Water safety planning: adapting the existing approach to community-managed systems in rural Nepal

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ABSTRACT

Water Safety Plans (WSPs) improve the quality and secure the quantity of drinking water supplies, and hence improve public health outcomes. In developing countries such as Nepal, thousands of residents die each year as a result of poor water, sanitation and hygiene (WASH) services and WSPs show great promise for improving both health and livelihoods. The Nepali Non-Governmental Organisation Nepal Water for Health (NEWAH) has been working in partnership with Engineers Without Borders Australia and WaterAid Nepal to develop a WSP methodology suited to rural, community-managed water supply systems. Three pilot projects were undertaken incorporating community-based hazard management into the standard World Health Organization and Nepali Department of Water Supply and Sewerage WSP approaches. The successes and challenges of these pilots were assessed, and it was determined that community education, behaviour change, and the distribution of simplified WSP documentation to households and managers were essential to implementing successful WSPs within this context. This new WSP methodology is currently being mainstreamed throughout all of NEWAH's WASH projects in rural Nepal, as well as being shared with the wider Nepali WASH sector.

Key words | community, Nepal, rural, WASH, Water Safety Plan, WSP

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INTRODUCTION

A significant challenge to Nepal achieving universal water and sanitation coverage is the adoption of appropriate water, sanitation and hygiene (WASH) practices throughout rural areas. This includes the technical implementation of drinking water supply schemes and sanitation systems, as well as behaviour change around water use, sanitation and hygiene. To bridge the gap in government WASH services, many Nepali Non-Governmental Organisations (NGOs) are partnering with rural communities. One such NGO is Nepal Water for Health (NEWAH) who implements projects combining the development of water supply and sanitation infrastructure with education and behaviour change campaigns around sanitation, hygiene and livelihood opportunities.

Traditionally, water suppliers in developed countries have conducted regular testing to determine water quality. However, often by the time results are available the water has already been used or consumed by the public. The past decade has seen the introduction of Water Safety Plans (WSPs) to the arsenal of water utilities worldwide. WSPs are a method for ensuring the safety of drinking water supplies through preventative risk management. Their application depends upon identifying water quality and quantity hazards and implementing and monitoring control measures to avoid adverse health outcomes (World Health Organization 2008; Bartram *et al.* 2009). Following their introduction in large-scale utilities in developed countries, their application has been expanded to smaller-scale water systems in developing communities.

In recent years, there has been a government directive to develop WSPs for drinking water supplies in Nepal. The Nepal Government Department of Water Supply and Sewerage (DWSS) has developed a ten-step approach

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to their implementation in Nepal, based upon the World Health Organization (WHO) method (Table 1). This approach has been used throughout Nepal, with a particular focus on urban water utilities. However, there are inherent challenges in applying the WSP methodology to rural systems that are managed by communities with limited or no background in WASH (for a Bangladeshi example see Mahmud *et al.* (2007)). In such communities, users generally have very little scientific knowledge, and are unfamiliar with the intense assessment and documentation required as part of standard WSP preparation. In such cases, it is necessary to develop tools which can assist communities in identifying hazards and implementing control measures and monitoring regimes (Howard 2003).

This study aimed to adapt the DWSS WSP methodology to be more effective in community-managed water supply systems in rural Nepal. Specifically, it aimed to: (1) develop tools for the preparation of effective WSPs by communities; (2) pilot this WSP methodology in three communities, adapting the methodology as required throughout the project; and (3) assess the results of the pilot projects and prepare a WSP methodology which is suitable and effective for communities in rural Nepal.

Table 1 | Water safety plan: steps for action (Department of Water Supply and Sewerage 2011)

1. Team formation	A Water Safety Planning (WSP) Team is formed which has a thorough understanding of the water supply system and its inherent hazards. This Team is responsible for developing, implementing and maintaining the WSP, and ensures that day-to-day monitoring is performed as required.
2. System assessment	The WSP Team visits the water supply system from source to consumer to gain a comprehensive understanding of the system. The Team then prepares documentation on the system layout.
3. Hazard identification and risk analysis	The WSP Team identifies hazards throughout the water supply system, and determines their likelihood, impact and risk rating. Hazards requiring intervention are then prioritised based upon their risk rating.
4. Control measures	Control measures are implemented to minimise the risks associated with hazards. The control system should be based on the multiple barrier approach, such that should one preventative measure fail, it can be compensated for by others. Following the identification of hazards and controls, the WSP Team determines critical limits for the proper functioning of each control.
5. Urgent corrective action	Controls which need to be implemented as soon as possible are identified. The WSP Team prepares an inventory of these urgent corrective actions, but it is the responsibility of the Water and Sanitation Users Committee for the water supply to ensure these actions are carried out.
6. Monitoring plan	The WSP Team prepares a monitoring plan to ensure each control measure is functioning correctly and health-based targets are being achieved. The WSP Team must decide what to monitor, when to monitor, and who will be responsible for this.
7. Validation	Validation is the process of gathering evidence that each control measure is able to function correctly and achieve the WSP objectives. Validation is not used for day-to-day management, and is only performed by the WSP Team upon the installation of controls, following an event which may have impacted upon the water supply system, and on a regular basis of several months.
8. Verification system for effectiveness	The WSP Team verifies whether the WSP and water supply system as a whole is functioning effectively. This is only performed by the WSP Team upon the completion of the WSP and water supply system, following an event which may have impacted upon the water supply system, and on a regular basis of several months.
9. Assessments of users' satisfaction	Users must be satisfied with the water supply system and WSP, otherwise they may choose to collect water from an alternative, potentially unsafe, source. The WSP regularly assesses the satisfaction of users by surveys and discussion groups investigating the opinions of users regarding the water supply system and WSP, whether they choose to collect water from an alternative source, and the incidence of diseases traditionally associated with water supply.
10. Documentation	The WSP Team prepares a report compiling all WSP activities. This document can be used in guiding further WSP activities.

METHODS

NEWAH identified that although it would be beneficial to develop a WSP methodology appropriate for communities and implement it in their projects, they had limited organisational capacity to do so. Hence, a joint project was initiated between NEWAH, Engineers Without Borders Australia (EWB) and WaterAid Nepal (WAN) to develop a WSP methodology suited to community-managed WASH projects in rural Nepal. This included the secondment of three Australian EWB engineers (working voluntarily) over a two-year period, hereon in referred to within the classification of NEWAH staff.

To better understand the applicability of the existing WSP methodology, and develop and trial new community tools, three WSP pilot projects were conducted within the hilly and Terai regions of Nepal. In addition to WSP development, each of these pilots involved an existing NEWAH WASH project (detailed in Table 2). These projects are driven by the water and sanitation users' committees (WSUCs) of clusters, and in most cases include both an infrastructural and educational component. In particular, NEWAH staff train users, caretakers and sanitation masons in construction, operation and maintenance, and the community (with a focus on community health and sanitation volunteers (CHSVs)) in sanitation and hygiene education. The WSUC is also trained in the management of a maintenance fund which each household must contribute to. The projects generally have a four- to five-year lifespan, where monitoring and evaluation are performed by NEWAH staff, working in partnership with WSUCs, for two years following the completion of project infrastructure. Difficulties, often related to maintenance, are addressed during this period. It is anticipated that in future WSPs will be included in monitoring and evaluation, with reviews of their effectiveness conducted and addressed during this time. At completion, the project is 'handed over' for management by the community themselves.

WSP development was conducted during the implementation phase of these projects. At each stage of WSP development, new approaches and tools were developed and trialled to increase community understanding of the WSP process and improve the identification of hazards and control measures. To develop the new methodology, NEWAH staff first identified that a key aspect of developing WSPs in community-managed systems would be community engagement. As such, community workshops were incorporated into the WSP methodology from the outset to ensure a wide range of stakeholders understood and contributed to WSP development. The inclusion of such workshops is advocated by the existing DWSS approach.

The first WSP pilot project was conducted in Ayodhyapuri Village Development Committee (VDC) of Chitwan District, located on the low lying Terai plain. This project is further detailed in a paper by McMillan (2011). An initial WSP workshop included staff from NEWAH, the Water Supply and Sanitation Division Office and the District Public Health Office. The workshop identified a large number of hazards and potential control measures associated with Ayodhyapuri's drinking water systems. A second

Table 2 | Details of water, sanitation and hygiene projects

Village Development Committee	District	Topography	Major water source/s	Improvement of existing system	Installation of new system	Sanitation and hygiene education
Ayodhyapuri	Chitwan	Terai	Groundwater	Hand-dug wells	Hand-dug wells; plastic biosand filters; concrete biosand filters	Yes
Namtar	Makawanpur	Hill	Springs	Gravity-fed system – intakes, pipelines, tanks; public taps	Public taps; pour-flush toilets; improved tanks; source protection	No
Thumi	Gorkha	Hill	Stream; springs	Improved existing public taps	Gravity-fed system – source protection, intakes, pipelines, tanks; public taps; pour-flush toilets	Yes

workshop was held in Ayodhyapuri with NEWAH staff and the local WSUC. The WSUC were introduced to WSP concepts and shown a simplified process flow diagram, and identified further hazards and controls based on their local context and knowledge. The output from the two workshops was used by NEWAH to develop an improvement plan and WSP implementation materials for the community. The tools developed included a well hazard mapping exercise (Document 3.3, Table 3), a WSP 'Snakes and Ladders' game to encourage WSP knowledge building (available as an MS Excel file, which can thus be altered for any WSP, Table 3), and a household WSP checklist to address common hazards (Document 10.1, Table 3). A third workshop was conducted to share the WSP tools and materials

Table 3 | Water Safety Plan documentation and tools developed throughout the project (all tools are available in both English and Nepali from the WHO/IWA Water Safety Portal: www.wsportal.org)

Document title	Description
Overall	
The Water Safety Plan Process – How to prepare Water Safety Plans for community-managed water supply systems in rural Nepal (Barrington *et al.* 2012)	Manual on how to prepare WSPs in rural Nepal, including references to the forms detailed below, as well as examples from pilot projects.
Training in the NEWAH WSP Approach	PowerPoint presentation for teaching staff about WSP development and implementation. To be used in conjunction with the Hazards, Controls and Responsibility tools.
0.1 Tasks to be completed during each WSP field activity	Used by the WSP Team Leader throughout the WSP process. Ensures that all WSP activities are completed and documented.
1. Team Formation	
1.1 Stakeholder Identification	Identifies WASH project stakeholders.
1.2 WSP Sub-Team Details	Details members of each of the WSP Sub-Teams.
1.3 WSP Timeline	Details of the WASH project and WSP timeline, updated regularly.
2. System Assessment	
2.1 Initial Assessment	Initial assessment of the water supply system, environment, and community WASH behaviours.
2.2 Water Quality	Key water quality parameters.
Flow Diagram Images	Images to be used when preparing flow diagrams. Corresponding images are used in the Hazards and Controls tools.
3. Hazard Identification and Risk Analysis	
3.1 Workshop Agenda	Workshop agenda.
3.2 Workshop Participants	Contact details of workshop participants.
3.3 Well Hazard Mapping Exercise	Instructions on conducting a well hazard mapping exercise for groundwater supplies.
3.4 Hazard and Risk Assessment Guidelines	Guidelines for assigning likelihood, impact and risk ratings to hazards.
3.5 Workshop Minutes	Minutes from workshops.
Workshop Presentation	Presentation used during the District Level WSP Workshop
Hazards – Gravity Flow	Large tool printed on flag material. To be used in WSP training and all WSP Workshops (Figure 1(c)).
Hazards – Groundwater	
Hazards – RWHS	

(*continued*)

Table 3 | continued

Document title	Description
Controls – Gravity Flow	Large tool printed on flag material. To be used in WSP training and all WSP Workshops (Figure 1(d)).
Controls – Groundwater	
Controls – RWHS	
Responsibility	Large tool printed on flag material. To be used in WSP training and Community Workshop 2 (Figure 1(e)).
4. Control Measures	
4.1 Hazard and Risk Assessment Spreadsheet	Spreadsheet to be updated throughout the WSP development and implementation process. Contains details of all the identified hazards and controls, as well as implementation, monitoring, validation and corrective actions.
5. Urgent Corrective Action	
5.1 Urgent Improvement and Upgrade Plan	Controls identified during Community Workshop 2 which need to be implemented ASAP.
5.2 Longer Term Improvement and Upgrade Plan	All other controls.
6. Monitoring	
6. 1 WSUC and Caretaker Guide	Guide containing a flow diagram of the particular water supply system and detailing monitoring and corrective actions which are the responsibility of the WSUC and caretakers.
6.2 CHSV Guide	Guide containing a flow diagram of the particular water supply system and detailing monitoring and corrective actions which are the responsibility of the CHSV.
7. Validation	
7.1 Control Validation	List of validation activities for each control measure.
8. Verification System for Effectiveness	
8.1 Verification	Guide to verifying whether the WSP has been implemented as intended and is effective.
9. Users' Satisfaction	
9.1 Community Feedback	Community feedback on the effectiveness of the WASH project and WSP, and identification of areas which may require improvement.
10. Documentation	
10.1 Household WSP Guide	Guide to be distributed to all households in the cluster. Contains a flow diagram of the water supply system, details of any hazards which households can assist in controlling, and a guide for treating water during an emergency event.
10.2 Emergency Procedure for WSUC and Caretakers	Emergency procedure for WSUC and caretakers.
10.3 Repair and Maintenance Chlorination Procedure	Caretaker procedure for chlorinating tanks during repairs and maintenance.
10.4 Water Safety Plan – English.doc	Reference document to be provided to the WSUC, DWSS and other stakeholders. Details the water supply system, all of the identified hazards and controls, and the current status of the WSP in terms of implementation and effectiveness.
11. Supporting Programmes	
WSP Snakes & Ladders – Gravity-Fed System	Board game which can be printed as large flags and used to educate community members about the benefits of WSPs.
WSP Snakes & Ladders – Groundwater System	

with the WSUC. The WSUC reviewed the materials and provided further feedback on the suggested WSP control measures. Following revisions, NEWAH distributed the WSP materials to the WSUC for use at the household level.

The second WSP pilot project was conducted in Namtar VDC of the hilly Makawanpur District. An initial site visit was conducted with NEWAH staff, WSUC members, CHSVs and other relevant stakeholders to introduce the WSP concept and assist those who had not previously visited the site to understand the water supply systems. The first WSP workshop was held in Bharatpur, and was facilitated by NEWAH staff. The workshop brought NEWAH staff and WSP stakeholders together to build on their understanding of WSPs, share knowledge, build relationships between NEWAH and their stakeholders, and to workshop the application of the WSP process to the two selected Namtar VDC clusters, similarly to the first workshop conducted for the Ayodhyapuri project. The second site visit included a community workshop with the WSUC, CHSV and NEWAH staff. Theory behind the WSP process was provided with the aid of visual diagrams and simplified concepts. On the day prior to the community workshop, NEWAH staff walked the water supply from the source to public taps with the WSUC, so as to gain knowledge, listen to issues, collect samples and take photographs. In a subsequent site visit, a second community workshop was facilitated by NEWAH staff to present the WSP materials developed based on the community input and outcomes of the first workshop. The community was queried on their understanding of the risks and controls identified in the WSPs, and were shown point of use disinfection options in response to community concerns regarding the microbiological quality of the drinking water. Following the community feedback from this workshop, the WSP materials were reviewed. Overarching WSPs for each cluster were developed and included the improvement schedule based on the agreements made within the communities at the conclusion of the second workshop. The materials developed for use at the community level (Documents 5.1, 5.2, 6.1, 6.2, 10.2, 10.3, Table 3) were also reviewed and distributed by NEWAH staff during a subsequent visit.

The third WSP pilot project was conducted with some understanding of the accomplishments and shortfalls associated with the projects in Ayodhyapuri and Namtar VDCs. NEWAH staff facilitating the pilot project at Thumi VDC were able to visit Ayodhyapuri and Namtar VDCs for follow-up investigation of the implementation of the WSPs. This included a site visit, surveys (following the development of Document 9.1) and discussions with members of the Community WSP Teams. The results of the pilot projects were then analysed and used to adapt the WHO and DWSS WSP frameworks to include aspects which may improve WSP uptake and effectiveness for community-managed water supplies in rural areas. In particular, it was identified by NEWAH staff that several simple tools could be designed to assist in WSP development and uptake. These tools were developed and trialled in Thumi VDC (these tools are detailed in Table 3 and are available online as part of the IWA/WHO Water Safety Portal: www.wsportal.org).

The structure of the Thumi VDC WSP project was based upon that of Namtar VDC, but also involved WASH education, similar to Ayodhyapuri VDC. An initial site visit was conducted by NEWAH staff so as to identify stakeholders, form Community WSP Teams, and gain an understanding of the water supply systems and WASH behaviours in the area. This included the development of a flow diagram for each individual water supply system in the participating clusters of the VDC.

The second site visit included an interactive workshop, where Community WSP Teams used simplified flow diagrams and group activities to identify hazards and controls at each process step of their water supply system (Figure 1(a)). It was identified through this workshop that the figures depicting water supply elements (e.g., source, public tap, consumption) needed to be consistent across all of the WSP tools. As such, figures for each process step were selected and are included in the WSP package for use in flow diagrams, hazards and controls tools (Table 3).

Three versions of the hazards and controls tools were developed prior to the workshop, so as to be applicable to gravity-fed systems, groundwater systems and rainwater harvesting systems (these tools are available as MS Word files, and it is thus possible to edit them to include steps in the process which may be unique to other water supply systems, Table 3). At the workshop, Community WSP Team members first discussed the hazards which may arise at each process step for their water supply system (with the assistance of

Figure 1 | (a) Thumi VDC Community WSP Teams discussing the flow diagram for their water supply system. (b) Community WSP Team identifying hazards in their water supply system. (c) Community WSP Teams sharing the hazards they have identified with the larger group. (d) Community WSP Teams sharing the controls they have identified with the larger group. (e) Community WSP Teams assigning responsibility for control implementation and monitoring. (f) Draft monitoring plans for Thumi VDC WSPs.

their individual flow diagram) (Figure 1(b)), before sharing these hazards and their risk ratings with the larger workshop group using the hazards tool (Figure 1(c)). This sharing was considered essential by NEWAH staff, as most water supplies within the VDC faced similar hazards, and this highlighted relevant hazards which may have been overlooked by individual Community WSP Teams. Following this, each Community WSP Team then identified controls they could implement for each of these hazards, again sharing them with the larger group, in this instance using the control tool (Figure 1(d)). The control tool allowed the workshop participants as a whole to decide whether the proposed control would be simple or difficult to implement and/or practice (as suggested by Greaves & Simmons (2011)), or was already present in the community. This classification of controls was included to demonstrate to the Community WSP Team that most controls would be simple to implement, raising morale. It also highlighted to NEWAH staff which controls the Community WSP Team may require the most assistance with implementing.

A workshop was then conducted with stakeholders at the district level, with the majority being either VDC secretaries or members of the District WASH Coordination Committee. These members of the District Level WSP Team were introduced to the WSP preparation process and the hazards and controls identified by the Community WSP Teams, and offered feedback where appropriate. It was generally noted by NEWAH staff that although the District Level WSP Team had a better understanding of water quality testing and national policy than the Community WSP Teams, their lack of knowledge on specific communities inhibited their contributions to individual WSPs. However, the workshop was still considered essential in terms of regional planning and disseminating information on WSPs to areas where NEWAH may not directly work.

A second community workshop was then conducted in Thumi VDC to identify any further hazards and controls, and develop an implementation and monitoring plan for the WSP. Community WSP Teams reviewed and added to the hazards and controls identified in the first workshop and indicated which controls needed to be implemented immediately (resulting in the completion of Document 5.1, Table 3). Using a responsibility tool, the workshop group as a whole assigned responsibility for the implementation and monitoring of individual controls to the WSUC, CHSVs, caretakers and/or users (Figure 1(e)). Plans were then developed detailing both the responsibility for and frequency of monitoring (Figure 1(f)). NEWAH staff collected these materials and compiled the WSP documentation. As well as the traditional WSP report required by the DWSS (Document 10.4, Table 3), this documentation included the preparation of implementation guides (Documents 5.1 and 5.2, Table 3), validation, verification, monitoring, maintenance and emergency guides for the WSUC and caretakers (Documents 6.1, 7.1, 8.1, 10.2 and 10.3, Table 3), monitoring guides for the CHSVs (Document 6.2, Table 3), Household WSP guides (Document 10.1, Table 3), and further materials designed specifically to assist in the effective implementation of the WSP by communities.

From the results of these three pilot projects, a manual was developed for the preparation of WSPs in rural Nepal

(Barrington *et al.* 2012). It was noted that while developing the new WSP methodology, NEWAH staff were confused as to how many steps were required for WSP development, and how it was possible that WSP methodologies with different steps could produce similar WSPs. In light of this, and to allow for easier mainstreaming of this WSP methodology in Nepal, the new WSP methodology for rural Nepal was based upon the DWSS framework. The NEWAH methodology incorporates further tools and activities, as well as simplified validation and verification suggestions, such that the DWSS methodology can be easily applied to rural, community-managed water supply systems. This new methodology also includes an extra step so as to incorporate the many supporting programs, such as WASH education and NGO partnerships, which improve the effectiveness of NEWAH WASH projects, and WSPs in particular.

RESULTS AND DISCUSSION

In each of the pilot projects, it was evident that the standard method of WSP implementation would need to be adapted to community-managed systems. In most urban systems in Nepal, WSPs are developed by a core group of drinking water specialists employed by a drinking water utility. However, in rural, community-managed projects, WSPs need to be developed by NGOs, local staff and stakeholders and, most importantly, users themselves. WSPs must be cheap and require minimal water quality testing. Adaptations for the application of the DWSS WSP methodology to rural, community-managed systems is detailed in Table 4, and a manual for application of the new methodology has been prepared (Barrington *et al.* 2012).

The major focus of these pilot projects was to determine the most effective methods for enabling and encouraging WASH users to identify hazards and implement control

Table 4 | Alterations made to Department of Water Supply and Sewerage Water Safety Plan methodology for application to rural, community-managed water supply systems

1. Team formation	Stakeholder identification has been included so as to include all parties with vested interests from the community to district level in Water Safety Plan (WSP) development. WSP Teams also develop a preliminary WSP timeline during this step.
2. System assessment	Images representing each process step in gravity-fed, groundwater and rainwater harvesting systems have been compiled such that flow diagrams and hazards and controls tools are easily understood by community members.
3. Hazard identification and risk analysis	The inclusion of WASH education allows communities to more readily identify hazards within the water supply systems. Group discussions during workshops include an analysis of WASH behaviours which may impact upon water quality and quantity, not simply physical processes. A tool has been developed to assist in the identification of hazards at each process step (Figure 1(c)). A specific procedure has been developed for mapping hazards around groundwater sources.
4. Control measures	A tool has been developed to assist in the identification of controls at each process step (Figure 1(d)).
5. Urgent corrective action	The documentation of longer-term corrective actions is now included.
6. Monitoring plan	Community WSP Teams decide upon monitoring methods, frequencies and responsibilities during an interactive workshop (Figure 1(e)).
7. Validation	Simple validation methods are suggested, so that controls can be validated without the requirement of expensive water quality tests.
8. Verification system for effectiveness	Simple verification tools have been developed which can be easily applied by the Community WSP Team without requiring the assistance of NGOs or water utilities.
9. Assessments of users' satisfaction	A survey has been prepared to assess users' satisfaction. It can be used during group or one-on-one discussions, and through observations of WASH practices during routine monitoring.
10. Documentation	Includes materials designed specifically to assist in the effective implementation of WSPs by communities (forms developed are detailed in Table 3).
11. Supporting Programs	Supporting programs can contribute significantly to the success of WSPs, particularly WASH education. The new methodology encourages the implementation of supporting programs and knowledge sharing of WSP experiences with other NGOs and water utilities.

measures to mitigate the risks of inadequate water resources. NEWAH staff determined that the most effective way of achieving this was through interactive workshops with community and district stakeholders. Developing and including interactive tools for identifying hazards and controls proved an effective way of engaging WSP Teams and prompting ideas in a non-threatening environment, and participation by both males and females across all age groups was observed. These workshops were most effective when coupled with WASH education. Where users were not educated in WASH, there was limited uptake of the WSP as they could not understand why specific control measures should be implemented to improve health outcomes. Although WASH education may be unnecessary when developing utility-based WSPs, it is essential when working with community-based water and sanitation systems.

As well as identifying physical hazards to drinking water quality and quantity, it was apparent that in community-managed systems, behaviour change constitutes a large proportion of WSP controls. Behaviour change has not traditionally been a significant aspect of WSP development, particularly where they have been implemented in developed countries and urban areas by water utilities. However, these rural projects identified that it would be beneficial to address behavioural hazards in community developed WSPs, including those related to sanitation and hygiene. In particular, behaviour change around hand-washing, cleaning of baby nappies and livestock management was deemed essential by Community WSP Teams. The inclusion of behavioural hazards is more likely to occur following WASH education, and where NGO staff are able to prompt Community WSP Teams during hazard identification.

It was apparent from the District Level WSP Workshops that very little is known about the quality of water in rural Nepali communities, and that it may be difficult to meet the National Drinking Water Quality Standards (Ministry of Planning and Works 2005) through WSPs. However, communities themselves seemed content with improving their water quality through WSPs, even if they could not guarantee that it would meet the National Standards. Although all improvements in water quality should be applauded, we recommend that further investigation is performed into water quality issues in rural Nepal. Even if community users are satisfied with a certain level of water quality improvement, they may still be exposed to significant risks, which are currently going unnoticed due to a lack of water quality data.

It was also noted that providing comprehensive WSP documentation to the community may be ineffective for WSP implementation in rural Nepal. Providing caretakers, WSUCs and CHSVs with WSP monitoring guides, and households with simplified WSP guides related only to their own interactions with the water supply, assisted in communities being able and more inclined to implement and review their WSP. The tools developed by NEWAH allow for 'targeting' of WSP implementation, such that stakeholders are not overwhelmed by documentation that is irrelevant to their own roles and responsibilities.

Finally, anecdotes can be drawn from our experiences which indicate that communities can see the value in WSPs. In Ayodhyapuri VDC, at the time of WSP development, a school well was being constructed within 2 m of a pit toilet. When it was identified during a WSP workshop that the water from this well would likely be contaminated with faecal pathogens, construction was immediately halted and the new well moved 10 m away from the toilet pit. In Namtar VDC, during WSP development, users identified that there was a flooding risk around one of the source intakes. The community have since planted trees around this area to stabilise the soil.

Further investigation into the effectiveness of this new WSP methodology is required to ensure that communities are maintaining WSPs in the longer term, but preliminary monitoring and evaluation visits to Ayodhyapuri and Namtar VDCs are promising. It will be interesting to investigate the application of validation and verification steps in communities, as these steps are sometimes misunderstood by even seasoned water professionals.

The methodology has been developed so that it is flexible to the needs of individual communities, and we welcome any improvements identified through further application. Ideally, this WSP approach will be shared throughout the Nepali WASH sector and continuously adapted as further insight is gained into the application of WSPs in rural Nepal.

CONCLUSIONS

The results from the three pilot projects have been evaluated by NEWAH staff, and a WSP process has been

developed which is conducive to rural, community-managed water supply systems in Nepal. This involves the development and incorporation of simple tools and documentation to assist in WSP development within interactive community workshops. It is anticipated that this methodology will be adapted by other NGOs and water utilities in Nepal, and improved as further experience is gained in the development of WSPs for rural, community-managed water systems.

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