HOUSEHOLD WATER USE IN THE KATHMANDU VALLEY:

A DRY SEASON SURVEY

WASH-MIA Rapid Report

ICRE
UNIVERSITY OF YAMANASHI

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Preface

Kathmandu Valley has been facing chronic insecurity of domestic water that is one of the inevitable resources for people's daily life. It is known that water supply from the public sector is much less than the demand due to increasing population in the Valley and people have to rely on water from other sources such as well, spring as well as purchased water. Water is sometimes low quality. Such water situation may have been causing harmful effect on physical and psychological health of people and also impeding their daily social and economic activities.

A SATREPS (Science and Technology Research Partnership for Sustainable Development) project "Hydro-microbial approach for water security in Kathmandu Valley" (Project manager: Futaba Kazama, University of Yamanashi and Narendra Man Shakya, Tribhuvan University) jointly funded by Japan Science and Technology Agency (JST) and Japan International Cooperation Agency (JICA) has launched in 2014. Objectives of this project are to create water insecurity maps of the valley in terms of water scarcity and chemical and microbial contamination and to develop and provide water treatment systems in some water insecure areas based on the maps. Our group, social and economic evaluation group, of the project conducted a wide scale household survey on water related issues in household. The data are being used in the project as a basis for evaluating water insecurity and for clarifying social and economic issues caused by the water insecurity.

The survey was conducted before the Gorkha Earthquake and similar surveys have been ongoing after the earthquake both in dry and wet seasons. This report shows the summary of the results of the first survey mainly on the present situation of water source, availability, handling in households, cost etc., and the results of the following surveys will be published sequentially. The data in the current issue would be useful to understand the water problems in the Kathmandu Valley just before the earthquake.

Prof. Junko Shindo
Social and economic evaluation group
SATREPS "Hydro-microbial approach for water security in Kathmandu Valley" Project

Acronyms and abbreviation

ADB	Asian Development Bank
APWF	Asia-Pacific Water Forum
CBS	Central Bureau of Statistics
GEQ	Gorkha Earthquake
HH	Household
JICA	Japan International Cooperation Agency
JST	Japan Science and Technology Agency
KMC	Kathmandu Metropolitan City
KrM	Kritipur Municipality
KUKL	Kathmandu Upatyaka Khanepani Limited
LPCD	Liter per capita per day
LSMC	Lalitpur Sub-metropolitan city
MDG	Millennium Development Goal
MLD	Million liters per day
NRs	Nepali Rupees
PPS	Proability Proportional to household size
TM	Thimi Municipality
UN	United Nations
UNICEF	United Nations Children's Fund
UY	University of Yamanashi
WHO	World Health Organization
WTP	Willingness to pay

Acknowledgement

We would like to express our sincere gratitude to Japan International Cooperation Agency (JICA) and Japan Science and Technology Agency (JST) for funding the project. We respect the timely help and support from group leaders of all working groups under this project; Prof. Narendra M. Shakya, Dr. Hiroshi Ishidaira, Prof. Suresh D. Shrestha, Dr. Takashi Nakamura, Dr. Ishwor M. Amatya, Dr. Tadashi Toyama, Prof. Jeevan B. Sherchand and Dr. Eiji Haramoto. We are highly indebt to the interviewers whose effort in negotiating and pursuing the local people to participate in the survey. We also are thankful to the Japanese and international students of University of Yamanashi who helped to bring the questionnaires back to Japan. We are also very much grateful to Mr. Sudeep Hada and Dr. Vishnu P. Pandey for their endless support, suggestions and participation in the initial phase of the survey. Lastly, we appreciate the participants for providing their valuable time and information and also appreciate their commitment to engage in this study in the remaining surveys and follow-up studies.

Summary

An imbalance between high water demand and low supply in the Kathmandu Valley has created water insecurity. This situation has hit households hard with increased stress for water management, increased cost, loss of time and other uncountable problems. Households approach multiple water sources in addition to municipal water (piped water) to fulfill their water needs. However, such 'private self-supply' often excluded from official statistics and is usually taken as granted by government. Asian Development Bank (ADB) in 2009 conducted wide scale survey about water use in the valley but the main aims were to establish the baseline of Kathmandu Upatyaka Khanepani Limited (KUKL) services and to propose indicators for future performance monitoring for KUKL rather than to understand dynamics of household water use. In addition, within the span of 5 years, household KUKL connections have been increased by thousands but the supply is stagnant. Hence, we strongly believe that the current scenario has been changed a lot from what had been presented by ADB (2010). Hence, our objective was to reveal current situation of household water dynamics including use and purpose of multiple water sources, per capita water consumption, monthly cost spent on water etc. These information will be helpful for several researchers as well as for different stake holders.

The survey was conducted in Kathmandu Metropolitan City (KMC), Lalitpur Sub-metropolitan City (LSMC), Kritipur municipality (KrM) and Thimi municipality (TM) during January to March 2015. For easiness to report the results, we have divided it into Kathmandu district (KMC and KrM), Lalitpur disctrict (LSMC) and Bhaktapur district (TM). This was a multi-stage cluster survey with probability proportional to household size sampling technique. 39 clusters were then selected and around each cluster 30 households were surveyed. A structured questionnaire was used which included questions about socio-demographic characteristics, domestic water use behavior, water quality management, hygiene behavior, expenditure on water and physical symptoms. Total 1139 households were interviewed. Since 9 interviewees were below 15 years of age, they were excluded for data analysis.

In this study, 80% of household lie in Kathmandu district, 7% in Bhaktpur and 13% in Lalitpur district. Out of 1130 households, 657 (58%) were house owners and 694 (61%) were of Janajati ethnicity. The mean age of the respondents was 40 years. 76% of the participants were literate. 66% of the households had private connection from KUKL (piped water) and 52% had private well. 71% of households used jar water, 31% tanker water, 9% rainwater, and 3% stone spout. 78% of households received piped water < 4 hours a week. 87% of household used piped water for cooking, 74% for drinking, 76% for bathing and 70% for laundry. Only 12% households used groundwater for drinking and 22% for cooking. Groundwater was mainly being used for bathing (87%) and laundry (94%). 100% of jar water using households use it for drinking and 53% use it for cooking purpose. 95% and 93% of tanker water using households used it for bathing and laundry and less number of household used it for drinking and cooking. Surprisingly, none of the households in Bhaktapur used tanker water. None of the households could rely only on piped water, and 34% of households were relying on alternative water sources only. The average per capita water consumption in liter (LPCD) was 121. The average monthly cost for piped water was NRs.

267. The jar water using households were paying monthly NRs. 1145 only for jar water and the tanker water using households were paying NRs. 4029 monthly only for tanker water.

The results of this study showed that piped water was extremely insufficient for meeting the daily water needs of the valley residents. Consequently, people are spending comparatively large amount of money for buying jar water and tanker water to maintain LPCD at 121. Our study, did not go in details regarding the cost of installation and maintenance of shallow groundwater wells. But it is not difficult to speculate the economic burden for 52% of households in this study which used groundwater. Almost all the households relied on alternative water sources, however the water management stress could be larger to 34% of the households which did not use piped water because regardless of its performance piped water has been preferred for drinking and cooking and has been considered as a permanent water source. This study has revealed the water dynamics of households in dry season. The availability and use of multiple sources can be interpreted in terms of burden for water management and cost. Hence, future research focusing on the scenario of water insecurity and the effect of water unavailability on people's life can be an interesting aspect to be explored.

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1. Introduction

Many international organizations are separately or jointly putting effort to reduce water scarcity that the developing parts of the world are facing. Focusing on Asia and Pacific, Asian Development Bank (ADB) formulated and initiated 'Water for All' policy in 2001. Likewise, United Nations (UN) initiated several Millennium Development Goals (MDGs) and one of them was to halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation (Goal 7 Target10 c). These efforts have resulted in 90% coverage of use of improved drinking water sources in South Asia by 2010 which was 18% increment in the level in 1990. However, the increments were basically made in other improved water sources rather than piped water.

In South Asia, 65% of population use other improved sources than pipe source (25%) (UNICEF/WHO 2012). According to report by ADB, the number of people with a tap in the house (23%) lags significantly behind the overall MDG figures for improved water supply (91%) in South Asia (ADB/APWF 2013). Moreover, the data for piped water supply did not include duration of supply i.e. whether the supply is 24 hours a day and 7 days per week or intermittent supply (ADB/APWF 2013). According to a report on water in Asian cities published by ADB, the cities in which none of the population had 24 hours piped water availability were Dhaka, Karachi and Kathmandu whereas it was 1% and 60% in Delhi and Colombo respectively (Andrews & Yniguez 2004). These findings are clearly highlighting that in this region, water sources other than piped water constitute bigger proportion of household water.

The Kathmandu Valley being capital city is the most urbanized center of Nepal. The city has seen extensive population growth which increased from 1.6 million in 2001 to 2.5 million by 2011 and the population growth rate of 5.2% was one the highest in South Asia (CBS 2012). Rapidly grown population has water demand of 320 million liters per day (MLD) but the water supplying agency could only provide 106 MLD and 76 MLD in wet and dry seasons, respectively (KUKL 2010). In order to provide water to all connections despite of huge water deficit, the agency can supply water intermittently to the households. None of the municipal areas in the valley are receiving piped water 24 hours supply per day while most of them were receiving <4 – 7 hours per week (ADB 2010). Therefore, like in many Asian cities, alternative water sources constitute large proportion of domestic water use in the valley.

Other improved sources consist of groundwater (tube well / protected bore well/ protected dug well), protected spring and rain water while unimproved sources include unprotected dug well, vendor's tanker water, unprotected spring water, bottled water, and surface water (WHO/UNICEF 2012). According to a wide scale survey conducted by ADB 2010, 52% of households use groundwater, 10% use stone spout, 1% use river water, 27% use rainwater, 17% use bottled or jar, 8% use vendor's tanker and 4% use other sources in the valley. Private self-supply is greatly practiced by urban dwellers as 'coping-strategy' against partially or highly inadequate municipal water supply (Foster et al. 2010). But, 'private self-supply' by households is often excluded from official statistics and is usually taken as granted by government. In 2009, ADB had conducted a wide scale survey about water supply status but within the period of 5 years after that survey KUKL

connections has been increased by thousands but the performance of KUKL is rather stagnant. In a short span of time, water business has flourished tremendously. So, undoubtedly the composition of water sources being used in households as well the coverage of different water sources might have experienced a huge shift. Therefore, we felt an urgency to understand as well as to document current household water use situation of the valley.

This study is a part of "Hydro-microbial approach for water security in Kathmandu Valley" project of University of Yamanashi (UY) under the program "Science and Technology Research Partnership for Sustainable Development", jointly funded by Japan Science and Technology Agency (JST) and Japan International Cooperation Agency (JICA). It aimed to ensure safe water supply. One of the aims of this project was to understand different dynamics of household water use based on a wide scale household survey in the valley in dry and wet seasons.

2. Methodology

2.1 Study settings:

The survey was conducted in Kathmandu metropolitan city (KMC), Lalitpur Sub-metropolitan city (LSMC), Kritipur municipality (KrM) and Thimi municipality (TM) from January to March, 2015. KMC and KrM lie Kathmandu district and LSMC in Lalitpur district and TM in Bhaktapur district.

2.2 Study design:

This is a multi-stage cluster survey which includes two steps to select samples. Firstly, 50 clusters were selected using probability proportional to HH size (PPS) sampling technique. Here, wards in KMC, LSMC, KrM and TM were considered as clusters. Secondly, 30 HHs were randomly selected within each selected clusters. For second stage of selection, random geographical location was chosen and 30 HHs closest to the location were selected. Only one household per house was surveyed. The total number of clusters was curbed from 50 to 39 because of occurrence of GEQ on 25th of April 2015. The total number of 1139 HHs were interviewed.

The inclusion criteria of the participants were being above 15 years of age, should be in the state to give interview physically and mentally, and were willing to provide written informed consent to participate in the study voluntarily. The trained interviewers conduct face to face interview with the participants.

2.3 Measurements:

A structured questionnaire was used and data was collected by trained interviewers. The questionnaire included socio-demographic characteristics, domestic water use behavior, water quality management, hygiene behavior and physical symptoms.

Domestic water use behavior

The questions in this heading included different sources of domestic water such as municipal supplied piped water, groundwater, rainwater, jar water, private vendor's tanker water and other sources, frequency of use, amount of used, storage, purpose of use and cost. Domestic water in this study is defined as the water used for drinking, cooking, laundry, bathing, gardening, toilet, cleaning within the HH by family members.

Hygiene

Regarding hygiene, participants were asked about their behaviour of washing hand before preparing meal and after toilet, frequency of bathing and clearing water storage vessels.

Physical symptoms

We asked participants if they had any physical symptoms in last two weeks. The symptoms included headache, fever, cold, vomiting, stomach ache, back-pain, trachoma, typhoid etc.

Covariate variables

Socio-demographic characteristics included age, gender, literacy and occupation of all the members of the household and ethnicity, and socio-economic status. Ethnicity was based on last name of the participants which also indicates social hierarchy. Socio-economic status was determined by constructing wealth index based on household asset possession such as mobile phone, refrigerator, motorbike, vehicle, invertor etc. (Cordova A 2009).

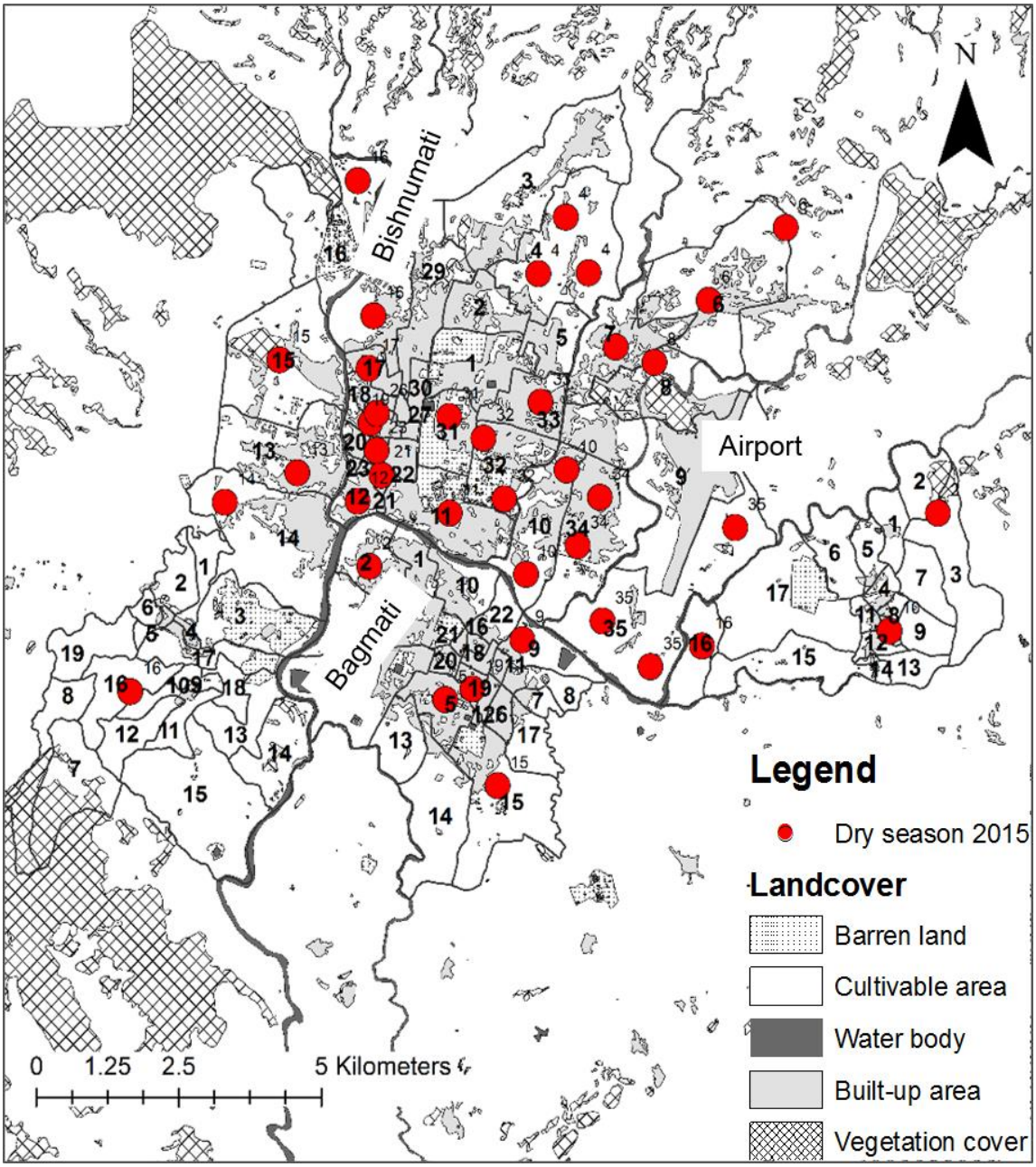

Figure 1 Distributions of survey locations in the Kathmandu Valley

3. Results

3.1. Socio-demographic characteristics of households

Nine HHs were excluded from the study since their age was below inclusion criteria (15 years). The district wise composition of HHs were Kathmandu 80.2%, Bhaktapur 6.8% and Lalitpur 13% (Table 1). The proportion of gender of the respondents was also nearly equal (Table 2). Except in Bhaktapur, most of the houses have two HHs and in all the districts the average family size was four (Table 3). Among our respondents, the percentage of owners were higher in Bhaktapur (77%) whereas that was lower in Lalitpur (44%) (Table 4).

Table1. Household composition

District	n	%
Kathmandu	906	80.2
Bhaktapur	77	6.8
Lalitpur	147	13.0
Total	1130	100.0

Table 2. Gender of respondents

	Male (%)	Female (%)
Kathmandu	51.1	48.9
Bhaktapur	46.8	53.2
Lalitpur	46.9	53.1
All	50.3	49.7

Table 3. Number of households and family size

	Households	Family size
	Median (Min-Max)	
Bhaktapur	1 (1-7)	4 (1-7)
Kathmandu	2 (1-25)	4 (1-12)
Lalitpur	2 (1-6)	4 (1-8)
All	2 (1-25)	4 (1-12)

Table 4. House ownership status of participants

	House ownership			
	Owner n (%)	Tenant n (%)	Proportion of Owners	Proportion of tenants
Bhaktapur	59 (77.6)	17 (22.4)	3/4	2/9
Kathmandu	533 (58.8)	373 (41.2)	3/5	2/5
Lalitpur	65 (44.2)	82 (55.8)	4/9	5/9
All	657 (58.2)	427 (41.8)	4/7	3/8

Janajati ethinic group was in higher proportions in our sampling followed by Brahmin and then by Chettri (Table 5). The percentage of Brahmin ethnic group were higher in Kathmandu and Janajati were higher in Bhaktapur. The mean age of the respondents were 40 years (Table 6).

Table 5. Ethinicity of households

District	Brahmin n (%)	Chettri n (%)	Janajati n (%)	Dalit n (%)	Don't want to disclose, n (%)
Bhaktapur	10 (13.0)	5 (6.5)	58 (75.3)	0 (0)	4 (5.2)
Kathmandu	228 (25.2)	130 (14.3)	546 (60.3)	1 (0.1)	1 (0.1)
Lalitpur	26 (17.7)	26 (17.0)	90 (61.2)	2 (1.4)	4 (2.7)
All	264 (23.4)	160 (14.2)	694 (61.4)	3 (0.3)	9 (0.8)

Table 6. Age (in years) of respondents

	Mean	Median	Minimum	Maximum
Bhaktapur	42	42	16	75
Kathmandu	41	40	15	87
Lalitpur	35	35	15	78
All	40	39	15	87

Majority of our participants attained university level education or at least attended upper secondary school (Table 7). The most common occupation of the respondents was business followed by domestic work and then service (Table 8). The mean age of HH heads was 48 years (Table 9). Most of them have achieved university level education (Table 10) and common profession was business followed by service (Table 11). On an average monthly expenditure was NRs 35,319 (1USD = 107.16, as of 2016/08/03). Based on our data, respondents of Lalitpur district had lower expenditure (NRs. 17187) among others. Five categories of wealth status was constructed based on wealth quintile and whole data set was used. Since majority of our respondents were from Kathmandu district all categories had equal proportion of the HHs. The HHs in Lalitpur district too were distributed almost equally in 5 wealth quintiles. But, in Bhaktapur district, 40% of the HHs fall in “rich” category, 8% in “very rich” category and remaining HHs were almost equally divided into remaining categories (Table 13).

Table 7. Education of respondents

	Illiterate	No formal education	Primary school (1-5)	Lower secondary (6-9)	Upper secondary (10-12)	College/University	Do not want to disclose	missing
Bhaktapur	2 (2.6)	10 (13.0)	2 (2.6)	4 (5.2)	20 (26.0)	30 (39.0)	1 (1.3)	8 (10.4)
Kathmandu	44 (4.9)	164 (18.1)	40 (4.4)	60 (6.6)	271 (29.9)	314 (34.7)	8 (0.9)	5 (0.6)
Lalitpur	6 (4.1)	13 (8.8)	18 (12.2)	9 (6.1)	29 (19.7)	65 (44.2)	1 (0.7)	6 (4.1)
All	52(4.6)	187 (16.5)	60 (5.3)	73 (6.5)	320 (28.3)	409 (36.2)	10 (0.9)	19 (1.7)

Table 8. Occupation

(I)	Agriculture	Profession/ Manager	Business skill	Skilled manual labor	Unskilled manual labor	Service	Remittance
Bhaktapur	14 (18.2)	4 (5.2)	14 (18.2)	0 (0.0)	0 (0.0)	15 (19.5)	2 (2.6)
Kathmandu	1 (0.1)	37 (4.1)	378 (41.7)	6 (0.7)	62 (6.8)	128 (14.1)	4 (0.4)
Lalitpur	4 (2.7)	2 (1.4)	41 (27.9)	3 (2.0)	3 (2.0)	29 (19.7)	1 (0.7)
All	19 (1.7)	43 (3.8)	433 (38.3)	9 (0.8)	65 (5.8)	172 (15.2)	7 (0.6)

(II)	Domestic work	Student	House wife	Retired	No job	missing
Bhaktapur	12 (15.6)	5 (6.5)	1 (1.3)	0 (0.0)	2 (2.6)	8 (10.4)
Kathmandu	167 (18.4)	83 (9.2)	2 (0.2)	9 (1.0)	18 (2.0)	11 (1.2)
Lalitpur	28 (19.0)	34 (23.1)	0 (0.0)	0 (0.0)	0 (0.0)	2 (1.4)
All	207 (18.3)	122 (10.8)	3 (0.3)	9 (0.8)	20 (1.8)	21(1.9)

Table 9. Age of household head

Age in years	Mean	Median	Minimum	Maximum
Bhaktapur	47	46	25	75
Kathmandu	48	47	15	87
Lalitpur	44	44	17	78
All	48	46	15	87

Table 10. Education of household head

	Illiterate	No formal education	Primary school (1-5)	Lower secondary (6-9)	Upper secondary (10-12)	College/ University	Do not want to disclose	missing
Bhaktapur	2 (2.6)	8 (10.4)	2 (2.6)	1 (1.3)	17 (22.1)	34 (44.2)	1 (1.3)	12 (15.6)
Kathmandu	49 (5.4)	212 (23.4)	32 (3.5)	52 (5.7)	261 (28.8)	287 (31.7)	8 (0.9)	5 (0.6)
Lalitpur	8 (5.4)	18 912.2)	27 (18.4)	10 (6.8)	29 (19.7)	51 (34.7)	0 (0)	4 (2.7)
All	59 (5.2)	238 (21.1)	61 (5.4)	63 (5.6)	307 (27.2)	372 (32.9)	9 (0.8)	21 (1.9)

Table 11. Occupation of household head

(I)	Agriculture	Profession/ Manager	Business skill	Skilled labor	Unskilled labor	Service	Remittance
Bhaktapur	20 (26.0)	2 (2.6)	18 (23.4)	0 (0)	0 (0)	24 (31.2)	3(3.9)
Kathmandu	6(0.7)	46 (5.1)	413 (45.6)	5 (0.6)	98 (10.8)	184 (20.3)	12 (1.3)
Lalitpur	5 (3.4)	1 (0.7)	60 (40.8)	5 (3.4)	4 (2.7)	46 (31.3)	9 (6.1)
All	31 (2.7)	49 (4.3)	491 (43.5)	10 (0.9)	102 (9.0)	254 (22.5)	24 (2.1)

(II)	Domestic work	Student	House wife	Retired	No job	Missing
Bhaktapur	4 (5.2)	0 (0)	0(0)	0(0)	0 (0)	6 (7.8)
Kathmandu	70 (7.7)	10 (1.1)	0 (0)	9 (1.0)	19 (2.1)	34 (3.8)
Lalitpur	6 (4.1)	5 (3.4)	0 (0)	0 (0)	0 (0)	6 94.1)
All	80 (7.1)	15 (1.3)	0 (0)	9 (0.8)	19 (1.7)	46 (4.1)

Table 12. Household asset possessions

Assets	n	%	Assets	n	%
Electricity	1126	100	Radio	943	83
TV	1113	98	Mobile	1103	98
Phone	906	80	Fridge	933	83
Bicycle	350	31	Motorbike	814	72
Vehicle	285	25	Computer	912	81
Fan	792	70	Kerosene stove	380	34
Electric stove	303	27	Gas stove	1093	97
Helper	203	18	Invertor	1126	100

Reliability score = 0.67

Table 13. Wealth status based on wealth index

	Kathmandu		Bhaktapur		Lalitpur	
	N	%	N	%	N	%
Very poor	184	20	14	18	28	19
Poor	177	20	13	17	37	25
Medium	192	21	13	17	21	14
Rich	173	19	31	40	23	16
Very rich	180	20	6	8	38	26
Total	906	100	77	100	147	100

3.2 Water sources

In this study, piped water connection and presence of groundwater well in respondents' own compound were defined as private water source possession. Over all 66% HHs had piped water connection and 52% HHs had private groundwater inside their compound (Table 14). In Kathmandu district, 64% HHs had piped water connection and 56% had groundwater well. HHs in Bhaktapur district had highest piped water connection but lowest groundwater wells. Water sources other than piped water has been considered as 'alternative water sources'. In addition to groundwater, another source that has been widely used was jar water (Table 15). The coverage of jar water was 72% in Kathmandu and 89% in Lalitpur but it was lowest in Bhaktapur (22%). In Bhaktapur, tanker water usage was also zero. Its coverage was highest in Lalitpur (75%) but not that much high in Kathmandu. Among other sources, rain water was also commonly used by HHs. Other different alternative sources such as stone-spout, river water and spring water were rarely being used by the participants. The concept of neighbour's water sources such as piped water or well water had been first used by ADB (2010). The results showed that people now are not depending much upon neighbour's water sources and only 1% of our study participants used public wells.

Table 14. Private water source possession

	Piped water		Groundwater	
	n	%	n	%
Kathmandu	583	64	508	56
Bhaktapur	66	86	20	26
Lalitpur	101	69	62	42
All	750	66	590	52

Table 15. Different water sources in use

	Rain water		Jar water		Tanker water		Stone spout		Neighbour's piped water	
	n	%	n	%	n	%	n	%	n	%
Kathmandu	45	5	651	72	244	27	31	3	25	2.8
Bhaktapur	7	9	17	22	0	0	0	0	0	0
Lalitpur	47	32	131	89	111	76	1	1	2	1.4
All	99	9	799	71	355	31	32	3	27	2.4

	Neighbour's well water		River		Public well		Spring		Others	
	n	%	n	%	n	%	n	%	n	%
Kathmandu	14	1.5	1	.1	4	.4	2	.2	3	.3
Bhaktapur	0	0	0	0	0	0	0	0	0	0
Lalitpur	17	11.6	0	0	8	5.4	1	.7	0	0
All	31	2.7	1	.1	12	1.1	3	.3	3	.3

3.2.1 Piped water

When the hours of piped water being supplied in the valley is divided into < or > 4 hours per week category then majority of the households received water < 4 hours per week (Table 16). Only one household reported receiving water 24 hours a day. Among three districts, almost all the households of Lalitpur in this study receive only < 4 hours water supply per week.

Table 16. Piped water supply hours per week

Piped water supply	< 4 hours supply		>4 hours supply		Continuous supply		Don't know	
	n	%	n	%	n	%	n	%
Bhaktapur	36	55	28	42	0	0	2	3
Kathmandu	454	78	118	20	1	0	10	2
Lalitpur	98	97	2	2	0	0	1	1
All	588	78	148	20	1	0	13	2

In Bhaktpur, almost all the households use piped water for drinking, cooking, and bathing (Table 17). Whereas, in Kathmandu and in Lalitpur majority of HHs use it for cooking and bathing. In both districts only 67% of HHs use piped water for drinking. Over all, piped water is being used as cooking water source for majority of the HHs. 74% HHs use it for drinking, 76% use it for bathing and 70% use it for laundry.

Table 17. Purpose of use of piped water

Purposes	Kathmandu		Bhaktapur		Lalitpur		All	
	n	%	n	%	n	%	n	%
Drinking	380	67	62	94	98	67	540	74
Cooking	476	84	62	94	98	98	636	87
Bathing	412	73	60	91	87	87	559	76
Laundry	390	69	52	79	70	70	512	70
Cleaning	362	64	29	44	37	37	428	58
Gardening	234	43	6	9	10	10	250	35
Other purposes	164	30	0	0	2	2	166	24

3.2.2 Groundwater

Groundwater is mainly being used for laundry, bathing, and house cleaning (Table 18). Only around 12% HHs use it for drinking and 22% for cooking. Compare to Lalitpur and Kathmandu, use of groundwater for drinking and cooking seemed to be higher and that for bathing, laundry and cleaning seemed to be lower in Bhaktapur.

Table 18. Purpose of use of groundwater

Purposes	Kathmandu		Bhaktapur		Lalitpur		All	
	n	%	n	%	n	%	n	%
Drinking	59	12	6	30	5	8	70	12
Cooking	113	22	6	30	10	17	129	22
Bathing	446	88	10	50	55	93	511	87
Laundry	484	95	13	65	54	92	551	94
Cleaning	488	96	15	75	55	93	558	95
Gardening	364	72	11	55	22	37	397	68
Other purposes	279	55	1	5	11	19	291	50

3.2.3 Jar water

Jar water is very widely used water source specially used for drinking purpose. In Kathmandu, each HH buy jar water on an average of 6.4 times per week which is 4.5 and 4.1 for Bhaktapur and Lalitpur, respectively (Table 19). Over all, people buy 6 jars of water per week. Among those who use jar water, almost all use for drinking and around half proportion use for cooking (Table 20).

Table 19. Frequency of buying jar water

District	Jar water frequency/ week	
	Mean (SD)	Median
Kathmandu	6.4 (3.6)	7.0
Bhaktapur	4.5 (2.4)	4.0
Lalitpur	4.1 (3.9)	3.0
All	6.0 (3.7)	7.0

Table 20. Purpose of jar water use

Districts	Drinking		Cooking	
	n	%	n	%
Kathmandu	645	100	328	51
Bhaktapur	17	100	10	59
Lalitpur	131	89	82	63
All	793	100	420	53

3.2.4 Tanker water

Tanker water is bought nearly two times per month (Table 21). Surprisingly, none of the HHs in Bhaktapur in this study used tanker water. In Kathmandu, among those who used tanker water use it mainly for bathing, laundry and cleaning (Table 22). Only half of those HHs which used tanker water, used it for cooking purpose. But almost all of the HHs in Lalitpur use it for cooking. In Kathmandu, 30% use it for drinking but in Lalitpur that value reached to 84%.

Table 21. Frequency of tanker water buying per month

District	Tanker water frequency/ month	
	Mean (SD)	Median
Kathmandu	1.9 (1.1)	2.0
Bhaktapur	0	0
Lalitpur	1.7 (0.9)	2.0
All	1.9 (1.0)	2.0

Note: Frequency >4/ month omitted in analysis; n/N = 68/354;

Table 22. Purpose of use of tanker water

Purposes	Kathmandu		Lalitpur		All	
	n	%	n	%	n	%
Drinking	73	30	93	84	166	47
Cooking	130	53	102	92	232	66
Bathing	225	93	110	99	335	95
Laundry	225	93	103	93	328	93
Cleaning	216	89	85	77	301	85
Gardening	159	65	26	23	185	52
Other purposes	131	54	22	20	153	43

Bhaktapur: no tanker water users

3.2.5 Combination of water sources in use

The concept of categorizing the use of different water sources into three was used by ADB (2010). Here, improved is defined as using piped water only, alternative meant sources other than piped water. None of the HHs depend totally in Kathmandu whereas it was 4% in Bhaktapur and 1% in Lalitpur (Table 23). In contrast, 36%, 14% and 31% HHs in Kathmandu, Bhaktapur and Lalitpur, respectively, use alternative source only.

Table 23. Combination of water sources in use

Water use	Improved only		Improved and alternative		Alternative only	
	n	%	n	%	n	%
Kathmandu	0	0	583	64	323	36
Bhaktapur	3	4	63	82	11	14
Lalitpur	2	1	99	67	46	31
All	5	0	745	66	380	34

Improve: Piped water; Alternative: Groundwater, jar water, tanker water, rain water, spring water, stone spout, and river water

Water consumption in this study is based on piped water, groundwater, jar water and tanker water. Over all, mean water consumption per HH was 436 L/ day (Table 24). Highest volume of water consumption was in Kathmandu followed by Bhaktapur and then by Lalitpur. Highest water consumption per capita (LPCD) was in Bhaktapur. Both in Kathmandu and in Bhaktapur, LPCD exceeded optimum level (100 L) as defined by Howard & Batram (2003) but that was at the brink of the level for Lalitpur. It showed that although there is very poor provision of water by the utility, people somehow are managing to access for the optimal level of the water they need even in dry season. However, the quality of the water being used is uncertain and it will be interesting to know the consumption pattern difference in wet season.

Table 24. Water use per day per HH & per capita (Excluding spring and river water)

		Water use per household per day in litres	Water use per capita per day in litres (LPCD)
Bhaktapur			
n = 77	Mean	385	162
	Median	300	80
Kathmandu			
n = 906	Mean	458	122
	Median	320	80
Lalitpur			
n=147	Mean	329	96
	Median	233	63
All			
N = 1130	Mean	436	121
	Median	291	80

3.3 Water use by house ownership

ADB (2010) reported significant differences in the water sources and amount of water used by owners and tenants. In this study, the percentage of tenants using groundwater, rainwater, jar water, neighbour's well and public well were slightly higher than that of owners (Table 25). Whereas, the percentage of owners using tanker water and stone spout were slightly higher than that of tenants. However, equal percentage of owner and tenants were depending on alternative water source only (Table 26).

Table 25. Different sources in use by owner and tenants

Ownership	Piped water		Groundwater		Rainwater		Jar water		Tanker water	
	N	%	N	%	N	%	N	%	N	%
Owner	435	66.2	328	49.9	46	7.0	441	67.1	223	33.9
Tenant	314	66.5	262	55.5	49	10.4	358	75.8	132	28.0
Ownership	Neighbor's piped water		Neighbor's well water		Stone spout water		Public well		Spring water	
	N	%	N	%	N	%	N	%	N	%
Owner	15	2.3	14	2.1	22	3.3	5	.8	1	0.2
Tenant	12	2.5	17	3.6	10	2.1	7	1.5	2	0.4

Table 26. Combination of water sources

Ownership	Owner		Tenant	
	n	%	n	%
Improved water only	4	.6	1	.2
Improved and alternative water only	431	65.6	313	66.3
Alternative only	222	33.8	158	33.5

Table 27. Water consumption per HH and per capita

Ownership of house	Water consumption (L/ day)	
		Per capita
Owner (n = 657)	Mean	125
	Median	88
	SD	111
Tenant (n = 472)	Mean	116
	Median	56
	SD	171

p-value > 0.05 (Independent sample t-test)

Although slight differences on coverage of different water sources were seen between owner and tenants, mean water consumption per capita were not different significantly (p-value > 0.05) (Table 27).

3.3 Monthly water cost and willingness to pay

The mean monthly cost for piped water, jar water and tanker water were NRs. 267, NRs. 1145 and NRs. 4029 respectively (Table 28). The mean monthly cost for HHs in Bhaktapur was NRs. 261 and NRs. 1434 for piped water and jar water respectively. NRs. 4507 per month has been paid by HHs in Kathmandu for tanker water. And, HHs in Lalitpur paid NRs. 331 for piped water.

Table 28. Monthly cost of piped water, jar water, tanker water and total water use

		Piped water cost/month	Jar water cost/month	Tanker water cost/ month
Bhaktapur	Valid cases	66	17	0
n = 77	Mean (NRs)	261	1434	0
	Median (NRs)	300	1200	0
Kathmandu	Valid cases	556	651	243
n = 906	Mean (NRs)	257	1180	4507
	Median (NRs)	150	1260	2700
Lalitpur	Valid cases	96	131	111
n=147	Mean (NRs)	331	933	2981
	Median (NRs)	200	600	2000
All	Valid cases	718	799	354
N = 1130	Mean (NRs)	267	1145	4029
	Median (NRs)	150	1120	2400

N or n = valid cases + missing cases

Table 29. Monthly water cost

Category	Summary	Monthly cost (NRs.)
Kathmandu	Mean	1579
	Median	1400
	Std. Deviation	1509
Bhaktapur	Mean	374
	Median	300
	Std. Deviation	404
Lalitpur	Mean	2379
	Median	2010
	Std. Deviation	1670
Owner	Mean	1694
	Median	1400
	Std. Deviation	1632
Tenant	Mean	1482
	Median	1365
	Std. Deviation	1399
All	Mean	1607
	Median	1400
	Std. Deviation	1544

In this study, the mean monthly cost for water paid by the participants were NRs. 1607 (Table 29). The monthly cost of water paid by HHs has been categorized by district and ownership of house. HHs in Bhaktapur paid only NRs. 374 monthly whereas HHs in Lalitpur paid NRs. 2379. Low

monthly water cost for Bhaktpur might be because tanker water use was none and less percentage of HHs used jar water (Table 15). The difference in monthly cost between owners and tenants was also not very big.

Table 30. Willingness to pay for good quality water

	Willingness to Pay (NRs.)			
	Kathmandu	Bhaktapur	Lalitpur	All
Mean	515	494	378	496
Median	300	400	250	300
Std. Deviation	712	853	408	690

The willingness to pay (WTP) for good quality water was not very high compared to the monthly cost they are spending for water (Table 30). Maximum mean WTP was reported by HHs in Kathmandu which as NRs. 515.

3.4 Water treatment practices

Almost all HHs treat drinking water (Table 31). Only 20% HHs treat water used for cooking, 10% treat water used for vegetable washing and brushing teeth. Nearly 4% HHs used water for bathing purpose too. Among the different types of methods used for treating drinking, cooking, vegetable washing and teeth brushing water, filtering, using ceramic filter, was the widely adapted method (Table 32). For treating drinking water, 44% of HHs use more than one type of treatment method, 12% of HHs boil only, 2% HHs used electric filter only and 2% HHs used Chlorine/ Alum/ Potash only. For treating cooking water, 23% HHs use more than one type of treatment method. 9% HHs use chemicals, 6% HHs use boiling, 4% HHs use domestic treatment plant for treating water used for cooking. For bathing, 50% HHs used chemical treatment method.

Table 31. Treatment of water used for different purposes

Treatment	No		Yes		missing	
Purpose	n	%	n	%	n	%
Drinking	178	15.8	947	83.8	5	0.4
Cooking	889	78.7	228	20.2	13	1.2
Vegetable wash	1001	88.6	115	10.2	14	1.2
Brushing teeth	1008	89.2	108	9.6	14	1.2
Bathing	1074	95.0	42	3.7	14	1.2
Other purposes	1089	96.4	24	2.1	17	1.5

Table 32. Different water treatment methodologies in practice

Method of treatments	Drinking		Cooking		Veg washing		Brushing teeth		Bathing		Others	
	n	%	n	%	n	%	n	%	n	%	n	%
Filtering (Ceramic filter)	371	40	127	57	79	71	68	74	13	33	6	26
Boiling	113	12	14	6	2	2	-	-	3	8	-	-
Electric filter	21	2	2	1	1	1	-	-	2	5	1	4
Chlorine/Alum/Potash	16	2	20	9	19	17	18	20	20	50	16	70
Domestic treatment plant	3	0	9	4	4	4	6	7	2	5	-	-
More than one type	412	44	52	23	6	5	-	-	-	-	-	-
Total	936	100	224	100	111	100	92	100	40	100	23	100

3.5 Sanitation and hygiene

In this sub-heading the data on wastewater management practice and cleaning frequency of water storage vessels were included. The HHs which were connected to sewer were 96% and 4% still flush their waste to septic tank or pit (Table 33). Less than 60% of HHs in both Bhaktapur and Lalitpur were connected to sewer and around 40% had septic tank or pit.

Hygiene behaviour such as cleaning of storage vessel has been directly linked with risk of diarrhoeal diseases. 81% of HHs clean the storage vessels every day. 14% clean them on weekly basis and 4% on monthly basis as well (Table 34).

Table 33. Wastewater management category

	Flush to piped sewer		Flush to septic tank/pit		Flus to somewhere		Missing	
	n	%	n	%	n	%	n	%
Kathmandu	868	96	36	4	0	0	2	0
Bhaktapur	44	57	33	43	0	0	0	0
Lalitpur	86	59	54	37	3	2	4	3
All	998	88	123	11	3	0	6	1

Table 34. Frequency of cleaning water storage vessels

	n	%
Yearly	1.0	.1
Monthly	48.0	4.2
Weekly	154.0	13.6
Daily	916.0	81.1
Never	6.0	.5
Missing	5.0	.4

3.6 Health status

The percentage of HHs reporting physical illness in this study was 11%. These physical symptoms were related with water such as back pain, stomach ache, scabies, trachoma etc. Only 1.6% HHs reported that at least one of their family member experience diarrheoa in last two weeks (Table 35). The number of cases were none for Bhaktapur, 11 (1.2%) for Kathmandu and 7 (4.8%) for Lalitpur district. 41% HHs in Bhakatpur did deworming in last 6 months and the percentage was 19 for Kathmandu and 20 for Lalitpur (Table 36).

Table 35. Diarrhoea cases last two weeks

District	Frequency	Percent
Bhaktapur	0	0.0
Kathmandu	11	1.2
Lalitpur	7	4.8
All	18	1.6

Table 36. Deworming in last 6 months

District	Frequency	Percent
Bhaktapur	32	41.6
Kathmandu	173	19.2
Lalitpur	30	20.4
All	235	20.8

4. Conclusion and limitation

This study assessed different dynamics of HH water use in dry season in the Kathmandu Valley which is undergoing a severe water scarcity. After ADB report (2010), this is the first wide scale HH survey in the Kathmandu Valley. The uniqueness of this study lies in the vision of bringing the information about HH water dynamics on to the surface. Per capita water consumption had always been an issue of debate due to lack of detailed information. In addition, in this growing water market, pattern of water buying and the cost associated will be an interesting information for several researchers as well as to different stake holders. This report tried to estimate HH expenditure in water only. Similarly, this study added facts and figures about water treatment practices, sanitation and hygiene practices in HHs and about health situation.

Less than 67% HHs possessed private water source (either piped water or groundwater). 66% HHs have piped water connection and 52% HHs have groundwater well. Among different alternative water sources, the coverage of jar water was highest (71%) followed by groundwater and then tanker water (31%). Majority of HHs use jar water for drinking purpose and groundwater and tanker water for bathing, laundry and cleaning. Piped water was supplied only < 4 hours/ week. So, basically the demand of large volume water had been full filled either by groundwater or by tanker water. Among three districts in this study, HHs in Bhaktapur did not rely on tanker water. On an average, frequency of buying jar water and tanker water were 6/ per week and 2/ month respectively. The estimated mean LPCD in this study was 121. The mean monthly expenditure in water was NRs. 1607 but the mean WTP for good quality water was 3 times lower than this expenditure.

Majority of HHs treat drinking water and mostly used treatment methods were with filter (40%) or more than one type of methods (44%). It is found that some percentage of HHs treat water for cooking and for washing vegetables too and the most common treatment method was filtering. However, those HHs which responded that they treat water for bathing, majority have reported treating it by chemical method. 88% of HHs were connected to sewer lines. 81% of HHs clean their water storing vessels daily. The percentage of HHs reporting diarrhoea were only 1.6%.

The findings of every study should be interpreted in the light of some limitations. One limitation of this study is related to little ambiguity in information related to tanker water amount used by HHs. Since several sequential similar surveys are ongoing we look forward to revise and curb the before mentioned limitation and release more revised data in near future. Apart of such limitation, our study has unveiled different dynamics of rarely studied HH water consumption aspect. Our team hopes that these data will be helpful in decision making for betterment of the water sector in the Kathmandu Valley and we recommend further researches on the scenario of water insecurity and the effect of water unavailability on people's life.

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