AN ASSESSMENT FOR DRINKING WATER QUALITY

(A CASE STUDY OF DHUNGEDHARA AT KATHMANDU VALLEY)

Submitted to

National Health Research Council (NHRC)
Ram Shah Path, Kathmandu
Nepal

Submitted by

Rupesh Kumar Sah
B.Sc. Environmental Science
Trichandra Campus
Ghantaghar , Kathmandu

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ABBREVIATION:

CBS:	Central Bureau of Statistics
EPA:	Environmental Protection Agency
ENPHO:	Environment and Public Health Organization
HMG:	His Majesty's of Government
NHRC:	National Health Research Council
NPC:	National Planning Commission
TSS:	Total Suspended Solid
WHO:	World Health Organization

ACKNOWLEGEMENT:

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My sincere thanks go to CEMAT WATER Lab and NHRC officials for their cooperation, support and assistance for the project.

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ABSTRACT

Stone tapes, locally called "*Dhungedhara*", were used as the only means for drinking and other domestic uses before the city water supply system established. High population growth in Kathmandu Valley is increasing sort-supply drinking water for all the people. Leachate from solid waste, sewerage, waste dumping and leakage from drainage system can also be given credit for this contamination. However, due to inadequate quantity of city water supply, being even severe in dry seasons, people are driven towards stone taps with out even knowing the quality of water. Public water supply is not reliable enough. In this context water from natural springs (Dhungedhara) has a very significant contribution in providing water to urban communities but the quantity and quality of such springs seems to be deteriorating day by day. Hence a research on this subjects water and its implementation will lead to safe drinking water protect springs from its extinction. The major objective of this research was to study the general condition of Dhungedhara in Kathmandu Valley and assess the quantity and Quality of public Dhungedhara in relevance to the public health also to study the quality of Dhungedharas in drinking water supply. In order to achieve these objectives the water sample from three stone taps in Kathmandu valley from Budhnagar and Baneshwer area were taken based on taps being in use were in Kathmandu valley. Identification was done giving priority to the taps extensively used for domestic purposes like drinking, cooking, washing, bathing etc. One sample each from three different stone taps was collected. These samples were analyzed in the laboratory to assess the quality of the water. Also during the sample collection, consultation was done with the local people and water users. Views of different people were collected and incorporated.

Thoroughly carryout laboratory test for different water quality parameters includes: **Physical parameters** like pH, Turbidity, Electrical Conductivity, Total Suspended Solid (TSS), and Temperature; **Chemical parameters** like Ammonia, Total hardness, Iron (Fe), Chloride and **Bacteriological parameters** like Total Coliform and Fecal Coliform etc. Laboratory test results were analyzed thoroughly and compares with WHO standards and suitability for the drinking purpose and briefly discussed in the report.

From the analysis it was found that there is no significantly high value of any physical, chemical and microbiological parameters than WHO guideline value still in one case of Budhnagar though the pH found less than WHO value which is also not significant from the health point of view. Based on the present study, though there are not much significant and unacceptable facts has came out the general recommendation for preserve and protect the source of these taps from pollution and its possible sources of contamination, public awareness program launching including the campaign against using polluted water, its impacts on health. The health-checking program should be incorporated with it, maintain proper sanitation in and around the tap stand, improve the drainage, prohibit the encroachments and heavy construction cum excavation work in and around the tap stand.

1. INTRODUCTION

Stone tapes, locally called "*Dhungedhara*", were used as the only means for drinking and other domestic uses before the city water supply system was established. Use of these stone taps are still in practice in some areas for drinking and other domestic purposes due to the scarcity of city water supply. High population growth in Kathmandu Valley causing increases sort-supply of drinking water for all the people. Reliable study about the sources of these stone taps are still catching ground water constitutes the most of the volume of these water sources. On the way to the tap, though the water stream pass through a series of filters consisting of gravel to fine granules, the possibility of contamination can not be discarded. Due to the fast growing urbanization and population growth in the Kathmandu Valley, the infiltration source for the ground water is depleting. Similarly, urban sprawl near these taps is responsible for ground water contamination. Leachate from solid waste, sewerage, waste dumping and leakage from drainage system can also be given credit for this contamination. However, due to inadequate quantity of city water supply, being even severe in dry seasons, people are driven towards stone taps with out even knowing the quality of water.

Kathmandu, capital of Nepal consists of small urban conglomerates and a large rural sector. The population of the valley stood at 1093414 in 2001 NPC (CBS).

This population growth created a pressure on the existing infrastructures. Its deficiency are easily observed in the valley of them, public water supply system is inadequate to meet the growing demand and major system required rehabilitation and expansion. Nepal Water Supply Corporation is the responsible organization for the water supply for Urban and some rural areas of Kathmandu valley. The present water demand for domestic use in Kathmandu is 130 MLD (1995); it is forecasted that it will increase day by day. The sources tapped around the valley are drying up with the increasing rate of detestation at the catchment area. The ground water level an attempt sources of water for citizen. is started to lowering with the over with drawl. Due to the insufficient supply of potable water from the municipal supply system, there is increasing trend of using untreated water from conventional water source such as wells, ponds, Dunghedhara and other sources also consequently result ill health among the inhabitants.

Most of the ill health in the developing countries like Nepal are caused largely due to the lack of water both in quality and quantity. Use of contaminated water is affecting the health if human beings through the different mode of activities as water is a good carrier of pathogens, and also is responsible to the water related diseases of water borne diseases such as typhoid, fever, dysentery, diarrhea etc. Therefore water which is essential need to the public must be free from pathogens harmful chemical and excessive amount of mineral and organic matter.

2. LITERATURE REVIEW:

Detail study regarding the source and contamination at source of these stone taps are still catching. However, some works had beeb done in the past regarding the water quality of some of the stone taps in Kathmandu valley. Environment and Public Health Organization (ENPHO) during 1989-1990 conducted water quality testing of different stone taps of Kathmandu Valley. During the study, altogether 21 samples were tested. Water quality parameters like Turbidity, pH, Conductivity, Total Hardness, Chloride, Ammonia, Nitrite, Nitrate, Orthophosphate, Iron and Oxygen consumed were analyzed. Result obtained showed the fecal contamination from all the taps in both the seasons. Which was unfit for the drinking purposes according to the WHO guideline. Similarly, it was also found out that in some taps pH and iron was more than guideline. And in most of the cases, Ammonia and Nitrate concentration was out of standard (WHO, 1971 standard).

Similarly, Thapa et. all (1993) conducted water quality assessment during January 1990 to September 1992. They have examined different chemical parameters such as temperature, pH, conductivity, flow rate, hardness, chloride, chemical oxygen demand (COD), N-NO_3, P-PO_4, iron, sulfate, turbidity and the Total Coliform in different stone taps of Pashupati area. The NO_3^- ion concentration was found to be higher than permissible value in most of the cases which can cause Methaemoglobinaemia in infants, produce carcinogenic nitrosamine and can cause gastro carcinomas. Similarly the total coliform count in most of the samples was found higher than the permissible value.

3. SIGNIFICANCE OF THE PROBLEM:

Relevant of the proposed works for national health priorities; safe drinking water supply for all people is their in born right. The government has decide to provide safe drinking water to the public by the end of 2005 B.S. This project will contribute to government aim up to some extent. In urban areas like Kathmandu, water supply system is not sufficient enough to meet the demand of the city. Moreover public water supply is not reliable enough. In this context water from natural springs (Dhungedhara) has a very significant contribution in providing water to urban communities while the quantity and quality of such springs seems to be deteriorating day by day. Hence this research on this topic will provide guideline for supply safe drinking water to the people.

So the provision of safe drinking water supply is one of the most effective and permanent solution for improving health of people for that community.

4. LIMITATIONS OF THE STUDY:

Due to the time and budget limitation, study was confined to 3 stone taps. The seasonal variation could not be identified so as to compare the pollution strength due to rainwater during raining season. This research is mainly based on laboratory test.

5. OBJECTIVE OF STUDY:

5.1 General Objectives

To study the general condition of Dhungedhara in Kathmandu Valley by assess in terms of quantity and quality in relevant of drinking water to the public health.

5.2 Specific Objectives:

- To collect the water samples from different stone taps to test quality of the water sample by chemical and physical analysis from Budhnagar and Baneshwar area.
- To identify the quality of water of three taps in Kathmandu Valley representing Budhnagar and Baneshowar area.
- To compare the result with WHO drinking water quality standards.
- To discuss the laboratory test result with reference to WHO drinking water standard and report.
- To provide recommendations and suggestions for the improvement of these stone taps.

6. PROJECT DESIGN AND METHODOLOGY:

Preliminary surveys of the stone tap surrounding and water user committee were made. A team of experts were carryout the identification of Three Dhungedhara in different localities of Kathmandu Valley. Firstly, three stone taps being in use were identified in Kathmandu valley. Identification was done giving priority to the taps extensively used for domestic purposes like drinking, cooking, washing, bathing etc. One sample each from three different stone taps was collected. These samples were analyzed in the laboratory to assess the quality of the water. Also during the sample collection, consultation was done with the local people and water users. Views of different people were collected and incorporated.

6.1 SAMPLING POINTS:

1. Budhanagar *Dhungedhara*
2. Mid Baneshwor *Dhungedhara* (Near Ratna Rajya School)
3. Baneshwor Height *Dhungedhara*

Samples were examined for the following parameters. The physical properties of the samples e.g. pH, Turbidity, Electrical Conductivity (EC), Total Suspended Solid (TSS) and Temperature of samples were study in the laboratory by the method pH meter, Spectrometry, Instrumental method, Gravimetric method and Thermometry method respectively.

Chemical parameters such as ammonia, total hardness, iron (Fe) and chloride (Cl) were tested with the help of spectrometry, titration, spectrometry and titration methods respectively.

For the microbiological analysis the samples were collected in the sterilize bottles and were analyzed with the help of membrane filter method in the laboratory. Three replication of water sample test were conducted and average of all value is taken.

Thoroughly carryout laboratory test for different water quality parameters includes: **Physical parameters** like pH, Turbidity, Electrical Conductivity, Total Suspended Solid (TSS), and Temperature; **Chemical parameters** like Ammonia, Total hardness, Iron (Fe), Chloride and **Bacteriological parameters** like Total Coliform and Faecal coliform etc. Laboratory test results were analyzed thoroughly and compares with WHO standards and suitability for the drinking purpose were found out. Based on result recommendation were made for the improvement of the quality of water for drinking purpose of these stone taps (Dhungedharas).

7. RESULTS AND DISCUSSION:

7.1 Sample test result

Table No. 1 **Sample test result**

Parameters ↓ / Location →	Results			Units	WHO Value
	Baneshwor Buddhanagar	Baneshwor RR School	Baneshwor Height		
PHYSICAL					
pH	6.4	6.5	6.5		6.5-8.5
Turbidity	< 1	1	1	NTU	5
Electric Conductivity	500	526	407	µs/cm	
Total suspended Solids	< 1	< 1	< 1	mg/L	
Temperature of the sample at lab	27.5	27.5	27.5	^0C	
CHEMICAL					
Ammonia (NH_3)	< 0.01	< 0.01	< 0.01	Mg/L as N	1.5
Total Hardness	157	175	108	Mg/L as $CaCO_3$	
Iron (Fe)	< 0.01	< 0.01	< 0.01	Mg/L	0.3
Chloride (Cl)	50.2	428	42.8	Mg/L	250
BACTERIOLOGICAL					
Total Coliform	Nil *	Nil *	Nil *	Col/100 ml	Nil
Fecal Coliform	Nil	Nil	Nil	Col/100 ml	Nil

Source: Laboratory test result, CEMAT WATER LAB (P) Ltd. Date: 16 - 3- 2058 BS

Note: * Other than Total Coliform Bacteria are found.

Based on the study for the assessment of drinking water quality of Dhungedhara, all the three samples analyzed were with in the guideline of World Health Organization (WHO) drinking water quality. But during the bacteriological parameter, although total colifom and fecal coliform were absent in the samples, other bacteria were found. Other than the

bacteriological parameters, rest of the parameters meets the WHO drinking water quality guideline. The observed values of all the tested parameters were found to be within the limit of WHO guideline value except pH in the sample from Budhnagar which is found to be not significant.

8. DISCUSSION:

8.1 Physical Parameters:

8.1.1 pH:

pH is standard measurements for any water quality sampling. pH is the measure of hydrogen ion concentration and is an important description of the chemical and biological properties of water. Values of pH for Baneshowar 1st near to Ratana Rajya Laxmi High School and Baneshwor 2nd are with in the acceptable range of WHO standard (6.5 - 8.0) but pH value of Budhnagar sample shows slightly lesser (6.4) than the WHO standard value which is not significant.

The pH of a solution is the negative of the logarithmic expression of the molar concentration of the hydrogen ion. So, what does that really mean? It means that it is a way to express how acidic or basic your water is. pH is not a contaminant, rather a measure of the acid-alkaline nature of water. The pH scale goes from 0 to 14, with 7 being considered neutral. Below 7, the water is considered acidic, and above 7 the water is considered alkaline. Most natural waters range from a pH of 4 to a pH of 9, but most commonly measure above 7 because of the presence of carbonates and bicarbonates in the water supply. The EPA considers a pH in the range of 6.5-8.5 to be acceptable for drinking water.

8.1.2 Turbidity:

Turbidity is a measurement of suspended particles in water. It is often an indicator of erosion and clarity of water and is caused by living and non-living suspended matter and color producing substances. High turbidity reduces photosynthesis of submerged rooted aquatic vegetation and algae. Values for turbidity in all the sample stone tap (Dhungedharas) were found upto 1 NTU which indicate clear water from all the stone taps throughout the year. This value from all the taps lie with in the WHO recommended value (5 NTU)

8.1.3 Electrical Conductivity:

Conductivity is a numerical expression of water's ability to conduct an electric current. Higher conductivity indicates pollution. Conductivity increases as dissolved solids, including industrial wastes increase. Specific conductance in natural surface waters range from 50-1500 megohms (uhmos). All values for sample tested falls with in the range of 407 to 526 µs/cm however this range is found with in the maximum allowable limit (1250 µs/cm) set by EEC. WHO has not set any limit of the conductivity.

8.1.4 Total Suspended Solid (TSS):

This is the contamination of water through the dissolving of different substances on its way particularly solid materials, which is not completely dissolved but make a suspension with it. Turbid, dirty water not acceptable for the human consumption. The values show for all samples is less than 1 mg/l not significant. It also brings changes in availability of water to plants through osmotic-pressure-regulating mechanisms and so of nutrient availability.

8.1.5 Temperature

Temperature is standard measurements for any water quality sampling. Temperature is an important description of the chemical and biological properties of water. The Ohio EPA standard states that the pH for warmwater habitat must fall between 6.5 and 9.0 Temperature standards are specifically based on the month water analysis is recorded. All values of temperature are within the acceptable range.

8.2 Chemical Parameters

8.2.1 Ammonia-Nitrogen:

Ammonia is the most reduced inorganic form of nitrogen in water and includes dissolved ammonia (NH_3) and the ammonium ion (NH_4^+). Nitrogen-fixing bacteria living in a symbiotic association with plants or in soil or water reduce nitrogen to ammonia and the ammonium ion. Although ammonia is only a small component of the total nitrogen cycle, ammonia contributes to the fertility of a water, since nitrogen is an essential plant nutrient. Ammonia is a common constituent of treated sewage. It may also be discharged from a wide variety of industrial and cleaning operations that use ammonia or ammonium salts. Natural waters contain concentrations of less than 0.1 mg/L (Mc Neely, et. al, 1979).

Ammonia is a surface and shallow ground water should be either due to domestic wastes or due to fertilizer. Ammonia in excess is the symbol of primary organic nitrogen pollution. Observed values of ammonia in all sample stone tap in Budhnagar (<0.01 mg/l), Baneshowar 1st near to Ratana Raj Laxmi High School (<0.01 mg/l) and Baneshwor 2nd (<0.01 mg/l) are with in the acceptable range of WHO standard 1991 (1.5 mg/l).

8.2.2 Total Hardness as CaCO3:

Hardness of water is generally known as soap consuming capacity and is mainly caused by the dissolved salts of calcium and magnesium. Water with hardness value below 100 mg $CaCO_3$ /100 ml are generally considered as soft water and are corrosive while those with values higher than 200 mg $CaCO_3$ /100 ml may cause scale deposition. . Observed values of total hardness in all sample stone tap in Budhnagar (157mg/l), Baneshowar 1st near to Ratana Raj Laxmi High School (175 mg/l) and Baneshwor 2nd (108 mg/l) are with

in the acceptable range of WHO standard 1971 (500 mg $CaCO_3$ /100 ml). The average value for total hardness in all the taps were found with in the WHO acceptable limit.

8.2.3 Iron (Fe):

Iron in drinking water is more significance in its aesthetic quality as importance in health aspect. At the level of about 0.3 mg/l iron stains a laundry and gives an undesirable taste (WHO 1984). But WHO 1991 recommends the maximum permissible limit of iron as 0.3 mg/l. Observed values of Iron in all sample stone tap in Budhnagar (<0.01 mg/l), Baneshowar 1st near to Ratana Raj Laxmi High School (<0.01 mg/l) and Baneshwor 2nd (<0.01 mg/l) are with in the acceptable range of WHO standard 1991 (0.3 mg/l).

8.2.4 Chloride:

Chloride is one of the major mineral constituents in water. High contents of Chloride give an undesirable taste of water. A sudden increase of chloride content indicates probable domestic organic pollution.

Chloride is also an indicator of sewage, animal wastes and road salt. It is present in all potable water supplies and in sewage, usually as a metallic salt. Chloride is essential in the diet and passes through the digestive system unchanged to become one of the major components of raw sewage. Values of chloride for Budhnagar (50.2 mg/l), Baneshowar 1st near to Ratana Raj Laxmi High School (42.8 mg/l) and Baneshwor 2nd (42.8 mg/l) are with in the acceptable range of WHO standard (250 mg/l).

8.3 Bacteriological Parameters:

8.3.1Total Coliform and Faecal Coliform (E. coli.):

Bacteria are microscopic organisms present almost everywhere on earth, and they have existed for a very long time. Some scientists believe that bacteria created the first molecules of oxygen that appeared on Earth, about 2 billion years ago.

Anthony van Leeuwenhoek first discovered bacteria in 1676, and in 1876 Robert Koch determined that they are responsible for many diseases. Bacteria are the beginning of the food chain, and as decomposers, bacteria play a critical role in recycling materials essential to plants and animals.

Coliform bacteria are the bacteria most commonly associated with water quality. Coliforms are a large group of various species of bacteria. They include bacteria that occur naturally in the intestines of warm-blooded animals (fecal coliform) as well as those that don't. Coliforms can include both disease causing (pathogenic) and non-disease causing (nonpathogenic) species.

Bacteria exist almost everywhere on earth. Some bacteria are helpful, such as the ones in the human intestine that help to digest your food. Some bacteria, called pathogenic

bacteria, are dangerous, and outbreaks of disease are attributed to them. The Black Plague, typhoid and cholera are all examples of diseases caused by bacteria. Bacteria play a large role in the health of all individuals, both human and animal.

Fecal coliform and *E. coli* bacteria are indicators of fecal contamination caused by humans or animals. Fecal contaminates may lead to water-associated communicable diseases such as hepatitis. Less serious ailments are flu-like nausea and vomiting. Sources of fecal contamination include poorly functioning septic systems, inadequately treated municipal wastewater, farm runoff, contaminated soils, and urban storm runoff.

According to laboratory test there are absence of Total Coliform as well as Fecal Coiliform in all the tested samples from the Budhnagar, Baneshowar 1st near to Ratana Raj Laxmi High School and Baneshwor 2nd But other than Total Coliform Bacterias are found probably due to lack of proper management protection of sources and sanitation around the taps.

According to WHO guideline for drinking water quality (1991) any potable water should be free of Fecal Coliform. This quality requirement is simply too high for a developing country like Nepal.

The Ohio EPA standard for primary contact recreation for fecal coliform shall not exceed 1,000 colonies per 100 millimeters (ml). The standard for *E. coli* is 126 colonies per 100 ml.

9. RECOMMENDATION:

With the present study and findings following recommendation have been made.

1. For acidic water, meaning the pH below 7 like of Budhnagar Dhungedhara, it can be treated with a special filter called calcite (contains calcium carbonate) or magnesia (contains magnesium oxide). Or, installation of a chemical feed pump that adds sodium carbonate is an alternative method for neutralizing acid water. If pH is alkaline (above 7) it will recommend to have a water softener installed, or a reverse osmosis system should take care of the problem. Less pH of Budhnagar Dhungedhara may be due to geological factors. So detail study on geology should be carried out.

2. Bacteria though not found in studied tap (Dhungedhara) water, is a fairly common condition that is easily remedied. The easiest way to combat bacteria in a water tap is to sanitize the tap. This process uses sodium hypochlorite, also known as household bleach. Chlorine commonly used in pools can be used also, but this requires first mixing the chlorine with water, and proper care must be taken when doing this.

3 Preserve and protect the sources of these taps from pollution and its possible sources of contamination.

4. Maintain proper sanitation in and around the tap stand, improve the drainage, prohibit the encroachments and heavy construction cum excavation work in and around the tap stand.

5. A wide public awareness program should be launched including the campaign against using polluted water, its impacts on health. The health-checking program should be incorporated with it.

6. Provision of collection and storage of water flowing goes unused for the latter use and/or use tap fitted with luck system so that the continuous flow could be regulated as per the need.

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4. Ed. Tom Cawley, 1996, Water Quality Monitoring Report.
5. WHO Guideline Value, 1991

CEMAT WATER LAB (P) LTD.

(Water Analysis Treatment Consultancy & Environmental Research)
Anam Nagar, New Plaza, Kathmandu, Nepal

Sender:- Mr. Rupesh K. Shah	Sample No:- 3	Lab. No:- ** /057
Source of Sample:- Stone Tap Water	Location:-	District:- Kathmandu
Collector:- Mr. Rupesh K. Shah	Date of Collection :-	Time: -.
Date of Receipt:- 16-03-058	Date of Analysis:- 16-03-058	

Parameters ↓	Location →	Results			Units	WHO GV
		Baneshwor, Buddhanagar	Baneshwor, 1st	Baneshwor, 2nd		
PHYSICAL						
pH		6.4	6.5	6.5		6.5-8.5
Turbidity		< 1	1	1	NTU	5
Electric Conductivity		500	526	407	µs/cm	
Total Suspended Solids		< 1	< 1	< 1	mg/L	
ab. Temp.		27.5	27.5	27.5	°C	
CHEMICAL						
Ammonia (NH_3)		< 0.01	< 0.01	< 0.01	mg/L as N	1.5
Total Hardness		157	175	108	mg/LasCaCO$_3$	
Iron (Fe)		< 0.01	< 0.01	< 0.01	mg/L	0.3
Chloride (Cl)		50.2	42.8	42.8	mg/L	250
BACTERIOLOGICAL						
Total Coliform		Nil *	Nil *	Nil *	Col/100 ml	Nil
Faecal Coliform		Nil	Nil	Nil	Col/100 ml	Nil

WHO GV = World Health Organisation Guideline Value (1991).

Analysed by : Checked by : Authorised Signature :
Date : Date: Date:

Remarks: -The observed values of all the tested parameters are found to be within the limit of WHO guideline values, except that of pH in the sample from Buddhanagar, Baneshwor.

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* Other than Total Coliform Bacteria's are found.