Remote monitoring of privately-managed rural water supplies using Grundfos LIFELINK

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Abstract

Technologies that allow rural water system performance to be tracked and managed remotely are becoming increasingly relevant as delivery models that share operational and administrative responsibilities among public and private stakeholders begin to be explored. Water Missions International is utilising one such technology to monitor rural water supply systems implemented under its "TradeWater" private service delivery programme. The LIFELINK system developed by Grundfos is an automated water distribution point that is integrated with a secure payment facility and real-time GSM monitoring system. The LIFELINK system encourages accountability and transparency while allowing an extensive amount of water use data to be collected and used to develop water businesses.

This study sought to summarise LIFELINK monitoring data available to date for TradeWater operations in Uganda and Malawi. Particular focus was given to the accuracy and reliability of on-going household penetration, water usage, and consumption expenditure estimates that can be obtained with this data. The study also sought to explain how this data can be used to evaluate performance of rural water supply systems and adapt management strategies.

In general, income from water sales and other revenue-generating sources have remained fairly constant to date but all three projects considered in this study are continuing to operate under a financial deficit. This implies that additional measures must be taken to either reduce costs or increase revenue. In each case, the percentage of total households in the service area collecting water from the TradeWater business centre decreased over time. However, it is also evident from positive trends in average volume collected per user that the customers who were retained over time were increasingly satisfied with their level of service.

Spatial analysis of water users at the Kikondo, Uganda TradeWater project site with GPS labelling of LIFELINK water keys allowed a negative correlation to be observed between distance travelled to collect water and average volume of water collected each day over

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the ten-month observation period. Although the entire village of Kikondo is less than 200 m in diameter, it appears that distance of residence from the water access point at the TradeWater Business Centre plays a role in water use decisions.

Analysis of water user data from TradeWater pilot sites made possible with LIFELINK technology indicates that promotional activities, marketing campaigns and targeting of water delivery with local vendors could lead to increases in both household penetration as well as consumption. A strategic combination of these approaches will be employed in these pilot projects in order to improve cost recovery. The remote monitoring system described here has enabled the financial and technical performance of rural water supply systems to be gauged in a useful and transparent manner. If scaled, such technologies could revolutionise the way stakeholders monitor and adapt small-scale rural water supply systems.

Keywords
Information and communications technology [ICT], monitoring and evaluation, remote monitoring, rural water supply.

Introduction and purpose
The Rural Water Supply Network identifies the assumption that “communities are always capable of managing facilities on their own” as one of the major myths plaguing the rural water supply sector (RWSN Executive Steering Committee, 2010). The typical water committee that is responsible for a community-managed water supply system is faced with a multitude of technical and financial challenges that are often insurmountable even with adequate post-construction support. In order to address these challenges, alternative service delivery models that share operational and administrative responsibilities traditionally placed on local water committees among public and private stakeholders are being explored across the sector. In this context, technologies that allow water system performance to be tracked and managed remotely by these different stakeholders are becoming increasingly relevant.

Water Missions International is utilising one such technology to monitor rural water supply systems implemented under its “TradeWater” private service delivery programme. The LIFELINK system developed by Grundfos is an automated water distribution point that is integrated with a secure payment facility and real-time GSM monitoring system. The LIFELINK system encourages accountability and transparency while allowing an extensive amount of water use data to be collected and used to develop water businesses.

This study sought to summarise LIFELINK monitoring data available to date for TradeWater operations in Uganda and Malawi. Particular focus was given to the accuracy and reliability of ongoing household penetration, water usage, and consumption expenditure estimates that can be obtained with this data. The study also sought to explain how this data can be used to evaluate performance of rural water supply systems and adapt management strategies.

Context

Water Missions International is a US-based nonprofit Christian engineering ministry providing sustainable safe water solutions to people in developing countries and disaster areas. By the end of 2012, after only a decade in operation, the organisation was supporting operations in 49 countries through 9 country programmes established in East Africa, Latin America and the Caribbean, and Southeast Asia. The majority of the projects implemented by Water Missions International have been rural water treatment and supply systems designed to meet demand in small towns and settlements.

Traditionally, locally elected committees have been trained and equipped to manage the ongoing technical and financial operations of water supply systems installed by Water Missions International. In 2012, the organisation developed and began piloting an alternative management model, called "TradeWater", that allows it to operate as a low-cost water service provider in settings where community-based management is unfeasible but where a sustainable water-related business can be established. In communities where the TradeWater programme is implemented, Water Missions International constructs and maintains responsibility for all operational and administrative aspects of the water supply system. The infrastructure and hardware costs associated with a typical TradeWater project include water source development, construction of structures such as enclosures and tank support towers, and installation of a solar pumping system, proprietary filtration and/or disinfection treatment equipment, storage tanks and a distribution tap or network. All of the upfront capital expenditure is covered through a combination of individual and corporate donations. Trustworthy and longstanding members of the community (called "Water Agents") are employed to operate the water system under a sustainable, nonprofit business model, where ongoing cost recovery is achieved through sales of safe water and/or water-related services such as pay-per-use public bathing facilities. Dedicated staff members from Water Missions International's local country office train Water Agents as well as provide administrative oversight and maintenance support. The water business can be sold or transferred to a local individual or institution once it has been established and proven capable of breaking-even.

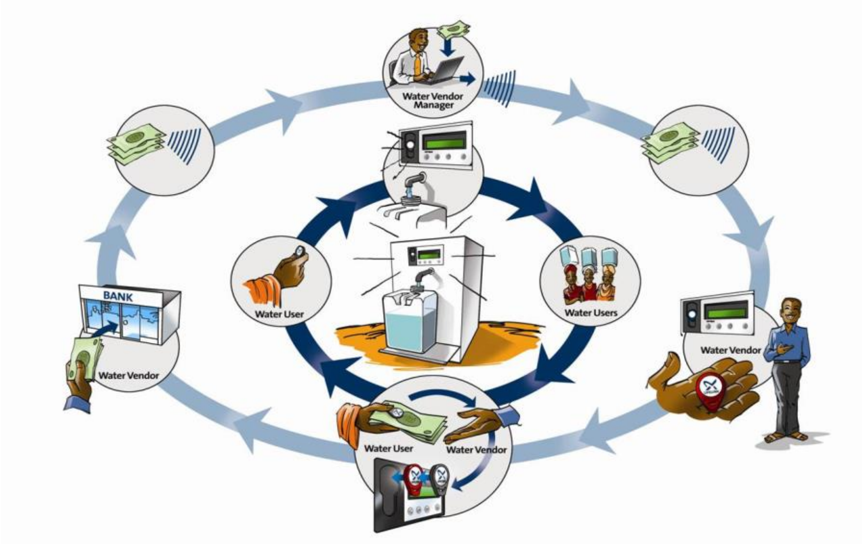
There has been some precedence for implementing a business model similar to that which is employed by the TradeWater programme. Most notably, WaterHealth International has been successful in establishing and maintaining financially stable water service delivery businesses in India, Bangladesh, Ghana and the Philippines (IFC, 2012). Unlike the TradeWater programme, WaterHealth International finances 60 to 70% of capital expenses through long-term loans from entities such as Acumen Fund (Meehan, 2007). Any revenue that is in excess of operational and maintenance costs covers debt service and profits go to WaterHealth International. In contrast, profits generated by the TradeWater programme are reinvested in the project site or used towards capital expenditure of new TradeWater sites.

The first TradeWater pilot project opened for business in Kikondo, Uganda in February 2012. Kikondo is a fishing settlement of close to 380 households less than 5 km due South from Jinja on the shore of Lake Victoria. Two additional pilot projects, Matanda (Malawi) and Kimmi Island (Uganda), were commissioned in June and September 2012, respectively. Matanda is a community of about 180 households 12 km northwest of Lilongwe outside the administrative authority of the Lilongwe Water Board. Kimmi Island is an isolated Lake Victoria island community, 25 km due southeast from Entebbe, of 590 semi-permanent households predominately supported by the local fishing industry. Traditional community-based management was not recommended for any of these sites due to the transient nature of the communities. Source water for the Uganda TradeWater project sites is drawn from Lake Victoria with a solar pumping system and treated with filtration and chlorine disinfection. The Matanda TradeWater project utilises a solar pumping system on a deep borehole and chlorine disinfection. The capital expenditure (hardware and software) for these pilot projects ranged from $45,000 to $95,000 USD, depending on complexity of the water supply system and distance from the local country programme office. All analyses presented in this report include operations through November 2012.

A Grundfos LIFELINK unit (shown in Figure 1) was installed at each TradeWater pilot site in order to facilitate the tracking of operations and enable better decision-making. The LIFELINK unit allows users to pay for water through a secure payment facility with a “water key”. Water keys are purchased by water users and then loaded with credit, transferred either via mobile money or directly from a “credit key” that is held by the Water Agent. Once inserted into the LIFELINK unit, a preset collection fee is deducted from the water key for each litre of water dispensed (see Figure 2). In the context of the TradeWater programme, the “Water Vendor Manager” shown in Figure 2 represents dedicated TradeWater staff members in Water Missions International’s local country office (called “Water Agent Managers”) and the “Water Vendor” represents the Water Agent. The funds transferred and volumes distributed during each transaction are transmitted via GSM and recorded in an online database that can be viewed in real time. Alarms are generated and can be viewed online when satellite connection with the LIFELINK unit has been lost, when the actuated valve, modem or PLC fails and when the water reservoir is empty. The amount of credit remaining on the Water Agent’s credit key can be viewed and extended remotely as well. LIFELINK technology keeps the Water Agent financially accountable by logging all credit transfers and allowing verification through comparison with both the amount of cash deposited in the specific TradeWater project bank account and with the value of water dispensed during each tapping session. Water Agent Managers are also able to make informed administrative decisions regarding water price and promotional activities based on information obtained from the LIFELINK system.

Figure 1: LIFELINK unit installed at Kikondo TradeWater business centre.

Figure 2: Grundfos LIFELINK Payment System.



Grundfos has developed its own business and management model for implementing the LIFELINK system in rural communities in Kenya (WBCSD, 2012). In this model, Grundfos installs a LIFELINK unit at a protected borehole with a solar pumping system and storage tank. Individual water users are able to add credit to their water keys via a popular mobile banking system and collect water from the LIFELINK unit. Grundfos maintains responsibility for maintenance of all equipment, including the LIFELINK unit, and covers these costs by automatically deducting a service contract fee from the revenue that is generated each month. Any additional revenue remains in a bank account that is managed by a local water committee. Prior to the company's partnership with Water Missions International, the LIFELINK system had only been implemented in Kenya under this model. In contrast to this model where no specific role is required at the local level, the lack of both mobile banking services and on-the-ground Grundfos technical support and the necessity of water treatment requires operational, money handling, and maintenance responsibilities to be covered by local staff in the Uganda and Malawi TradeWater programmes.

Methodology

The LIFELINK units installed at each TradeWater pilot site record the amount of credit transferred and volume of water distributed during each tapping session. All data points are also time stamped and labelled with a unique water key identification number, allowing the information to be analysed on both temporal and individual user level. This data is automatically transmitted at regular intervals to Grundfos' proprietary data management system, Global Revenue Management (GRM). Water Missions International's internal database is allowed to access the GRM platform on a daily basis to retrieve all data available for each pilot site (see Figure 3). For this study, all data was exported to and analysed in Microsoft Excel.

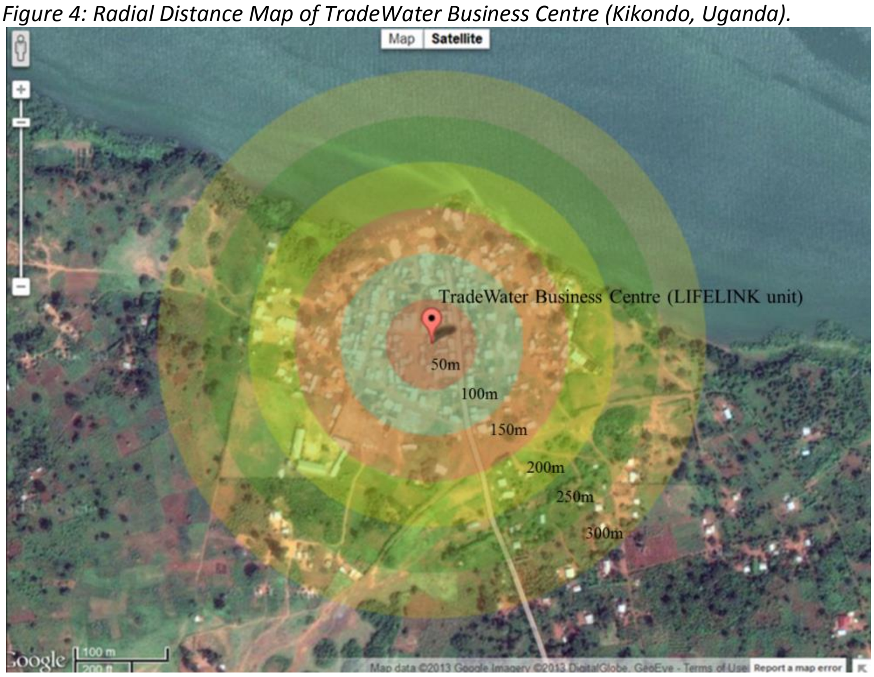
Figure 3: Screenshot of Data Retrieved from Grundfos GRM System.

CardID	CreditType	Amount	Balance	SecondCardID	DateTimeStamp	WaterUnit	AmountOf	Tap
AA6700	Received from 2nd card	2000	2000	AAA121	02/02/12 13:59:25	870235		
AA6700	Received from 2nd card	1000	3000	AAA121	02/02/12 14:02:41	870235		
AA6700	Received from 2nd card	1000	1190	AAA121	03/19/12 13:02:54	870235		
AA6700	Received from 2nd card	1000	1000	AAA121	04/17/12 10:52:13	870235		
AA6770	Dispensed	2.5	2817.5		02/16/12 15:45:15	870235	1	Tap 1
AA6770	Dispensed	25	2792.5		02/16/12 15:45:44	870235	10	Tap 1
AA6770	Dispensed	22.5	2770		02/16/12 15:46:15	870235	9	Tap 1
AA6770	Dispensed	50	2720		02/16/12 15:47:44	870235	20	Tap 1
AA6770	Dispensed	25	2695		02/16/12 15:54:32	870235	10	Tap 1
AA6770	Dispensed	25	2670		02/16/12 15:54:56	870235	10	Tap 1
AA6770	Dispensed	25	2645		02/16/12 16:06:41	870235	10	Tap 1
AA6770	Dispensed	22.5	2622.5		02/16/12 16:07:04	870235	9	Tap 1
AA6770	Dispensed	50	2572.5		02/16/12 16:32:12	870235	20	Tap 1
AA6770	Dispensed	50	2522.5		02/16/12 16:32:47	870235	20	Tap 1
AA6770	Dispensed	25	2497.5		02/17/12 4:56:25	870235	10	Tap 1
AA6770	Dispensed	25	2472.5		02/17/12 4:56:51	870235	10	Tap 1
AA6770	Dispensed	25	2447.5		02/17/12 5:00:15	870235	10	Tap 1

Credit transferred to the LIFELINK units at each TradeWater pilot site was recorded as income and compared to operational and capital maintenance expenditures as tracked with Water Missions International's accounting platform (Quickbooks Enterprise Solutions, Manufacturing and Wholesale Ed. 13.0). It was assumed that each individual user (or water key) represented a single household. However, many households were known to purchase and use water keys jointly. In order to account for this behaviour as well as for vendors and institutional users (schools, health clinics, etcetera), the volume of water collected per user was summed for each day and water keys used to collect more than 100L per day were excluded from household-level analysis. The fraction of households in the service area collecting water from each TradeWater business centre, (household penetration), was estimated on a monthly basis by adding the sum of the number of active individual users to the estimated number of households collecting water indirectly from the TradeWater centre. The number of households collecting water indirectly was calculated as the quotient of the average daily volume of water collected by institutional users and vendors divided by the average daily volume of water collected by active individual users, and then dividing by the total number of households in the service area. Monthly consumption expenditure on water per household was estimated by dividing the average amount of credit transferred by each individual user by the average monthly household income. Average monthly household income was assumed to be 171,500 UGX for rural, Eastern Uganda (UBS, 2010) and 118,125 MWK for Malawi (Scottish Executive, 2005).

GPS labelling of residences associated with water keys in Kikondo, Uganda allowed distance from residences to the TradeWater business centre to be calculated. Average daily volume collected per user was evaluated based on distance travelled. In addition, household penetration was evaluated based on distance required to travel by summing the number of active individual users within defined radii of the TradeWater kiosk and dividing by the total number of households counted within each radii on a satellite image of the village (see Figure 4).

Figure 4: Radial Distance Map of TradeWater Business Centre (Kikondo, Uganda).



Findings and discussion

Probably the most valuable aspect of the LIFELINK system is its ability to track and report financial data. Since any sustainable enterprise must first and foremost be financially stable (cover all expenses with income), decision-making usually begins with an analysis of financial operating trends. Figures 5, 7 and 9 illustrate trends in income as reported by LIFELINK compared with real expenses for TradeWater pilot projects in Kikondo, Kimmi Island and Matanda, respectively. In the figures, total income represents all revenue generated from water sales and additional services offered at TradeWater business centres such as mobile phone charging and bathing shelters. Operating expenses include staff commissions and salaries as well as administrative, chemical and transportation costs. Total expenses account for capital maintenance expenditures, including major maintenance, repair and depreciation costs.

In general, incomes from water sales have remained fairly constant to date. Trends in income from water sales appear to be consistent with trends in daily and average monthly production for Kikondo, Kimmi Island and Matanda shown in Figures 6, 8 and 10, respectively. Income from additional revenue sources in Kikondo, particularly that which was derived through solar mobile phone charging, showed a marked increase in October and November. The reason for this trend is unknown. Although expenses fluctuated from month to month they appear to have decreased in all pilot projects over time. This trend is likely a result of less support (that is, staff time and transportation from the country programme office) being required over time as the Water Agents become more comfortable with their job. However, as displayed in Figure 11, all three projects are continuing to operate under a financial deficit where total expenses are more than double the total income. This implies that additional measures must be taken to either reduce costs or increase revenue in order for these pilot projects to be financially stable.

Figure 5: TradeWater Financial Summary (Kikondo, Uganda).

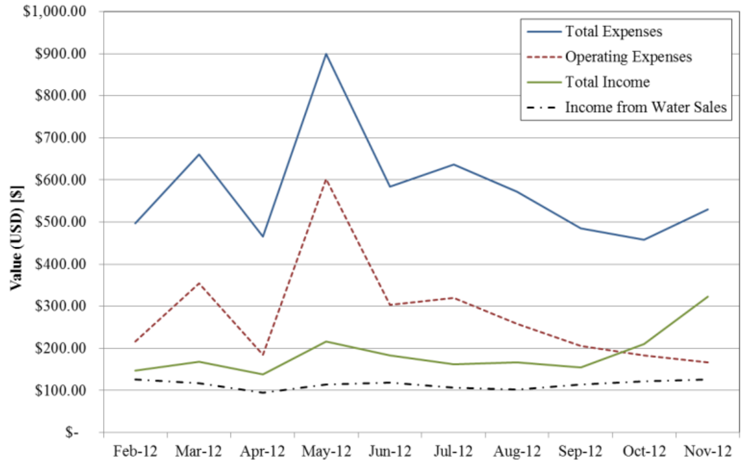


Figure 6: TradeWater Production Summary (Kikondo, Uganda).

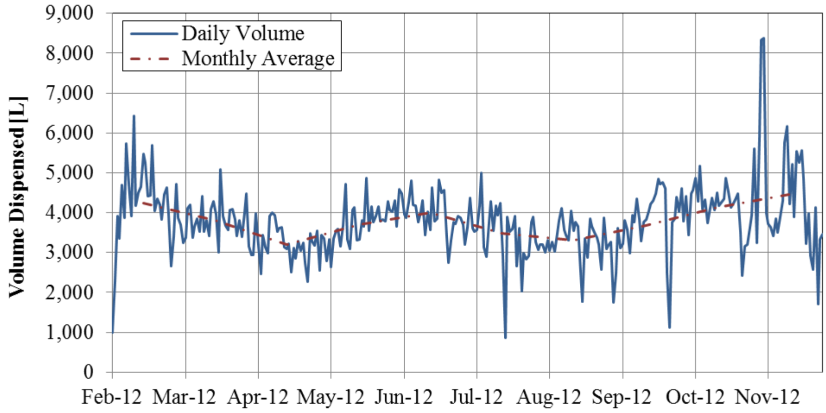


Figure 7: TradeWater Financial Summary (Kimmi Island, Uganda).

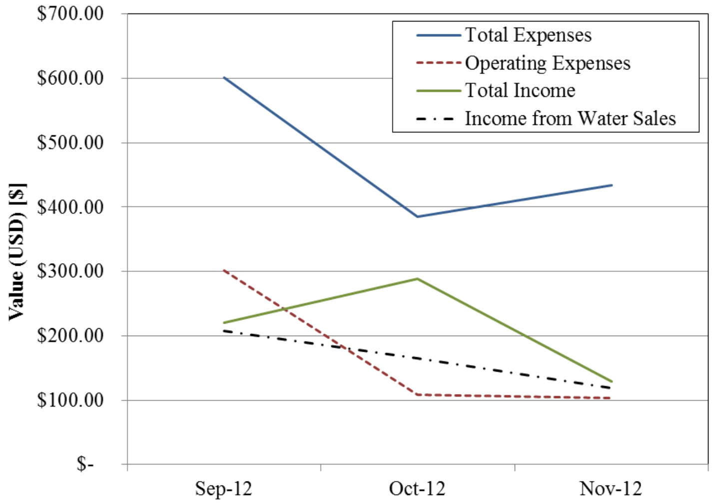


Figure 8: TradeWater Production Summary (Kimmi Island, Uganda).

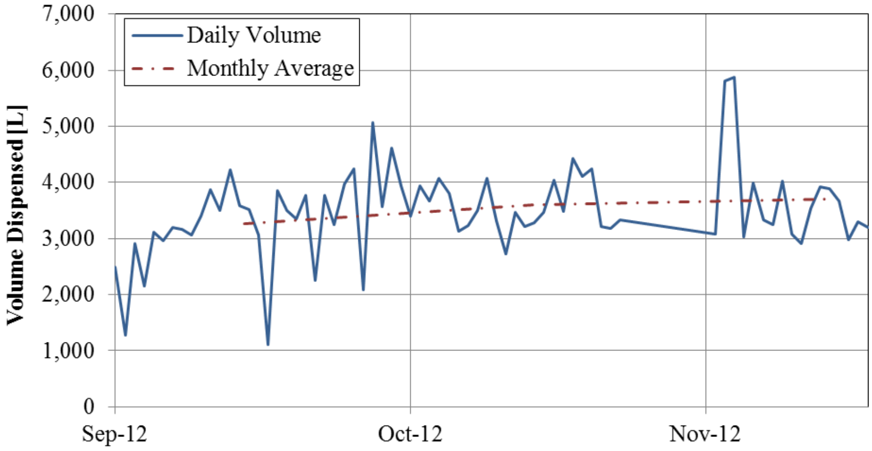


Figure 9: TradeWater Financial Summary (Matanda, Malawi).

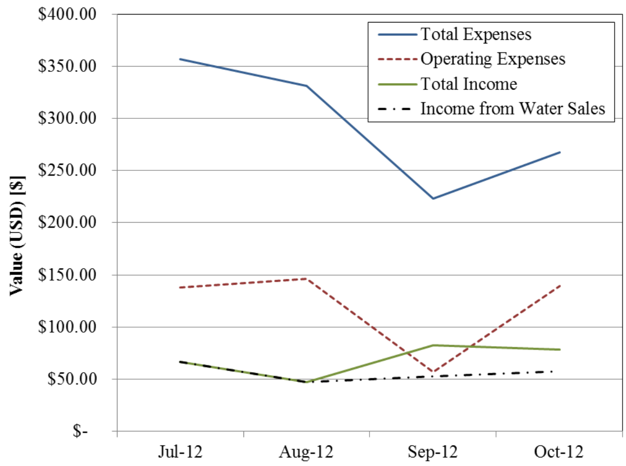


Figure 10: TradeWater Production Summary (Matanda, Malawi).

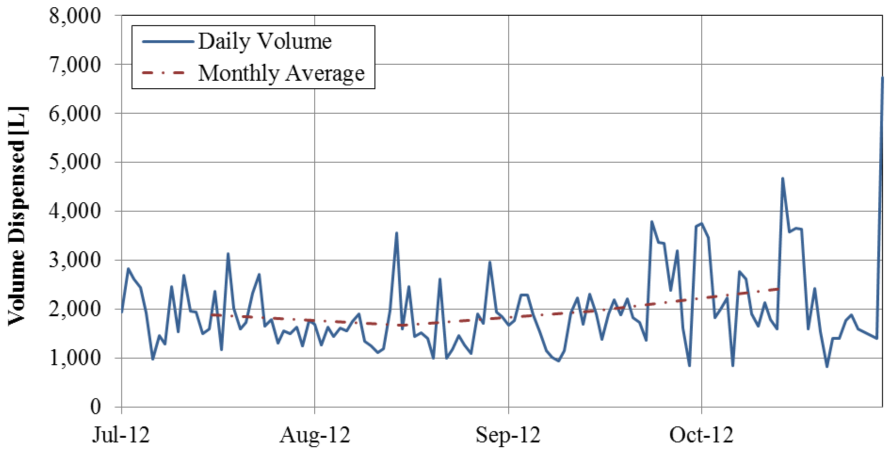
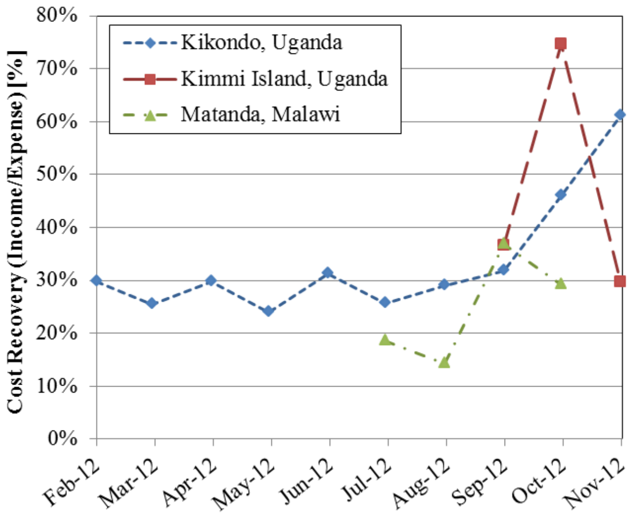


Figure 11: TradeWater Cost Recovery Summary.



Although there are steps that could be taken to reduce the costs associated with these three pilot projects, analysis of data made available through LIFELINK has illuminated a number of ways that revenue could potentially be increased. Revenue is a direct function of water price, number of customers (household penetration), and consumption per customer. The LIFELINK system allows trends in and interactions between these variables to be observed in real time. Such an analysis can help to inform managers of how increasing water price may affect demand and of the likelihood that household penetration and consumption can be increased through targeted promotional or marketing initiatives.

Figures 12, 13 and 14 display trends in household penetration and consumption for TradeWater pilot projects in Kikondo, Kimmi Island, and Matanda, respectively. In each case, the percentage of total households in the service area collecting water from the TradeWater business centre decreased over time, even by as much as 30% (in Matanda). This does not seem to be an encouraging trend. However, it is also evident from positive trends in average volume collected per user shown in these plots that the households which continued to collect water from the TradeWater business centre either increased their consumption over time or continued to collect a high volume of water while the "low" using customers ceased to collect water. This suggests that the customers who were retained over time were increasingly satisfied with their level of service. The number of users who were either sharing water keys or reselling water purchased from the business centres (those users who were collecting more than an average of 100L per day) increased over time in all three pilot projects (see number of institutional and vendor users in Tables 2, 4 and 6). These users were found to be visiting the LIFELINK unit much more frequently as well as collecting much more water (about 10 times more) than other users. It was this phenomenon, as well as the steady increase in the average volume collected per user that led to the consistent monthly income and production seen in Figures 3-9 in spite of decreased individual household penetration.

Figure 12: Household Penetration and Consumption (Kikondo, Uganda).

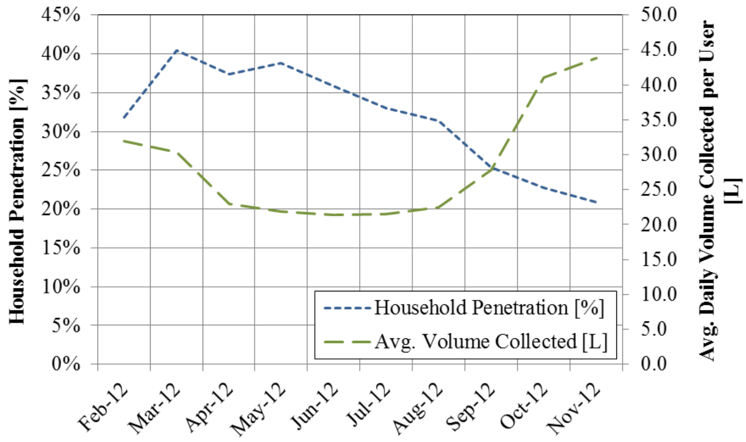


Figure 13: Household Penetration and Consumption (Kimmi Island, Uganda).

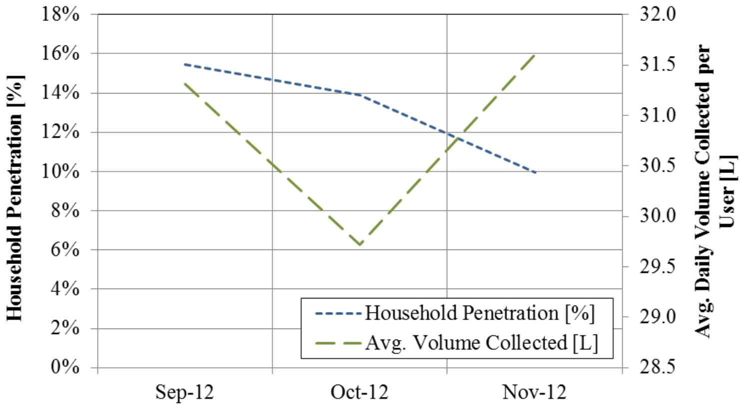
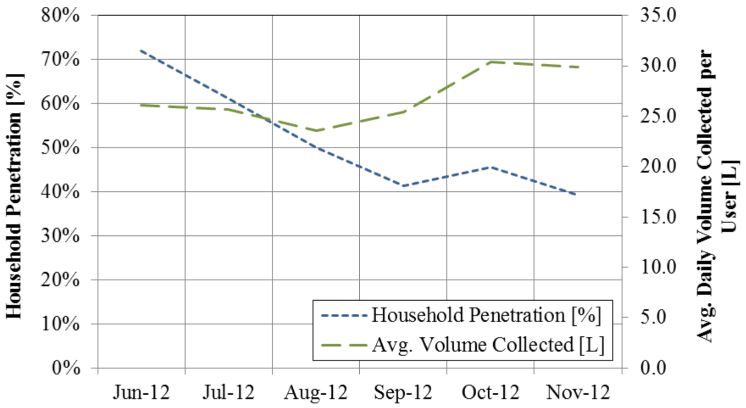


Figure 14: Household Penetration and Consumption (Matanda, Malawi).



It appears that promotional activities (that is, creative pricing structures) and marketing campaigns (that is, promotional messaging intended to increase demand among specific types of users) could lead to increases in both household penetration as well as consumption. There is significant room to increase market share in all three pilot projects, especially in Kimmi Island where household penetration has been exceptionally low at less than 20%. If household penetration were to return to the highest level seen during the study period at all three sites and consumption maintained, income would be increased by 70 to 100%. This would enable full cost recovery in the Kikondo and Kimmi Island TradeWater projects. There also seems to be room to increase individual consumption because, on average, users are only collecting volumes of water on the order of 30L per day. Assuming an average household size of 4.5 (NSO, 2008) and 5.6 (UBS, 2010) people in Malawi and Uganda, respectively, this means that individual consumption from TradeWater operations is less than 7.5L each day. Sporadic household surveys in Kikondo have indicated that this volume of water is being used for drinking and cooking and that lake water is being used for other domestic purposes including laundry, bathing, and dishwashing.

When attempting to increase consumption or considering an increase in water price, care must also be taken to ensure that consumption expenditure, (the amount of available household income spent on water), remains as low as possible. This is important for ensuring that access is being provided and that water price doesn't outweigh local demand for paying for safe water. The average consumption expenditure in each TradeWater pilot project has increased steadily as consumption itself has increased over time (see Tables 1, 3 and 5) but has remained below the 3% threshold that the UNDP has suggested as an indicator of economic hardship (UNDP, 2006). This implies that there is room to increase consumption or water price in the project without limiting financial accessibility. To date, the TradeWater staff managers in Uganda and Malawi have decided to maintain a constant water price in each pilot project (50 UGX per 20L container in Kikondo, Uganda; 100 UGX in Kimmi Island, Uganda; and 5 MWK per 20L container in Matanda, Malawi). The TradeWater project in Matanda should certainly consider increasing water price because of its exceptionally low average consumption expenditure (less than 0.2%).

Table 1: Individual User Data (Kikondo, Uganda).

Month	Users [no.]	Household Penetration [%]	Daily Averages			
			Tapping Sessions per User [no.]	Volume Collected per User [L]	Consumption Expenditure [%]	Total Volume Dispensed [L]
Feb-12	107	32%	2	31.9	1.4%	4,238
Mar-12	132	40%	2	30.4	1.3%	3,804
Apr-12	122	37%	2	22.9	1.0%	3,209
May-12	116	39%	2	21.9	1.0%	3,694
Jun-12	103	36%	2	21.4	0.9%	3,999
Jul-12	98	33%	2	21.5	0.9%	3,475
Aug-12	84	31%	2	22.5	1.0%	3,307
Sep-12	73	25%	2	27.8	1.2%	3,674
Oct-12	70	23%	3	41.0	1.8%	4,126
Nov-12	66	21%	3	43.8	1.9%	4,452

Table 2: Institutional and Vendor User Data (Kikondo, Uganda).

Month	Users [no.]	Daily Averages per User	
		Tapping Sessions [no.]	Volume Collected [L]
Feb-12	4	29	438
Mar-12	3	43	656
Apr-12	3	28	463
May-12	3	31	691
Jun-12	5	28	711
Jul-12	4	23	595
Aug-12	3	34	796
Sep-12	6	30	651
Oct-12	10	28	679
Nov-12	13	29	582

Table 3: Individual User Data (Kimmi Island, Uganda).

Month	Users [no.]	Household Penetration [%]	Daily Averages			
			Tapping Sessions per User [no.]	Volume Collected per User [L]	Consumption Expenditure [%]	Total Volume Dispensed [L]
Sep-12	83	15%	1	31.3	1.4%	3,263
Oct-12	71	14%	1	29.7	1.3%	3,594
Nov-12	48	10%	2	31.6	1.4%	3,697

Table 4: Institutional and Vendor User Data (Kimmi Island, Uganda).

Month	Users [no.]	Daily Averages per User	
		Tapping Sessions [no.]	Volume Collected [L]
Sep-12	9	9	252
Oct-12	10	13	323
Nov-12	11	13	340

Table 5: Individual User Data (Matanda, Malawi).

Month	Users [no.]	Household Penetration [%]	Daily Averages			
			Tapping Sessions per User [no.]	Volume Collected per User [L]	Consumption Expenditure [%]	Total Volume Dispensed [L]
Jun-12	112	72%	1	26.1	0.2%	2,681
Jul-12	97	61%	2	25.7	0.2%	1,890
Aug-12	76	50%	1	23.6	0.1%	1,665
Sep-12	63	41%	2	25.5	0.2%	1,957
Oct-12	74	46%	2	30.4	0.2%	2,426
Nov-12	61	39%	2	29.9	0.2%	1,776

Table 6: Institutional and Vendor User Data (Matanda, Malawi).

Month	Users [no.]	Daily Averages per User	
		Tapping Sessions [no.]	Volume Collected [L]
Jun-12	6	7	419
Jul-12	6	10	303
Aug-12	7	8	307
Sep-12	11	12	271
Oct-12	10	7	217
Nov-12	11	7	257

Spatial analysis of water users in Kikondo, Uganda with GPS labelling of LIFELINK water keys allowed a negative correlation between distance travelled to collect water and average volume of water collected each day over the ten-month study period to be observed. This relationship is illustrated in Figures 15 and 16. Further analysis showed a decrease in household penetration, in addition to average daily volume collected, as distance from residence to the TradeWater Business Centre increased. Although the entire village of Kikondo is less than 200 m in diameter, it appears that distance of residence from the TradeWater Business Centre plays a role in water use decisions. While this finding is certainly not groundbreaking, it suggests water sales could be increased if accessibility was improved through construction of additional distribution points or increased vending initiatives.

Figure 15: Average Daily Volume Collected per User versus Distance Travelled (Kikondo, Uganda).

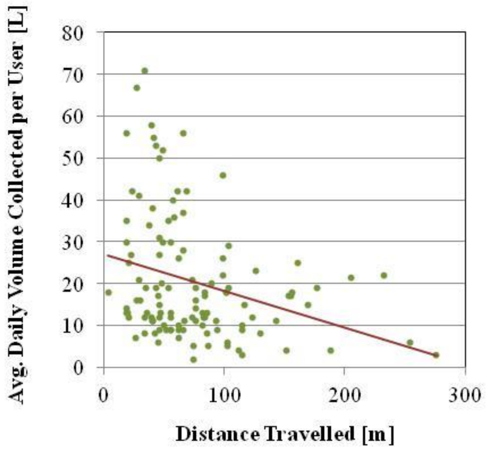
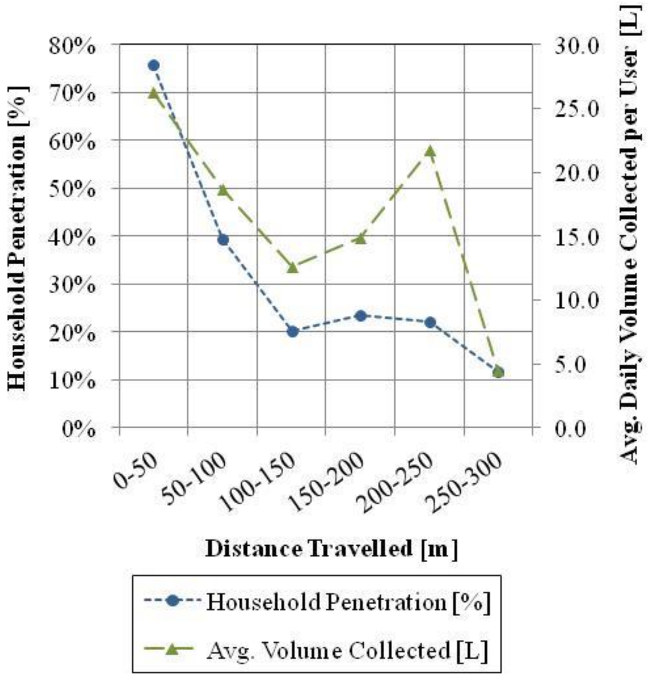


Figure 16: Effect of Distance Travelled on Household Penetration and Average Daily Volume Collected per User (Kikondo, Uganda).



Conclusions

On-going critical analysis of household penetration and consumption is essential for adequate financial management of water supply systems. Data collected through the LIFELINK system has greatly simplified the tracking of these variables in Water Missions International's TradeWater programmes and has enabled the analysis of additional indicators of sustainability.

When systems with relatively fixed costs are found to be operating under a financial deficit, as in the three pilot sites referenced in this study, steps must be taken to increase revenue. This can be accomplished by increasing penetration, consumption, or water price, or by generating revenue from alternative sources. Each of these avenues comes with unique challenges. Traditional marketing and promotion techniques can be employed to increase the number of water users and consumption per user in a particular community. Water Missions International has engaged with local health promotion clubs in the communities where these pilot sites are located and plans to work with these entities to develop ongoing marketing strategies. In addition, Water Missions International plans to explore strategies of pairing promotional offers with creative pricing structures for the range of products that are offered at TradeWater business centres. If these initiatives are able to increase penetration and consumption in the pilot sites to the highest levels seen to date, Water Missions International is optimistic that the TradeWater business model can achieve full cost recovery.

When accessibility is found to hinder potential users from collecting water from the system as appears to be the case in Kikondo, the amount of travel and time required to collect water can be reduced (and number of users increased) by adding additional water points. However, the cost of expansion can be prohibitively expensive when LIFELINK units are used as the distribution points because the current design would require installation of multiple units in a community. Grundfos is working to reduce the price of the LIFELINK unit in order to make this option more feasible. Alternatively, local vendors can be incentivised to supply water to areas where demand for on-premises delivery is high. Encouraging the resale of water can increase household coverage and thus increase revenue. GPS labelling of water keys has enabled specific areas with low household penetration to be identified at TradeWater pilot sites. Local vendors have not been engaged in a strategic manner to target low penetration areas at these particular TradeWater pilot sites. TradeWater staff in Uganda and Malawi is planning to coordinate distribution with local vendors in the coming months in a manner similar to other Water Missions International country programs. This strategy should also lead to increased cost recovery.

The remote monitoring system described here has enabled the financial and technical performance of rural water supply systems to be gauged in a useful and transparent manner. Although other automated water distribution technologies are available and will continue to be developed, the LIFELINK system is a viable off-the-shelf option for tracking community-level finances and capturing water use data. If scaled, the technology could revolutionise the way public and private stakeholders monitor and adapt small-scale rural water supply systems.

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