Measuring the impact of multiple-use water services in Tanzania and Burkina Faso: water service quality, nutrition, and health

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Abstract/Summary
Multiple-use water services (MUS) is an integrated service delivery approach that takes into account households' full range of water needs. Past studies have shown the benefits of MUS in terms of enhancing income and livelihoods diversification. However, little is known about whether MUS is associated with improved health, nutrition, or water service quality. We used a matched control design dietary diversity among rural households receiving MUS through two large-scale water supply programs in Burkina Faso and Tanzania. Data was collected from 2,704 households representing five MUS typologies and a control group. Key informant interviews, focus group discussions, and water quality testing were also conducted. Comparisons across different MUS household typologies and the control group reveal a consistent positive trend regarding the benefits of MUS one to four years after project implementation. Households receiving MUS have experienced fewer injuries, enhanced food security, and use more reliable and safe water sources. These results contribute to a growing global evidence base regarding the variety of benefits associated with higher levels of water services in rural communities.

Introduction

Multiple-use water services (MUS) is an integrated water service delivery approach that takes into account a range of household' needs when planning, financing and managing water services. The MUS model explicitly acknowledges households' tendancy to re-allocate water intended for one type of activity to another, such as domestic water supplies being used for livestock watering or irrigation channels being accessed for drinking needs. In this way, MUS recognizes a more holistic approach that protects water systems from overuse, while simultaneously supporting synergistic uses of water at the household- and community-level. In practice, MUS typically delivers a higher level of water service, with at least 50 liter per capita per day (LPCD) available on household premises.

Past studies have shown the benefits of MUS in terms of enhancing water-based income generation (Crow, Swallow, & Asamba, 2011; Noel, Hoang, Soussan, & Lovett, 2010), especially in the presence of enabling factors, such as markets and electricity (Davis, Hope, & Marks, 2011). In rural Senegal, productive uses of water were linked to livelihood diversification among women (van Houweling, Hall, Diop, & Davis, 2012) and improved technical operation of water systems (Hall, Vance, & van Houweling, 2014).

Other potential benefits of MUS beyond income and livelihoods are less understood. Fully documenting such benefits is necessary to justify the often higher upfront investment required to establish the higher level of service offered by MUS.

Context, aims and activities undertaken

Study Objective: The study's objective was to rigorously assess a range of impacts expected to arise from MUS, including improvements in child health, safety during water collection, food security and nutritional status [2]. Sandec's Water Supply and Treatment group collaborated with United States Agency for International Development (USAID) and the Global Water for Sustainability (GLOWS) program, including partner organizations Winrock International, Virginia Tech, and Florida International University, to systematically evaluate the MUS component of two rural water supply programs in Africa.

Background: The first program, called the West Africa Water, Sanitation and Hygiene (WA-WASH) program in Burkina Faso (2011 to 2015), offered households the option to invest in subsidized self-supply (upgraded private wells equipped with rope pumps), along with other program activities. The second program, called the Integrated Water, Sanitation and Hygiene (iWASH) in Tanzania (2010 – 2015), used a demand-led approach to engage community members during the installation of new or upgraded communal water supply systems (reticulated networks, upgraded community wells with rope pumps, and/or livestock troughs). Both programs featured "impact boosting activities" that were tailored to local conditions and designed to mazimize the systems' potential for productive use. These activities included seed distribution networks, market garden demonstrations, support for improved poultry housing (kinengunengu) and livestock husbandry (Figure 1).

Figure 1. Impact boosting activities within the WA-WASH and iWASH programs

Study Design: Baseline (pre-intervention) data on outcomes of interest for this study were not collected prior to the launch of the programs. Thus, it was not possible to directly measure the before-after status of households receiving MUS. We instead relies on a two-step strategy to estimate impacts: (1) randomized sampling of various household typologies in WA-WASH and iWASH intervention communities, as well as a control group, and (2) statistical matching techniques. This article reports results for the first step only.

Communities that had participated in the iWASH and WA-WASH programs at least one year prior to the study were eligible for enrolment into the *treatment group*. Communities that were located within the program service regions and were pre-qualified for participation (but had not yet done so) were eligible for enrolment in the *control group*. From this eligible pool, communities were purposively selected to optimise variation in the water supply and impact boosting intervention(s) received.

Based on community visits and discussions held with field staff, the study team pre-defined and randomly sampled several household typologies. Within WA-WASH communities, household typologies include: (a) investors, (b) neighbours of investors (those who did not invest but who are accessing an investor's upgraded well), and (c) non-neighbours (those who did not invest in and do not use an investor's upgraded well, i.e., a pseudo-control within treatment communities). Within iWASH communities, household typologies include: (d) members of MUS interest groups and (e) non-members of a MUS interest group. Finally, households randomly selected from control communities (as described above) were defined as: (f) control households.

Data Collection: Between May and October 2015, field teams conducted 2,704 interviews with heads of households (men and women). Surveys probed on the water sources used throughout the year for any purpose, health status of adults and children, self-reported food security, dietary diversity, and other measures of well-being. In addition, semi-structured interviews were held with a key informant in each community (typically the village chief) to estimate population size, proximity to markets, and other community-level measures. Focus group discussions were held with men and women (both separately and mixed) of all household typologies in Burkina Faso to better understand the changes experienced since community members had participated in the WA-WASH program. Finally, fecal contamination of households' main drinking water sources was assessed using compartment bag test (CBT) kits in Burkina Faso (n = 181) and hydrogen sulfide (H_2S) vials in Tanzania (n = 35). Table 1 summarizes household typologies and sample sizes.

<table>
<tr><th>Category</th><th>Household typology</th><th>Household interviews</th><th>Focus group discussions</th><th>Key informant interviews</th><th>Microbial water quality</th></tr>
<tr><td rowspan="3">WA-WASH (19 communities)</td><td>a. MUS investors</td><td>146</td><td rowspan="3">8</td><td rowspan="3">19</td><td>59</td></tr>
<tr><td>b. Neighbours</td><td>292</td><td>0</td></tr>
<tr><td>c. Non-neighbours</td><td>451</td><td>59</td></tr>
<tr><td>Control – Burkina Faso (9 communities)</td><td>f. Control</td><td>438</td><td>0</td><td>9</td><td>63</td></tr>
<tr><td rowspan="2">iWASH (7 communities)</td><td>d. MUS interest group members</td><td>322</td><td>0</td><td rowspan="2">7</td><td rowspan="2">35</td></tr>
<tr><td>e. Non-members</td><td>410</td><td>0</td></tr>
<tr><td>Control - Tanzania (3 communities)</td><td>f. Control</td><td>645</td><td>0</td><td>3</td><td>0</td></tr>
<tr><td colspan="2">Total sample size</td><td>2,704</td><td>8</td><td>38</td><td>216</td></tr>
</table>

Table 1. Household typologies and sample sizes for the WA-WASH and iWASH programs.

Main results and lessons learnt

Illness and Injuries. As compared to control households, MUS households reported experiencing fewer instances of children experiencing diarrheal episodes in the past week, as well as fewer injuries experienced by women while fetching water. In bivariate tests, only the difference in the rate of injuries among households in the iWASH program (3%) and control communities (12%) was statistically significant ($p < 0.05$). Other health measures were not found to be significantly different across MUS and control groups.

Food Security. The survey asked respondents to rate their household's food security in the past year as being very secure, somewhat secure, or insecure. Interviewers explained the concept of food security in the local language. Results show that whereas food insecurity existed to some extent in all communities, the share of households identifying as insecure was significantly lower within communities receiving MUS. For example, within iWASH communities, 84% of MUS interest group members identified as "very secure", as compared to 65% of non-members and 53% of control households reporting the same.

Nutritional Status. The household survey included a standardized set of questions designed to assess the overall nutritional status of women of reproductive age (FAO 2014). Three measures were analysed: (1) the total number of food types consumed in the past week, (2) consumption of animal products (meat, milk and eggs), and (3) consumption of leafy green vegetables. Statistical comparisons revealed that overall dietary diversity was slightly but significantly improved only among households participating in the iWASH program (6.4 food types), as compared to control households (5.4 food types). In both programs, households receiving MUS were more likely to have consumed animal products in the past week, as compared to control households. For example, 92% of WA-WASH investors and 91% of iWASH interest group members had consumed meat, milk or eggs in the past week, as compared to only 82% and 77% of control households, respectively (Figure 2).

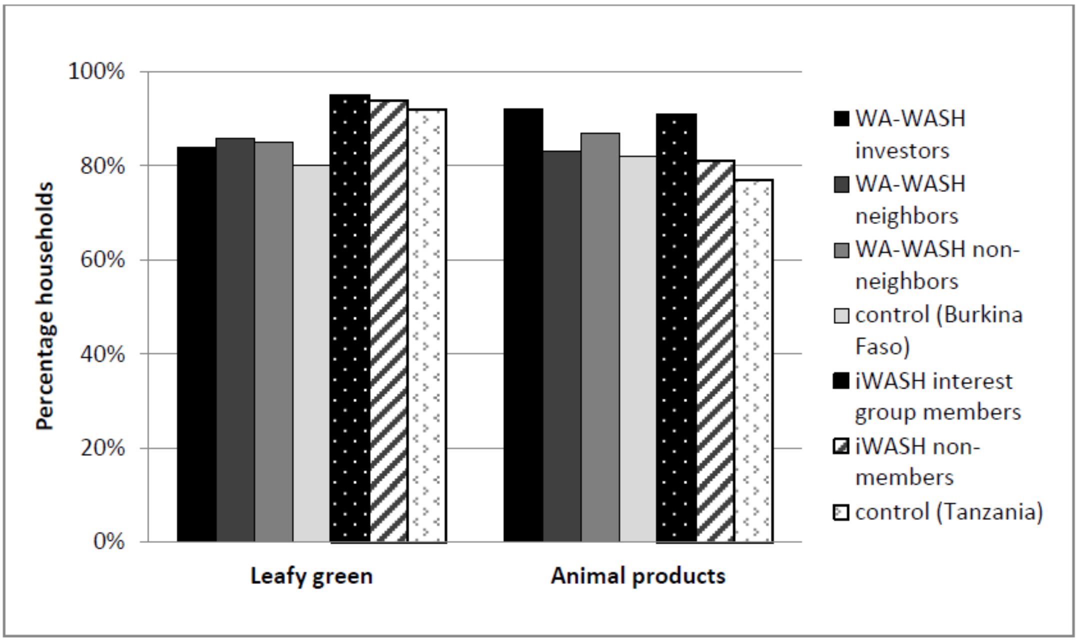

Figure 2. Share of households consuming leafy green vegetables and animal products within the past week.

Water Service Quality: We report preliminary results here for the WA-WASH program only. A greater share of MUS households (34%) reported waiting at some point during the year for their main drinking water source (traditional or improved wells) to recharge, as compared to control households (19%). However, MUS households typically waited for the water to return in the well for half the amount time as compared to control households (median of 60 minutes and 120 minutes, respectively). In terms of technical breakdowns, MUS households experienced fewer (16%) full day interruptions in water service, as compared to non-MUS households (23%). Water quality testing revealed that the majority (69%) of upgraded wells with rope pumps provided water categorized by the WHO as low risk (< 10 CFU/ 100 ml). By contrast, nearly all traditional wells (93%) were categorized as very high risk. A higher share of improved community wells (84%) had no detectable E.coli as compared to improved wells on premises (54%). Overall, we find most (75%) MUS investors are accessing a source categorized as safe or probably safe, whereas only 47% are doing the same in the control group.

Conclusions and Recommendations

Our analysis of the impact of two large-scale MUS programs in Africa is limited due to the lack of statistical controls for potential confounding factors. Nonetheless, through strategic enrolment and randomized sampling across various household typologies, direct comparisons reveal a consistent positive trend demonstrating the benefits of MUS one to four years after implementation of the WA-WASH and iWASH programs. Households receiving MUS had experienced fewer injuries while fetching water, were more food secure, and were more likely to be consuming animal products. MUS systems were more reliable overall and delivered higher quality water. However achieving WHO standards for microbial safety for all remained elusive. These results expand the growing evidence base regarding the benefits of higher levels of water services in rural communities globally. Planned future analyses include using multivariate modeling to further control for sources of bias, investigating potential spillover effects of MUS among neighbouring households, and estimating the return on investment for MUS projects.

Acknowledgements

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