How Many People Did We Provide Safe Water For?

Here's the scenario: The Ugandan Water Project has just restored a broken borehole that had been sitting idle for over 5 years. The pipes had long since rusted and the community had been unable to mobilize sufficient funds for the costly repair. The project's donors, members of a small church congregation in the United States, are eager to hear a report on the project they sponsored. They had just spent weeks fundraising for it.

We ask community members a seemingly simple question: *How many people will use this borehole now that it has been rehabilitated?* First, we ask the local hand pump technician: 400 people, then a neighbor to the borehole: about 330 people. Later that day, we ask the local pastor: at least 500 people, and an elected community official: 786 people. What we discover is quite puzzling: We get a different answer from each person we ask.

The hand pump technician remembers how many households he had to visit last time he and the water committee were collecting money for a repair. The neighbor considers how many households are in the vicinity of the borehole and estimates how many people live in each home. The pastor gauges based on the size of his own church congregation. The elected community official recalls the number of voters from the most recent local election.

It occurs to the elected official to check the census data for the village, but she knows the most recent survey was years ago. Like much of Uganda, the village has grown substantially since then, making the official record unreliable. None of the surveyed community members considers how many people may continue to fetch from the local pond, nor do they consider that some on the outskirts of town fetched from the spring the next village over, even before the borehole broke down.

We are faced with a tough decision. We have been offered four population estimates, each from credible sources, but none match up. Each respondent stands by their figure, despite the fact that the highest and lowest estimates differ by over 450 people. *What should we do?* The project's donors eagerly await their report.

Dialing in the Digits for our Donors

The Ugandan Water Project has incredible donors. They are generous and kind. Almost all track their investment from inception, through installation, and, ultimately, to impact. Our funders hold us to a high standard, as they should. They expect that we deliver top value for their dollar. We embrace the challenge and love to exceed expectations!

One metric that our donors are most interested in tracking is the population served by the projects they fund. It is natural that donors are drawn to this indicator. The more people served the bigger the impact, right? For now, let's answer it this way: Yes, but to a point.

Please don't get us wrong. Like our donors, we want our projects to serve as many people as possible. Each of those "people served" is a person of great value, created with a purpose. They are individuals with unique skills, abilities, and passions; they are loved and appreciated. Each is a son or a daughter. Many are mothers, fathers, mentors, and leaders. All drink water.

We strive to meaningfully impact the lives of as many people as we can. Water is our tool, and we believe in its transformative power. Access to safe and reliable drinking water unlocks human potential and helps communities flourish. Water is life. With the help of our donors, we are committed to hydrating a nation.

But what really goes into assessing population impact? The process is not as straightforward as one may think. This is not meant as an excuse. Rather, it is a humble acknowledgement. While challenges abound, we are fully committed to dialing in the digits. Our donors deserve it.

In recent years, our team has invested significant time and energy into understanding population estimation challenges and honing approaches that allow us to more accurately register the number of lives impacted by our work. The process has been eye-opening. While there is a lot to unpack, we thought that you, too, might enjoy a behind-the-scenes look at the numbers. Here's your chance to dive in. Be our guest, and come along on the journey.

The Limits of Production

It is worth beginning our discussion with an acknowledgement that several methods exist to estimate the population served by a water project. Approaches can differ by technology type and context. Each method has strengths and limitations, especially when compounded by resource constraints. For simplicity of discussion, we will resign our present exploration to one of the Ugandan Water Project's solutions types, community boreholes.

Now that our sights are set squarely on boreholes, let's dive deeper into the technology itself. We install India Mark II hand pumps on all boreholes we support. These hand pumps are excellent human-powered water extracting tools, endorsed by the Ugandan Government as the national standard for hand pump technology. They are robust and quite reliable when properly maintained. There is, however, a limit on how much water an India Mark II hand pump can produce each day. Naturally, this restricts the number of people who can be served by a single borehole.

According to the Rural Water Supply Network, India Mark II hand pumps are designed to serve communities of 300 people. This figure aligns nicely with a Government of Uganda estimate of the average population served by boreholes in Uganda, also 300 people. While these estimates provide a useful reference point, they are high-level figures that leave much to be explored.

Though the exercise risks oversimplification, it is worth crunching some numbers ourselves. While several variables can impact the production capacity of India Mark II hand pumps (cylinder depth, aquifer yield, seal wear, etc.), it is commonly estimated India Mark II pumps have the capacity to discharge 1,000 liters of water per hour. Assuming a pump is open for use during all 12 daylight hours, the maximum discharge of a continuously pumped India Mark II is 12,000 liters per day.

While theoretically possible, this is unlikely in practice. There are often breaks in fetching, and time lost during fetching because of inefficient pumping, users socializing, and transferring collection containers in and out. With this in mind, a limit of 8 pumping hours, which equates to a production of 8,000 liters per day, may be more appropriate. For those who are skeptical that a third of all fetching time in a day is lost to inefficiencies, we can split the difference and assume 10 hours of pumping, or 10,000 liters per day.

Now that sounds like a lot of water! *But how many people can it actually serve each day?* Though there are no magic daily water use thresholds, prominent water development organizations have offered some useful volumetric guidance. For example, WaterAid, IRC WASH, and mWater have developed the RapidWASH assessment tool, which breaks down daily per capita water use into four service levels (Table 1). According to the RapidWASH breakdown, 20 liters of water per capita per day (lcd) is appropriate for basic water service provision.

Table 1: Water quantity service ladder indicator used in the RapidWASH assessment tool

Service Level	Definition
Improved	At least **50 lcd** and sufficient water for drinking, cooking, personal hygiene, and other uses [which may include household cleaning, watering gardens and livestock, recreational uses, etc].
Basic	At least **20 lcd** and sufficient water for drinking, cooking, and personal hygiene
Substandard	At least **5 lcd** and sufficient water for drinking and cooking only
No Service	Less than **5 lcd** or insufficient for drinking and cooking
Note: For comparison, the average American uses approximately **400 liters** of water per day	

With these benchmarks as our reference, we can estimate the maximum number of people that can be served at each service level using each of the three daily water production estimates we derived above (Table 2). We can deduce that India Mark II hand pumps can likely provide a basic quantity of water for a maximum of 400 to 600 people, depending on our pumping-continuity assumptions. For simplicity, let's say the upper limit is 500 people.

Table 2: Maximum number of people served by India Mark II hand pump at each service level

Service Level	Minimum lpd required for service level	Max population served at production of 8,000 liters per day	Max population served at production of 10,000 liters per day	Max population served at production of 12,000 liters per day
"American"	400 *	20	25	30
Improved	50	160	200	240
Basic	**20**	**400**	**500**	**600**
Substandard	5	1,600	2000	2,400
No Service	---	*Unlimited*	*Unlimited*	*Unlimited*
*400 lpd is not a minimum service level requirement; it the American national average, used here for demonstration				

As this exercise demonstrates, for India Mark II hand pumps with a fixed production capacity, serving more people only increases impact to a point. In our case, a maximum of 500 people can be supported at a basic service level. Of course, more than 500 people may use water from the borehole, and some water is undoubtedly better than none, but beyond 500 people the quantity of water available will not satisfy the requirements for basic provision.

So far, we have deduced that the hand pumps installed by the Ugandan Water Project are designed to serve 300 people, are estimated to serve an average of 300 people per borehole in Uganda, and can likely serve a maximum of 500 people at a basic service level. These figures all seem reasonable and consistent, but they are generalizations; they do not reflect the reality for any one individual borehole. This is insufficient because each and every community we serve is unique. We owe it to both our donors and the communities we serve to treat them as such.

How Many People Live in *YOUR* Neighborhood?

Since 2015, the Ugandan Water Project has used a data platform called mWater to collect, manage, and report community-specific data. For each project we install, data collection begins before installation, with our Pre-Site Assessment survey. We resume data collection at the time of project installation, then continue after installation with monitoring surveys, which are conducted every six months for two years after the project is installed.

During each of these community touch points, we ask a key informant to estimate the number of borehole users, or how many people will use the borehole if it is rehabilitated. Our key informants are community insiders who have special knowledge of the borehole. Typically, they are members of the water committee, which is the local entity responsible for borehole governance.

Sometimes key informants are able to derive their estimates from local records. Other times, approximations are based on local knowledge and observations made by the key informant. While estimates provided by our key informants are often the most viable method of assessing the number of water users, this approach is far from perfect.

Let’s break this down further.

To begin, communities do not always keep records that reflect how many people use the borehole. Even when records exist, they may be outdated or imprecise, which forces key informants to supplement estimates with their local knowledge. Where records are unavailable, key informants are left to approximate based on their lived experience alone. Our key informants have often expressed that it is difficult to make this approximation, especially when they live in a large community. The result: highly variable population estimates.

You may be wondering why it is so difficult for key informants to accurately estimate the number of borehole users. We were wondering this ourselves, so we started asking around and searching for answers. What we have learned to date is noteworthy.

One reason is that there are often multiple water sources in a community, and sometimes even multiple improved water sources, like boreholes. Most households rely on multiple water sources, and not all community members use the same water sources. Further muddying the waters, some sources are used during the dry season, but not during the rainy season. Several other factors influence whether or not one will fetch from a particular water source, including the proximity of the source to one’s home, taste, price, and historical fetching patterns.

Even if we assume that all community members rely on a single local borehole, accurately estimating population in the absence of reliable records can be challenging. A simple question may help bring the point home: *How many people live in YOUR neighborhood?*

If you live in a small community, your estimate may be pretty close, perhaps even spot on. But if you live in a large neighborhood, this is a much more challenging exercise. Your estimate may be off by 100 people, perhaps even more. Almost certainly, if we asked you the same question a year from now, or if we asked your neighbor the same question today, the result would be slightly different.

This brings us to another important reality, one that can be particularly puzzling for donors: It is not uncommon for the population estimates from our Pre-Site Assessment to differ from the estimates that we attain during installation and, later, through the monitoring cycle. The aforementioned challenges shed light on some of the variability, but not all. It is important to also consider the pressures placed on key informants, particularly during the Pre-Site Assessment.

Let's explain.

With so many communities in need of safe water, our team is committed to investing our limited resources into communities with the greatest water insecurities. While we wish we could install projects in all communities we visit, we cannot guarantee that a completed Pre-Site Assessment will translate into an installation. To appropriately manage expectations, we make this clear to our key informants. While we believe this transparency is an essential part of stewarding healthy relationships, it can negatively affect the quality of our Pre-Site Assessment data.

Recognizing that their community may be competing against other prospective communities for water projects, key informants find incentive (unprovoked by the Ugandan Water Project) to present the most compelling case possible for why their community deserves a water project. Skewing population estimates towards a reasonable extreme is one way to achieve this. Whether done intentionally or subconsciously, such a response is understandable.

A quick comparison of Pre-Site Assessment and monitoring data for communities we have installed projects in suggests that this may, in fact, be happening. On average, population estimates provided by key informants during the Pre-Site are higher than those offered throughout the monitoring cycle, when the incentive to overestimate is diminished.

Living With The Tension

Now, let's attempt to tie our preceding discussions together. According to our mathematical wrangling, boreholes serviced by the Ugandan Water Project have the technical capability to serve a maximum 500 people at a basic service level. *What, then, should we do when the population estimates provided by our key informants exceed the 500 person threshold?*

The answer is not perfectly clear. Some may assert that we should cap our population estimates at 500 people. The logic is fairly sound. Since the technology can only serve 500 people at a basic service level, any estimates exceeding 500 should be truncated. While this is a reasonable approach, others may argue that this technique disregards local experience and fails to adequately account for the significant water-related needs that exist in many large communities.

For example, it is reasonable that more than 500 community members could use smaller volumes of water (less than the 20 lcd threshold) from the borehole for drinking and cooking, while sourcing water for washing and other domestic uses elsewhere, perhaps a surface water source. By this logic, the borehole could, in fact, serve more than 500 people, even if technically falling short of the specifications necessary for basic service provision.

For the time being, we live with the tension of landing somewhere in the middle. Our enumerators are trained to carefully probe during surveys, ensuring that the population estimates reported by key informants are reasonable. As long as the estimates offered by key-informants are not extreme outliers, we respect local knowledge and lived experience, utilizing key informant-based estimates in our calculations and donor reports. While we favor locally-derived estimates in this regard, we do not lose sight of the India Mark II's technical limits. Oftentimes, we include a slight caveat with the population estimates we share with donors.

Through all of this, one thing is clear: The more data we have, the more confident we can be in our estimates. For this reason, our enumerators ask key informants to provide population estimates each time they are on site. From Pre-Site through our 2-year monitoring cycle, we source population estimates 6 times. As data accumulates, we can identify and omit obvious outliers. Once outliers are removed, we can average the remaining observations for a particular site, which produces a result that is more likely to be reflective of the true population than any single observation in isolation.

Setting Our Sights Sky High

As we have described, accurately estimating population served is rife with challenges. Sometimes it can take several site visits across multiple years to dial things in. Even then, we do not always know for sure how close our estimates are to reality. Communities are dynamic, and things change. People come and go, new water sources are developed and others dry up. Even our best efforts to assess the number of people served by our projects can miss the mark. Acknowledging this, we are always in search of new approaches that can improve our estimates.

For example, we have considered the possibility of employing census-style methods. While a census-style approach would likely improve the accuracy of our estimates, we have opted not to pursue it. There are several reasons for this, but we can boil it down to one: feasibility. This approach would involve surveying a member of each household in the community to determine household size and water use patterns. This is an expensive and relatively complex undertaking, especially in large communities. For the time being, we have not deemed the marginal increase in data accuracy worth the significant additional expense that this approach would require.

One thing that we have tried, and found successful, is using households as the subject of our inquiry. Rather than asking key informants about the number of individuals served by the borehole, we ask about the number of households that rely on the borehole. We then multiply the household figure by the Ugandan national average for household size, approximately 5 people. While we have found that this approach tends to give us more reliable estimates, it is not without limitations. Most notably, this method builds upon the national average household size, which may not accurately reflect the average household size in a given community.

We also use additional mWater-based methods to corroborate population estimates. For some time now, it has been possible to add population density layers to maps in the mWater portal. These map layers, sourced from the Humanitarian Data Exchange, use a dataset that was developed jointly by Columbia University and Facebook. In short, the dataset was produced using machine learning techniques to identify buildings from satellite images. Next, this information was used in combination with census data to derive population estimates. It's all pretty amazing!

With these map layers available in mWater, we have been able to overlay population density maps onto satellite images of the communities we serve. Quite literally, this offers a birds-eye-view of the population distribution in any community that we work in. A new mWater feature released this month takes the existing feature to the next level by allowing users to calculate the estimated population living within a fixed radius of any GPS point.

We can now use this new feature to estimate how many people live within a set distance of any borehole. While any distance can be analyzed, we will typically employ a 1 km cut-off. We will use this threshold because it approximates the maximum distance for a 30-minute round trip to the borehole, with fetching time included. The 30-minute benchmark is significant because it is a requirement for basic household water access, according to the industry standard JMP Service Ladder. While this method of population estimation also suffers from imperfections, it offers an additional tool that we can use to cross check our key-informant data.

Striking a Careful Balance

As we have shown, there are many ways to estimate population. Not all are created equal. We encourage you to always look critically at the population numbers provided by implementing organizations. We might even go as far as to encourage you to view population estimates with a skeptic's eyes. Be wary of estimates that exceed the known technical capacity of the project type you sponsored. And remember, in the world of water technology, more people served by a single project is better … but often only to a point.

Of course, we want to help the *most* people, but we also want to help each person the *most*. This requires a careful balance. It is all too easy to pursue one at the expense of the other.

One thing is for sure: Whenever possible, it is best to corroborate population estimates using multiple data sources, an approach called triangulation. We have taken this to heart. While no approach is perfect, we have confidence in the capabilities of our mixed methods. We will always provide population impact estimates to the best of our abilities, and we will never suffer from a lack of transparency because you deserve to know what's behind the numbers. You always deserve our very best.