

A Decision-Making Tool for Water Supply Improvements in Low-Income Rural and Peri-Urban Communities in Nepal

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Abstract

This ongoing project seeks to develop decision-making tools to aid practitioners in Nepal to select the most appropriate water supply improvements (including water source selection, water collection, treatment, and storage), using selected small low-income communities as case studies. These include three rural communities (Bhalakhalak, Sonbarshi, Chamar Tolia) and a peri-urban squatter community near Kathmandu (Manohara). Household data was collected via questionnaires and site visits to assess the current practices and inform decision-making. Standard water quality data was also collected to characterise water sources, several of which were deemed unsuitable for safe water supply. A decision framework, in the form of a 'Yes/No' decision tree, was then developed which incorporated site-specific technical, demographic, and socio-economic considerations and used literature information and local experience. It is hoped that the framework can be applied to decision-making in other low-income communities in Nepal that face similar challenges.

1. Introduction

It has been reported that Nepal has reached its 2015 Millennium Development Goal (MDG) for access to improved water supply (on a percentage population basis), with 81% access having been achieved by 2005 and a 2015 MDG of 73% (Shrestha, 2006), however small low-income rural communities and peri-urban squatter communities account for the vast majority of people in Nepal who still do not have access to safe water today. To-date there has already been many excellent household-level and community-level projects to improve water supply in Nepal and many are still ongoing. For example, an effective household water treatment solution known as the Kanchan™ filter has been proven to effectively remove arsenic from groundwater, which is a widespread problem in Nepal (Ngai et al., 2006). Indeed, there is no shortage of potential technical solutions for improving water supply in low-income communities. However, the criteria for selecting the most appropriate solutions for a given community are not always clear. Various forms of decision-making frameworks have been proposed for applications around the world (e.g. Analytical Hierarchy Processes, Water Safety Plans; Skinner, 2003) however it was desirable to create an easy-to-use model that incorporates factors that are specific to low-income small communities in Nepal.

Therefore, the specific objectives of this project were to:

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1. Collect household data via questionnaires and site visits to assess the current water supply practices in four low-income communities in Nepal (three rural, one peri-urban) and develop an understanding of the relevant demographic, technical, and socio-economic patterns in each community.
2. Collect on-site water quality data to characterise water sources and inform decision-making.
3. Develop a decision-making framework that can be applied by water supply practitioners in Nepal to assess appropriate solutions specifically for small low-income communities.
4. Apply the decision-making framework to the case study communities to provide recommendations for improved water supply and to subsequently take the required steps to aid in the implementation of the recommendations.
5. Incorporate the research outcomes and knowledge gained from the project into curriculum in the area of water supply to be taught at the Nepal Engineering College.

2. Research Methods and Key Findings

The selection of case study communities aimed to incorporate a broad range of community characteristics into the development of the decision-making framework, to make the framework as widely applicable within Nepal as possible. The selected communities included three rural communities (Bhalakhalak, Sonbarshi, and Chamar Tolia) and one peri-urban squatter community (Manohara), which are described in further detail below.

A questionnaire was circulated to households in each of the case study communities with the cooperation of the community leaders. The questionnaires were intended to gain demographic and socio-economic data (e.g. number of persons per household, average household income), health information, and current water collection/treatment/storage practices. Site visits were also conducted during this period, to clarify cases where the reported information was unclear.

Standard water quality analyses were performed on samples from water sources from each community to gain an understanding of their suitability for community water supply. The parameters included pH, colour, turbidity, hardness, alkalinity, total dissolved solids, magnesium, iron, manganese, arsenic, total coliforms, and *E. coli*, as well as others. The water quality data used for the project was produced by an accredited external laboratory, although the laboratory at the Nepal Engineering College was also used for additional confirmatory analyses.

The questionnaires and site visits yielded important information about each community, summarised below.

Bhalakhalak is situated in the Changunarayan Village Development Committee (VDC), in the northern part of the Bhaktapur district. The village is seated at an altitude of approximately 1550 m and overlooks the Kathmandu Valley to the south. The village population is estimated to be approximately 174. The majority of the able working population rely on farming for their livelihood. The two springs currently being used by the locals for water supply are shared with neighbouring villages and there are regular disputes over access to the water. Access to the nearest spring is physically restricted, as it involves trekking down steep and slippery mountain paths (Figure 1). Both springs achieve a score of “high risk” on the WHO risk assessment checklist (WHO, 2006), since there is no protective fencing, the source has no surface runoff diversion ditch to protect it (Figure 2), and livestock have unrestrained access to the spouts.



Figure 1: A woman in Bhalakhalak carrying containers to the spring site on a steep mountain path.



Figure 2: Bhalakhalak spring water collection point, with vulnerability to surface runoff intrusion.

Sonbarshi village is part of the Guari VDC located in Nepal's Kapilvastu District, in the south-western region of Nepal. The village is in an extremely remote location, roughly 8 km from the nearest town. The village is located within the Terai region of Nepal and roughly 10 km from the border with India. The survey indicated that the population is 528 people living in 66 households. Farming is the main source of income. It has been estimated that roughly 80% of the households survive on less than 100 Nepali rupees (NRS) (< £1) per day. The VDC has installed a number of shallow wells. Drainage is very poor. Obstructions in drainage channels cause water to overflow, which damages property and causes pooling on the main route through the village. The pools are insect breeding sites. Sickness and disease is apparent throughout the community; the children have visible skin diseases, respiratory and ear and throat infections. The illnesses are most severe during the monsoon season; the highest instances of conjunctivitis and diarrhoea are at that time of year.

Chamar Tolia is a village located in Tenuhawa VDC, Rupandehi district in the Terai region. Surveys indicate that the population of the village is approximately 132. The villagers are members of the

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untouchable caste. As such, sourcing materials or labour for any work that must be done in the village can be difficult. Chamar Tolia is a farming community, and most of the villagers work in the fields to produce rice. The villagers earn approx 50 NRS per household per day. An artesian well is the main source of drinking water for the village. Water that is not collected for drinking flows into an irrigation ditch and provides a source of water for the crops. This system is not necessary during the monsoon season however it is vital during the dry winter months. The well is in good condition, and the area surrounding it is low risk, and it is a constant source for the village. There are other private wells within the village, although the owners specified that they only used the water for washing. There are no forms of household water treatment practised within the village. There are also no toilets and open defecation is readily practiced in the rice paddies.

The **Manohara** squatter community is situated on the bank of the Manohara River, in the Bhaktapur district of the Kathmandu Valley. The site lies at approximately 1300 m above sea level, in a very congested and polluted area adjacent to one of the main routes into Kathmandu and directly under the flight path of Kathmandu Tribhuvan Airport. The population of the settlement is estimated to be somewhere between 4000 and 4500. The site is expanding rapidly; the inhabitants frequent the site for six months and then leave for the remainder of the year for work and other reasons. There are ongoing disputes with the local government and landowners over the rights of the squatters to the site and to clean water. The existing wells within Manohara achieve a score of either “high” or “very high” risk of contamination (WHO, 2006). As such, the disease rate within Manohara is relatively high; over half the households suffer from water-related illnesses. Surveys of Manohara indicate that one third of households use some form of basic water treatment on a regular basis.

Examples of the types of data collected by the questionnaires and the site visits are shown in Table 1 below. The data illustrates that basic sanitation and hygiene practices are not commonly applied in the communities, that the collection of clean water most often requires > 15 minutes per day and a travel distance > 100 m, that women and girls are often those solely responsible for the collection of clean water (but not always), that household water treatment is uncommon, and that water-related illness is widespread.

The water quality testing confirmed that the water sources being used in some of the communities (Bhalakhalak, Manohara) were unfit while those in other communities (Sonbarshi, Chamar Tolia) generally met WHO guidelines (WHO, 2006). Table 2 below summarises some of the averaged water quality data collected from the drinking water sources of the case study communities during November 2007 to January 2008. The data in Table 2 is only meant to be illustrative – significant variability in certain parameters, especially microbiological parameters, were observed in subsequent sampling periods.

Table 1. Sample of questionnaire data collected.

Question	Bhalakhalak	Sonbarshi	Chamar Tolia	Manohara
Households with toilet (without)	9 (26)	0 (58)	0 (17)	215 (72)
Hand-washing with soap or mud (no hand-washing)	32 (3)	54 (4)	13 (2)	252 (35)
Distance travelled to drinking water source < 100m (> 100m)	4 (31)	29 (14)	7 (9)	77 (203)
Time spent fetching water < 15 minutes (> 15 minutes)	3 (32)	46 (12)	4 (12)	57 (230)
Women and girls solely responsible for water collection (total households)	14 (35)	26 (61)	2 (15)	176 (329)
Water treatment before consumption (no treatment)	0 (35)	0 (58)	0 (16)	94 (193)
Households reporting diarrhea (dysentery)	8 (0)	38 (12)	15 (9)	58 (34)

Table 2. Sample of source water quality data collected.

Parameter (Units)	Bhalakhalak*	Sonbarshi	Chamar Tolia	Manohara**
Turbidity (NTU)	<1	4.9	1.8	2.2
Total Dissolved Solids (mg/L)	164	497	407	not analysed
Colour (Hazen)	<5	7.5	<5	<5
Iron (mg/L)	<0.05	0.9	0.4	<0.05
Manganese (mg/L)	<0.05	0.5	0.4	10.9
Arsenic (mg/L)	<0.005	<0.005	<0.005	not analysed
Total Coliform (CFU/100 mL)	183	0	2	167
E. coli (CFU/100 mL)	61	0	0	54

* combined data for 2 springs

**data for stone taps

Literature was reviewed to list potential community-level and household-level water supply technical solutions. This included Nepal-specific literature as well as broader literature reports from around the world. Solutions that had already been applied successfully in selected locations in Nepal and for which there was some degree of existing local experience were identified for special consideration. The resulting decision-making framework took the form of a 'Yes/No' decision tree (a small portion is shown in Figure 3), with each question leading the user in different directions based on the answer, eventually leading to recommended water supply practices at the end. The intention was that the model would be easy to use and would not be demanding in terms of the required data or interpretation by the user, although some basic information is needed (as described above).

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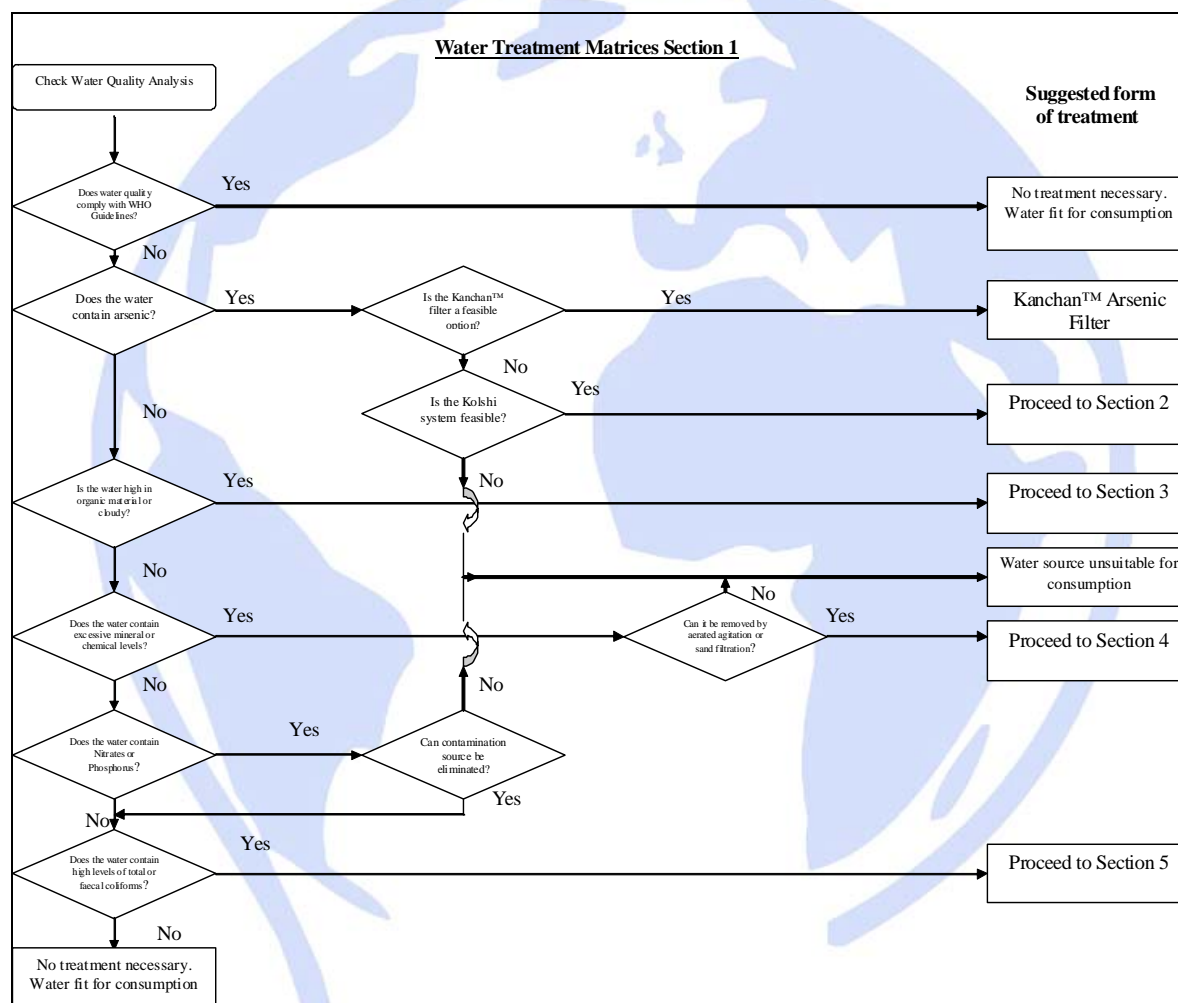


Figure 3. A section of the decision-making framework that was developed in this project.

The framework is still being developed and the final decision-making tree will be available online at the project website: www.nec.edu.np/delphe/. Application of the decision-making framework to-date has led to initial practical recommendations for water improvements for each community.

The water sources at Bhalakhalak are considered high risk. For several of the Bhalakhalak spring sources it is recommended that they no longer be used and instead replaced by alternate spring sources which are known to be located nearby, while for others it is recommended that they continue to be used but with household water treatment; likewise for Manohara. This project is ongoing and the next steps will be to determine the optimal household treatments that are most likely to be accepted by the community people (e.g. possibly household sand filters and/or chlorine/coagulant drops). Any recommended household treatment will need to be easy-to-use, and significant support and buy-in from the community groups will be necessary, since the questionnaires made it clear that household water treatment is not typical in these communities currently (especially in Bhalakhalak). Water supply within Sonbarshi and Chamar Tolia is less of a problem currently, in comparison; sanitation improvements are a more pressing concern in those communities.

3. Future Steps

This project will continue until 2010 and current/future steps will be to involve private- and public-sector local NGOs and government agencies to now assist in implementing the solutions that have been recommended through this study. Engineering students from the Nepal Engineering College (guided by staff) will assist with the technical design of the solutions in these communities. The decision-making framework will continue to be adapted as it is applied and as new factors of relevance are recognised and added. A further aspect of the project is to develop curriculum at the Nepal Engineering College to train the future Nepalese leaders in the area of water and sanitation.

The project also seeks to empower women and is therefore actively forming women's groups to take the initiative in informing community members and leadership roles in implementing and maintaining new water supply practices in their communities.

Lastly, while most of the discussion in this paper is on improving water supply, the project will also consider sanitation and drainage solutions for each community using a similar approach, since these issues are all inter-related in terms of their impact on quality of life and must be considered together.

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