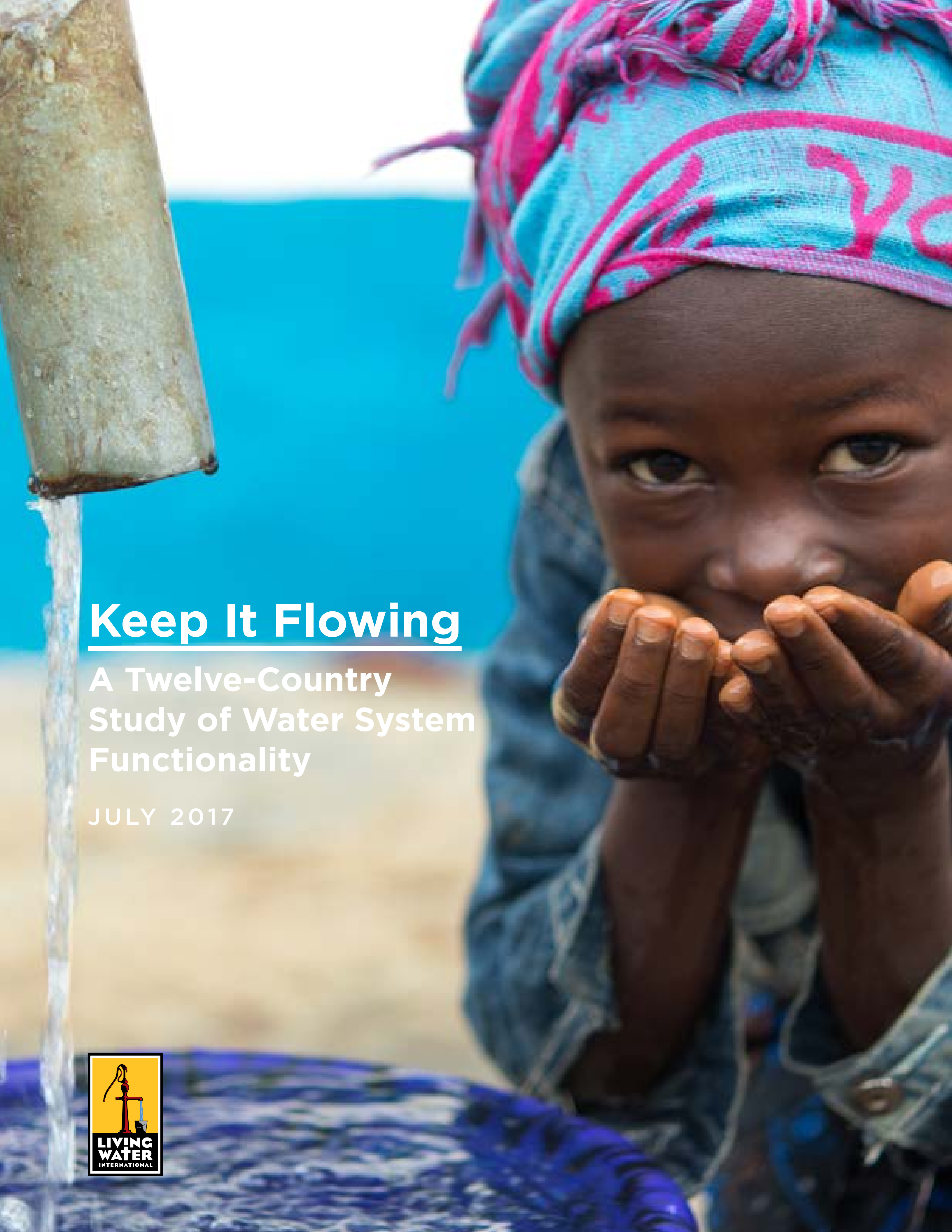

Keep It Flowing

A Twelve-Country Study of Water System Functionality

JULY 2017

LIVING WATER INTERNATIONAL

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Executive Summary

For more than 25 years, Living Water International has been a leader in drilling water wells around the world. We are committed to making sure each well and water system we install continues operating many years into the future—providing water, for life, in Jesus' name. Five years ago, we expanded our scope beyond just drilling wells and began to focus on three-to-five year programs that increase water, sanitation, and hygiene (WASH) access across whole districts. We called this model the "WASH Program Area" (WPA). We now have ten WPAs in seven countries.

In recent years, Living Water has begun building systems to better monitor whether new water systems continue to provide water over the long term. But this left us with the question: how many of the older systems (installed in 2014 or before) are still working today, and what can we learn from them?

We conducted this study to try and answer two questions:

1. **How many of Living Water's systems installed between 2001-2014 still have water flowing?**

2. **What are the reasons that the systems are (or are not) still working?**

The research process was straightforward. We first got a list of all the water systems that Living Water installed since 2001—the year we first started collecting GPS data.

The final list included 3,815 wells from 12 countries. Using statistical sampling methods, it was determined we needed to collect data on 795 water points. Once the 795 systems were randomly selected from the list of 3,815 water points, Living Water staff in each country used the GPS coordinates to go visit those water points from September to October, 2014.

The results are remarkable. We found that 77.1 percent of all systems still worked. An additional 5.8 percent had "limited functionality", which means water is flowing but there are other identified problems with the system. Our findings are very encouraging, especially when comparing them against the industry average. For instance, the functionality rate in sub-Saharan Africa of 66.8 percent (plus an additional 8.4 percent with limited functionality) is on the higher end of findings from other similar studies in the region.

We weren't satisfied, however, just knowing if a pump was still working. We also wanted to know why it was or was not working. **The results show there are three main factors that increase the likelihood a pump would still be working:**

Type of community management structure. If a community had a water committee, it was 9.8 times more likely that the water system would still be working than if no management existed at all.

Whether there was a financial contribution by the water users. If the community members who used the water were contributing funds for the ongoing operation of the system, then it was 1.7 times more likely to be working.

Type of pump installed. Afridev pumps were 1.87 times more likely to be working than India Mark IIs.

We are greatly encouraged by the results of this study. As an organization, we are committed to always learning and improving, and consider this study an important milestone.

Jonathan Wiles
Vice President of Strategy & Program Development

Nathan Mallonee
Director of Monitoring, Evaluation & Learning

The Global Water Crisis

Today, 844 million people around the world still drink water from rivers, lakes or other unprotected sources. While this may seem overwhelming, great progress has been made. Since 2000, billions of people have gained access to basic water services.[1]

As more and more water systems are installed, we're facing a new problem: too many of them are failing prematurely.[2] Surveys from a range of developing countries consistently show that 30-40% of water systems don't work at any given time.[3]

FOR MORE INFORMATION ABOUT THE GLOBAL WATER CRISIS, VISIT WATER.CC/WHYWATER

Water, for life, in Jesus' Name

For more than 25 years, Living Water International has been a leader in drilling water wells around the world. We are committed to making sure each well and water system we install continues operating many years into the future — providing water, for life, in Jesus' name.

FOR MORE INFORMATION ABOUT OUR HISTORY, VISIT WATER.CC/ABOUTLIVINGWATER

We are committed to using the right technology and applying the best engineering principles for every well we drill. If a well is not drilled properly, or the pump is not installed correctly, the system will quickly fail. But we are also committed to collaborating with communities to help them maintain pumps long after the Living Water drilling rig pulls out of the community. The community owns these water systems, so the community must be equipped to maintain them.

Permanent access to safe water is foundational to community development, but it requires more than just drilling a well. To see long-lasting improvement, a community must recognize the need for its own involvement—something that takes time and trust. Five years ago, we expanded our scope beyond just drilling wells, and began to focus on 3-5 year programs that increase water, sanitation, and hygiene (WASH) access across whole districts. We called this model the “WASH Program Area” (WPA), and launched the first one in Ruhaama County, Uganda in 2012. The program included 23 communities, benefitting nearly 40,000 people. We now have ten WPAs in seven countries.

Each WPA promotes water system sustainability by establishing community management, technical support, supply chains, and management support. We define “water system sustainability” as “empowering communities to keep boreholes and other systems working for their designed life cycles.”

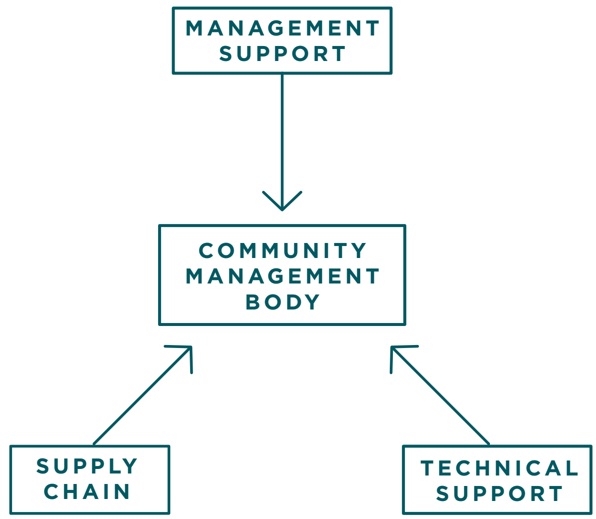

FIGURE 1 **OVERVIEW OF LIVING WATER SUSTAINABILITY FRAMEWORK (2015)**

One of the best ways to equip a community for sustainability is to empower them to form a community water committee. In the early stages, Living Water assists communities by providing maintenance checks and doing repairs. But our hope is to eventually “work ourselves out of a job” in each place, freeing us to help more communities.

WASH Program Area

Why We Conducted the Study

In recent years, Living Water has begun building systems to better monitor whether new water systems continue to provide water over the long-term. Our goal is to have more data about how many are working at any given point. This will not only help us serve these communities better, but will also help us improve our future programs. But this left us with the question: how many of the older systems (installed in 2014 or before) are still working today, and what can we learn from them?

Our two research questions were:

1) How many of Living Water's systems installed between 2001-2014 still have water flowing?

Once we knew the number of systems still providing water, we could compare that to benchmarks set by other studies. Our expectation was that our results would fall in the ranges found in similar studies: between 60-70% functionality for sub-Saharan Africa and higher than that in Latin America. We would not expect to see results higher than 85% functionality based on an analysis of these studies.[4]

2) What are the reasons that the systems are (or are not) still working?

There are many good reasons why a pump might no longer be functional. In some cases, a hand-pump might be installed and used for many years, but is eventually replaced by a piped water system installed by the government. In that case, we would expect the community would decide the hand-pump was no longer needed.

What is more common, unfortunately, is that a hand pump breaks and the community is not able or willing to fix it. In these cases, we want to understand some of the reasons why a community may not maintain a pump, which is why we collected additional data in each community, including:

- **Type of community management structure**
- **Type of pump**
- **Financial contribution of users**

This type of study is not unique to Living Water—in fact, there are over 120 similar studies done by different organizations or researchers over the years.[5] What is unique, though, is the size of this study. We collected data in 12 countries using a consistent approach. This is the first time, to our knowledge, that a study has spanned so many countries.

How We Conducted the Research

The research process was straightforward. We first got a list of all the water systems that Living Water installed since 2001 — the year we first started collecting GPS data. We eliminated a few countries due to health pandemics, internal conflict, or because we did not operate there anymore. The final list included 3,815 wells from 12 countries.

Living Water has experienced rapid growth in recent years, with a majority of systems having been installed since 2010. Therefore, the average system in this study is less than 5 years old. Also, most of the systems in this timeframe are boreholes with hand pumps, even though in recent years we have started implementing a broader range of water projects to better serve large communities or address environmental challenges.

Rather than visiting each system to collect data, we decided to collect data on a smaller sample of systems. Using statistical sampling methods, it was determined we needed to collect data on 795 water points. To make sure the sample would be representative of all 3,815 systems, we did two things. First, we made the selection completely random. Second, we made sure the selection had the same percentage of systems per country in the sample that are in the total population. Table 1 (p. 9) shows the breakdown of how many surveys we wanted from each country and how many were collected.

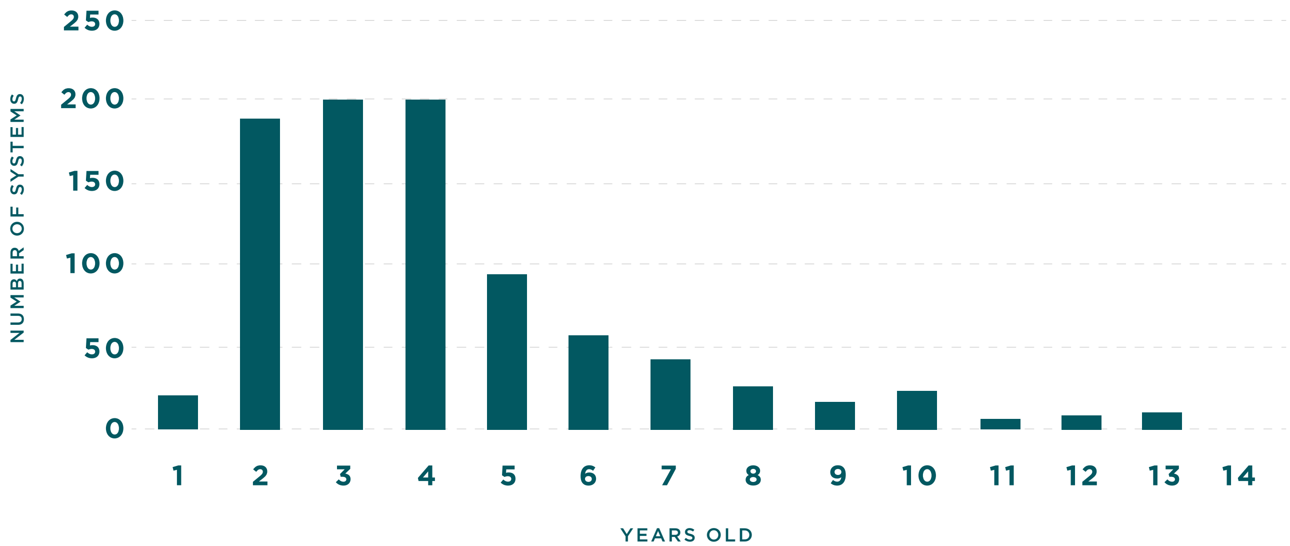

FIGURE 2 **AGE OF WATER SYSTEM IN THE STUDY**

COUNTRY	POPULATION (WATER SYSTEMS)	SAMPLE SIZE	SURVEYS COLLECTED
EL SALVADOR	475	81	80
ETHIOPIA	140	58	62
GHANA	54	35	32
GUATEMALA	290	79	79
HAITI	109	58	53
INDIA	1,332	90	94
KENYA	227	68	84
MEXICO	125	57	49
NICARAGUA	288	77	70
RWANDA	376	77	70
UGANDA	290	73	66
ZAMBIA	109	42	39
TOTAL	3,815	795	792

TABLE 1 **SAMPLE SIZES AND SURVEYS COLLECTED**

Once the systems were selected, Living Water staff in each country used the GPS coordinates to go visit each water point. Surveys were loaded onto an Android app so that our staff could collect data on smartphones and instantly submit it to an online database. When they arrived at a pump, they photographed it with water flowing. This meant we could verify that water was flowing, for those considered functional, and we could also match the GPS data stored on that picture with the original GPS coordinates for the system to make sure they visited the correct location.

While at the pump, the staff observed the system and answered several survey questions. The primary question was: is water flowing from the pump? Next they interviewed a community member to gather more information and to identify any problems with the pump.

Living Water staff collected this data from September to October, 2014. Once they submitted it to the online database, staff in our Houston office began analyzing it. This included reviewing the pictures and associated GPS data to ensure the correct systems were reported on and verifying that water flowed from systems classified as functional.

After compiling the results, we submitted a paper to the Water and Engineering Development Centre (WEDC) at Loughborough University in the UK. The paper was presented at the annual WEDC conference in July, 2017.[6]

What We Found

The results are remarkable. We found that 77.1% of all systems still worked. An additional 5.8% had "limited functionality", which means water is flowing but there are other identified problems with the system.

Functionality rates varied by region. In sub-Saharan Africa (Ethiopia, Ghana, Kenya, Rwanda, Uganda, Zambia), it was 66.8%. India, the only county from Asia in the study, had a rate of 78.7%. In Latin America and the Caribbean (El Salvador, Guatemala, Haiti, Mexico, Nicaragua), 88.2% of systems functioned. These variances are in line with findings from other studies and datasets—for instance, it mirrors the regional differences found in the Water Point Data Exchange (2016) at the time of the study.

How does this compare to other organizations?

Our findings are very encouraging, especially when comparing them to studies from other organizations. The highest rates of performance were in Latin America & the Caribbean, followed by India and then Africa. This is to be expected. The income levels in Latin America are higher, on average, than most countries in sub-Saharan Africa. This means there are also better supply chains and greater technical knowledge and capacity.

That said, the functionality rate in sub-Saharan Africa of 66.8% (plus an additional 8.4% with limited functionality) is on the higher end of findings from other studies in the region. Most

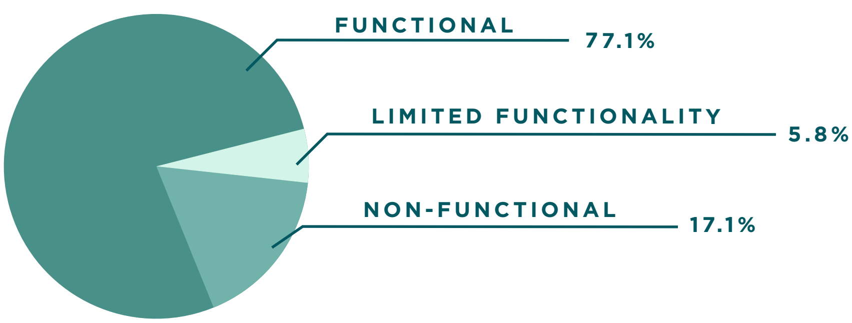

FIGURE 3 **WATER SYSTEM FUNCTIONALITY**

REGION	SAMPLED WATER SYSTEMS	FUNCTIONAL	LIMITED FUNCTIONALITY	NON-FUNCTIONAL
SUB-SAHARAN AFRICA	367	66.8%	8.4%	24.8%
INDIA	94	78.7%	0%	21.3%
LATIN AMERICA & CARIBBEAN	331	88.2%	4.5%	7.3%
TOTAL	792	77.1%	5.8%	17.1%

TABLE 2 **WATER SYSTEM FUNCITONALITY, BY REGION**

single-country studies show a range between 60-70% of water points being functional.[7] In a recent paper, researchers reviewing studies similar to this noted that functionality for systems with different ages can't be expected to exceed the mark of 85% functionality.[8]

Why does a pump continue to work?

We weren't satisfied just knowing if a pump was still working. We also wanted to know why it was or was not working. That's why we also collected data from the community.

We had our suspicions. We imagined the formation of committees to help manage and operate the pump would be a factor, and that communities would be more likely to maintain their pumps if they contributed funds for its maintenance.

We used a statistical analysis technique called logistical regression to determine if any of the possible factors had an effect. This essentially allowed us to isolate the effects of each factor on the likelihood that a water point would have water flowing. For instance, we can control for the age of the system when comparing the effects that the type of hand pump might have.

Most of our hypotheses were confirmed. The results show there are three main factors that increase the likelihood a pump would still be working.[9]

MANAGEMENT TYPE	# OF WATER SYSTEMS
Community Water Committee	430
Individual or Community Member	56
Institution	269
Local Government	21
Nobody	16
TOTAL	792

TABLE 3 **MANAGEMENT TYPE FOR WATER SYSTEMS**

1) Type of community management structure

Whether or not a community had a management structure in place, such as a water committee, was highly correlated with whether or not a system was still working. If a community had a water committee, it was 9.8 times more likely that the water system would still be working than if no management existed at all. Management by an institution, such as a school or health care facility, also increased the likelihood by 5.56 times.

Interestingly, management of water systems by local government had the smallest effect when compared to the other types of management structures. And the results were not statistically significant—meaning that we cannot be certain that having the local government manage the water point increases the odds of it continuing to work compared to having no management at all.

2) Whether there was a financial contribution by water users

If the community members who used the water were contributing funds for the ongoing operation of the system, then it was 1.7 times more likely to be working. There are two probable reasons for this. First, making a payment increases the community's ownership of the system. Users think if they pay for the water, even if a minimal amount, then the system should be maintained. Second, on a practical level, it provides necessary funds to pay for repairs.

3) Type of pump installed

There are three main types of hand pumps that Living Water has installed with boreholes. These include the India Mark II, the Afridev, and the U3, which is a combination of the India Mark II and Afridev. In some cases, there was an electric pump instead of a hand pump. When looking at the results, we found that Afridev pumps were 1.87 times more likely to be working than India Mark IIs. This is not surprising since Afridev pumps were developed after the India Mark IIs, and the routine, preventative maintenance is easier to perform.

Where do we go from here?

We are greatly encouraged by the results of this study. As an organization, we are committed to always learning and improving, and consider this study an important milestone.

The results of this study have already influenced our work in practical ways, including:

We will push to invest in the best pumps available and appropriate for each context.

We will keep emphasizing sustainability, working to find the most effective ways to increase a community's ability to maintain a safe water supply.

We will continue to promote community water committees or community-based organizations that collect contributions from water users and are responsible for repairs.

We will expand the number of WASH program areas (WPAs) so we can take the time necessary to mobilize and equip each community to maintain their water system.

Moving forward, we are working on two exciting projects that will give us better data on an ongoing basis. First is a global tool for measuring water system status on a more real-time basis—if it's working, how long it takes to perform repairs, etc. This will be part of a new global information system we will launch in 2018, which will allow our field staff and community members to report up-to-date information about the status of each water point. Second is an improvement to water quality monitoring—how frequently water is tested, and what factors we test for. If water is flowing, but has become contaminated, people will still get sick. A recent study shows that 1.8 billion people in the world drink water contaminated by fecal material.[10] Although this can happen for many reasons, many of them can be controlled by the community, so we will continue working to see that communities have access to water that is reliably flowing and safe.

Endnotes

[1] UNICEF & World Health Organization (2017). Progress on drinking water, sanitation, and hygiene: 2017 update and SDG baselines. Retrieved from https://www.unicef.org/publications/index_96611.html.

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[7] Rural Water Supply Network (2009).

[8] Carter & Ross (2016).

[9] The results were statistically significant; see Wiles & Mallonee (2017).

[10] World Health Organization (2017). Drinking-water fact sheet. Retrieved from http://www.who.int/mediacentre/factsheets/fs391/en/.

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