Sustainability: Science, Practice, & Policy
http://ejournal.nbii.org

ARTICLE

User satisfaction and sustainability of drinking water schemes in rural communities of Nepal

Betman Bhandari[1]* & Miriam Grant[2]

[1] Centre for Affordable Water and Sanitation Technology, 2916 5th Avenue NE, Calgary, Alberta T2A 6K4 Canada (email: bbhandari@cawst.org)
[2] Department of Geography, University of Calgary, 2500 University Drive NW, Calgary, Alberta T2N 1N4 Canada (email: grant@ucalgary.ca)

Water-supply programs consist of three essential components: technology, people, and institutions. The interface of these facets determines whether a particular scheme is sustainable. This article highlights the differences in maintaining and operating water-supply systems in rural villages and rural market centers in Nepal. The analysis considers disparities between users' willingness to pay based on data collected through surveys of 205 households and representatives of 12 water-user committees. Due to varying geographical locations and socioeconomic conditions among rural villages and rural market centers, core operation and maintenance problems for drinking water sustainability are immensely different. Weak institutional capacity is the prime obstacle in the provision of drinking water in the rural villages while technicalities such as insufficient water quality and inconvenient water-point locations are the major issues in the rural market centers. Moreover, levels of user satisfaction influence the operation and maintenance of both types of systems. This study considers user-satisfaction parameters and the overall influence of satisfaction on users' willingness to pay.

KEYWORDS*:* rural areas, municipal water supplies, sustainable development, social behavior, socioeconomic factors, drinking water

Introduction

Water supplies and sanitation were first highlighted on the development agenda about 30 years ago. This was a result of the 1977 United Nations Conference in Mar del Plata, Argentina that recommended proclaiming the 1980s to be the International Drinking Water Supply and Sanitation Decade with the goal of "provid[ing] every person with access to water of safe quality and adequate quantity, along with basic sanitary facilities, by 1990" (World Water Assessment Programme, 2003). International water policies and management practices have generally considered water to be a free and renewable resource. Governments in developing countries have often subsidized water supplies, typically in an attempt to achieve social and health benefits for low-income households that comprise a large majority of the rural population (Lammerink, 1998; Whittington et al. 1998). Furthermore, developing countries have made huge investments in their rural water supplies under the presumption that local communities will be involved in their maintenance and operation.

Rural water-supply schemes in Nepal are partially or fully funded from governmental and nongovernmental resources. Many governmental organizations (GOs), nongovernmental organizations (NGOs), and international nongovernmental organizations (INGOs) are working in Nepal to increase coverage and to provide safe water supplies and sanitation to underserved populations in poor and remote areas. The consumption of water in rural communities of Nepal is quite different from other countries. The customary strategy does not normally entail charging for water from public taps that are located among 5–15 houses within a 500 meter distance. However, other countries and agencies such as the World Bank recommend that users should pay for water services (Asthana, 1997). To escape problems created by this approach, donor and government officials in developing countries have focused on financial issues, especially the generation of revenue through domestic connection (Singh et al. 1993).

Project-evaluation reports from developing countries indicate that shoddy construction of drinking water supply (DWS) schemes, excessive administrative centralization, lack of rewards for good operation and maintenance, and widespread corruption in supporting organizations are the major causes of failed system maintenance (Howe & Dixon, 1993; Singh et al. 1993). Similarly, in the context of Nepal, most DWSs are unsuccessful due to lack of involvement

*Corresponding Author

by women during the planning stages, government supervision, supporting mechanisms for the handover of DWSs, and coordination among local water-user committees, local government, and district water-supply authorities (Sharma, 1998; Bhandari et al. 2005).

Although evaluation reports by governmental and nongovernmental agencies have highlighted the core problems for project sustainability, fundamental differences between rural market centers and villages have not been properly analyzed. The cultural, political, and socioeconomic situations—as well as the geographical settings—of Nepalese market centers and villages are quite distinct. Rural market centers tend to be located at the junction joining two or three villages and offer economic, social, administrative, and financial services (RUPP, 1999). Due to a subsistence economy and unemployment, internal migration pressure is increasing in rural market centers. The level of infrastructure in market centers has become a prime attraction for migrants and this trend has increased pressure on water supplies.

Many scholars claim that water-supply projects will be sustainable when consumers are willing to pay user charges that are sufficient to cover all costs in excess of grants. Willingness to pay (WTP) can be construed as an indication of the demand for improved services and their potential sustainability (Kaliba et al. 2003). In contrast, other observers have concluded that rural water systems are unlikely to be sustainable unless grants are available to finance most or all initial construction costs (Bohm et al. 1993). A study of Kathmandu's water supply shows that additional costs are almost twice as much as current monthly bills paid to the water utility (Pattanayak et al. 2005). Researchers recommend different models for WTP, but most assessments envisage a cost-recovery policy in the rural water sector (Whittington et al. 1990; Altaf et al. 1993; Howe & Dixon, 1993). Research has involved the use of the contingent valuation (CV) method to forecast WTP for potable water-supply services. Piper & Martin (1997) and Kaliba et al. (2003) report that households located far from water points evince higher WTP than counterparts living within proximate distance. Moreover, this relationship appears to be valid both for low-income users and where water quality and supply systems are poor.

According to government policy, the operation and maintenance costs of DWS projects in rural areas of Nepal should be covered by the community itself while the investment cost for such projects should be financed by the government or donor agencies (NPC, 1998). Communities may also contribute to project investment by providing labor, land, and local materials. Individual house connections or meter systems are not used in the rural water-supply system; therefore, grain or small amounts of cash can be raised from beneficiary households to cover the scheme's maintenance and operation expenses.

A sustainable water future depends on appropriate prices and the necessary resources need to come from project consumers (World Bank Water Demand Research Team, 1993; Whittington, 1998). However, Whittington et al. (1990) discovered that rural customers in Nigeria do not want to pay for water in advance or commit themselves to a fixed monthly payment due to their mistrust of public providers. Some scholars have focused on community-water education and the creation of organizational capacity to ensure project sustain-ability (Baker et al. 2006). The literature shows that water-user committees play a vital role in the sustainability of rural water schemes and that the enhancement of facilitation skills, the clarification of responsibilities, the improvement of transparency in decision making, and the augmentation of credibility are essential for making a committee trustworthy (Lopez-Gunn & Cortina, 2006).

According to Bohm et al. (1993), WTP for improved water services increases with income and wealth, family size, education, and dissatisfaction with traditional sources. In the same vein, a study on household demand for an improved water-supply system in Kathmandu shows that consumers' WTP for better service is increasing (Whittington et al. 2002). A similar study in Indian cities shows contradictory results and suggests that satisfied consumers are not willing to pay more for improved DWS schemes (Raje et al. 2002). Most scholars have focused on the financial sustainability of municipal (urban) or corporate water systems. The current study examines the variables that influence users' WTP for the operation and maintenance of rural DWS schemes in Nepal. This analysis also compares core problems on the basis of an institutional survey regarding the sustainable operation and maintenance of DWS schemes in the country.

Methods of Data Collection and Analysis

The Survey Instruments

A three-pronged survey instrument was applied in this study of drinking water schemes in Nepal. The methodology first called for informal discussions with key informants about the strengths and weaknesses of existing water-supply schemes and their management. In the second phase, a random institutional survey of water-user committees was conducted. The final stage of this process involved implementation of a systematic random survey of 205 Nepalese households.

Supply conditions refer to such factors as hours and timing of provision, quantity, tap pressures, and quality of water that were deduced from factor analysis. A five-point Likert scale—including points for not at all satisfied, not satisfied, partially satisfied, satisfied, and highly satisfied—indicated respondents' opinions on each of these factors. Also, a ranking question was included to find the level of importance that respondents assigned to each factor. Three major procedures—conjoint analysis, dichotomous choice, and the payment-scale approach—are popular for contingent evaluation (Baidu–Forson et al. 1997; Kaliba et al. 2003). To elicit WTP information from individuals, the dichotomous choice approach was applied. Responses were obtained on a dichotomous scale (yes or no) on the supposition that users would have to pay at minimum double the present amount (from Rs. 20–100 (US$1=Rs. 72) per month. Respondents' assessments of the trustworthiness of the water-user committees and the affordability of water charges were obtained in a similar manner.

Model

The most widely used model in CV studies is based on logistic regression. The model here uses variables of degree of satisfaction (DOS), trustworthiness of water-user committees (WUC), and affordability to describe users' WTP for water. Because of the dichotomous structure of the dependent variables (i.e., WTP) a non-linear prob-abilistic model was used to help estimate the probability of occurrences of an event as given by

$$\text{Probability (event)} = 1/1+e^{-z} \tag{1}$$

Where Z is the linear combination of variables X_1, X_2, X_3,…, X_n

$$Z = B_0 + B_1X_1 + B_2X_2 + \ldots + B_pX_p \tag{2}$$

The above probability expression can be transformed to determine the log odds in favor of the event as

$$\text{Log }\{\text{Prob (event)}/1\text{–Prob (event)}\}$$

$$= B_0 + B_1X_1 + B_2X_2 + \ldots + B_pX_p \tag{3}$$

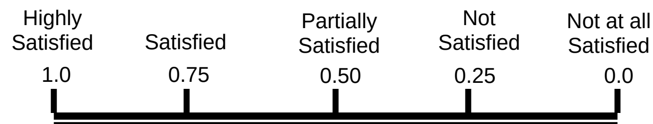
In the present context,

$$Z = B_0 + B_1\text{ (DOS)} + B_2\text{ (Affordability)} + B_3\text{ (WUC Trustworthiness)} \tag{4}$$

It was assumed that the variable corresponding to the degree of satisfaction might have a negative influence on the WTP of water users. In other words, people with low satisfaction levels might indicate their WTP in anticipation that in the future their demands would be fulfilled, while those who were already satisfied might not be willing to pay.

Degree of Satisfaction

The composite index approach is also a simple and straightforward format that is widely used in planning and evaluation studies such as the human-development index and the rating index (Sullivan, 2002; Sullivan et al. 2003). Specifically, this satisfaction scale was developed on the basis of factor analysis to measure user satisfaction (Figure 1).



$$\text{AWI} = \frac{f_h(1.0) + f_s(0.75) + f_p(0.50) + f_n(0.25)}{ni * N}$$

AWI = Average Weighted Index
f_h = frequency of high satisfied
f_s = frequency of satisfied
f_p = frequency of partially satisfied
f_n = frequency of not satisfied
ni = number of items
N = total number of observations

Figure 1 Satisfaction scale.

Study Area and Data Collection and Analysis Methods

The literature often describes drinking water in just two types of DWS schemes: urban and rural. In fact, geographic location and accessibility of water can make a major difference in the livelihoods and living standards of rural residents. This study in Nepal was therefore carried out with two geographical categories of rural water-supply systems: village and rural market center. Villages are rural settlements without a market or any public facilities. In contrast, rural market centers are small communities with a market and public services. Village-market centers generally have more than three foot trails that meet within their boundaries. Usually rural market centers in Nepal have more than 100 households with teashops, schools, and a few government-service centers. The DWS samples were chosen from both villages and market centers. Due to the many INGOs and NGOs working in the drinking water field, the study area was chosen from two districts: Kavre from the mid-region of Nepal and Baglung from the western region of the country (Figure 2).

Figure 2 Study area.

Sampling

On the basis of information provided by the Department of Drinking Water Supply and Sewerage, we chose for this study the largest DWS schemes in the Kavre and Baglung districts (Table 1). The number of surveyed households was based on the project reports prepared by the DWS installation agencies. A sample size of 88 respondents was selected from a total of 771 market-center households. Similarly, a sample size of 117 respondents was drawn from a total of 1,327 rural village households,. This sampling methodology assumed that the expected rate of occurrence was not less than 90% at the 95% confidence level with a precision level of 3%. Following Arkin and Colton (1963), the sample size (based on a total of 2,098 households) was computed from the following formula.

$$n = \frac{NZ^2 * p * (1-p)}{Nd^2 + Z^2 * p\,(1-p)} \qquad (5)$$

Where,

n = sample size
N = total number of households
Z = confidence level (at 95% level Z = 1.96)
p = estimated population proportion (0.5, this maximizes the sample size)
d = error limit of 5% (0.05)

Data Collection

Prior to data collection, the lead author held a meeting with selected local residents, community leaders, officials from the district water-supply offices, representatives from local NGOs, contact persons, and members of the village-development committees (VDC). During the session the villages to be included in the survey were identified and this determination ensured the cooperation of relevant individuals from the respective villages and communities throughout the field-survey period. This initial meeting served as a confidence-building measure. Because they were well informed of the research goals, villagers and WUC members involved themselves actively in participatory rural appraisal sessions, discussions, and WTP workshops. The four locally hired enumerators visited households through random sampling and interviewed either household heads or women in charge of household finances.

Table 1 Sample water-supply projects in rural market centers and rural villages.

DWS projects in rural market centers	Village-development committees	Benefited HH	Subsample size	Year completed
Todke DWS (INGO)	Dudhilabhati Ward No. 5	80	14	1994
Bhulkemul DWS (GO)	Narethanti Ward No. 1, 3	208	25	1989
Bajange Dahare DWS (NGO)	Bhimpokhara Ward No. 6	57	7	1996
Shipaghat DWS (INGO)	Panchkhal Ward No. 3, 5	135	12	1994
Chalal DWS (GO)	Chalal Ganeshthan Ward No. 1, 8, 9	183	20	1992
Mechhe DWS (NGO)	Kushadevi Ward No. 1, 2	108	10	1995
Totals		771	88 (11%)	
DWS projects in rural villages				
Gahate DWS (INGO)	Dagahatundanda Ward No. 6, 7	166	20	1993
Tangram DWS (GO)	Tangram Ward No. 6, 7, 8, 9	501	28	1992
Bhim Pokhara DWS (NGO)	Bhimpokhara Ward No. 5	192	20	1994
Geldung DWS (INGO)	Dhumkharka Ward No. 8, 9	142	14	1994
Bhamarkot DWS (GO)	Panchkhal Ward No. 1, 2, 3, 4	135	15	1994
Jalachiti Taukhal DWS (NGO)	Taukhal Ward No. 4	191	20	1990
Totals		1327	117 (9%)	
Grand Totals		2098	205 (10%)	

Data Analysis

Data were analyzed using a standard social science statistical software program. The degree of satisfaction with drinking water services installed by different development agencies was measured using the Likert scale, a scaling approach used in social research through standardized response categories on surveys in which the concept of measuring an object is assumed to be one-dimensional (Likert, 1932; Trochim, 2001). The survey data were then analyzed by binary logistic regression.

The scale's internal consistency was measured by the reliability coefficient, Cronbach's alpha (Cronbach, 1951), that ranged from 0 to 1; the larger the value, the greater the reliability. Logistic regression was then used to determine whether such demographic variables as gender, age, education, and income helped to explain perceptions regarding WTP. Bivariate data categorical responses were then analyzed using Pearson's χ^2 distribution test to discern if two variables were independent of each other (Tessler & Warriner, 1997). If the two variables were not dependent ($p < 0.05$), Cramer's V was employed as a measure of association (Bishop et al. 1975). The value of Cramer's V ranged from 0 (no association) to 1 (perfect association). A Wald test was used to assess the statistical significance of each coefficient (β) in the model.

Results and Discussions

Exploring Factors Related to Consumers' Satisfaction

Factor analysis was employed to select the satisfaction component among highly correlated items. This technique is often used to examine underlying patterns (reliability) or to identify relationships among a large number of variables and to determine whether the information can be summarized (validity) into a smaller set of factors or components (Kim & Muller, 1978).

The data matrix has sufficient correlation to justify interrelated sets of variables. If visual inspection reveals no substantial correlation greater than 0.3 then factor analysis is probably inappropriate. At the first stage, variables were selected and assessed in order of their significance of covariance (< 0.5) with at least a 0.01 confidence level. The principal components method was used to analyze the data.

Factor analysis reveals that water sufficiency, reliability of water supply, trustworthiness of the water-user committees, convenient water-point location, water quality, and water pressure (flow rate) have become prime indicators (principal components) of users' degree of satisfaction (Table 2).

Table 2 Factor analysis based on performance-related indicators.

Variables	Items	Factor-loading Degree of Satisfaction
WATERSUFF	Water sufficiency	0.852
RELIABILITY	Reliability of water supply	0.790
TWUC	Trustworthy water-user committee	0.763
CONWPL	Convenience of water-point location	0.720
QUALITY	Quality of water supply	0.693
PRESSURE	Pressure of water supply	0.667

The set of items identified through factor analysis was combined to form a scale measuring users' preference toward a high level of satisfaction.

Users' Priorities and Satisfaction Levels with DWS Services

Sixty percent of the respondents in the household survey were women, the traditional managers of DWS schemes. Respondents over 50 years of age were designated "old" so as to compare different possible age-group views.

A non-parametric, one-sample χ^2 test was run to examine if any association existed among these categories. In Table 3, B is a logistic regression coefficient, df is the degrees of freedom, SE is the standard error, and R indicates the relative contribution of each dependent variable to the model in explaining the variance of the dependent variable. Logistic regression indicated that no significant association existed between the degree of satisfaction and respondents' demographic characteristics.

Table 3 Logistic regression of the relationship between demographic variables and users' degree of satisfaction.

Variables	B	SE	Wald	df	Sig.	R
Gender (male)	0.6068	0.2932	4.2840	1	0.0385	0.0893
Age (older)	-0.6975	0.2924	5.6919	1	0.0170	-0.1136
Class (wealthier)	0.2053	0.2900	0.5013	1	0.4789	0.0000
Education (literate)	0.2612	0.2971	0.7726	1	0.3794	0.0000

On the basis of average weight index analysis, the study reveals that preferences differ between rural market centers and villages. Users from the rural market centers are more concerned about water sufficiency, water pressure, and convenience of water-point locations. In contrast, among rural village users, reliability, trustworthiness, and convenience of water-point locations are the major concerns. Inconvenient water-point locations are a common problem in both areas. Dissatisfaction with WUCs is relatively high in rural areas (Table 4).

Table 4 Weightings on indicators of satisfaction level.

Indicators	Rural market centers	Stress for improvement	Rural villages	Stress for improvement
TWWUC	0.2097	6	**0.1185**	**1**
QUALITY	0.2001	5	0.2104	5
CONWPL	**0.1628**	**3**	**0.1249**	**2**
WATERSUFF	**0.1038**	**1**	0.2132	6
PRESSURE	**0.1330**	**2**	0.2001	4
RELIABILITY	0.1906	4	**0.1329**	**3**

Note: Bold face indicates users expressing high levels of concern for the improvement.

A recent analysis of water quality shows that the reservoirs and intakes of most of the DWSs in Nepal have pathogen contamination, particularly in the rainy season (Bhandari & Wickramanayake, 2001). However, the current study shows that users from both villages and market centers are less concerned about water quality. The authors conclude that awareness about the importance of safe water is insufficient since users believe that piped water is clean.

Usually the WUCs for rural DWS schemes face problems in the rainy season. The flooding of intake structures and the washout of supply pipelines are periodic problems during this time of the year, resulting in consumer skepticism about water-supply reliability. During the survey of engineering specifications, discussion with WUC members revealed that they were unaware of the importance of the location of their water points. Consequently, some water points are located on private lands and others are in the middle of congested villages. This arrangement creates inconveniences in fetching water, problems with the drainage of wastewater, and fear of landslides during the rainy season. Likewise, WUC members in the rural market centers mentioned that due to burgeoning construction of new houses they now face a water shortage during the dry season.

Synthesis of Group Discussion

According to the manual for rural DWS schemes in Nepal, the WUC has authority to raise money for maintenance and operation from each household. Outside of government-installed DWSs, the WUCs in the study areas raise funds annually and some households pay their share in grain (25–40 kgs) to the village-maintenance operator.[1] Relatively poor families have been exempted from water tariffs for most DWS schemes in the country, a provision that is usually implemented during project installation. The WUC is responsible for evaluating and monitoring these issues.

The WUCs must also pay wages for village-maintenance workers. According to the rural DWS institutional survey, on the basis of the past three years (2001–2003), the WUC of NGO-installed projects are raising Rs. 240–600 annually from each household for this purpose. Similarly, INGO-installed projects have charged Rs. 600–1200 per year for maintenance and operation. Government-installed systems have no capacity to raise money. However, all water schemes have bylaws that users should be responsible for the repair or maintenance of the water faucet (tap) and the cleanliness of their own tap-stand platform. This project found that all WUCs in the rural market centers have bylaws requiring that all households should pay a water tariff of Rs. 50–150 per month or Rs. 600–1800 annually. The WUCs in the market centers indicated that they experienced a 10–15% default rate; however, they are trying to convince and remind all residents of their responsibilities at each meeting. On the other hand, the WUCs in the rural villages reported that more than 50% of their residents had not paid water dues for two to three years. The WUCs stressed that they have no authority to punish or force payment. Government authorities are also located far from the communities and the appeal procedure is complex and lengthy. The market-center WUCs realized that such issues need to be settled by community consensus and highlighted that people perceive an extra burden due to a lack of awareness about the importance of safe drinking water.

One of the survey instruments used in this study involved group discussions with the key DWS stakeholders. Different views and problems were identified in exchanges with the members of the WUCs in rural market centers and rural villages. According to the ranking technique, rural villages encounter the following leading problems:

1. Insufficient collection of money (water tariffs) from water users for maintenance and operation.
2. Difficulty retaining maintenance workers in project areas since they often leave the villages to search for higher paying jobs.
3. Frequent damage by natural disasters such as landslides, floods, and forest fires.

The WUCs in the market centers report the following major problems:

1. During peak hours there are a lot of users at each water point and households located far from the piped tap stands must search for other unprotected sources.

[1] Local market price of grains per kg = Rs. 10–15

2. The majority of households use water in kitchen gardens and encounter an acute shortage for three to four months during the dry season.
3. Water pressure in taps is not sufficient in more elevated settlement areas.

The results show that the market-center WUCs are successful administering DWS projects, but they face technical problems. Due to unexpected household growth and increasing health and hygiene awareness, the water consumption rate is high in the market centers. On the basis of the group discussion, the average consumption rate is 60 liters per capita per day (lpcd) in the market centers and 45 lpcd in the rural villages. Engineers in the district explained that they used 45 lpcd in general in the design of rural DWS projects.

Assuming that a pour-flush latrine needs an average of 2–3 liters of water for every flush, a person would need 12–18 liters of water each day for flushing purposes alone. The minimum criterion of either 25 or 45 lpcd is meant for domestic demands—drinking, cooking, bathing, washing clothes and dishes, latrine flushing, watering animals, and maintaining sanitary conditions in the latrine, bathroom, kitchen, and overall household. The expansion of rural infrastructure significantly influences quality of life and, as a result, increases the consumption of drinking water (Ghimire, 2002). Under such circumstances, supplied water should meet basic requirements, including the quantity essential for maintaining minimum sanitary conditions in latrines and household premises. The conclusion is that an assessment of demand should be revised on the basis of settlement patterns and their evolving development.

Engineers have projected population outward for 15 years on the basis of the national growth rate rather than in the context of the specific expansion of the market centers. Village WUCs have managerial problems and sufficient institutional capacity is essential before handing projects over for local operation and control.

Satisfaction Level vs. Willingness to Pay

The first assumption to be tested was whether satisfaction level affects users' WTP for the operation and improvement of DWS schemes. Data were analyzed on a category-wise basis and regression coefficients were obtained as reported in Table 5. In both categories, χ^2 values are quite significant, indicating the goodness-of-fit of the models. Another measure of goodness-of-fit is the percentage correct classification. In the market-center category, the prediction accuracy is about 93%, while in the rural category it is 89%. The significance of Wald's statistic shows values less than 0.05 (assumed significance level), implying that the variable sufficiently deviates from zero. The exp (B) value corresponding to each variable suggests significant changes in both categories. The exp (B) value corresponding to each variable indicates its respective contribution to the odds in favor of WTP.

The values corresponding to DOS in both categories show that changes in the satisfaction level hardly have an impact on the probability estimates of WTP. With respect to the variable for trustworthiness, its effect on WTP is quite pronounced as reflected by a very high exp (B) value in the market-center category. Most of the respondents in this classification stated that there were insufficient managerial skills due to poor training and support. A change in the value of trustworthiness from 0 to 1 increases the odds in favor of WTP by nearly 19 times. By comparison, in the village schemes, the impact of satisfaction on WTP is relatively small. However, in this category trust in the management system with regard to project planning and execution dominates the odds in favor of WTP. This result indicates that user-satisfaction level influences the probability estimates of WTP. This outcome contrasts to findings reported by Raje et al. (2002) for the Mumbai (Bombay) metropolitan water supply.

Table 5 Logistic model for the two categories.

Category	Variable	B	SE	Wald	df	Wald Sig.	exp (B)
Rural market centers*	DOS	2.9578	1.0990	7.2399	1	0.0071	19.2551
	Affordability	1.5184	0.7887	3.7061	1	0.0542	4.5649
	Trustworthy	2.9475	1.1256	6.8567	1	0.0088	19.0582
Rural villages**	DOS	1.9345	0.4800	16.2414	1	0.0001	6.9209
	Affordability	1.1192	0.4669	5.7469	1	0.0165	3.0624
	Trustworthy	2.2904	0.5512	17.2660	1	0.0000	9.8786

Log likelihood* = -418.46
Wald chi-square goodness of fit* = 196.04
Log likelihood** = -306.14
Wald chi-square goodness of fit** = 143.56

Table 6 Willingness to pay corresponding to different satisfaction levels.

Satisfaction category	Rural market centers			Rural villages		
	N	W	NW	N	W	NW
Not satisfied	12	5 (41.7%)	7	10	3 (30.0%)	7
Partially satisfied	31	10 (32.3%)	21	55	19 (35.1%)	35
Satisfied	36	27 (75.0%)	9	46	30 (65.2%)	16
Highly satisfied	9	7 (77.7%)	2	7	6 (85.7%)	1
Total	88	49 (55.7%)	39	117	58 (49.6%)	59

Note: N = Number of respondents, W = Willing to pay, NW = Not willing to pay

This study reveals that satisfaction level, affordability, and WUC trustworthiness have a significant influence on the probability estimates of WTP (Table 5). The statistical analysis shows that user satisfaction and trustworthiness are highly influential indicators in the allocation of maintenance and operation charges in DWS schemes.

The correspondence of WTP to different satisfaction levels shows that a high percentage of satisfied respondents in both schemes is willing to pay for maintenance and operation (Table 6). A high percentage of poorly satisfied and partially satisfied users reduced WTP for the upkeep of DWS schemes. Group discussions with the members of WUCs in both rural villages and market centers indicated that households situated close to a traditional water source are reluctant to participate in a community DWS. Furthermore, because of the often inconvenient location of the water points, they are not willing to pay or commit to improving the system.

In this context, two important issues should be considered before allocating water rates. First, user-satisfaction level, WUC trustworthiness, and affordability are crucial factors in determining WTP. Second, the convenience of water-point locations needs to be reviewed to improve both types of DWS schemes.

Conclusion

This study focuses on the operational sustainability of rural water-supply systems in Nepal. The Department of Drinking Water Supply and Sewerage, with the assistance of the United Nations Children's Fund and bilateral aid organizations, developed a blueprint that is often used by GOs and NGOs for project implementation. The analysis shows no significant association between satisfaction and respondent variables such as gender, age, economic status, and education. The principal component analysis shows that water quantity, reliability, WUC trustworthiness, convenience of water-point locations, water quality, and water-flow pressure are the most crucial and correlated variables in the performance of water-supply systems.

The study also indicates that users' preferences differ between rural villages and market centers regarding the improvement of existing systems. On one hand, users in market centers strongly prefer water quantity, adequate flow pressure, and convenient water-point locations. On the other hand, users in rural villages place high priority on good operation and maintenance management, convenient water-point locations, and reliability of supply. Therefore, water engineers and planners in Nepal ought to consider villages and rural market centers separately when designing and planning rural water-supply programs.

Although the issue of inconvenient water-point locations is the same in both types of DWS schemes, the study concludes that problems differ in rural settings. Village DWS schemes face institutional inadequacies such as weak managerial skills on the part of the WUC and, in contrast, market centers face technical obstacles such as water shortages and insufficient pressure head in the supply system. In this regard, the study indicates that enhancement of institutional capacity at the community level and water education are essential for the sustainability of DWS projects in rural villages throughout the country.

The Nepalese government allocated Rs. 8.26 billion (approximately US$115 million) in fiscal year 2003–2004 to implement various water-supply and sanitation projects (NPC, 2003). However, due to weak institutions, after a few years these projects again will require repairs or rehabilitation. In the absence of diagnosis of core problems in rural DWS schemes, the same trends will be repeated again and again. Because the rural water-supply program has no provision to install meters, grain or cash collection from each household is the main monetary source for maintenance and operation. The study shows that DOS highly influences WTP for maintenance and operation in both settings. Satisfied and highly satisfied users of market center and rural village DWS schemes evince a willingness to pay for improved water systems. This finding indicates that good service and consumer satisfaction can attract more revenue to upgrade and operate existing infrastructure.

Acknowledgement

This research was funded by the Social Sciences and Humanities Research Council (SSHRC) of Canada. We would like to extend our sincere thanks to SSHRC for providing the research grant and to the farmers from the Kavre and Baglung districts for their voluntarily participation in our field survey.

References

Altaf, M., Whittington D., Jamal, H., & Smith, V. 1993. Rethinking rural water supply policy in the Punjab, Pakistan. *Water Resources Research* 29(7):1943–1954.

Arkin, H. & Colton, R. 1963. *Tables for Statisticians*. New York: Barnes & Noble.

Asthana, A. 1997. Where the water is free but the buckets are empty: demand analysis of drinking water in rural India. *Open Economies Review* 8(2):137–149.

Baidu-Forson J., Ntare, B., & Waliyar, F. 1997. Utilizing conjoint analysis to design modern crop varieties: empirical example for groundnuts in Niger. *Agriculture Economics* 16(3):219–226.

Baker, C., Lentz R., & Curry, S. 2006. *Strategy of Widespread Implementation of Numerous, Independent Small Scale Household Water Treatment Programs.* World Water Week in Stockholm. Beyond the River: Sharing Benefits and Responsibilities. August 20–26, Stockholm International Water Institute.

Bhandari, B., Grant, M., & Pokharel, D. 2005. Sustainable community water: managing supply systems in the mid-hills of Nepal. *Water Policy* 7(2):201–214.

Bhandari, B. & Wickramanayake, B. 2001. Community management and water quality in rural water supply system in Nepal. *Asia-Pacific Journal of Rural Development* 10(2):53–67.

Bishop, Y., Fienberg S., & Holland, P. 1975. *Discrete Multivariate Analysis: Theory and Practice.* Cambridge: MIT Press.

Bohm, R., Essenburg, T., & Fox, W. 1993. Sustainability of potable water services in the Philippines. *Water Resources Research* 29(7):1955–1963.

Cronbach, L. 1951. Coefficient alpha and internal structure of tests. *Psychometrika* 16(3):297–334.

Ghimire, G. 2002. *Progress Report: IRAP Piloting and other Activities in Nepal.* Bangkok: International Labour Organisation http://www.iloasist.org/Downloads/NEPAL%20IRAP1.PDF.

Howe, C. & Dixon, J. 1993. Inefficiencies in water project design and operation in the third world: an economic perspective. *Water Resources Research* 29(7):1889–1894.

Kaliba, A., Norman D., & Chang, Y. 2003. Willingness to pay to improve domestic water supply in rural areas of central Tanzania: implications for policy. *International Journal of Sustainable Development and World Ecology* 10(2):119–132.

Kim, J. & Muller, C. 1978. *Introduction to Factor Analysis: What It Is and How to Do It.* Thousand Oaks, CA: Sage.

Lammerink, M. 1998. Community managed rural water supply: experiences from participatory action research in Kenya, Cameroon, Nepal, Pakistan, Guatemala and Colombia. *Community Development Journal* 33(4):342–352.

Likert, R. 1932. A technique for the measurement of attitudes. *Archives of Psychology* 22(140):55–68.

Lopez-Gunn, E. & Cortina, L. 2006. Is self-regulation a myth? Case study on Spanish groundwater user associations and the role of higher-level authorities. *Hydrogeology Journal* 14(3):361–379.

National Planning Commission. 1998. *National Planning Commission Report.* Kathmandu: NPC.

National Planning Commission. 2003. *National Planning Commission Report*. Kathmandu: NPC.

Pattanayak, S., Yang, J., Whittington, D., & Bal Kumar, K. 2005. Coping with unreliable public water supplies: averting expenditures by households in Kathmandu, Nepal. *Water Resources Research* 41(2):1–11.

Piper, S. & Martin, W. 1997. Household willingness to pay for improved rural water supplies: a comparison of four sites. *Water Resources Research* 33(9):2153–2163.

Raje, D., Dhobe, P., & Deshpande, A. 2002. Consumer's willingness to pay more for municipal supplied water: a case study. *Ecological Economics* 42(3):391–400.

Rural–Urban Partnership Programme (RUPP). 1999. *Impact Study of Rural-Urban Partnership Programme on Poverty Reduction*. Kathmandu: United Nations Development Programme.

Sharma, S. 1998. *Resource Management for Water Supply and Sanitation Sector.* Sixth National Convention of Engineers on Resource Management for Infrastructure Development. December 3–4. Kathmandu: Federation of Engineering Institutions of South and Central Asia.

Singh, B., Ranasubban, R., Bhatia, R., Briscoe, J., Griffin, C., & Kim, C. 1993. Rural water supply in Kerela, India: how to emerge from a low-level equilibrium trap. *Water Resources Research* 29(7):1931–1942.

Sullivan, C. 2002. Calculating a water poverty index. *World Development* 30(7):1195–1210.

Sullivan, C., Meigh, J., & Giacomello, A. 2003. The water poverty index: development and application at the community scale. *Natural Resources Forum* 27(3):189–199.

Tessler, M. & Warriner, I. 1997. Gender, feminism, and attitude toward international conflict: exploring relationships with survey data from the Middle East. *Water Politics* 49(2):250–281.

Trochim, W. 2001. *Research Methods Knowledge Base, 2e.* Mason, OH: Atomic Dog Publishing.

Whittington, D., Pattanayak, S., Yang, J., & Kumar, K. 2002. Household demand for improved piped water services: evidence from Kathmandu, Nepal. *Water Policy* 4(6):531–556.

Whittington, D. 1998. Administering contingent valuation surveys in developing countries. *World Development* 26(1):21–30.

Whittington, D., Davis J., & McClelland, E. 1998. Implementing a demand-driven approach to community water supply planning: a case study of Lugazi, Kenya. *Water International* 23(3):134–145.

Whittington, D., Okorafor, A., Okore, A., & Mcphail, A. 1990. Strategy for cost recovery in the rural water sector: a case study of Nsukka District, Anambra State, Nigeria. *Water Resources Research* 26(9):1899–1913.

World Bank Water Demand Research Team. 1993. The demand for water in rural areas: determinants and policy implications. *The World Bank Research Observer* 8(1):47–70.

World Water Assessment Programme. 2003. *Water for People, Water for Life.* New York: United Nations Economic, Social, Cultural Organization & Berghahn Books.