B−27 RESIDENTIAL WATER CONSUMPTION PATTERN IN KATHMANDU VALLEY, NEPAL

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Water demand management can be a viable option to reduce water shortage. This study aims to examine residential water consumption pattern for understanding potential water management measures at a household level. Household questionnaire survey based on stratified random sampling was conducted in Kathmandu valley. Depending on duration of piped water supply, income and storage facilities, households were found to use different water sources. Average ±standard deviation of water consumption was 36.9 ±11.1 L/ca/d and varied across different income and water source users. Water consumption of households depending on multiple sources was found to be consuming high proportion of their consumption for non- potable use than household. Since water consumption patter varied among different income and water source user groups, this variation has to be accounted for water demand management.

Key words: *demand management, household, Kathmandu, source, water consumption*

1. INTRODUCTION

In Kathmandu valley, water shortage has become a serious problem. The water utility supplies 75,720 m^3/d during dry season and 105,170 m^3/d during wet season, while demand is estimated to be 320,000 m^3/d[1)]. The government aims to import 170,000 m^3/d of water from neighboring watershed, by 2013.

Due to high investment cost and delay in completion of the project, government of Nepal has stressed for water demand management [2)]. Lack of empirical data on water consumption pattern hinders the implementation of those measures. Also, potential impacts of water demand management are unknown. Earlier studies in Kathmandu valley reported high rate of groundwater extraction[3)] and stressed for improvement of piped water services[4)]. This research aims to provide essential information for water management by examining water sources of households and their consumption pattern.

2. METHODOLOGY

(1) Sample design

Multistage stratified random sampling was conducted for selection of 217 households in Kathmandu valley. At first stage, the study area was categorized into three zones on basis of population density. For each zone, toles (informal residential clusters) were numbered and listed. Using random table, toles were selected and finally, five households were selected from each tole.

(2) Questionnaire survey

A structured questionnaire survey was conducted during December, 2011 and January, 2012. Table 1 shows the contents of questionnaire survey.

Table1: Contents of questionnaire survey

Section	Questions
Socio-economic information	Family size, monthly income, housing ownership
Water supply sources	Types of sources, their purposes, duration of piped water supply *etc.*

(3) Water consumption measurement

Thirty two households were selected for measuring water consumption for drinking, cooking, general hygiene, bathing, laundry, dishwashing and toilet for seven consecutive days. Total water consumption was calculated as shown in Eq. 1.

$$Twc = \frac{D+C+H+B+L+U+T}{N * 7} \quad \text{(Eq. 1)}$$

Where, *Twc*: Total water consumption (L/ca/d)
D, *C*, *H*, *B*, *L*, *U*, and *T* stands for water consumption (L/family/week) for drinking, cooking, hygiene, bathing, laundry, dishwashing and toilet use, respectively and *N*: Family size (person)

(5) Data Analysis

Descriptive statistics like frequency, mean and median were used to examine data on demographic characteristics, water supply sources and water consumption. The data were processed, tabulated and analyzed using and Microsoft Excel- 2010.

3. RESULTS AND DISCUSSION

(1) Water supply sources

Surface water and groundwater were major water sources. Table 2 shows description of water sources and percentage of respondents using those sources. Households were mostly depended on piped water supply (77.4%) and private wells (43.3%).

The water supply utility supplied water to different section of service area in rotation basis, ranging from two hours in a day to two hours in seven days. Households located closer to sources received piped water supply more frequently. Due to intermittent supply, households were depended on multiple alternative sources as shown in Fig. 1. The majority of households (58.9%) receiving piped water supply for less than one h/day had to purchase water from tanker, vendor or bottled water. Hence intermittent water supply posed health risks[5], and added additional financial burden on households.

As shown in Fig. 2, free water sources *i.e.* public tap, public well and stone spout, users belonged to low and medium income groups. Those sources were not available at all locations. In addition, the majority of vendor users also belonged to low income groups (67.9%), while 67.7% of tanker users belonged to high income group. This difference among income groups for selection of water sources can be partly attributed to contrast in size of their water storage tanks as shown in Fig. 3. The median size of storage tanks owned by high income group was 6,000 L, while it was 450 and 160 L for medium and low income groups, respectively. Large storage tanks were not affordable and feasible for low income households.

Table 2: Description of water supply sources

Sources	Description	% of users (*N*= 217)
Piped water	Utility's piped water supply for an individual house	77.4
Private well	Well on private land and its use restricted by owner	43.3
Bottled water	Private water supplier, who supplies packaged water (20 L)	35.9
Tanker	Private water supplier, who supplies in bulk (5-12m^3)	14.3
Vendor	Private water supplier, who supplies in retail (15-25 L)	12.9
Stone spout	Traditional water fountain and used by community	10.1
Public standpipe	Utility's piped water supply for community	8.8
Public well	Well used by community	7.4

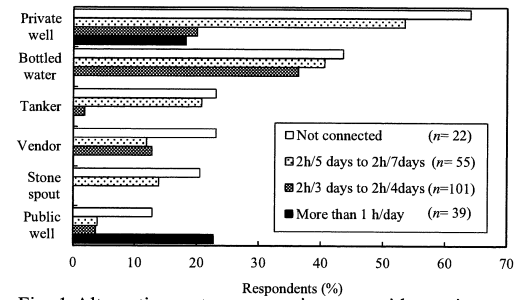

Fig. 1 Alternative water sources in areas with varying duration of piped water supply

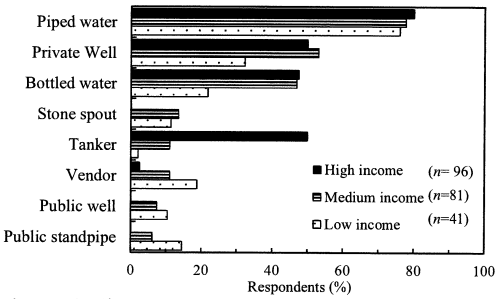

Fig. 2 Distribution of water supply sources in different monthly income groups *i.e.* low (less than NRs 15,000), medium (NRs 15,000 – NRs 30,000), high (above NRs 30,000)

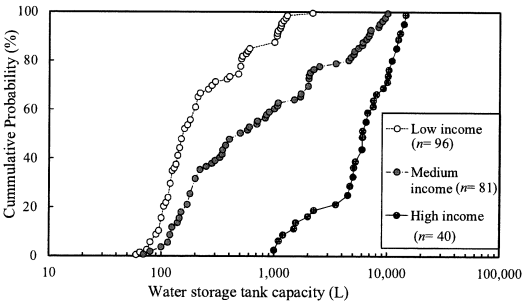

Fig. 3 Water storage tank among different income group

(2) Water consumption pattern

Average water consumption of 32 households, based on direct measurement, was 36.9 ±11.1 L/ca/d. Based on questionnaire survey, CBS[6] reported average water consumption for Kathmandu as 35.0 L/ca/d. Average water consumption pattern of low income group was 28.9 ±8.8 L/ca/d, while for medium and high income group it was 34.4±5.1 L/ca/d and 52.1±7.5 L/ca/d, respectively. Water consumption per capita of low and medium income group was lower than basic water requirement of 50.0 L/ca/day[7].

Water consumption of households depending on different sources varied as shown in Fig 4. The households depending only on piped water was found to have the lowest water consumption (23.3±3.8 L/ca/d), while users combining piped water with tanker (47.7±10.5 L/ca/d) had the highest consumption, followed by users combining private well and bottled water (45.4±10.5 L/ca/d) and piped water and private well (41.5±6.8 L/ca/d).

Table 3 shows that households depending only on piped water consumed high proportion of total consumption for potable purpose (21.5%) and least (78.6%) for non-potable. Meanwhile, households depending on combination of tanker or well in combination with piped water, consumed above 80% of total consumption for non-potable purpose. This suggests that households depending only on piped water have been coping with water shortage by reducing their water consumption for non-potable use, while high income households were less likely to reduce their consumption, instead purchase water to fulfill their demand. Households having access to private well were likely to consume more water, since wells were easily accessible and freely available. High consumption for non-potable use among well users suggests potential of grey water reuse and rainwater harvesting to reduce groundwater extraction.

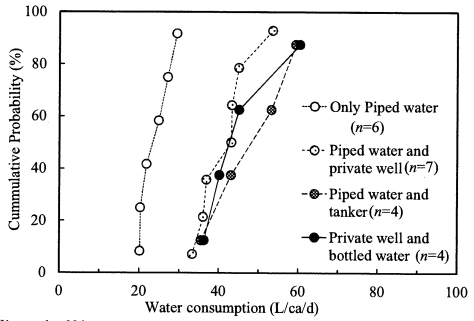

Fig. 4 Water consumption of selected water source combinations

Table 3: Proportion of water consumption for different activities

	Piped water	Piped water and tanker	Piped water and private wells	Private wells and bottled water
Drinking (%)	7.0	3.8	4.3	3.5
Cooking (%)	14.4	12.1	11.9	13.9
Hygiene (%)	15.6	17.9	15.2	9.0
Bath (%)	13.3	12.5	13.4	19.9
Laundry (%)	13.4	15.5	12.8	18.9
Dishwashing (%)	22.5	18.4	19.2	17.1
Toilet (%)	13.8	19.7	23.3	17.6

4. CONCLUSIONS

The majority of households were found to be dependent on multiple sources. Duration of piped water supply, monthly income and size of storage tank were determining factors for selection of alternative water sources. Water consumption of different income groups and water source users varied. Higher consumption of water for non-potable use suggests potential of grey water reuse and rainwater harvesting. Social acceptability and technical feasibility of these measures have to be further explored.

REFERENCES

1) Kathmandu Upatyaka Khanepani Limited: *Quarterly operating report: First Quarter 2065* (July-October, 2008), Kathmandu Upatyaka Khanepani Limited, 2008
2) National *Trust for Nature Conservation: Bagmati Action Plan (2009/10-2014/15)*, NTNC, Kathmandu, Nepal, 2010.
3) Pandey, V.P., Chapagain, S.K. and Kazama, F.: Evaluation of groundwater environment of Kathmandu valley. *Environment Earth Science*, 60, 1329-1342, 2010.
4) Whittington, D., Pattanayak, S.K., Yang, J.C. and K.C. B.: Household demand for improved water services: Evidence from Kathmandu Nepal. *Water Policy*, 4, 531-55, 2002.
5) World Health Organization: Guidelines for drinking-water quality incorporating1st and 2nd addenda, Vol. 1 Recommendations, 3rd Edition. WHO, Geneva, 2008.
6) Central Bureau of Statistics: *A report on water survey of Kathmandu, 2005*. Central Bureau of Statictics, Kathmandu, Nepal, 2005.
7) Gleick, P.H.: Basic water requirement for human activities: Meeting basic needs. *Water International*, 21, 83-92, 1996.

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