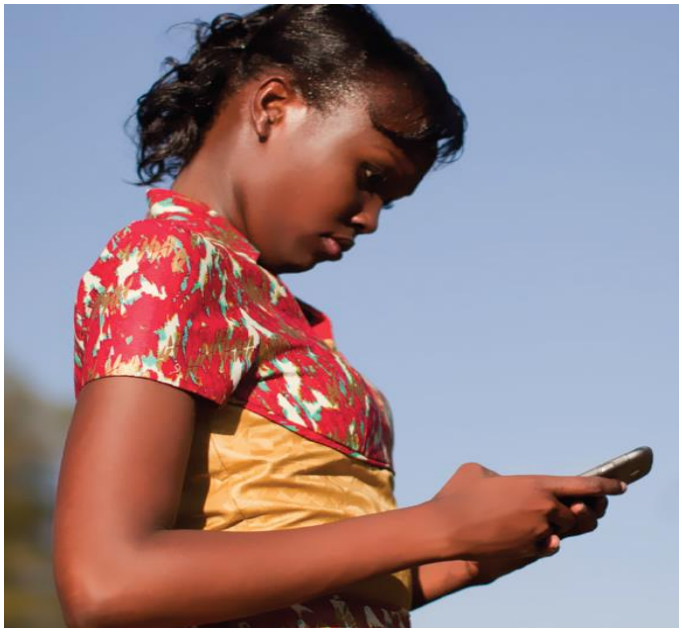
# UNLOCKING THE POTENTIAL OF INFORMATION COMMUNICATIONS TECHNOLOGY TO IMPROVE WATER AND SANITATION SERVICES

## UGANDA CASE STUDY



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# PREFACE

*This report has been prepared for the Water and Sanitation Program (WSP) Study on "Unlocking the Potential of ICT Services in the Water and Sanitation Sector". The study builds on and complements the World Banks' Africa Regional Strategy (2011) and the World Bank Group's Information and Communication Technology (ICT) strategy (2012). It further complements the E-Transform Africa series, a collaboration between the African Development Bank, the World Bank and the African Union, which captures the existing use of ICT in six sectors (agriculture, climate change, education, health, financial services, government) and two cross-cutting themes (regional trade and integration, ICT competitiveness).*

*WSP has spearheaded the use of ICT in many countries in particular with its contribution in financing the use of the mWater pilot platform in countries such as Senegal, Mali, Niger and Benin, Akvo Flow and Fulcrum in Liberia and Sierra Leone and Maji Voice in Kenya. As many sector stakeholders are interested to learn from these pilot interventions, it is necessary to improve the documentation on these experiences and propose practical modalities for scale-up.*
*There is also a very strong drive around the use of ICT in the WASH sector and a growing interest among external partners. As such, there is a need to develop clearer partnership platforms with both short- (i.e. project specific) and medium-term objectives, to understand the potential information that can be generated through ICT, increase accessibility to and use of that information, and ensure that ICT generated information is implemented more sustainably in support of WASH objectives.*
*The study was carried out by the Water and Sanitation Program (WSP) of the World Bank to fill a gap in understanding how the potential of ICT can improve water and sanitation services globally with a particular emphasis in Africa. It covers a global desk review and case studies in 7 African countries (Kenya, Uganda, Tanzania, Senegal, Benin, Niger and Liberia), complemented by cases from other regions (Latin America, North America, South Asia and East Asia) and analyses strengths and weaknesses of existing ICT tools. It also provides evidence on how ICT can be used to leapfrog the water and sanitation sector towards more sustainable service delivery.*

*As such, this study sought to not only document experiences of ICT use in the WASH sector but also analyze them within a framework of enabling factors and barriers in terms of Vision, Process, Customer/User, Service Delivery, Human Capacity, Governance and Finance.*

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# ACRONYMS

| | |
|---|---|
| DEA | Directorate of Environmental Affairs (Uganda) |
| DWD | Directorate of Water Development (Uganda) |
| DWRM | Directorate of Water Resources Management (Uganda) |
| IRC | International Water and Sanitation Centre |
| M4W | Mobiles for Water |
| MWE | Ministry of Water and Environment (Uganda) |
| NWSC | National Water and Sewerage Corporation |
| SNV | Netherlands Development Organisation |
| Triple S | Sustainable Services at Scale |
| WSDB | Water Supply Database |

# 1. INTRODUCTION

Uganda, like many developing African countries is embracing the use of Information and Communication Technology (ICT) in the WASH sector to improve service delivery in both urban and rural settlements. The proliferation of affordable ICTs, principally in the form of mobile phones, has presented opportunities to address information gaps that tend to hinder service delivery by transforming the way information is generated and shared amongst stakeholders. According to Jiménez and Pérez-Foguet (2010) water access problems in low resource areas arise from social and political causes rather than technical or physical problems. Having functional water services especially in rural communities is not so much a technological challenge but rather an institutional one. The political interference, lack of voice and visibility for the poor communities, poverty, low literacy and weak institutional capacities make service delivery hard. The issues in the water sector are complex and diverse and there is no single solution. However, addressing the underlying issue of governance by establishing systems or structures to develop, manage and deliver water services to communities is seen as critical if access to these services is to improve (Hutchings et al, pp.10, 2012).ICTs have become ubiquitous and are being applied in developing countries to support the establishment of reliable and inclusive information practices to facilitate the management of WASH activities and produce actionable information to achieve sustainable delivery of services. ICTs offer ways of changing relationships between communities and service providers and provide a platform for more affordable information dissemination, communication between service providers and communities and monitoring of interventions in the sector (Hellström & Jacobson, 2014; Breslin, 2013).

While there are many potential benefits offered, ICT implementation, use and scale-up face multiple challenges. Issues of poor communication infrastructure, education barriers (low literacy), politics, culture of technology use and capacity of local government institutions to act on the information generated must be addressed if technological interventions are to be meaningful and influence service delivery and water access.

This report presents findings of a field study conducted in Uganda in October 2014. This report is one of seven country case study reports that make up the third step of the WSP study *Unlocking the Potential of ICT Services in the Water & Sanitation Sector in Africa*[1]. The case study reports sought to address two of the following key objectives of the study: 1) Document relevant experiences of key ICT applications in the water and sanitation sector, highlighting the strengths and weaknesses of current initiatives, and 2) Identify binding constraints impacting ICT adoption and scale-up.

The first section of the report offers a landscape analysis of Uganda; briefly introducing the regulatory and operating environment for the ICT and WASH sectors, looking at existing ICT use in the WASH sector and the current state of ICT policy. The second section then looks specifically at two case studies, the National Water and Sewerage Corporation's e-water payment system and Mobiles 4 Water. As part of each country case study one to two ICT initiatives were examined in detail using the dual framework analysis introduced and described in the *Analytical Report* .This allowed for an increased in-depth assessment of the barriers and enabling factors of success faced by ICTs currently in play in the African WASH sector and supported the highlighting of key principles upon which successful sustainability and scalability models can be constructed. The study is based on reports on the national water utility (National Water and Sewerage Corporation), and the Mobiles 4 Water intervention and interviews and focus group discussions carried out among users and

[1] All study reports can be found on the Unlocking ICT Potential site in the Resources Folder. Submitted Reports - Study on Unlocking ICT Potential

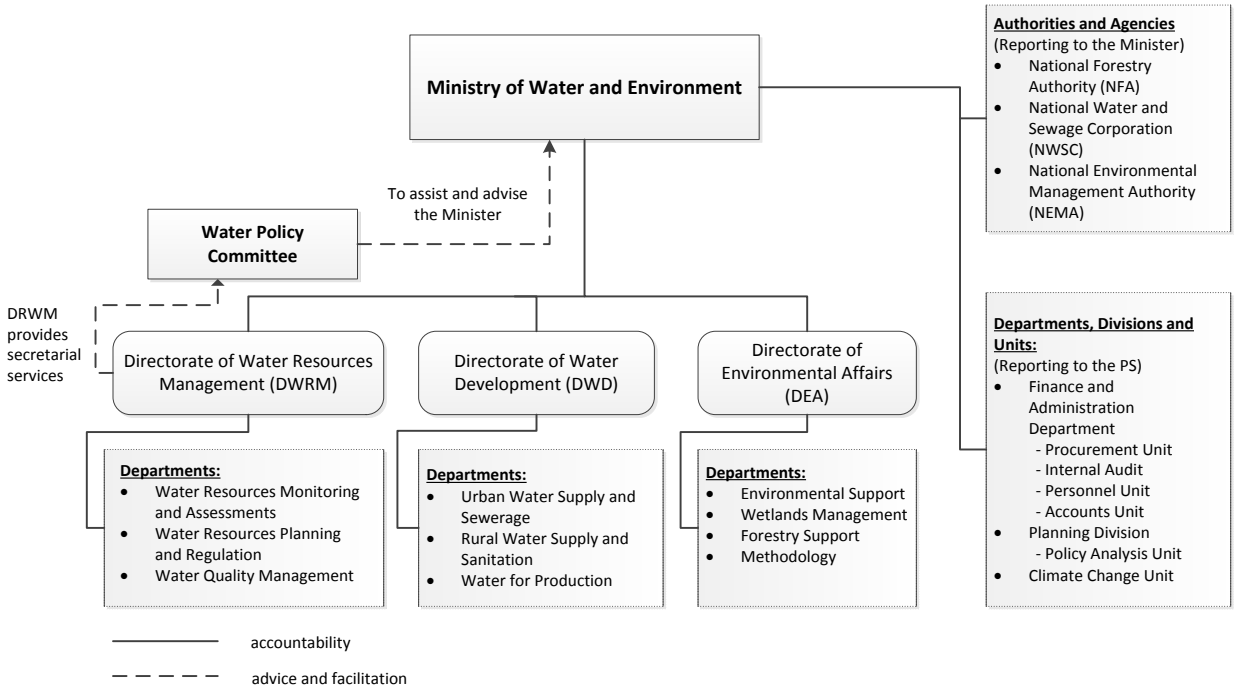
implementers in Uganda. The stakeholders that were consulted during the preparation of this report are presented in Annex A.

# 2. LANDSCAPE ANALYSIS

## 2.1 Regulatory and Operating Environment

The Ministry of Water and Environment (MWE) is the service authority for the water sector in Uganda and is responsible for setting policies and standards, and managing and regulating water resources. It is also charged with determining priorities for water development and management. It has three directorates namely; Water Resources Management (DWRM), Water Development (DWD) and Environmental Affairs (DEA).

**Figure 1: The structure of the Ministry of Water and Environment (Uganda) showing the directorates, departments and linkages. (Source: Ministry of Water and Environment)**




The Directorate of Water Resources Management (DWRM) is responsible for developing and maintaining national water laws, policies and regulations; managing, monitoring and regulation of water resources through issuing water use, abstraction and wastewater discharge permits; Integrated Water Resources Management (IWRM) activities; and coordinating Uganda's participation in joint management of trans-boundary waters resources and peaceful cooperation with Nile Basin riparian countries. The Directorate of water Development (DWD) is responsible for providing overall technical oversight for the planning, implementation and supervision of delivery of water and sanitation services to both urban and rural areas. The Directorate of Environmental Affairs (DEA) is mandated to manage environmental and wetland resources and to sustain the biophysical and socio-economic values of the wetlands in Uganda.

Regarding sanitation and hygiene activities, the Ministry has a Memorandum of Understanding with the Ministries of Health (MoH) and Education, Science, Technology & Sports (MoESTS). The role of the Ministry of Water is therefore limited to development of public sanitary facilities and promotion of good practices of hygiene and sanitation in small towns and rural growth centers.

### 2.1.1 ICT Policy

In 2003, a national ICT policy was developed with the goal of promoting the development and effective utilisation of ICT, including timely access to information. Each sector was expected to design

elaborate action plans for implementation of relevant sections of the policy which together would form the National ICT Action Plan. However, the IT policy of the Ministry of Water and Environment (2011) is an internal policy covering email use, telephone use, connection of equipment to the ministry network, back-up of information and naming convention. The Ministry does not have a framework or specific policy that addresses and regulates the use of ICTs in the WASH sector.

### 2.1.2 ICT use in the WASH sector

The Water and Environment Sector Liaison Department (WESLD), under the Directorate of Water Development, houses an MIS unit that is responsible for the operation and maintenance of the water supply database (WSDB). The WSDB is the major source of information on point water sources and piped water supplies in rural and urban areas and is regularly updated to offer more accurate information on the status of safe water sources in Uganda. The ministry hopes to use the WSDB information to produce a new water atlas in 2015. WESLD is also working on an initial design for a data warehouse that will allow all ministry staff to obtain up to date reports and also to serve as a document repository where water sector and project documents can be downloaded. Currently, the database is accessed by Ministry staff, including district staff, but stakeholders' access is limited to downloading reports. Access for users outside the ministry is via the ministry website. The Ministry maintains a log of resources downloaded from its website. To keep information updated, the ministry regularly trains districts water officers on how to use the information for planning and budgeting, resource allocation as well as on updating procedures. The reporting component of the WSDB has been improved in FY 2013/2014 to include a real-time mapping tool to allow users to generate maps of areas of interest, for example a map plotting the location of improved water sources for a specific district, or water resource distribution and access for a particular financial year as shown respectively in figures 2 and 3 below.

**Figure 2: Location of water sources in Abim district (Source: Sector Performance Review, 2014)**

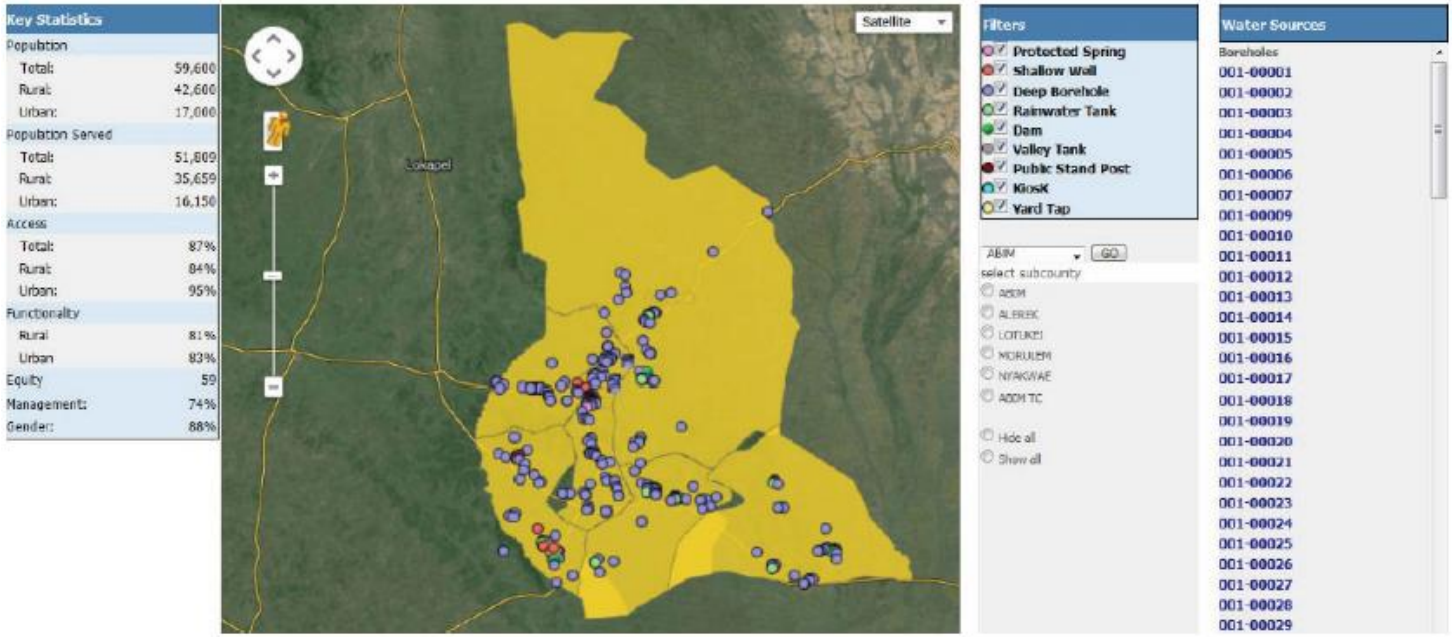
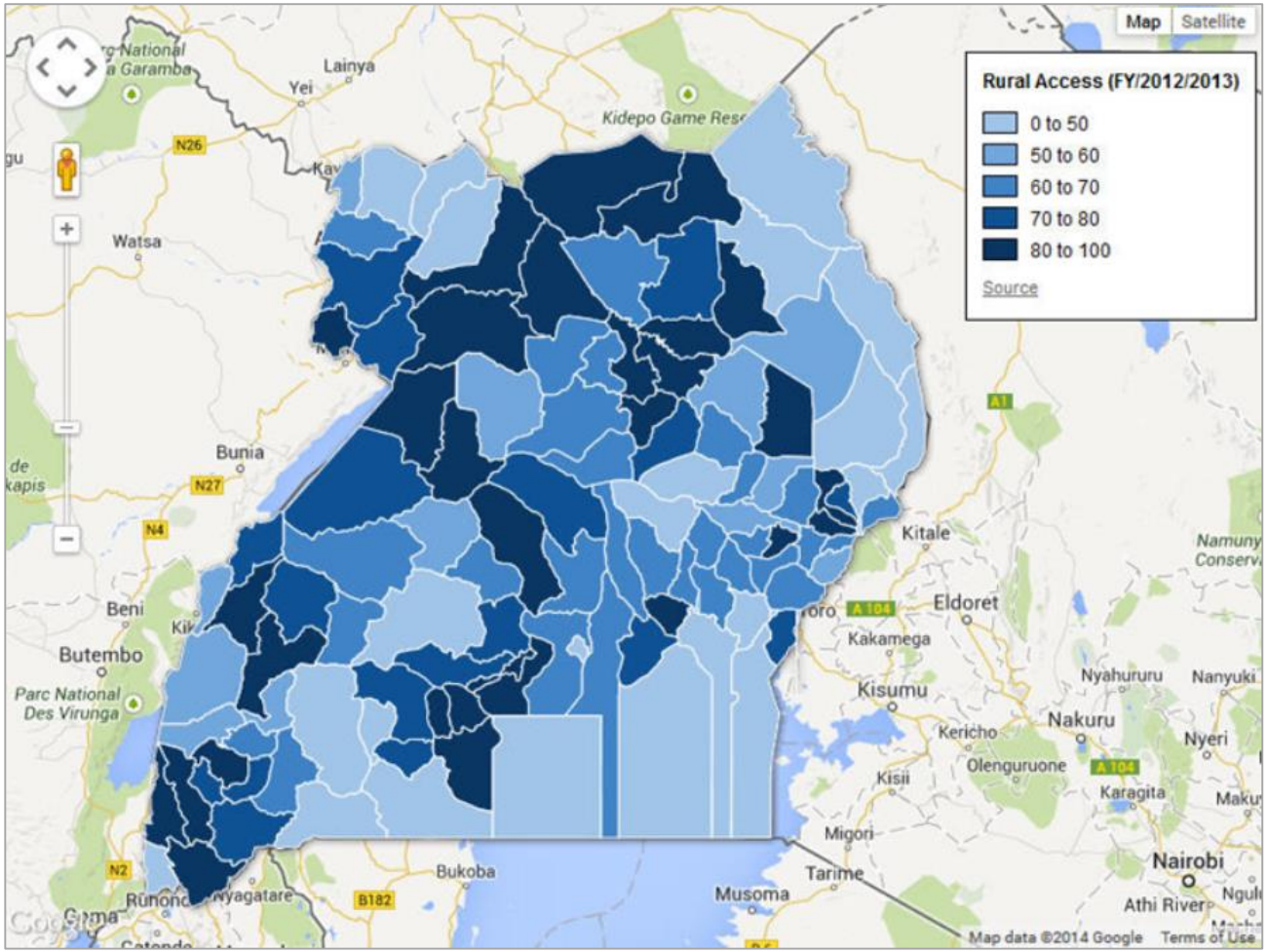


**Figure 3: Resource coverage in the 2012/2013 FY (Source: Sector Performance Review, 2014)**



Monitoring of the online access to the WSDB shows that very few ministry staff, including district staff, are actually making use of the WSDB. Despite efforts to train users, the database is underutilised. The ministry also continues to rely on a paper-based system to collect data on several indicators from the districts. Information on performance of water sources (quantity of water flowing, quality of water), functionality of water sources (rate of breaking down, frequency of maintenance, requirements for major repairs) and existence of water user committees for every water source (and their composition in terms of Gender) is collected quarterly from every district. District Water officers have reporting mechanisms through the lower administrative levels (that is, extension staff at sub-county level that collect information from the communities and relay it to the districts). The Ministry provides form templates for data collection and these are downloaded and printed by the Districts, filled by the extension workers and submitted back to the Ministry (by the DWO) in paper form. The MIS unit analyses the information collected and uploads to the DWD-MIS (Directorate of Water Development Information Management System) database. It is from here that all data on rural water from the district local governments and other sub-sectors is accessed. The data collected facilitates the annual updating of the WSDB database and forms part of the Water Sector and Environment Sector Performance Report.

The ministry is planning to develop a data collection procedure manual to synchronise data linked to key partner databases, to avoid duplicated data collection activities and to support departments that report on the same indicators. It is hoped that other stakeholders such as local governments, the bureau of statistics and civil society organisations will be involved. A general information system development strategy for the ministry is also planned.

# 3. CASE STUDY: E-WATER PAYMENT

The National Water and Sewerage Corporation (NWSC) is the public utility that provides water services to urban centers and towns in Uganda.

***NWSC's Vision is*** *'To be a leading water utility in the world'* and their **Mission** is *'To provide efficient and cost effective water and sewerage services, applying innovative managerial solutions to the delight of our customers'.*

Over the last sixteen years, the Corporation has undergone tremendous structural, operational and financial improvement. As of June 2013, the Corporation was mandated to provide services in 23 key towns across the country, representing a market of approximately 2.7 million people. As of the end of February 2014, NWSC was operating in 40 towns with 6 more lined up for take-over by the end of 2014. It is expected that the number of towns under the jurisdiction of NWSC will increase to 91 by June 2015. The water service coverage is estimated at 78% translating into over 3.8 million people served in gazetted urban towns country wide, for which 94 million $m^3$ of water is produced per annum from 26 water treatment plants and distributed through 6,966 km of water mains. In addition, NWSC operates 2 conventional sewerage treatment plants and 21 waste stabilization ponds with a total sewer network length of 483 km. The work force by end of June 2014 stood at 2,200 with a staff productivity ratio of 6 staff per 1000 connections. The number of new water connections averages 28,000 per annum with 99.9% of these connections metered.[2]

Performance improvements in the NWSC over the last sixteen years have been characterized by a rapid expansion of the customer base which has more than quadrupled to 366,097 connections as at December 2014; the reduction in water losses from the peak of 60% to the current performance of 33.6%; the improvement in staff productivity from 40 staff per thousand connections to 6 staff per thousand connections. On the finance side, the Corporation turnover has more than quadrupled between 1999/2000 and 2012/2013 and has sustained a corporate surplus after depreciation standing at 20.2 billion UGX. This has enabled the construction of an average of over 100 km of new water mains, 21,637 new connections, funding of minor capital investments and meeting all the co-funding obligations for major capital investments using internally generated funds.

With a fully-fledged Information Technology department, the organization has been able to utilize ICTs to support a number of business processes, as shown in Table 1 below, including the implementation of an e-water payment system which is a financial platform that enables customers to have the flexibility of when and how to pay for their water services.

**Table 1: History of ICT uptake and use in the National Water and Sewerage Corporation (NWSC)**

| Year | System |
|---|---|
| ~1990 | Block mapping exercises for Kampala |
| ~1993 | Introduction of Billing system in Kampala (starting with big consumers) |
| ~1995 | Implementation of Scala Accounting system at the Head Office |
| ~1999 | Review of Scala implementation under the Small Towns project, Increase Scala modules, User licenses and increase coverage to area offices |
| ~2001 - 2003 | • Expansion of country-wide WAN |

[2] http://www.nwsc.co.ug/index.php/about-us/ourprofile

| | |
|---|---|
| | • Remote access to Scala accounting system at the head office, using CITRIX<br>• Corporate website and email system developed. |
| ~2004 - 2007 | • Call center implementation<br>• Upgrade of billing system<br>• Corporate Telephony system (VoIP) |
| ~2008 - 2010 | • Multi Company setup of Accounting system<br>• Internal Software development<br>• Handheld meter reading device implementation<br>• SMS/mobile solutions |

## 3.1 Description of the E-Water Payment Platform

### 3.1.1 Vision

The e-water payment system was developed to facilitate and improve payment for water services by customers. For a long time, the utility operated cash offices at every branch and had to employ personnel to collect money from water users. In an effort to focus more on its core services/business, that is, water services provision to its customers, the utility embarked on plans to phase out cash offices and relinquish non-core services, for example relinquishing the collection of bills to institutions that have the facilities to manage those services. This was also fueled by the need to reduce costs associated with running cash offices and bill collections (for example, paying cash officers and risks of transporting cash daily to the commercial banks) and reduce the inconveniences of payment for its customers. The utility used to spend about 6 billion UGX annually on bill collection.

### 3.1.2 Process

The e-water payment application was developed internally by the Information Technology Department of NWSC using a prototyping approach. The initial prototype was run in parallel with some customers paying their bills in selected banks while others paid at the utility's cash offices. Payment in the bank required a customer to fill out a deposit form and submit it together with the money to be paid to the cashier in the bank. This resulted in a lot of discrepancies as some accounts were wrongly credited due to human error. The utility then developed a version that included an interface between the bank's core financial system and the customer accounts database which was integrated with an SMS function. When a customer paid their bill, his or her account was credited in real time and an SMS notification sent to the customer. In August 2010 this version was piloted with one bank (Bank of Africa) and once successful was rolled out to other banks. With time, all cash offices were closed as more customers moved to the e-water system. Currently, this service has been rolled out to 25 banks (or financial institutions) in Uganda.

To increase the convenience of payment and to reduce payment arrears, the utility partnered with four telecom companies that were implementing mobile money services to allow customers to pay bills using their mobile phones. As a financial platform, e-water was developed following financial procedures, processes and manuals that stipulated controls that had to be replicated in the system. The financial institutions already have data quality controls in place allowing information output into the utility's system to be verified. The system has a reporting module that allows for extraction of data by profiled users, for example billing officers who upload bill batches and accountants who log in to reconcile accounts and load into the billing system. All information is kept in the e-water system until the utility receives an electronic bank statement that is fed into the billing system. Erroneous information on the statements is sent back to the banks for verification. The different branches then log into the system to pick the reconciled transactions of customers in their areas of operation and load them into the billing system to update the customer accounts.

### 3.1.3 Customers/Users

The e-water payment platform was developed to be used by all customers of the utility who receive water services from the utility (approximately 350,000 connected customers) as well as a number of companies that use the utility's commercial services, for example, renting of office space, payment for new connections or re-connections and the quality testing laboratory. For customers to use the system, they simply need to walk into any participating bank or subscribe to the mobile money platform of their telecom provider.

### 3.1.4 Human Capacity

The e-water payment platform relies on established human capacity and infrastructure both within the banks that receive the payments as well as within the telecom providers who receive mobile money payments and credit the accounts of the utility. Initially, the implementation of an e-water payment system created a burden of reconciling transactions, in response NWSC has automated the reconciliation process and has set up a unit of trained reconciliation accountants to deal with the exceptional cases

### 3.1.5 Finance

The only development costs incurred were on personnel within the utility that developed the system as the IT department had to recruit software developers to work on the system. Maintenance of the e-water infrastructure is currently one of the areas the utility is spending a substantial amount of money. To manage country-wide connections, it costs the utility approximately 1.5bn UGX annually.

## 3.2 Data Analysis and Findings: Assessing the impact of the E-water payment platform

Table 2 below assesses various aspects of the development, implementation and application of the e-water payment tool. The ICT impact chain developed by Gigler (2011) is used to assess the social and human impact of the ICT intervention. This involves an assessment of the information and communication options that have been made available, and the ability of the communities to use these opportunities to improve the quality of their lives.

**Table 2: Impact assessment of the e-water payment platform using the Impact Chain analysis (Gigler, 2011)**

| Condition | Dimension | Assessment |
|---|---|---|
| **Information Needs (existing information ecologies)** | Information needs<br>Communication needs<br>Communication channels<br>Information gaps | The need to focus on core activities of water services provision to urban areas and towns was the key driver for this tool. With a number of financial institutions in place as well as the increased use and affordability of mobile technology, electronic payments were considered more convenient and cost-effective for both the customers and the utility. |
| **Access to ICTs (ICT Infrastructure)** | Access to electricity<br>Access to ICT infrastructure<br>Geographic location | The areas served by the utility, urban areas and towns, have access to electricity and are covered by all the major telecom providers in Uganda. According to the 2014 statistics from the Uganda Communications Commission, over 53.3% of Ugandans use mobile phones[3]. Most of these users are in urban areas and towns and frequently use mobile phones for communication and to carry out financial transactions. The Financial institutions that NWSC partners with are strategically located in the urban centers and towns so customers have access to payment points. Furthermore, all the telecom providers currently support mobile money payment platforms. Therefore, regardless of the telecom provider one subscribes to, all customers are able to pay for their water services using their mobile phones. |
| **Basic Use of ICTs (Simple ICT use)** | Literacy rates<br>Level of education<br>Socio-cultural context<br>Basic ICT training | The e-water payment platform is appropriate for the customers served by the utility. Since the utility serves a vast number of users country wide it uses English as opposed to a local language, which has not impeded usage. Residents are either literate or semi-literate but capable of using technology to make payments or use their banks to effect payments to the utility without needing to be trained. |

[3] http://www.ucc.co.ug/data/qmenu/3/Facts-and-Figures.html

| Condition | Dimension | Assessment |
|---|---|---|
| **Meaningful use of the ICT tool (Level of use of the tool)** | ICT Capacity building<br>Local and relevant content<br>Technical local appropriation<br>Sustainability | The closure of cash offices at NWSC forced customers to use the e-water payment system. The existing infrastructure within the financial institutions and telecom providers to support mobile payments has greatly contributed to the sustainability of the payment platform. NWSC has set up a reconciliation unit to deal with exceptions of erroneous payments and has also revamped its customer care center to respond to customer queries. The system is integrated with the billing system and customers are able to request their bills and make payments without physically moving to the utility offices but rather through use of their phones. |
| **Enhanced Information Capability (multiplier effect)** | ICT Capabilities<br>Information literacy<br>Communication Capabilities<br>Content Capabilities<br>Local technical & social appropriation | Because of the convenience that mobile technology gives to customers, more are using the mobile phones to pay for services than walking to the banks or financial institutions. This is also driven by the ability to query how much one owes the utility and immediately proceed to the payment options provided. The service is not complicated and no complaints have been logged by the utility in terms of the technology itself since the service was extended to support mobile payments. The utility has registered improvements in payments since customers are able to pay outside office hours and on weekends. |

## 3.3 Discussion

With the e-water payment system, NWSC has been able to collect payments from 98% of its current customer base. Customers now have more payment points since the participating banks have more branches than the utility country wide. Also, customers are more willing to use the system to pay for services as their accounts are credited in real time as opposed to the previous system that required time for reconciling bank payment records with the customer accounts database. This payment platform has remained attractive to customers because there are no added costs incurred by the customers in terms of bank payments. Even with the introduction of a tariff for mobile money payments, the convenience the service provides outweighs the cost. Telecom operators charge a tariff of 1,300 Uganda Shillings (approx. 40 cents) that is paid by the customer. The cost is deducted off the customer's mobile money account as soon as payment is made. With the introduction of mobile payments, the bill collections have increased by 15%. Since e-water became the mode of operation, it has influenced the creation of an institutional policy on payments for water services. A finance management manual has also been developed to accommodate the use of the e-water payment platform.

With the implementation of e-water, NWSC has been able to reduce costs of operating non-core activities and increase revenues that have in turn been invested in the core-functions of the utility, for example core staff development and infrastructure development.

## 3.4 Opportunities and Challenges

One of the main challenges the utility faced was the need to develop an integrated platform or interface with various banks that used different core banking systems to connect with its own core customer banking system. To solve this, a generic interface was developed and used together with a uniform protocol which allowed the different banks to access the utility's database.

With the closure of cash offices a number of staff became redundant and had to be re-trained and redeployed as field officers to support enforcement and curb illegal connections, arrears reduction, non-revenue water reduction and customer care.

Numerous complaints have been raised regarding poor customer services/care while paying bills but the utility has no jurisdiction over bank employees. Since the utility has no control over its customers' experiences in the banks, customers are encouraged to then use alternative banks or mobile payments. A fully fledged customer service center has been set up to handle customer complaints.

In implementing e-water, NWSC has had to keep improving the payment platform based on user experiences and feedback. Not all the requirements for this platform were clear from the beginning and therefore the development methodology adopted allowed for improvements and a better understanding of stakeholder needs. Aside from the e-water payment system the utility runs other systems, for example an automated billing system (internally developed), an e-procurement platform, a Human Resources management system and a water quality information system (that processes water test results from the utility's commercial laboratory used by other water service providers, breweries and beverage companies). The utility has successfully built enough capacity to develop, maintain and support the use of ICT tools.

# 4. CASE STUDY: M4W (MOBILES FOR WATER)

In 2010, the Ministry of Water and Environment in Uganda published a Water atlas that led to the development of the Water Supply Database (WATSUP). The water atlas used information on water coverage and functionality of water sources that was collected in 2009 and was therefore over a year old at the time of publication. This lead to the identification of the need to have more reliable and cost-effective mechanisms for updating functionality information, especially for rural water supply,

along with the need for better systems that produced actionable information that could lead to improvement in the delivery of water services, especially for rural communities in Uganda.

## 4.1 Description of the M4W System

### 4.1.1 Vision

In March 2011, the M4W (Mobile Phones for improved water access) concept was developed by SNV (Uganda) and Makerere University. Makerere University developed the system while SNV were to be the implementers. In June 2011, a consultative meeting was held by SNV and Makerere to present the M4W concept to other NGOs in the WASH sector. IRC/Triple-S (Sustainable Services at Scale) joined the M4W initiative during the project initiation while Water Aid (Uganda) joined in January 2012, after the system had been deployed in the initial five districts. According to Peter Magara of IRC/Triple-S, low functionality rates in rural areas and a lack of information to aid planning and respond to the issues that affect water users in rural communities motivated the development of the M4W system. M4W was developed to improve efficiency in reporting faults, trigger actions for response to reported faults and improve the efficiency in updating both the district and national information systems on rural water supply.

### 4.1.2 Process

SNV Uganda first approached Makerere University with their dual challenge concerning the lack of reliable information on rural water sources and the need to facilitate reporting and repair of faults in rural communities. As Makerere University had already undertaken some research on the use of mobile-based tools in rural or poorly connected environments, they recommended mobile-based technology.

Makerere in partnership with the implementing partners conducted a review of the literature, existing systems and data collection processes to understand the issues in the water sector, specifically in rural water. Meetings were then held with officials from the ministry as well as NGOs in the sector who were implementing other systems. A field visit to Lira district (one of the implementing districts) was conducted, which included interviews with the district water officers and focus group discussions with the hand pump mechanics, community development officers and health assistants. Based on the information collected, an initial prototype was developed and deployed first in two districts (Kabarole and Lira).

The system uses a generic workflow system engine (YAWL) that allows for process configuration. This design was to allow for process flexibility, modifications and also for future scale-up where a new district profile could be easily created and added onto the platform. The forms for data collection (similar to what the ministry uses for the WATSUP update) were re-designed to run on the mobile phones without consuming a lot of memory. The system was evaluated and refined within the same year (2011) and then deployed in five more districts (Kasese, Kyenjojo, Arua, Masindi and Amuria). The system has undergone several iterations based on feedback from the users. Currently, the 3rd version is running and has been deployed in three more districts; that is Paliisa, Katakwi and Napak by Water Aid - Uganda.

In principle, districts are the custodians of community information. The system was developed so that data submitted by the hand pump mechanics was to be reviewed and approved by the district extension staff (the Community development officers and health assistants) before being posted. This created inefficiencies and unnecessary constraints since the extension staff where not conducting the reviews despite the efforts by the implementers to involve them in the project. To work around that, data from the hand pump mechanics was directly posted into the system but the extension staff had permission to review what had been submitted.

The implementation of the M4W system has faced a number of challenges since its inception in 2010 in terms of both the technology and the users. At the time of first deployment, affordable smart phones

were not readily available on the Ugandan market and phones that were affordable were limited in functionality in terms of processing power, performance and low memory. Despite the limitations the implementers chose to use low cost feature phones that could run basic java applications and were replaceable by the districts in case of loss. Slow 2G connectivity provided in the rural areas at the time meant that the system was unable to function in an online mode. The system therefore had to be enabled to work in an offline mode. Human error also presented challenges. A number of Hand pump mechanics personalised the phones and tampered with the application. Once sim cards were removed from the phones, internet settings were disrupted and phones had to be retrieved from the users. Also, the application was mistakenly deleted and had to eventually be moved from the 'games' folder of the phone into the 'applications' folder. Furthermore, the semi-literate users were struggling to input passwords and so the developers re-designed the authentication component to allow users to log into the system once and remain signed in. Finally, one of the aims of the M4W system was to use existing institutional structures to prevent the need for incentives. However, the lack of supervision by existing institutions at the district level created unnecessary delays in information gathering.

Another similar system, Akvo FLOW by Water For People (WFP), was also being implemented at the same time the M4W system was deployed. However, as FLOW was only being used to collect data, WFP was using its own data collectors without the involvement of the existing institutional frameworks. This was looked at by the ministry and the M4W implementers as an artificial intervention because of a lack of sustainability and the requirement of continuous incentivising of the data collectors. Furthermore, this tool was not contributing to capacity development at the community level in terms of improving the capabilities of hand pump mechanics or extension staff.

To ensure quality of data, a number of quality controls were built into the system. These included permissions to review submitted data by district extension staff and district water officers. The forms provided a set list of possible answers for a user to select from and were designed to not allow certain responses and to not accept empty fields. The OpenXdata platform that was used to develop the form also uses skip logic to further ensure quality control in data input. Skip logic in the data forms is a mechanism that directs a user or data collector to a series of questions based on their responses.

M4W has been scaled-up from the initial two districts to ten. The scale-up plan was informed by the experience from the initial two districts in which it was deployed. For the scale-up to take place, information on the rural administrative units for a district is extracted from the WATSUP database together with the initially mapped water sources in the district and imported into the M4W database. A district profile is then created and the mobile phones are configured based on the created user and district profile. The number of phones is dependent on the number of rural administrative units in the district. This profile as well as the district shape files are loaded onto the system. Training is then conducted for the district staff and the hand pump mechanics.

### 4.1.3 Customer/Users

There are three levels of users of the tool. First are the community members. To use the tool, community members use their mobile phones to send a structured SMS to report a fault/problem with their water source. The cost of the SMS to the user is approximately 220/= UGX. Training and outreach at the community level was provided by the hand pump mechanics and the extension staff.

Secondly the mobile platform is used by trained hand pump mechanics to respond to the faults reported by the communities and to submit assessments. Hand pump mechanics are required to have a java-enabled phone loaded with the application and internet access (to facilitate data submissions). The phones and mobile internet bundles are provided by the implementers. However, district water officers are given laptops and modems for internet access by the ministry to facilitate their work. To encourage hand pump mechanics to collect baseline data, a monetary incentive (an equivalent of 1USD per water source reported on) was given. Collecting baseline data is not the responsibility of hand pump mechanics according to the institutional framework but since the

mechanics were expected to visit the communities to train community members and label the water sources, the implementers capitalised on this opportunity to have the mechanics collect the baseline data as well. Baseline data collection was a one-off activity for every district and not continuous. Functionality information is thereby updated using the reports from the communities and hand pump mechanics.

The third level of use is for the online system, mainly used by the district water officers and implementers to monitor responses to faults and to generate management reports. The general public has access to the website (http://m4water.org/) that provides statistics of rural water supply indicating non-functional water sources and reasons for non-functionality (based on data collected by the system), maps showing water source distribution and location and summary information about the project. Currently the data is owned by the implementing partners but the overall plan is to hand the system over to the Ministry of Water and Environment.

### 4.1.4 Human Capacity

Hand pump mechanics were trained on how to use the tool and were tasked to train the community members. System manuals as well as mobile phones with the application loaded were given to the hand pump mechanics and the extension staff with water source labels and flyers to use for training the communities on how to use the system. The district water officers were trained on the use of the online system to monitor reported faults and to ensure that they were being resolved by the hand pump mechanics. Both the hand pump mechanics and water officers were trained on how to troubleshoot the phones. Approximately, 90 hand pump mechanics, 90 extension staff and 10 district water officers have been trained to use the tool to date.

**Figure 4: The M4W sticker placed on the borehole to act as the source label (left) and a flyer given to hand pump mechanics explaining how the system works (right)**

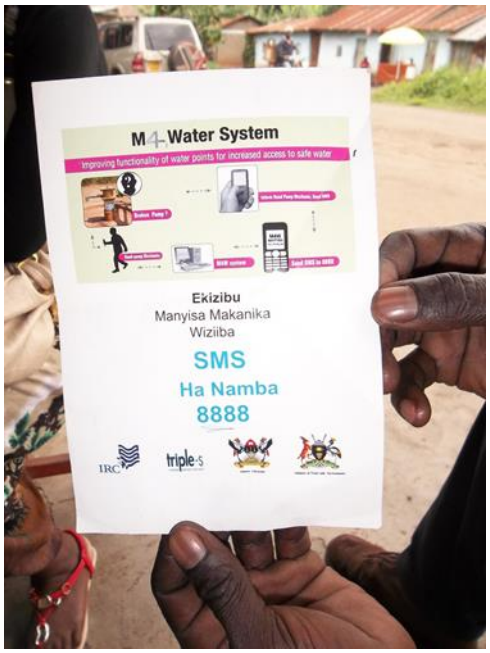



**Figure 5: The online dashboard used by the district water officer to monitor reported faults (by community members) and baseline data collection (by Hand pump mechanics)**

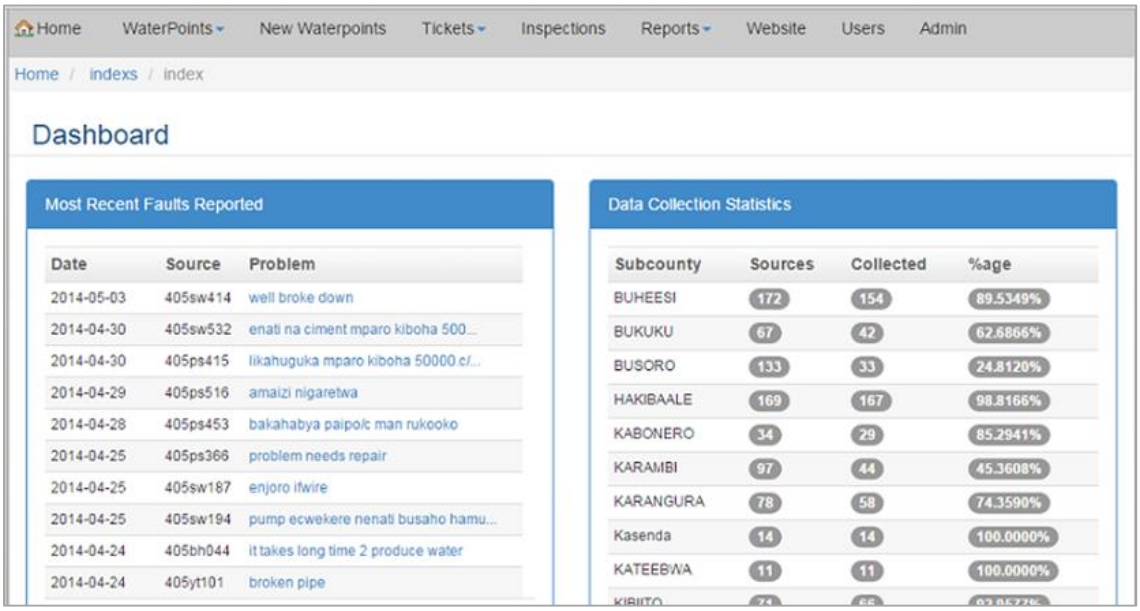
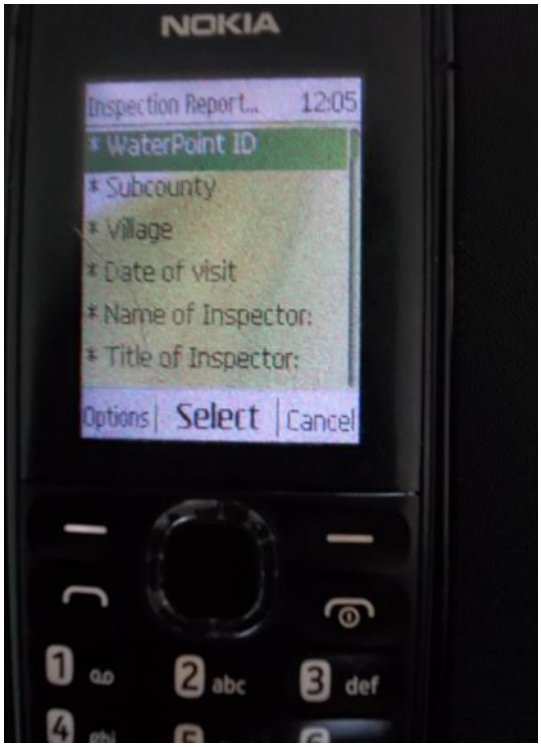



**Figure 6: A sample M4W assessment form (left) and the feature Java-enabled mobile phones given to the Hand pump mechanics and extension workers (right)**




### 4.1.5 Finance

The M4W project was initially financed by the Africa Technology & Transparency Initiative (ATTI) with 30,000 USD. The majority of this fund was spent on the development of the technology in terms of setting up the infrastructure, paying the developers, purchasing handsets and deployment (including training) in the first five districts. For the subsequent deployment and maintenance, the M4W consortium contributed 20,000 USD. Currently, the annual running costs of the system are budgeted at 300 million UGX. The major costs include replacement of the mobile phones (each mobile handset costs approximately 40USD), and management of the infrastructure (including the implementation of additional features on the system) and the personnel to maintain the system.

**Table 3: Summary of the M4W costs**

| Item | Cost (USD) |
|---|---|
| Development cost (including purchase of phones for 4 districts) | 30,000 |

| | |
|---|---|
| Development cost (including purchase of phones for additional districts and maintenance; 2011-2014) | 20,000 |
| Server hosting (outsourced) | 720 (annually) |
| Charging phones (by hand pump mechanics) | ~ 5 per month |

## 4.2 Data Analysis and Findings: Assessing the impact of M4W

**Table 4: Impact assessment of the M4W tool using the Impact chain analysis (Gigler, 2011)**

| Condition | Dimension | Assessment |
|---|---|---|
| **Information Needs (existing information ecologies)** | Information needs<br>Communication needs<br>Communication channels<br>Information gaps | Prior to the development of M4W, SNV (one of the implementers) carried out action research on the poor functionality of rural water supply. It was discovered that a number of sources were non-functional due to either poor maintenance or reporting mechanisms within the rural communities. Existing institutions in local government were not sufficiently supported to monitor water supply and this led to many inefficacies. |
| **Access to ICTs (ICT Infrastructure)** | Access to electricity<br>Access to ICT infrastructure<br>Geographic location | The typical users of the M4W initiative are based in rural communities with very limited access to electricity and unstable telecom coverage. Community users and hand pump mechanics have to move to nearby towns (or trading centres) to have their phones charged at a cost. This has resulted in loss of phone batteries as batteries are easily swapped and the phones themselves are stolen at the charging centres, resulting in additional expenses for the implementers to replace the lost phones as the system users cannot afford to replace them. |
| **Basic Use of ICTs (Simple ICT use)** | Literacy rates<br>Level of education<br>Socio-cultural context<br>Basic ICT training | The community users are typically rural farmers, semi-literate and use their phones for voice calls as opposed to SMS. The M4W application was developed in English and yet many rural hand pump mechanics are semi-literate. A number of them were discontinued and replaced with those who could use the phones. In other districts, users had to bring along people who would later re-train them on how to use the phone and the system. This has caused delays in submitting information to the system and also caused the need for more training which the implementers are not in a position to continue funding. |
| **Meaningful use of the ICT tool (Level of use of the tool)** | ICT Capacity building<br>Local and relevant content<br>Technical local appropriation<br>Sustainability | M4W was intended to provide information to update both the district and the ministry databases. Since the ministry does not have a flexible information system, the structure for a data warehouse was developed by the MIS working group of the ministry that would allow all of the different information systems in the sector to provide information to the data warehouse. This would further allow querying and analysis of information by different stakeholders. Unfortunately, this data warehouse had not yet been implemented and so the M4W application has not yet been integrated with the Ministry's information system to support automatic |

| Condition | Dimension | Assessment |
|---|---|---|
| | | information updates. With no linkages to any other systems, the M4W system is still operated and managed by the developer (Makerere University) and stakeholders are given access to download reports or files that they can use to lobby for funding and for their own planning.<br><br>The ministry is not yet keen on taking over the M4W initiative and this makes its sustainability and use in the districts very uncertain especially when the implementation or project period for the implementers comes to an end.<br><br>Failure to create a business model around the use of M4W especially for the hand pump mechanics resulted in low use of the technology. The M4W implementers are certain that if hand pump mechanics start to see the M4W phone as a tool that supports their business, since they get paid for repairing community water sources and collecting data, they would have optimum use for this tool and eventually make it sustainable for themselves. |
| **Enhanced Information Capability (multiplier effect)** | ICT Capabilities<br>Information literacy<br>Communication Capabilities<br>Content Capabilities<br>Local technical & social appropriation | The M4W has been considered a successful initiative because it has demonstrated that mobile based tools can work in rural settings. It has demonstrated that it is a more cost-effective and easier approach to getting more reliable information than current paper-based routines or systems that the Ministry uses. It has also been able to demonstrate that real time information on functionality status is possible to have compared to the length of time it took the Ministry to compile the data for the WATSUP data. However, the uptake of the tool among community members is low mainly due to the cost of reporting a fault and poor sensitisation on how to report faults. Part of the reason for this is that no funding had been put aside for the sensitisation activities and the districts are not financially able to run the M4W activities without the help of the implementers. |

## 4.3 Discussion

The M4W system has generally enhanced follow-up on water facilities in need of repair, has enabled prompt assessment of defects and has improved functionality especially in situations where the community is able to pay for the repair of the water source. Furthermore, about 1,705 additional water sources were mapped using M4W that were not originally in the WATSUP database. Of the sources considered functional, the M4W baseline study found that 1,104 (19%) water sources were not functional. Although it has registered some achievements especially regarding the collection of data, as discussed in 4.3.2 the low uptake within the communities and poor responsiveness have hampered its success.

### 4.3.1 Trends in the WASH indicators captured by the ICT tool

The M4W tool was developed with the major aim of monitoring functionality of rural water sources. This was specifically to be achieved by: improving efficiency in reporting faults of rural water sources, reducing the down-time of water sources that are reported as non-functional by the communities and providing real time information on the functionality status of water sources so as to regularly and cost-effectively update the district and national water information systems.

#### a) Update of information

The Ministry collects information on rural water sources through annual surveys that are conducted every quarter. The M4W was meant to support the ministry in this function and to make data collection cheaper, faster and more reliable. However, the ministry has continued to use its paper-based annual survey since there is no linkage between the M4W system and the Ministry's system (or database).

#### b) Use of data for planning

The data from the M4W is currently extracted and used by the implementing organisations for their own interests and assessment. However, this data is not being used by the Ministry to plan for improved service delivery. The district water officer of Kabarole says he uses the data to monitor the status of water access in the communities and to some extent uses the information to guide the budgetary process and lobby for funds to rehabilitate sources that are non-functional.

#### c) Reducing downtime of water sources/increasing response time

During the implementation of the tool, it was expected that hand pump mechanics on receiving a fault report would conduct an assessment and submit a repair report. The reality however is that some mechanics do not send these reports while others submit these reports much later. Furthermore, district water officers who were supposed to close 'tickets' (referenced faults) when repairs have been completed, have not been consistent in doing so. This has made tracking of response time and downtime very difficult.

### 4.3.2 Trends in the use and operation of the ICT application itself

The uptake of the M4W has been very low. Part of the reason is attributed to the cost of the SMS that is met by the community user. The developers are working on a new version of the system that will allow users to send SMS to a toll free number. It is hoped that this will increase usage of the tool among the community members. A community user from Katentebere village (in Kabarole district) says she has never used the system because the hand pump mechanic hurriedly explained the concept to her as he placed a sticker on the pedestal of the borehole that she is in charge of. She was given a flyer with the system details but the mechanic also provided his private telephone number at the back of the flyer. When she has a problem, she calls the personal number of the hand pump mechanic. This community member like many others believes the SMS system may not be as reliable and yet more costly and the officer who is notified may not respond. Calling the hand pump mechanic directly is seen as more reliable and feasible. About 715 SMS were sent by water users from Lira

and Kabarole districts to the system since 2011, and [only] 187 water sources (26%) were repaired on the basis of these messages.

According to Peter Wakholi from Makerere University, M4W has not necessarily improved the functionality of rural water in the 10 districts in which it has been implemented, but has greatly contributed to the understanding of the issues that affect functionality of rural water sources. It has produced information that all stakeholders can work with for better planning especially district water officers and the Non-Governmental Organisations (the implementers – SNV, IRC/Triple-S and Water Aid) who have formed the M4W consortium.

### 4.3.3 Gaps in data coverage

At the start of the implementation, the system assumed existence of structures at the community level, for example, the Water User Committee (WUC) that manage the water sources on behalf of the community. It was assumed that at least one of the members would report a problem in case it was too costly for any other community user. However, the realities have been different as approximately 33% of the water sources do not have these structures in place[4]. This further affects the number of complaints that the system is able to capture thus creating inconsistencies in actual functionality figures generated by the tool.

Furthermore, all reported faults were to be logged into the system. However, many community users resort to calling the hand pump mechanics directly and although the water sources may eventually get fixed (or not), this information is never logged into the system. This makes it difficult to have the true picture of the functionality status of rural water sources covered by the tool.

Community extension staff (health assistants and community development officers) who monitor service delivery activities at the community level were given phones to conduct water quality assessment and verify information submitted by the mechanics. However, these staff are also responsible for monitoring activities in other sectors like education, agriculture and health. Although the implementers anticipated that the extension staff would follow up on reports to check that repairs have been made and also report on sanitation and water quality assessment, there has been no registered use of the system by these staff. The major cause of this is their increased workload in other sectors and poor facilitation to do the M4W tasks. This has created a gap in the information available from the communities regarding WASH activities in the rural communities.

## 4.4 Opportunities and Challenges

In order to collect the one data set for the country wide WATSUP database update the Ministry of Water and Environment (Uganda) spent approximately 2 billion Uganda Shillings (approximately 1,000,000 USD). In contrast, according to Mr. Wakholi (the M4W developer), the M4W project was able to use the same processes and institutional structures to collect baseline data in 10 districts at a cost of only 600 million UGX. A national wide exercise using the M4W platform has been estimated to cost approximately 250,000 USD.

Poor connectivity always creates challenges in transferring of data, so there is a need for flexibility and to allow for offline modes. This may not be ideal for systems that depend on real-time data but at least allows for service continuity. For example, the offline mode allows for data collection and information to be uploaded to the database when connectivity is restored.

[4] http://m4water.org/

The existence of bureaucracies can hamper access to information. Before the M4W initiative, information on rural water was only accessible through the district water officer, but technology platforms can improve access to information by multiple stakeholders for improved planning and decision making. Furthermore, technology can allow for community engagement and participation whereby, communities are able to report faults directly to the district without having to go through their local leaders and or hand pump mechanics.

The M4W has been regarded as a '*proof of concept'* that mobile technologies can be used to support processes that have been previously paper-based. The low uptake by the community members is blamed on poor sensitisation mechanisms. The Ministry can therefore ride on the success and potential of this tool and use its existing structures and community sensitisation budgets to engage with communities and provide support to improve the uptake of this tool. The M4W system has not yet provided evidence on the utilization of the information for planning and resource allocation mainly because the integration with existing information flows used by the service authority (the Ministry) has not yet taken place. It has also not yet been integrated within the official reporting structures of the Ministry even though it offers potential to support the reporting mechanisms within the ministry especially on rural water sources.

M4W was purely a donor-implemented project, without whom the project seems unsustainable. The failure of the ministry to take it up poses a risk to the sustainability of this intervention. Already, the exit of Water Aid (Uganda) from Masindi in 2013/2014 has had an impact on the use of this application as it was fully supported by the organisation. IRC/Triple-S has closed operations in Uganda (as it was a 5 year project that came to an end in October 2014) and this means that the districts that have been supported by this organisation will struggle to keep M4W running.

# 5. CONCLUSION

Flexibility of the technologies is always important, implementing a configurable and reactive system that accommodates user feedback and allows for such feedback to inform the re-design of the system goes a long way in producing an intervention that responds to the user needs, is appropriate and will be continuously used. Initially, with M4W community members were expected to report faults, thereby triggering the creation of a ticket and action by the hand pump mechanic. However, in many communities, members call the hand pump mechanic directly and these complaints are never logged into the system. In response the system has now been modified to allow hand pump mechanics to report faults on behalf of the communities.

Technology should also be designed to meet the basic information needs. In terms of capabilities, technology should be simple and easily usable by the intended users. For the case of rural community based interventions, reducing the number of tasks (or screens) a user is expected to perform will make the technology more usable.

For community-based systems to remain sustainable, there has to be institutional support. In situations where officers of established institutions are reluctant to support the communities in using these interventions, implementers can partner with Community Based Organisations to oversee implementation at the community level. For example, Water Aid (Uganda) is partnering with Community based organisations in Napak (a very remote district in Uganda) to oversee and support the use of M4W.

Many intended users of mobile technologies live in areas with poor infrastructure especially electricity supply. These already financially-constrained community members have to pay for charging their devices. This may contribute to the low use of technological interventions. Therefore, it is useful to consider solutions that cater to the power/electricity challenges. Solar powered mobile devices are available on the market and can be used as alternatives for such communities.

Uganda needs a policy that regulates and supports the use of ICT in all sectors especially the WASH sector. It is therefore recommended that the relevant ministries work together with the National IT Authority to develop a sector specific ICT policy to regulate the development and use of ICTs in the sector.

Overall, technological solutions should be able to address not only information gaps/challenges but also cultural challenges especially within the governance structures. Communities alone cannot sustain technological interventions without the support of the national authorities and civil society. There is a need to invest in infrastructure especially electricity or alternatives, for example solar power, as well as stable telecommunication networks. The ministry needs to get involved in the implementation of ICT interventions to not only keep them sustainable but also to protect its citizens from being exploited.

# ANNEX A: LIST OF STAKEHOLDERS CONSULTED

This case study report has been prepared based on information gathered during a field visit in Uganda in October 2014. During this field mission, interviews were conducted with various official and focus group discussions with the rural ICT tool users. The table below provides a list and categories of the participants of this field study.

**Table 5: Participants of the field study on the Potential of ICT in WASH in Uganda**

| Tool | Category/Location | Name |
|---|---|---|
| **E-water payment** | NWSC (Utility: urban & towns) | • Ronald Muwanguzi, Head of IT (NWSC) |
| **M4W** | M4W Consortium (International organisations/implementers) | • Chemisto Satya Ali (SNV) |
| | | • Peter Magara (IRC/Triple S) |
| | | • Grace Alupo (Water Aid – Uganda) |
| | Makerere University/Omni Tech | • Peter Wakholi (Developer) |
| | User & District Intermediary | • Pius Katuramu (District Water Officer - Kabarole |
| | User: Hand Pump Mechanics | • Balyebuga Stephen |
| | | • Bwango Godfrey |
| | | • Mwanguhya Bonny |
| | | • Bright David |
| | User: Health Assistant | • Tumuhairwe Olive |
| | User: Community members | • 4 participants (Names withheld) ; kidubuli - Rwengaju |
| | | • 2 participants (Names withheld) ; Katentebere - Ibaale |
| | WSP | • Sam Mutono – WASH Specialist |

# ANNEX B: PICTORIAL OF FIELD MISSION

Focus group discussion with Kabarole District hand pump mechanics and health assistant: District water officer in attendance

Community members from Kidubuli – Rwengaju community

Community members from the Katentebere – Ibaale community

A community Development Specialist inspects a borehole in Katentebere – Ibaale community during the field visit.

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