waste disposal by the household

Agriculture land (ropani)	Waste disposal				Total	
	Manure pit		Other*			
	No.	%	No.	%	No.	%
< 5	42	87.5	6	12.5	48	43.6
5 - 10	29	93.5	2	6.5	31	28.2
> 10	23	74.2	8	25.8	31	28.2
Total	94	85.5	16	14.5	110	100

* Common place, near house and common container

7.2 Sanitation Awareness

The local communities' awareness toward sanitation is analysed in terms of their practices. As already noted above that 39 households did not have toilet and therefore they used nearby fields for defecation. Information from them was obtained about the reasons for not having toilet (*Table 23*). The reasons include preferring open field, bad smell of toilet and lack of money. The first two reasons can be related to lack of awareness, whereas the last one is due to poverty. While the chi-square test is used to examine the relationship between the households with different

Photo 6: Locales' initiated garbage container

landholding size and reasons for not having latrine, the result is found not significant at P =0.05 with $\chi^2_{tv} = 9.4$; $\chi^2_{cv} = 0.03$; and df = 4.

Table 23: Reasons for not having latrine

Agriculture land (ropani)	Reasons			Total
	Prefer open field	Bad smell	No money	
< 5	8	2	14	24
5 - 10	4	2	1	7
> 10	3	4	1	8
Total	15	8	16	39

Source: Field Survey (March 2003).

Secondly, information on places for defecation was also obtained from the households. Nearby open field and riverbank are two major places used by the communities for defecation. Thirty-one out of 39 households have used open field for defecation (*Table 24*). There is no significant relationship between the households with landholding size and places of defecation ($\chi^2_{tv} = 5.9$; P =0.05; $\chi^2_{cv} = 0.84$; df = 2).

Table 24: Place for defecation

Agriculture land (ropani)	Place for defecation		Total
	Open field	River bank	
< 5	19	4	23
5 - 10	6	2	8
> 10	6	2	8
Total	31	8	39

Source: Field Survey (March 2003).

Thirdly, information has been sought on hand washing practices after defecation. Four different hand-washing practices after defecation such as soap, ash, water and soil with varying magnitudes are found (*Table 25*). It is encouraging to note that majority of the households (36%) have used soap after defecation. Using ash after defecation that accounts for second position is also encouraging. Hand-washing practices of water and soil after defecation combining together represent 35%, which is yet at large that requires education programme. The chi-square test has not shown significant between the households with

landholding size and means of hand washing practice after defecation (χ^2_{tv} = 12.59; P =0.05; χ^2_{cv} = 0.00001; df = 6).

Table 25: Hand washing practices after defecation by economic status

Agriculture land (ropani)	Means of hand washing practice after defecation								Total
	Soap		Ash		Water		Soil		
	No.	%	No.	%	No.	%	No.	%	
< 5	6	38	2	13	4	25	4	25	16
5 - 10	16	25	25	40	15	24	7	11	63
> 10	17	55	4	13	5	16	5	16	31
Total No.	39		31		24		16		110
%	36		29		21		14		100

Source: Field Survey (March 2003).

A large number of the households who have used soap after defecation belong to Bungamati locality, which may be due to urbanism. However, there are other households of Bungamati locality also who use other three hand-washing practices. Majority of the sample households of Phasidol have used water and soil, whereas a large proportion of the sample households of Chundevi have used ash after defecation (*Table 26*). Several water borne diseases may occur due to hand-washing practices of water and soil after defecation. Besides lack of awareness, poverty can also be considered for using the latter two hand-washing practices. The means of hand washing practices after defecation do not relate with the localities significantly (χ^2_{tv} = 12.59; P = 0.05; χ^2_{cv} = 0.025; df = 6).

Table 26: Hand washing practice after defecation

Name of locality	Means of hand washing practice after defecation								Total	
	Soap		Ash		Water		Soil			
	No.	%	No.	%	No.	%	No.	%	No.	%
Bungmati	36	50	12	17	14	19	10	8	72	65
Chundevi	2	9	16	70	4	17	1	1	23	21
Phasidol	1	7	3	20	6	40	5	4	15	14
Total	39		31	28	24	22	16	12	110	100
%	35		28		22		15		100	

Source: Field Survey (March 2003).

Lastly, information from the households was sought on the practice of using slipper or shoes while go out or for toilet. This can be related to health hygiene. Diseases such as worm infection from the soil or dirty floor may occur due to bare foot walking. Only half of the sample households have used always slipper or shoes for outings or for toilet and another halves have used slipper sometimes (*Table 27*). Again, two major factors such as lack of awareness and poverty can be considered in this regard. Even some of the households belong to high economic status group have used slipper sometimes, which may be due to lack of awareness.

Table 27: Practice of using slipper/shoes

Agriculture land (ropani)	Slipper/shoes use		Total
	Always	Sometime	
< 5	8	8	16
5 - 10	24	39	63
> 10	24	8	31
Total	55	55	110

Source: Field Survey (March 2003).

7.2.1 Sharing of the study results and dissemination of water disinfection method

As stated above, the water consumed by the communities is contaminated with the bacteria and that the sample households are found quite unaware with the quality of drinking water they consume. Besides other objectives, this study has intended to share the results of water and sanitation and demonstrate one of the disinfection methods of drinking water to the communities[1], as an action-oriented objective. The sharing of the findings and dissemination of the disinfection method among the small groups was followed the steps given below:

(i)   The finding of the water quality and sanitation
(ii)   The state of the top ten diseases for Bungamati VDC obtained from the Bungamati Health Post
(iii)   Description of the causes of contamination of water and water borne diseases as observed in the villages
(iv)   The method of disinfection of drinking water or bacteria free drinking water

Below is a description of the disinfection method. Meanwhile, leaflet of the disinfection method was given to the households.

The disinfection method demonstrated is SODIS – Solar Disinfection. SODIS is a simple method, which can easily be handled by a villager at home. The cost is only for bottles, which is usually within the capacity of the general rural people. The method is environmental friendly. It requires sunshine and plastic mineral water bottle, which is also called as polyethylene terephtalate (PET) bottle. The method is that it uses sunlight to provide heat and ultraviolet radiation to inactivate the bacteria in the water of the bottle, thus making the water safe for drinking. However, one has to be careful while using this method, such as bottle type, bottle placement, sun exposure time, and handling practice of the water after treated.

SODIS is nowadays becoming popular. The Department of Water Supply and Sewerage (DWSS) and UNICEF have jointly initiated SODIS in Nepal. The effectiveness of SODIS has been tested in different geographical locations, seasons and with various technical options such as different types of bottles, different supporting materials in Nepal[2]. The results of field trial of SODIS at various places are found encouraging. The water of the bottles after the application of this method shows that over 99% of faecal bacteria is found to be removed in most cases. Only on fully cloudy days, the removal rate is found to be low, but still above 90%. In such case, the SODIS bottle needs to be exposed for 2 days in the sunlight.

The IEC materials of SODIS have been used to demonstrate it among the communities of the localities. The steps were followed according to what written in the leaflet (*Annex 7*).

---

[1] It was stated in the proposal that demonstration of disinfection method would be performed among the communities at different locations of the study region. As gathering of local people at places was not possible due to fear of Maoist insurgency, demonstration of the method was performed among small groups of the inhabitants of the study region.

[2] The Federal Institute of Environmental Science and Technology (EAWAG/SANDEC), Switzerland has supported DWSS to introduce this method in Nepal in 2001. The Environmental and Public Health Organization (ENPHO) has since that year been involved to disseminate the method. Other organizations like Clean Energy Nepal (CEN), Global Research Institute and Department of Community Medicine and Family Health, Institute of Medicine, Tribhuvan University are also involved in promoting its use in the communities.

Chapter 8

Summary, Conclusions and Recommendations

8.1 Summary

o This study has covered 110 sample households from three settlement localities such as Bungmati, Chundevi and Phasidol of Bungamati VDC. In spatial-social terms, Bungamati locality is a compact settlement with the domination of Newars; Chundevi is characterized by dispersed settlements consisting of mainly Bahun and Chhetri; and Phasidol comprises mainly Tamang communities residing in agglomeration form of settlement. A considerable proportion (nearly 43%) of the total sample households are illiterate, which includes all sample Tamang and some of other household heads.

o Agriculture as the main economic activity of majority of the households. Besides, trading occupation belongs mainly to the Newars. Majority of the sample households are small farmers with landholding size below 5 ropani, consisting of both Khet and Bari. The former is much more productive and valuable than the latter. The farm households raise livestock such as cow, buffalo and sheep. The sample households is identified as three classes such as low, medium and high in terms of the households owning below 5 ropani, 5-10 ropani, and over 10 ropani respectively.

o The three localities have different water sources, including 5 wells, 2 stone spouts, 5 ponds, 2 rivers, 6 public taps and few private connections of piped water. The inhabitants use the water of wells, stone spouts, and taps for drinking, cooking, washing cloths and bathing, whereas the water of ponds and rivers for washing cloths and bathing. Using of the well water has diminished in recent years due to coming up of pipe water system. The people of Bungamati locality use particularly the Nakhu River for washing clothes and bathing during the dry season when there is inadequate water supply in the pipe water system. Bungamati locality has three types of drinking water sources, well/stone spout, public tap and private tap. The inhabitants of Chundevi and Phasidol use well water for drinking and other domestic purposes.

o The quality of the drinking water is tested for 25 sample sites. The results of all physical and chemical parameters of the sample water sources lie within WHO guideline. But the bacteriological parameters such as coliform bacteria and E.coli show the values above the WHO guidelines. So, the water of all sources is not potable in terms of bacteriological point of view.

o The water used by the communities is found contaminated either at source points or at consumption points. The factors responsible for the contamination of water at source points include lack of protection and proper treatment of water sources, leakage in pipe distribution system, intermittent supply of water, poor drainage system and dirty environment at surroundings of the water sources. The contamination at consumption point within house is mainly due to lack of proper cleaning of water containers.

o Majority of the households are used to clean their water sources once a year, 88 out of 110 households fell into this category. This practice of regular yearly cleaning of the public water sources can be related to the religious functions or occasions. Other

households are used to clean their water sources every six-month or every month. A greater proportion of the households are used to clean the public tap (water tanks) than the traditional water sources such as wells and stone spout.

o Incidence of water borne diseases including diarrhoea is one of the basic health problems in the study area. The sample households are pretty aware with other causes than contaminated water of diarrhoea. The results show that eating more food is the most important, whereas contaminated water is the least. This means that local communities are not fully aware of the quality of drinking water. Eating in restaurant means foods served there are contaminated. There is not clear picture between education status and reasons of diarrhoea. In other words, all sample households have more or less the same perception toward reasons of diarrhoea.

o Bungamati VDC is prone to different common diseases related to water and others. Among the top ten diseases, skin disease is the most common disease. Nearly one-fourth of the total outpatient visits at the health post have been affected by this disease. The second most important disease is ARI. The incidence of diarrhoeal disease has occupied the fourth position. However, this result is quite different in case of sample households, in which diarrhoea is the most acute problem, followed it by cold and cough related to respiratory disease. May is the month for having highest incidence of diarrhoea disease.

o The cleaning of the drinking water sources by the local communities is ineffective because the water is still found contaminated.

o Environmental sanitation is essential to promote health and prevent diseases. The personal hygiene is explained in terms of frequency of bathing and washing cloths. As majority of the households have to depend on the common sources for water, which are also in few locations and the water supply from them is not sufficient all the year round, majority of the households found to have practiced bathing and washing cloths once a week. This means the personal hygiene in terms of bathing and washing cloths is poor. In case of toilet use, 71 out of 110 total sample households have access to latrine facilities. The condition of toilets is not so clean and hygienic due to shortage of water. With regard to solid waste management, Bungamati locality has its major streets being paved with bricks contains few garbage collection baskets. Being agricultural villages, collection and management of waste disposals are indeed not a serious problem, as the organic wastes are being used as manure in the farm fields. The household survey shows that 94 out of 110 households have used manure pit for the disposal of their wastes. The rest households have used containers (particularly in Bungamati locality) and nearby open places for the wastes.

o The local communities' awareness toward sanitation is as follows: First, 39 sample households do not have toilet and therefore they have used nearby fields for defecation. The reasons for not using toilets include preferring open field, bad smell of toilet and lack of money. The first two reasons can be related to lack of awareness, whereas the last one is due to poverty. Secondly, the communities have used nearby open field and riverbank for defecation. Thirty-one of the 39 households have used open field for defecation. This is the main reason of polluting water and other environment. Thirdly, majority of the households ($\approx$36%) have used soap after defecation. To use ash after defecation, which occupies second position, is also encouraging. The households with hand-washing practices just with water and soil after defecation represent $\approx$36%, which is yet at large that requires education programme. The majority of households (50%) who have used soap after defecation belong to Bungamati locality and less than 10% from other two

localities. Lastly, half of the sample households have always used slipper or shoes while go out including toilet, whereas the rest halves have used slipper sometimes. Diseases such as soil transmitted Helminthiases especially hookworm infestation occur due to bare foot walking. Lack of awareness and poverty can be considered as two major causes of poor environmental sanitation and personal hygiene.

8.2 Conclusions

o The three localities -Bungamati, Chundevi and Phasidol- of Bungamati VDC considered for this study present quite typical in terms of spatial, social and economic phenomena. Spatially, Bungamati is composed of compactly built houses and streets; Chundevi consists of dispersed settlement and Phasidol comprises agglomeration pattern. Socially, the Newars dominate in Bungamati, whereas the Bahuns and Chhetris and the Tamangs are in majority in Chundevi and Phasidol respectively. Majority of the sample households are illiterate. The subsistence-based agriculture is the main occupation and the majority of the households are small farmers with landholding size below 5 ropani. In Bungamati, a combination of trading and agriculture is the occupation of majority households.

o The communities of the study region depend on locally available different water sources. The traditional water sources including stone spout, well, pond and stream are still important for supplying water for drinking and other purposes, because the water from the public tap is not adequate.

o The quality of the water used by the communities in terms of physical and chemical parameters is found lying within WHO guideline, whereas the bacteriological parameters such as coliform bacteria and E.coli show the values above the WHO guidelines. So, the water of all sources is not potable in terms of bacteriological point of view. The contamination of the water at source points is due to lack of protection and proper treatment of source water, leakage in pipe distribution system, intermittent supply of water, poor drainage system and dirty environment at surroundings of the water sources. The contamination in house is due to the lack of proper cleaning of water containers. Being agricultural villages, collection and management of waste disposals are indeed not a serious problem, as the organic wastes are being used as manure in the farm fields.

o As a result of consumption of the contaminated water, incidence of diarrhoea appears to be the most acute problem among the sample households in the study region. It is found more acute during the dry summer months. Yet, majority of the households are not aware with the real cause of water contamination due to lack of education.

o The communities' perception toward environmental sanitation and personal hygiene is very poor. Inadequate supply and poor quality of drinking water are major causes of poor personal hygiene and environmental sanitation. Majority of the households are used to take bathing and washing cloths once a weak. Not all households do have latrine in their house. Open defecation at nearby field or on the riverbank is the only option for the households with no toilets. This causes surrounding environments polluted. The reasons for not having toilets include preferring open field, bad smell of toilet and lack of money. Yet, over one-third of the sample households have used hand-washing practices of water and soil after defecation, which may cause water borne diseases. Not all households do have practice of using slipper or shoes while go out including toilet. Diseases such as soil transmitted Helminthiases especially hookworm infestation from the soil may occur due

to bare foot walking. Lack of awareness and poverty are considered for such poor environmental sanitation and personal hygiene.

o On the whole, Bungamati locality is relatively better in environmental sanitation and personal hygiene than other two localities. However, if open defecation is controlled, the outlying villages such as Chundevi and Phasidol will be much better for living due to their open surroundings. For all, pipe water supply system is a major problem both in terms of quality and quantity. Conservation and management of the natural water sources would be the best option for regular supply of water to the communities, at least for some years unless the protected water supply system such as pipe is provided covering all villages of the Bungamati VDC. Massive awareness program to the local communities is warranted for improving both environmental sanitation and personal hygienic behaviour.

8.3 Recommendations

Based on the observation and study findings, the followings are the suggested recommendations for improving water quality, health and environmental sanitation.

o Number of public taps should be increased to covering all villages of Bungamati VDC. If this is not possible in near future, then proper conservation and management of locally available natural water sources should be made immediately through effective measures by the concerned agencies. Local communities should be involved actively in this regard.

o Quality of water both at sources and in house is contaminated. Regular monitoring of water quality at frequent intervals is essential. This activity requires involving of local communities. The awareness programmes toward conservation of surrounding environment and personal hygiene to the local communities through local NGOs currently concentrated in Bungamati locality only should be made more effective and expanded in other areas of the VDC by the concerned agencies.

o Open defecation habit must be controlled through making available affordable scheme to the communities for construction of toilets adaptable to the local condition. If private latrine is not possible for the households without toilets, common toilet system should be constructed. Defecation of the communities should be thought as energy source rather than waste. If biogas attached toilet is provided, this will not provide energy for cooking or lighting, but also protect health from soil transmitted as well as water borne diseases. The scheme will attract people to use toilets whenever they need, because it is tied with energy output.

o SODIS appears to be appropriate as well as effective method of water disinfection. It is affordable by the local communities. The concerned agencies such as department of health services should intervene this method into the communities under the health and sanitation package through involving local communities. As quality of water is directly related to health and hygiene, the health sector should think about it in its health service programme.

REFERENCE

ADB (1985), *Nepal Water Supply and Sanitation Sector Profile*. Manila: Asian Development Bank.

Adhikari, R., S. K. Rai, B. M. Pokharel and J. B. Khadka (1986), Bacterial study of drinking water of Kathmandu Valley. *Journal of Institute of Medicine*, 8 (3): 313-316.

APHA-AWWA-WEF (1995), *Standard methods for the examination of water and wastewater.* 19th edition Washington, DC

CBS, (2001), *Statistical Year Book of Nepal.* Kathmandu: Central Bureau of Statistics.

CBS, (1999), *Statistical Year Book of Nepal.* Kathmandu: Central Bureau of Statistics.

CEMAT (2000), *Report on Surface Water Quality Monitoring Works of Kathmandu Valley,* Urban Water Supply Reforms in the Kathmandu Valley Project, Kathmandu.

CEMAT (1999), *Report on Groundwater Monitoring Works of Kathmandu Valley,* Urban Water Supply Reforms in the Kathmandu Valley Project, Kathmandu.

Devkota, S.R. and Neupane, C.P. (1994), *Industrial Pollution Inventory of the Kathmandu Valley and Nepal.* Industrial Pollution Control Management Project, HMG/MOI/UNIDO/ 91029, Kathmandu.

DISVI (1990), *Water Quality Assessment in Terai Tube well Project.* Kathmandu: Health Education and Service Project.

DOHS (1999), *Annual Report 1998/99,* Kathmandu: Department of Health Services.

ENPHO/DISVI (1990), *Water Quality of Stone Taps (Kathmandu City).* Kathmandu: Environment and Public Health Organisation and DISVI.

ENPHO (1996), *Report on the Water Source Monitoring Program for the Shivapuri Watershed by Assessing Water Quality* (First Phase), Kathmandu: Environment and Public Health Organisation (ENPHO).

ENPHO (1999), *Monitoring of Groundwater Quality in the Kathmandu Valley,* Kathmandu: ENPHO

Hanushek, Eric A. and John E. Jackson (1977), *Statistical Methods for Social Scientists.* New York: Academic Press.

IUCN (1991), *Environmental Pollution in Nepal: A Review of Studies,* Kathmandu: IUCN/NPC.

Jha, M. G. et al (1997), *The Assessment of Groundwater Pollution in the Kathmandu Valley, Nepal,* Kathmandu: Department of Irrigation/Australian Geological Survey Organisation.

MHPP (1998), *National Water Supply Sector Policy* (Policies & Strategies), Kathmandu: Ministry of Housing & Physical Planning, His Majesty's Government of Nepal.

MOF (2001), *Economic Survey 2000-2001.* Kathmandu: HMG/Ministry of finance.

MOPE (2001), *Nepal: State of Environment Report 2001.* Kathmandu: UNEP, ICIMOD, MOPE, SACEP and NORAD

NPC (1998), *The Ninth Plan (1997-2002),* Kathmandu: National Planning Commission (NPC), His Majesty's Government of Nepal,

Palikhe, B. R. (1999), *Pesticide Management in Nepal: Implementation Issues and Experiences, Workshop on Present Environmental Challenges and Management of Pesticides, Chemical Fertilizer and Solid Waste,* October 3-4, 1999, SEJ Nepal, Kathmandu.

Poudel, S. N. (1998), Responses to Water Related Problems, *A Compendium on Environmental Statistics,* Kathmandu: Central Bureau of Statistics.

Pradhan, B., Sherchand J., Shrestha MP, Pradhanang S. (1995), Water Quality and People' Knowledge about Water-related Diseases: the case of Kirtipur locality, Kathmandu, Nepal, *Journal of the Institute of Medicine.*17: 26-31.

Pradhan, B. (1998), *Water Quality Assessment of the Bagmati River and its Tributaries, Kathmandu Valley, Nepal,* Ph.D. Dissertation, Department of Hydrobiology, Institute of Water Provision, Water Ecology and Waste Management, BOKU University, Vienna, Austria.

Pradhan, B. (2000), *Drinking Water Quality in Kathmandu Valley, Nepal.* Health Prospect New Vision for New Century, Vol. 2. No. 2.

Pradhan, B. (1999), Water Quality Analysis of the Bagmati River and its Tributaries in Kathmandu Valley Using Bacterial and Saprobic Measures. *Proceeding of III National Conference on Science and Technology.* March 8 – 11. Kathmandu: RONAST

Pradhan, PK (2000), Urban Growth Pattern and Food Security in Kathmandu Valley, A Paper Presented in the *Workshop on Integrative Strategies for Food Security Improvements in the Kathmandu Valley,* Kathmandu: April 30-May1.

Sharma, A P (1978), The quality of drinking water in Kathmandu. *Journal of Institute of Science.*Vol.11: 15-22.

UNICEF (1987), *Children and Women of Nepal: A Situation Analysis.* Kathmandu: UNICEF

Annexes

Annex 1: Method of Sample Processing and Analysis

Parameter	Optimum storage time	Methodology	Reference
Turbidity	Within a few days	Nephelometrically	Standard Method*
pH	Immediately	PH meter	Standard Method
Temp (°C)	Immediately	Thermometer	Standard Method
Iron (mg/l)	Within a few days	ENPHO test kit	
Chlorine mg/l	Immediately	Orthotoliden	Standard Method
Total hardness (mg/l)	Immediately	Titrimetric (EDTA)	Standard Method
Chloride (mg/l)	Desirable time	Silver nitrate	Standard Method
N-NH$_4$ (mg/l)	Same day	Colorimetric	Standard Method
PO$_4$ –P (mg/l)	Same day	Ascorbic acid	Standard Method
Floride mg/l	Within a few days	ENPHO test kit	
E.coli cfu/100 ml	Same day	Membrane filter technique	Standard Method

* APHA-AWWA-WEF (1995), *Standard methods for the examination of water and wastewater*. 19th edition Washington, DC

Annex 2 Physical, bacteriological and chemical results of sample drinking water sources

Sample sites	Date (2003)	Type of water source	pH	Temp (°C)	Iron (mg/l)	Chlorine mg/l	Total hardness (mg/l)	Chloride (mg/l)	N-NH₄ (mg/l)	PO₄–P (mg/l)	Floride mg/l	± test WS	± test CW	E.coli cfu/100 ml
1	Jan 5	TPr-Bu	6.5	15	ND	ND	18	10	ND	0.1	1.5	+		10
2	Jan 5	TPr-Bu	6.5	14	0.3	ND	10	24	ND	0.1	1.5	-	+	12
3	Jan 5	TPr-Bu	6.5	15	0.3	ND	37	20	0.2	0.1	1.5	+		5
4	Jan 5	TPr-Bu	6.5	14	0.3	ND	9	15	ND	0.1	1.5	+*	+*	40
5	Jan 7	TPr-Bu	7.5	15	0.3	ND	12	24	0.2	0.1	0		+*	102
6	Jan 7	TPr-Bu	6.5	15	0.3	ND	8	28	0.2	0.1	15	-	+	10
7	Jan 7	TPr-Bu	6.5	18	0.3	ND	19	30	0.2	0.1	1.5	+		8
8	Jan 9	TPr-Bu	8.2	13	0.3	ND	16	13	0.2	0.1	1.5	-	+	131
9	Jan 9	TPu-Bu	6.8	15	0.3	ND	16	32	0.2	0.1	1.5	+		5
10	Jan 9	TPu-Bu	6.5	15	0.3	ND	18	26	0.2	0.1	1.5	+		20
11	Jan 9	TPu-Bu	7.0	12	0.3	ND	19	45	0.2	0.1	1.5	+		2
12	Jan 9	TPu-Bu	6.5	15	0.3	ND	15	23	0.2	0.1	1.5	+		5
13	Jan 9	TPu-Bu	6.5	14	0.3	ND	12	22	0.2	0.1	1.5	+		7
14	Jan 9	TPu-Bu	7.5	15	0.3	ND	15	27	0.2	0.1	1.5	+		3
15	Feb 8	W-Bu	7.5	15	0.3	ND	20	26	0.2	0.1	1.5	+		48
16	Feb8	Ss-Bu	7.5	15	0.3	ND	30	45	0.2	0.1	1.5	+		58
17	Feb 8	Ss-Bu	7.5	18	0.3	ND	35	23	0.2	0.1	1.5	+		120
18	Feb8	TPr-Bu	7.5	15	0.3	ND	20	22	0.2	0.1	1.5	+		140
19	Feb 8	W-Ch	7.5	18	0.3	ND	230	27	0.2	0.1	1.5	+		200
20	Feb8	SS-Ph	7.5	15	0.3	ND	25	30	0.2	0.1	1.5	+		140
WHO GV			6.5-8.5	12-25	3.0	0.2	500	250	0.04-0.4	0.4-5.0	1.5	-	-	0

Note: WS = Water Source Points; CW = Consuming water.
W-Bu = Well Bungamati, TPu-Bu = Public tap Bungamati, TPr-Bu = Private tap Bungamati, Ss-Bu = stone spout Bungamati, Well Chundevi, SS-Ph.= Stone spout Phasidol
*Water sample from only from consumption point because water was not running from the tap.

Annex 3: QUESTIONNAIRE

Date of Interview: | 2058 | | | Name of Interviewer: | |

<u>Respondent</u> | Household head of the sample household

Use tick mark (✔) on the appropriate answer box or write down meaningful word(s) in the blank space

VDC/Municipality: | | Ward No: ☐ Village/Tole: | |

Serial No: | | Respondent's Surname | | Age | |

Ethnicity:

Brahmin/ Chhetri	Newar	Magar/ Gurung	Tharu	Scheduled Castes	Others

Religion:

Hindu	Buddhist	Muslim	Christian	Others, specify

Educational Status:

Illiterate	Literate	1 to 5 Grade	6 to 10 Grade	Above10 Grade

Occupation:

Agriculture	Business	Civil Servant	Labour	Student	Housewife	If other, specify

Economic Status of the Family (*Based on given criteria*): | Low | | Medium | | High |

Q. No. 1 Do you have your own house?

  (a) Yes ☐   Area ☐   (b) No ☐

Q. No. 2 Do you have your own agriculture land?

  (a) Yes ☐ *<u>continue</u>   (b) No ☐ *"<u>go to Q.No. 4</u>

Q. No. 3 How much land do you have for agriculture activity?

  (a) < 5 ropani ☐ (b) 5 - 10 ropani ☐ (c) > 10 ropani ☐

Q. No. 4 Do you have livestock?

(a) Yes ☐ *continue   (b) No ☐ *"go to Q.No. 5

Q. No. 4 How many livestock do you have?

(a) One ☐ (b) < 5 ☐   (c) <10 ☐ (d) >10 ☐

Q. No. 5 Do you sell livestock/product?

(a) Yes ☐   *continue   (b) No ☐   *"go to Q.No. 7"

Q. No.6 How many/much do you sells? Please write in appropriate cell.

Type	Number/ Quantity
Cattle	
Buffalo	
Goat	
Chicken	
Milk	
Others	

Q. No. 7 If you are a civil servant, what is your post?

Q. No. 8 How many members of your family have job? ☐

Q. No. 9   Do you have a latrine in your house?

(a) Yes ☐ *continue   (b) No ☐ *"Go to Q. No. 12"

Q. No. 10 What type of latrine do you have?

(a) Pit -latrine ☐   (b) Water seal latrine ☐   (c) Other (specify)

Q. No. 11 Could you give me the reason for not making a latrine?

(a) Prefer to go to open field ☐
(b) Bad smell ☐
(c) No space ☐
(d) No money ☐
(e) Other (specify)

Q. No. 12 Where do you usually go for defecation?

    (a) Open field   ☐

    (b) Riverbank   ☐

    (c) Common (public) toilet ☐

    (d) Other (specify) ☐

Q. No. 13 Do you clean your hands after defecation?

    (a) Yes ☐ *"Continue   (b) No ☐ *"Go to Q. No. 15"

Q. No. 14 what do you use for cleaning your hand after defecation?

    (a) Soap ☐   (b) Ash ☐   (c) Water ☐

    (d) Soil ☐   (e) Others (specify)

Q. No. 15 When do you use shoes or slipper?

    (a) Never ☐

    (b) For defecation only ☐

    (c) Always ☐

    (d) Other (specify) ☐

Q. No. 16 Where do you dispose your household wastes?

    (a) Manure pit ☐   (b) Nearby house ☐

    (c) Nearby stream ☐   (d) In the container ☐

    (e) On the street ☐   (f) Others (specify) ☐

Q. No. 17 What is the source of drinking water?

    (a) Public well/spring ☐   (b) Public tap ☐

    (c) Stream ☐   (d) Private tap ☐   (e) Pond ☐ (f) Other (specify) ☐

Q. No. 18 Do you have regular program of cleaning your water source?

    (a) Yes ☐ *"Continue   (b) No ☐ *"Go to Q. No. 20"

. No. 19 How often do you have program of cleaning your water source?

    (a) Every three month ☐   (b) Every six month ☐   (c) Once a year ☐
    (d) Whenever look dirty ☐

Q. No. 20 Do you have enough water for domestic activities?

    a) Enough ☐   (b) Not enough ☐

Q. No. 21 How frequent do you take bathes?

(a) Every day □   (b) One alternate day □   (c) Once a week □

Q. No. 22 How frequent do you clean your clothes?

(a) Every day □   (b) One alternate day □   (c) Once a week □

Q. No. 23 How long it takes to fetch water?

(a) Distance □   (b) Time □

Q. No. 24 How do you use water for drinking?

(a) Filter □   (b) Boil □   (c) Boil and filter □ (d) Other □

Q. No. 25 Do any body of your family have diarrhoea, dysentery or cholera within this month?

(a) Yes □ (b) No □

Q. No. 26 What could be the reason for that?

(a) Eating in restaurant □   (b) Due to the polluted air □

(c) Drinking contaminated water □ (d) Due to the dirty surroundings □

(e) Eating more food □   (b) Others specify □

Q. No. 27 Do any body of your family have skin disease or eye infection?

(a) Yes □   (b) No □

Q. No. 28 What could be the reason for having skin disease?

(a) Drinking contaminated water □ (b) Due to the dirty surroundings □
(c) Not frequently changing clothes □ (d) not taking regular bath □
(e) Bathing water is not clean □   (f) Others specify □

Q. No. 29 What is the common disease occurring in your community?

(a) Skin disease □   (b) Cold & cough □
(c) Acute respiratory infections □ (d) Diarrhoea □   (e) Dysentery □
(f) Worm infestation □ (g) Anaemia □ (h) Malnutrition □   (i) Others
specify □

Annex 4: Observation Checklist

Serial no.........   Date............................

Name of the Household owner............................

Age............

Village.........   Religion   Occupation

1. House condition and type
2. Cleanliness condition
3. Kitchen situation
4. Livestock
5. Sources of water
6. Situation of sources of water
7. Solid waste disposal
8. Personal cleanness
9. Health organization status (if present in the village)

Annex 5: Population of Bungamati VDC by Age Group and Sex

Age group	Ward number									Total	
	1	2	3	4	5	6	7	8	9	No.	%
<5	63	50	30	56	31	25	48	58	45	406	7.2
5-9	86	64	42	81	38	66	54	55	80	566	10.0
10-14	105	77	53	86	37	59	88	87	91	683	12.1
15-19	88	77	54	87	35	64	72	92	76	645	11.4
20-24	97	95	52	101	46	56	70	87	70	674	11.9
25-29	86	52	55	79	45	59	71	56	55	558	9.8
30-34	87	53	31	59	26	36	45	45	48	430	7.6
35-39	57	40	27	41	26	37	38	41	25	332	5.9
40-44	36	29	22	26	25	19	32	40	28	257	4.5
45-49	31	33	20	30	18	16	11	31	32	222	3.9
50-54	32	24	25	33	26	29	16	36	30	251	4.4
55-59	32	21	20	18	18	16	14	24	13	176	3.1
60-64	11	21	13	23	11	12	15	24	17	147	2.6
65-69	22	22	13	11	11	14	8	7	9	117	2.1
70-74	6	21	6	11	9	4	5	11	10	83	1.5
75-79	10	16	2	5	5	4	5	9	7	63	1.1
80-84	3	2	6	4	2	3	3	8	5	36	0.6
85+	3	2	5	2	2	2		4	1	21	0.4
Total	855	699	476	753	411	521	595	715	642	5667	100
%	15.1	12.3	8.4	13.3	7.3	9.2	10.5	12.6	11.3	100	

Source: CBS (2001).

Annex 6: Diseases Pattern Record, Bungamati Health Post

ICD code	Type of disease	Total	%
A. Communicable disease, immunization			
2	Measles	3	0.12
B. Communicable, water borne			
13	Typhoid	14	0.55
14	Diarrhoeal disease	199	7.79
15	Intestine worms	188	7.36
16	Jaundice, Infective Hepatitis	1	0.04
	C. Nutritional and Metabolic Disorder		
17a	Reproductive Tract Infection (RTI)	5	0.20
20	Avitaminoses and other nutrition deficiency	75	2.94
21	Anaemia	50	1.96
	D. Infectious disease		
23	Skin disease	624	24.43
24	ARI	336	13.16
25	Ear Infection	67	2.62
26	Eye sore and complain	59	2.31
27	Urinary Tract Infection	34	1.33
28a	Haemorrhage- Antepartum	1	0.04
29	Other complication	1	0.04
	E. Other Diseases and Injuries		
33	Chronic Bronchitis (COPD)	61	2.39
34	Gastritis	177	6.93
35	Pyrexia of unknown origin	49	1.92
36	Hypertension	11	0.43
37	Falls/Injuries/ fractures	313	12.26
38	Abdominal Pain	21	0.82
39	Toothache and other mouth complains	132	5.17
40	Arthritis, Rheumatism, Gout	18	0.70
41	Burns and Scalds	23	0.90
42a	Dog bite	10	0.39
42b	Other rabies susceptible animal bite	-	-
43a	Snake bite (poisonous)	23	0.90
43b	Snake bite (non poisonous)	-	-
44	Others	10	0.39
	Total	2554	100

Source: Bungamati Health Post Record March 2003.

Annex 7: Steps for SODIS (Solar disinfection)

Step-1

S⬤DIS
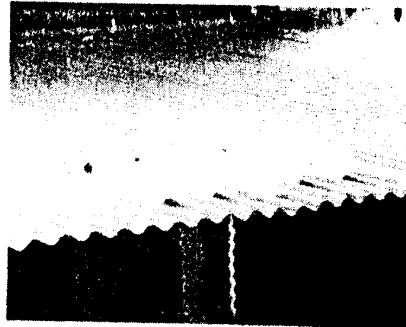Solar Water Disinfection

unicef ENPHO
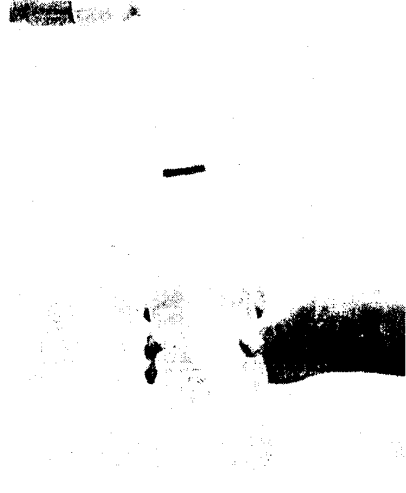
Step-2
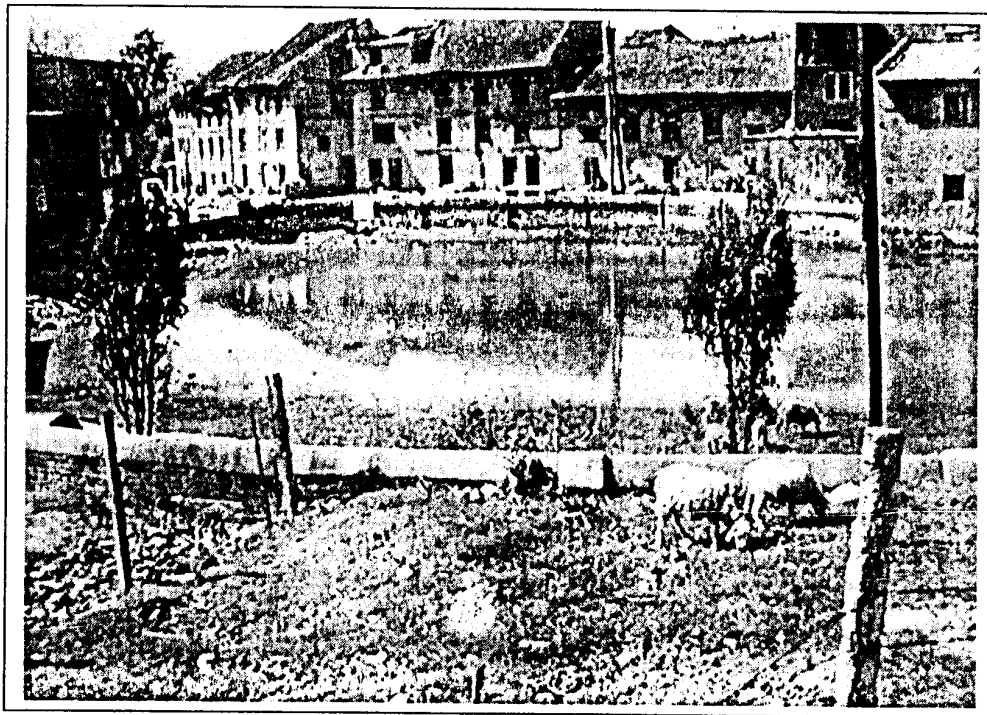
Step-3
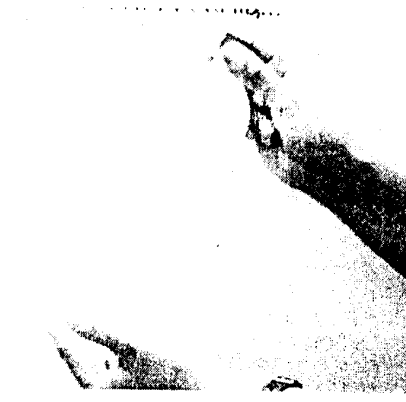
Step-4

Step-5

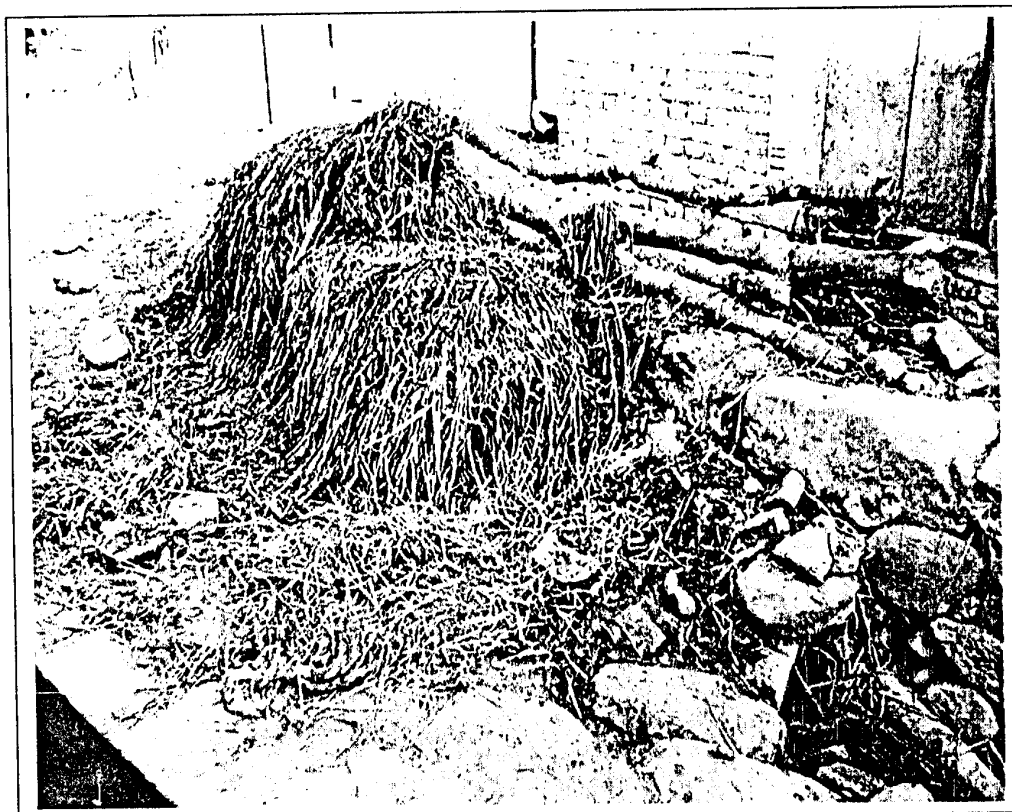*Annex: 8:* Some photographs of the Study Area locality

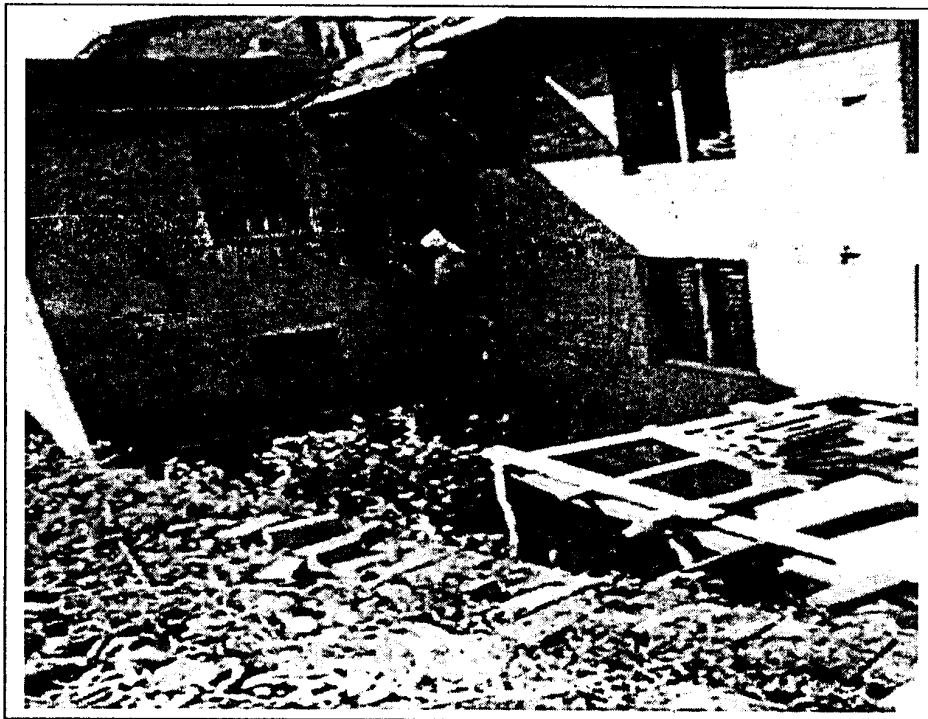Surrounding of Bungamati and very poorly maintained pond

Household surrounding and sanitation condition

Dirty Surroundings- one of the reasons of water pollution

Space is limited for construction of toilet