



# ASSESSING THE EFFECTS OF COVID-19 ON ACCESS TO WATER, SANITATION, AND HYGIENE IN USAID HIGH PRIORITY AND STRATEGY-ALIGNED COUNTRIES

Focus on Small Piped Providers in Ghana

**JANUARY 2021**

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## **DISCLAIMER**

The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

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## **ACRONYMS AND ABBREVIATIONS**

COVID-19	Coronavirus Disease 2019
CWSA	Community Water and Sanitation Agency
DA	District Assembly
GWCL	Ghana Water Company Limited
MoF	Ministry of Finance
MSWR	Ministry of Sanitation and Water Resources
SWE	Small Water Enterprises
WASH	Water, sanitation, and hygiene
WASHPaLS	Water, Sanitation, and Hygiene Partnerships and Learning for Sustainability
WSMTs	Water and Sanitation Management Teams

# EXECUTIVE SUMMARY

Between June and October 2020, the United States Agency for International Development (USAID) Water, Sanitation, and Hygiene Partnerships and Learning for Sustainability (WASHPaLS) project conducted a rapid assessment and forecasting analysis of the effects of the COVID-19 pandemic on access to water, sanitation, and hygiene (WASH) services and products in USAID high priority and strategy-aligned countries. “Deep dive” analyses were carried out in the Democratic Republic of the Congo (DRC), Ghana, Kenya, Mozambique, Nepal, Rwanda, and Senegal. One of central findings of the work in Ghana was that the government’s extended free water directive appeared to be combining with the pandemic’s income shock to threaten the ability of smaller water service providers to continue operating at acceptable performance standards. In response to this finding, USAID tasked WASHPaLS with conducting a follow-on analysis in Ghana to gain further insights into the challenges faced by small water providers and the ramifications on their customers.

This research sought to examine (i) the operational status of small piped water systems in Ghana, and (ii) potential constraints on government institutions for providing reimbursement support to small providers. Our approach was to combine interviews with rural piped system operators and other key stakeholders with consumer surveys via SMS in communities served by these rural piped systems (as well as elsewhere in Ghana, to provide comparisons by water supply modality).

***Although operators themselves reported performance declines (with increases in the number of days unavailable and decreases in the number of hours per day of service), rural piped water supply systems have not yet experienced widespread shutdowns.*** Indeed, participants in our SMS surveys in areas purposively sampled to capture customers of rural piped systems actually reported significant improvements in water availability, with the average increasing from 10 hours per day to 11 hours per day after the onset of the pandemic.

***There are warning signs of the medium- to long-term financial and operational soundness of these rural systems.*** Operators reported increases in system water production of nearly 50 percent, placing increasing wear on their equipment without concurrent maintenance, while the majority (62 percent) reported a cessation in revenue collection under the free water directive, reducing reported operating reserves from an average of three months to an average of two months. In addition, we note that the proportion of the rural population we purposively sampled ( $n = 1161$ ) that reported piped water to be their main drinking water modality dropped following the onset of COVID-19, suggesting that some system service may have been disrupted.

***Despite the free water directive, a significant fraction of small piped systems have continued to collect revenue to support operating expenses.*** In addition to the 38 percent that continued to collect revenue, 84 percent of the respondents to our SMS surveys reported still paying some amount for water. Rural respondents reported spending an average of 47 GHS (roughly USD 8) per month and urban respondents spent an average of 66 GHS (roughly USD 11) per month.

***Reimbursements by the Government of Ghana to the operators we interviewed have been minimal to date.*** While 67 percent of water systems reported receiving some compensation, the amount received was only a small fraction (4 to 16 percent) of the amount requested.

# I. INTRODUCTION

Between June and September 2020, the United States Agency for International Development (USAID) Water, Sanitation, and Hygiene Partnerships and Learning for Sustainability (WASHPaLS) project conducted a rapid assessment and forecasting analysis of the effects of the COVID-19 pandemic on access to WASH services and products in USAID high priority and strategy-aligned countries. The central question we sought to answer was:

***How will the COVID-19 pandemic (and resulting economic crisis) affect access to water supply services, sanitation services and products, and hygiene products across the WASH high priority and aligned countries, and how will these effects vary by subsector, geography, and provider type?***

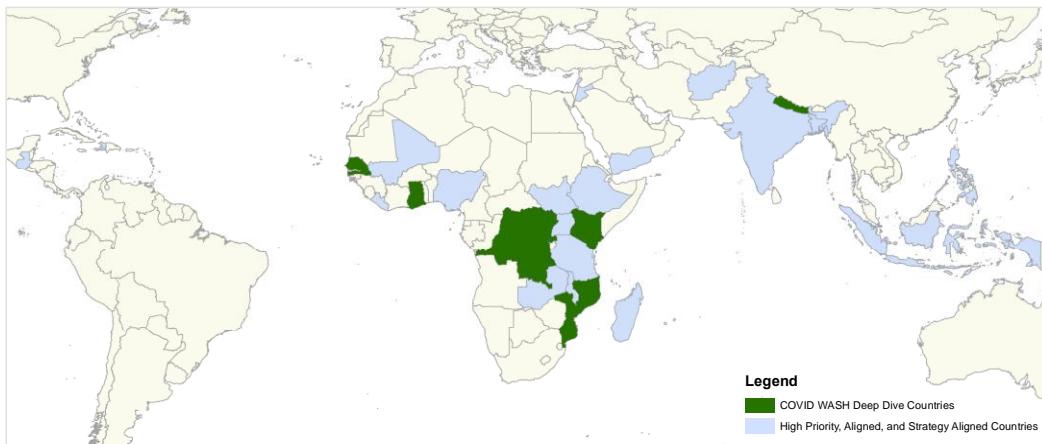
We proceeded on the assumption that direct health effects of the pandemic in USAID high priority and strategy-aligned countries would be exceeded by the economic shock of measures taken to contain the pandemic (such as, restrictions of movement, closures of business, disruptions of supply chains, and so forth).<sup>1</sup>

Our assessment was intended to provide both a snapshot of current WASH access conditions and to forecast near-term trends. The activities comprised (1) a series of “deep dive” analyses in seven countries and (2) the development of econometric models linking wealth indicators with WASH outcomes. The deep dives included interviews with key informants on the supply side and SMS-based questionnaires of hundreds of consumers with age, gender, and geographic distribution representative of the countries’ broader populations.

We selected seven countries for deep dive analysis based on their representation of a spectrum of geographic, cultural, and vulnerability characteristics, as well as the confidence in our ability to secure interviews with key informants identified via snowball sampling. The seven countries are the Democratic Republic of the Congo (DRC), Ghana, Kenya, Mozambique, Nepal, Rwanda, and Senegal (Figure 1). For the full analysis that combines results of the seven deep dives with the econometric analysis, we direct readers to the [WASHPaLS COVID-19 WASH Synthesis Report](#).

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<sup>1</sup> COVID-19 is likely to cause the first increase in global poverty in two decades, pushing some 100 million people into poverty and 50 million into extreme poverty in 2020, with an estimated 23 million going into extreme poverty in sub-Saharan Africa (Mahler et al. 2020). As we describe herein, the economic shocks of COVID-19 were experienced immediately and profoundly by high priority and strategy-aligned countries, and have persisted even as some of these countries have inched back toward pre-pandemic conditions of economic activity.



**Figure 1. Map of COVID WASH Deep Dive Countries.** Highlighted countries are USAID high priority and strategy-aligned countries, with the deep dive countries in green.

In Ghana, the government developed a multisectoral program valued at about USD 1.95 billion to respond to the anticipated social and economic impacts of the pandemic. The majority of these funds (USD 1.82 billion) were allocated under the Coronavirus Alleviation Programme to support selected industries (e.g., water sector, pharmaceutical sector supplying COVID-19 drugs and equipment), support small-to-medium enterprises, finance guarantees, build or upgrade district and regional health center infrastructure, among others (IMF 2021). As part of the support to the WASH sector, the government allocated USD 205 million in funds to pay, among other expenses, water bills for three months—from April to June—and to provide water tanker services to vulnerable communities, as well as investing in handwashing facilities in public places (Duti 2020). Ghana's Minister of Sanitation and Water Resources announced this free water directive in the [Sanitation and Water for All Ministerial Webinar in April 2020](#). The government's free water directive was subsequently extended through August and again through December 2020 (Ministry of Sanitation and Water Resources, 2020). In January 2021, after this study was completed, the Ghanaian president announced the extension of the free provision of water for the Ghana Water Company Limited (GWCL) 'lifeline customers' (up to 5 cubic meter) until March 2021, though this has created some confusion for rural water providers, and some systems have resumed charging customers for water (Jubilee House 2021).

One of central findings of our prior analysis for Ghana was that the government's extended free water directive (Ministry of Sanitation and Water Resources, 2020), sensibly intended to meet basic household needs during a time of intense economic pressure, appeared to have exacerbated the pandemic's income shock to threaten the ability of smaller water service providers to continue operating at acceptable performance standards. Smaller operators—especially those relying on grid electricity to move water from its (usually) underground source to elevated storage and eventually through a piped network to household and community taps—reported exhausting their cash reserves as they collected no, or substantially reduced tariff revenue. Furthermore, these small operators were simultaneously operating far above pre-COVID-19 levels, due to elevated consumption of tariff-free water as well as, plausibly, increased water usage for hygiene purposes.

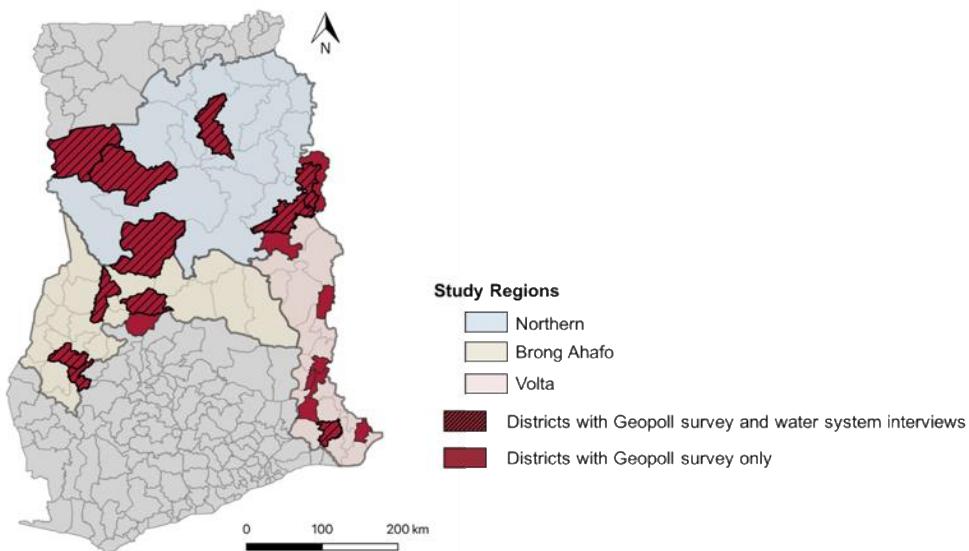
In response to this finding, USAID tasked WASHPaLS with conducting a follow-up analysis in Ghana to gain further insight into this small water provider problem by interviewing a larger sample of operators and expanding our SMS surveys to reach the largest possible sample of customers they serve. This report presents the findings of the follow-on analysis.

## 2. METHODS

This research sought to answer the following key questions:

1. What is the operational status of small piped systems in Ghana? Are service disruptions imminent? Have they already occurred, and if so, how widespread have the disruptions been? How are disruptions likely to increase as operating reserves are depleted?
2. What are the constraints on government institutions for tracking reimbursement needs, and responding to reimbursement requests from small providers?

**District Selection.** We opted to focus on small piped water system operators and customers. Relying on two databases maintained by the Community Water and Sanitation Agency (CWSA) (Community Water and Sanitation Agency, n.d.; Ministry of Sanitation and Water Resources 2018) we identified three regions with large numbers of small piped systems: Brong Ahafo, Northern, and Volta.<sup>2</sup> We contacted local officials in each region to select five to seven districts that satisfied two conditions: 1) they had at least one small piped system, and 2) any urban centers in the districts were not served by the national water supplier, Ghana Water Company Limited (GWCL). This process led us to select the 18 study districts depicted on Figure 2. We administered SMS surveys in each of these 18 districts and conducted interviews with water system managers in a subset of 12 districts where we were able to obtain contacts through snowball sampling (Figure 2).



**Figure 2: Map of the study districts.**<sup>2</sup> The SMS consumer survey included 18 districts: Brong Ahafo region (six districts): Asutifi North, Asutifi South, Kintampo North, Nkoranza North, Nkoranza South, and Wenchi; Northern region (seven districts): Kpandai, Nanton, Nanumba South, Sawla Tuna Kalba, Tatale Sanguli, West Gonja, and Zabzugu; Volta region (five districts): Afadzato South, Central Tongu, Ho West, Kadjebi, and Ketu. Water system interviews were conducted in 12 of these districts.

<sup>2</sup> We have used the old regional names and boundaries, to be consistent with the CWSA databases. The three study regions (Northern, Brong Ahafo, Volta) were each divided into multiple regions in December 2018.

**Key informant interviews.** To gage the operational status of small piped systems, we conducted structured interviews with small piped system operators, non-governmental organization (NGO) implementers, and government institutions (Table 1). We interviewed operators and managers of 29 small piped systems covering a broad range of management modalities:

- Water and Sanitation Management Teams (WSMTs) (19);
- CWSA (5);
- private operators (4);
- schools (1); and
- social enterprises (1).

We conducted the operator interviews via phone calls with an average duration of 1.5 hours each. In three cases, our questions required interviews with multiple respondents, leading to a total of 32 respondents overall.

We also interviewed the leadership of four NGO implementers: two international NGOs operating small water systems (World Vision and Global Communities) and two small water enterprises (SWEs: Water4 and Safe Water Network). These interviews took place in person, lasting 30 minutes on average. Global Communities has constructed four piped systems in the Savannah region (2), Oti region (1), and Western region (1); these systems are now operated directly by WSMTs. Water4 operates in the Wassa East district in the Western region. Their network comprises 182 public water points (62 handpumps and 120 kiosks) and 277 private connections (254 household connections, 7 schools, and 16 healthcare facilities). Safe Water Network operates 96 piped water systems in 12 regions.<sup>3</sup> World Vision has constructed a number of water systems across Ghana, including six in the Asutifi North district which were the focus of our interview; these systems are operated by WSMTs.

To evaluate constraints on government institutions, we conducted in-depth interviews with the District Planning Officer in Asutifi North (Brong Ahafo region) and the District Works Engineer in Wenchi (Brong Ahafo region). These interviews sought to detail the level of assistance that District Assemblies (DAs) provided to small piped systems under the free water directive. We also interviewed CWSA to understand the process for rural water system reimbursements.

All interviews took place in November and December 2020, and followed pre-set interview guides (Appendix 1). Following the small piped system operator interviews, we tabulated all responses and computed quantitative summaries. Following the implementer and government interviews, we analyzed interview notes qualitatively by searching for common themes. These interviews served to complement our SMS surveying of consumers, providing a depth of observation that is not possible to gain from a short SMS questionnaire.

**Table 1: Key informants interviewed.**

Key Informants Interviewed	Category	Number
Operators	- Operators and managers of small piped systems across 12 selected districts	29
Implementers	- International NGOs: World Vision and Global Communities - Small water enterprises (SWEs): Water4 and Safe Water network	4
Government	- District Assemblies (2) - Community Water and Sanitation Agency (CWSA)	3

<sup>3</sup> They are: Ahafo, Ashanti, Bono East, Brong Ahafo, Central, Eastern, Greater Accra, Oti, Savannah, Volta, Western, and Western North.

**SMS consumer surveys.** To document household perspectives regarding the operational status of small piped systems, we conducted a cross-sectional SMS consumer survey. Previous research conducted by the team executing this activity found that consumers often provide more reliable information about water services than the actual water suppliers (Acey et al. 2019). We contracted the mobile-based research firm GeoPoll to conduct the survey, using instruments of our design (see Appendix 2). SMS surveying is an extraordinarily efficient means of collecting consumer information; GeoPoll has formal access to mobile subscriber databases of millions of people in Ghana. Our survey could be easily read and filled out with a basic feature phone (non-smartphone) and was offered to potential respondents incentivized by a modest offer of top-up credit. We implemented two similar but distinct surveys:

1. a district-targeted survey, focused on jurisdictions with high numbers of small piped (non GWCL) water operators, as described above; and
2. a national survey, focused on small piped water consumers generally.

The instruments each consisted of about 15 questions and were offered in English. Both surveys queried information on water availability, source location, and costs of water. Respondents self-reported their region (and district for the district survey), as well as their status as urban or rural dwellers. The district survey also gathered information on water source type; for the national survey, only piped water customers were eligible. Both surveys asked about pre-pandemic and current conditions, and were executed from mid-November to early December 2020. We conducted all analysis in the statistical software program R v3.6.1(R Core Team 2019) and relied on Wilcoxon tests to examine whether differences were significant at  $p < 0.05$ .

Very few respondents refused the initial offer of phone credit in return for filling out the survey. However, our survey completion rates were relatively low due to our strict eligibility criteria: 13 percent for the district targeted survey (where residents of only 18 out of 216 districts in Ghana were eligible), and four percent of the national surveys (where only small piped water customers were eligible). We note that our SMS survey respondents, by virtue of their possession of a charged cell phone and the technical ability to fill out a survey, were likely a biased sample of the broader populations of our deep dive countries. We consider it likely that respondents had an elevated wealth and educational status in comparison to those that do not own a functional phone. Nonetheless, we consider these biases to be small enough to justify the use of SMS surveys useful, particularly given the relative ease of deploying them across large geographies.

## 3. RESULTS

### 3.1 KEY INFORMANT INTERVIEWS

**System operators.** The water supply systems whose operators we interviewed served a median of 4,500 people, with 123 private connections and 15 public standpipes (Table 2). Approximately 68 percent of water systems metered their production (Table 2). Under the free water directive, 69 percent of operators we interviewed reported that their production had increased, with a median change of +48 percent (Table 2). Some operators reported temporarily stopping operation under the free water directive (17 percent, 5 of 29) (Table 2). Operators also reported an increase in service interruptions under the free water directive; the median number of days with no water available increased from 0 to two days per week (Table 2). On days that water was available, operators reported that it was available for fewer hours: the median declined by six hours per day, from 24 to 18 hours (Table 2). Operators did not report changes in the number of days with scheduled outages (0 per week), though we note that they may not have been aware of all outages occurring within their networks and, at least in some cases, may not have kept accurate records of service interruptions (Table 2). It is also important to note that some customers may not have received services during the days and hours when the water system was functioning (i.e., 24 hours of water availability reported by the operator does not necessarily translate to 24 hours of service for all customers).

Most small piped systems stopped collecting revenue under the free water directive (62 percent, 18 of 29 respondents). Others elected to apply tariffs to commercial customers (24 percent, 7 of 29 respondents), and/or to collect outstanding bills (17 percent, 5 of 29) (Table 2). A minority continued to apply tariffs to all customers (10 percent, 3 of 29). At the start of the free water directive in April 2020, the median duration that operators reported that their cash reserves could cover was three months; at the time of this research (November 2020), the median was two months. In the interim, 14 percent (4 of 28) of water systems reported receiving financial assistance from their District Assembly and 11 percent (3 of 28) from other sources, including a Member of Parliament and donations (Table 2). Two of the CWSA managed systems reported receiving ongoing support from the CWSA Regional Office, to ensure continued operation. Additionally, 67 percent (18 of 27) of the operators reported receiving some compensation from CWSA, though this compensation was only a portion of the amounts requested (7 percent median, ranging from 4 to 16 percent) (Table 2). Operators were unclear on whether they would receive additional reimbursements. As of November 2020, CWSA had only disbursed reimbursements for the months of April-June 2020, approximately four months after water systems had submitted their requests. During this period, many operators reported postponing expenses (57 percent, 16 out of 28 respondents). The most commonly delayed expenses were maintenance (75 percent, 12 out of 16 respondents) and salaries (64 percent, 10 out of 16 respondents) (Table 2). As electricity (required to pump water for most systems) was the biggest monthly expense and was not provided free of charge (Table 2), some systems reported experiencing challenges paying their electricity bills. One system reported postponing electricity expenses (Table 2), and another system reported that they stopped operating for three days when their electricity was cut-off because they were unable to pay their electricity bills until the DA gave them funds.

**NGO implementers.** The two SWEs that we interviewed also reported major increases in water demand, ranging from 55 to 60 percent. To maintain consumption within production capacity and to limit waste, both SWEs instituted scheduled outages and/or rationing based on pre-COVID-19 consumption. One SWE required standpipe vendors to control the volume of water collected by each user and to limit water consumption to within a 50 percent increase over pre-COVID-19 levels. As one SWE reported, “We don’t want to limit people’s access to water, but we don’t want them to abuse it.” Both SWEs continued collecting revenue from private connections; one instituted unchanged tariffs but committed to refund customers proportionally to the CWSA reimbursements received. The other

applied tariffs when a user exceeded their pre-COVID-19 consumption level. Despite these measures, and although this particular operator ran a system relying on solar power as opposed to grid power, SWEs reported increases in operating expenses associated with maintenance linked to increased production.

Three of the four implementing organizations we interviewed reported that the free water initiative either had exhausted or would soon exhaust their cash reserves between November 2020 and January 2021. Nevertheless, they expected to continue operating with support from their national or international headquarters. None of the organizations expected to receive full reimbursement from CWSA. Additionally, all four organizations feared that the free water initiative would diminish customers' willingness-to-pay for water and jeopardize their campaigns to promote "pay-as-you-fetch". One respondent noted: "*The fear is that people will not be willing to pay again after COVID. People will say that if you've provided free water, you have the capacity to do this in the future as well.*" SWEs underscored the cost of re-sensitizing communities on payment: "*We are afraid of introducing pay as you fetch again: we will have to spend a lot of money to bring people back to pay for water.*"

**Table 2: Small piped water system operator interviews**

	Number of responses (max: 29)	Median (min-max)
<b>Water system characteristics</b>		
Estimated number of customers (people)	14	4,500 (1,000-9,000)
Number of private connections	28	123 (0-1,245)
Number of standpipes	29	15 (0-161)
Proportion of systems that metered their production	22	68% (15)
Breakdown of monthly expenses		
Electricity <sup>2</sup>		43% (0-80%)
Salaries	24	30% (0-94%)
Maintenance		15% (0-44%)
Consumables		3% (0-17%)
Other		<1% (0-25%)
<b>Changes during the Free Water Program</b>		
Water production (percent change) <sup>3</sup>	20	+48% (-20%-100%)
Proportion of operators who reported increased water production	29	69% (20)
Number of days per week with water unavailable to all customers		
Pre-COVID-19	28	0 (0, 7)
Current situation	29	2 (0, 7)
Number of days per week with scheduled outages <sup>4</sup>		
Pre-COVID-19	29	0 (0, 7)
Current situation	29	0 (0, 7)
Number of hours per day with water available		
Pre-COVID-19	29	24 (3, 24)
Current situation	29	18 (1, 24)
Proportion of operators reporting reduced services:		
Increased number of days per week with water unavailable	28	18% (5)
Increased number of days per week with scheduled outages	29	10% (3)
Reduced number of hours per day with water available	29	52% (15)
Temporarily stopped operating	29	17% (5)
<b>Financials</b>		
Proportion of systems that during the Free Water Program <sup>1</sup>		
Stopped collecting revenue	29	62% (18)
Applied tariffs to commercial customers	29	24% (7)
Collected outstanding bills	29	17% (5)
Continued to apply tariffs to all customers	29	10% (3)

Number of months that water systems' savings could cover			
In April 2020 <sup>5</sup>	18	3 (0, 8)	
In November 2020 <sup>6</sup>	16	2 (0, 12)	
Proportion of systems that received financial assistance from <sup>1</sup>			
CWSA	27	67% (18)	
District Assembly	28	14% (4)	
Other sources besides District Assembly and CWSA <sup>7</sup>	28	11% (3)	
Financial Assistance			
Amount requested from CWSA (GHS)	8	36,675 (9,000-162,670)	
Amount received from CWSA (GHS)	13	4,607 (920-100,000)	
Percent received from CWSA	6	7% (4%-16%)	
Proportion of systems that postponed expenses: <sup>1,8</sup>	28	57% (16)	
Electricity	16	6% (1)	
Salaries	16	63% (10)	
Maintenance	16	75% (12)	
Other	16	13% (2)	

<sup>1</sup>Reported as proportions, with the number in parentheses.

<sup>2</sup>28 out of 29 systems relied on grid power and one relied on solar power.

<sup>3</sup> Reported when operators knew the amount or percentage of change in production. Two operators stated production had increased but did not know by how much.

<sup>4</sup>Scheduled outages are commonly referred to as 'rationing'.

<sup>5</sup>Calculated as total bank account balance divided by monthly expenses.

<sup>6</sup>Self-reported.

<sup>7</sup>Other sources included a Member of Parliament and donations.

<sup>8</sup>Reported as proportion of systems who reported postponing expenses. Some systems reported postponing multiple expense categories. No system reported postponing consumables.

Several respondents indicated concern that the government had not fully anticipated the complexity and unintended consequences of administering a free water program in the highly fragmented and fragile rural water sector. As one respondent explained: "We have spent a lot of time and resources to sensitize communities on pay as you fetch...and it was working, and then there is the free water policy. The government should have thought through this carefully, and tried to work with stakeholders to adopt a more efficient approach to work for all types of systems."

**Government stakeholder interviews.** Our interviewees suggested that the free water initiative may initially have been intended strictly for urban water supply services, despite being announced to apply to all water supplies in Ghana. Rural water in Ghana is currently decentralized and is supplied by a variety of actors under different management models, including community-level water and sanitation management teams (WWSMTs) and private operators.

Once the free water policy was initiated, the sequence for CWSA reimbursing rural water suppliers was proposed as follows:

1. Water systems submit data on expenses, production, and consumption to DAs, along with a reimbursement request;
2. DAs vet and validate data;
3. DAs submit data to CWSA regional offices;
4. CWSA regional offices perform additional validation of data as needed;
5. CWSA submits requests from all regions simultaneously to the Ministry of Sanitation and Water Resources (MSWR);
6. MSWR submits to Ministry of Finance (MoF);
7. MoF approves reimbursement and transfers money to CWSA;
8. CWSA distributes reimbursement to DAs;
9. DAs transfer reimbursements to the system operators.

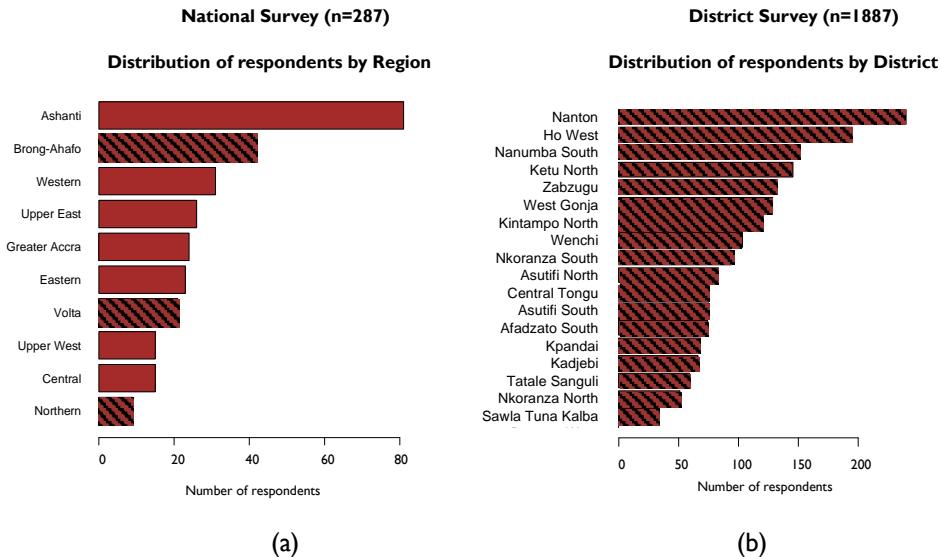
DAs were responsible for compiling reimbursement amounts for water systems in their districts and submitting them to CWSA. “*As a government institution, we are responsible for making sure free water is implemented,*” one DA official reported. DAs found the reimbursement process to be challenging, and our key informants reported that system operators could not fill out the request forms as CWSA required. Because the Ministry of Finance could also audit the rural water reimbursement data, CWSA was tasked with validating all claims independently of DAs, a particularly time-consuming endeavor because so many operators do not keep records of production, consumption, or finances. The first three months of reimbursement claims (April-June 2020) were completed in early August 2020, but very little had been paid by November 2020, and it is unclear whether further payments will be provided.

While many systems requested assistance from DAs to maintain operations under the free water directive, the DAs' ability to meet these requests depended on their own financial resources. One DA reported repairing broken handpumps and providing financial support to piped suppliers to cover electricity and operational costs, which they planned to recoup from CWSA reimbursements. Another DA official we interviewed reported that his district was unable to provide any financial assistance to water systems. Instead, he recommended water operators pre-finance expenses while waiting for reimbursements. Systems that were unable to pre-finance had to resort to selling water in violation of the free water directive. “The DA couldn’t force them to continue providing the water for free because it couldn’t support them financially,” one official said.

### 3.2 SMS CONSUMER SURVEYS

**Respondent population.** We obtained a total of 2,174 responses from the SMS consumer survey: 287 from the national sample and 1,887 from the district sample (detailed results of both surveys are presented in Appendix 3, Table S3.I).

Figure 3 provides the respondent distribution by region for the national survey and by district for the district survey. In both surveys, approximately half of the respondents (53 percent) were from rural areas; the remainder were from urban areas, and 80 percent were males, with an average age of 29 years (Appendix 3, Figure S4.I). In the district survey, 18 percent of the respondents had a household connection (“tap”) and 20 percent relied on public standpipes. For the national survey, where service by piped water was one of the sampling eligibility criteria, 44 percent of the respondents reported a household connection and 56 percent used standpipes.



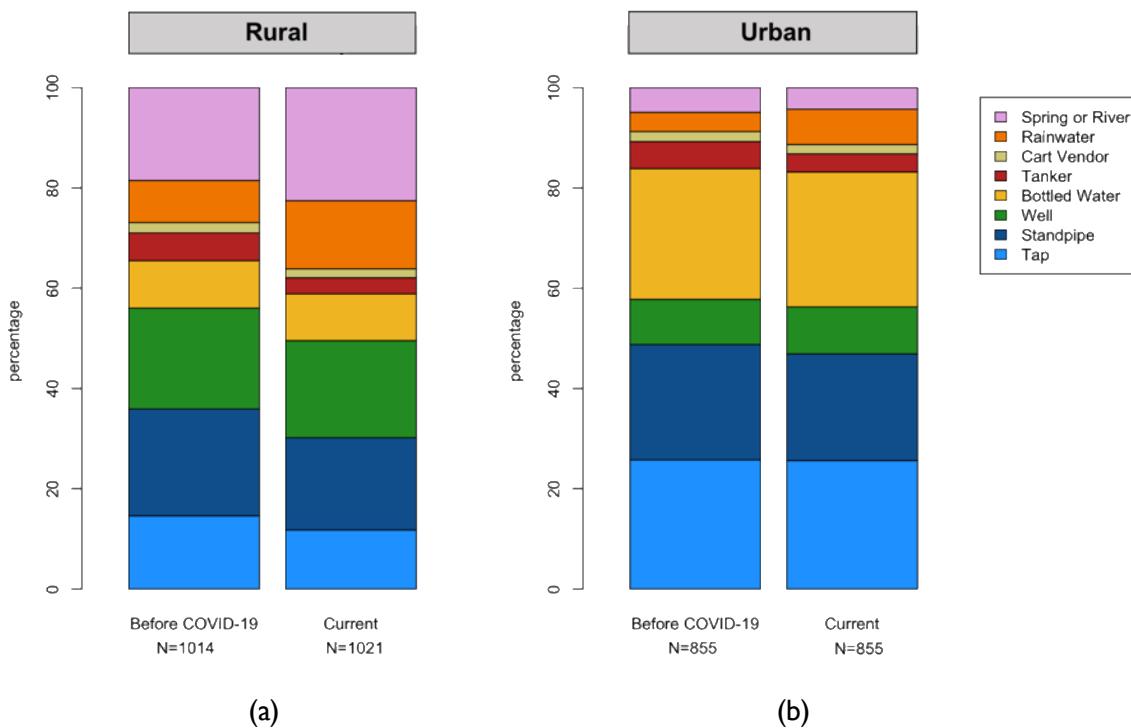
**Figure 3: Distribution of SMS consumer survey respondents.** (a) By region for the National Survey and (b) by district for the District Survey (b). The District Survey was conducted in 3 regions: Brong-Ahafo, Volta and Northern Region, which are shaded dark red in (a).

**Water Supply Sources.** In the district survey, we compared respondents' current main source of drinking water to their main source prior to the onset of COVID-19. Approximately 40 percent of the respondents reported currently using standpipe or tap water, with a significant urban/rural split (50 percent vs 30 percent, respectively (Figure 4)). For rural respondents, there was a net 16 percent decrease in the use of piped water (standpipe or tap) as compared to before COVID-19, counterbalanced by a net increase in use of rainwater (+56 percent) and spring or river (+20 percent) (Figure 4a, Appendix 3, Table S3.1). For the urban respondents, water supply modalities remained largely constant before and after the onset of COVID-19 (Figure 4b).

The nature of the change across each modality for rural respondents to the district-level survey is presented in Figure 5. Roughly half (46 percent) of those who reported a household connection ("tap") as their main drinking water source prior to COVID-19 reported transitioning to a new source, but 31 percent of the fraction who reported their present source to be a household connection were those who had not reported one as their pre-COVID-19 main source. Similarly, the proportion of those rural respondents reporting reliance on public standpipes exhibited a net decline (of 17 percent), with 18 percent of the fraction reporting them as their present source transitioning to it from non-piped modalities which they stated as their pre-pandemic main water supply sources.

Approximately half of the respondents that used standpipes or taps reported that COVID-19 did not change their ability to get their drinking water; the remainder were approximately evenly split between reporting that water access was currently easier or more difficult to access (Appendix 4, Figure S4.3). These results are consistent with our prior deep dive survey in Ghana where 22% of respondents reported that water was more difficult to access.

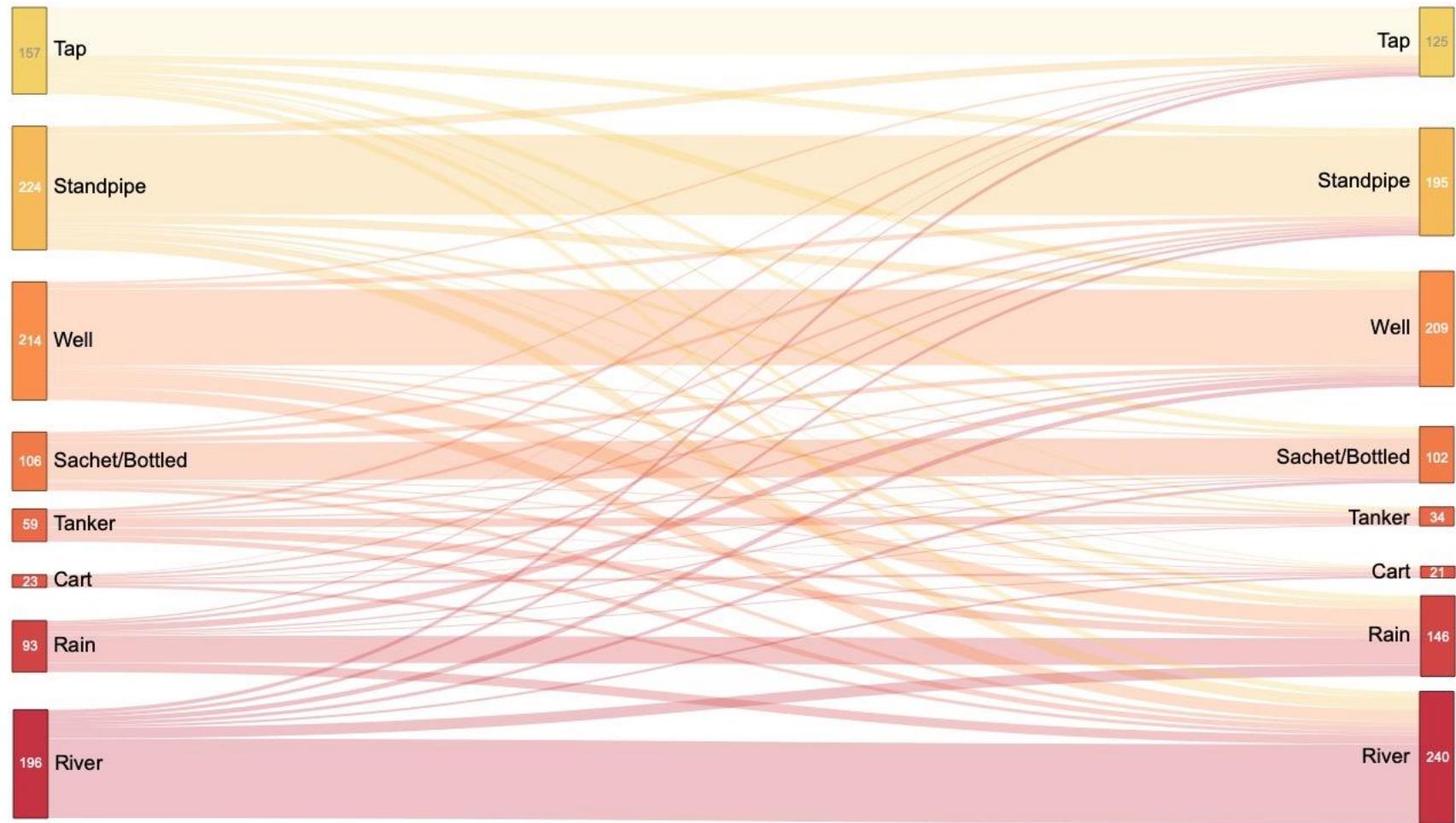
### Water Source before COVID-19 and currently – District Survey



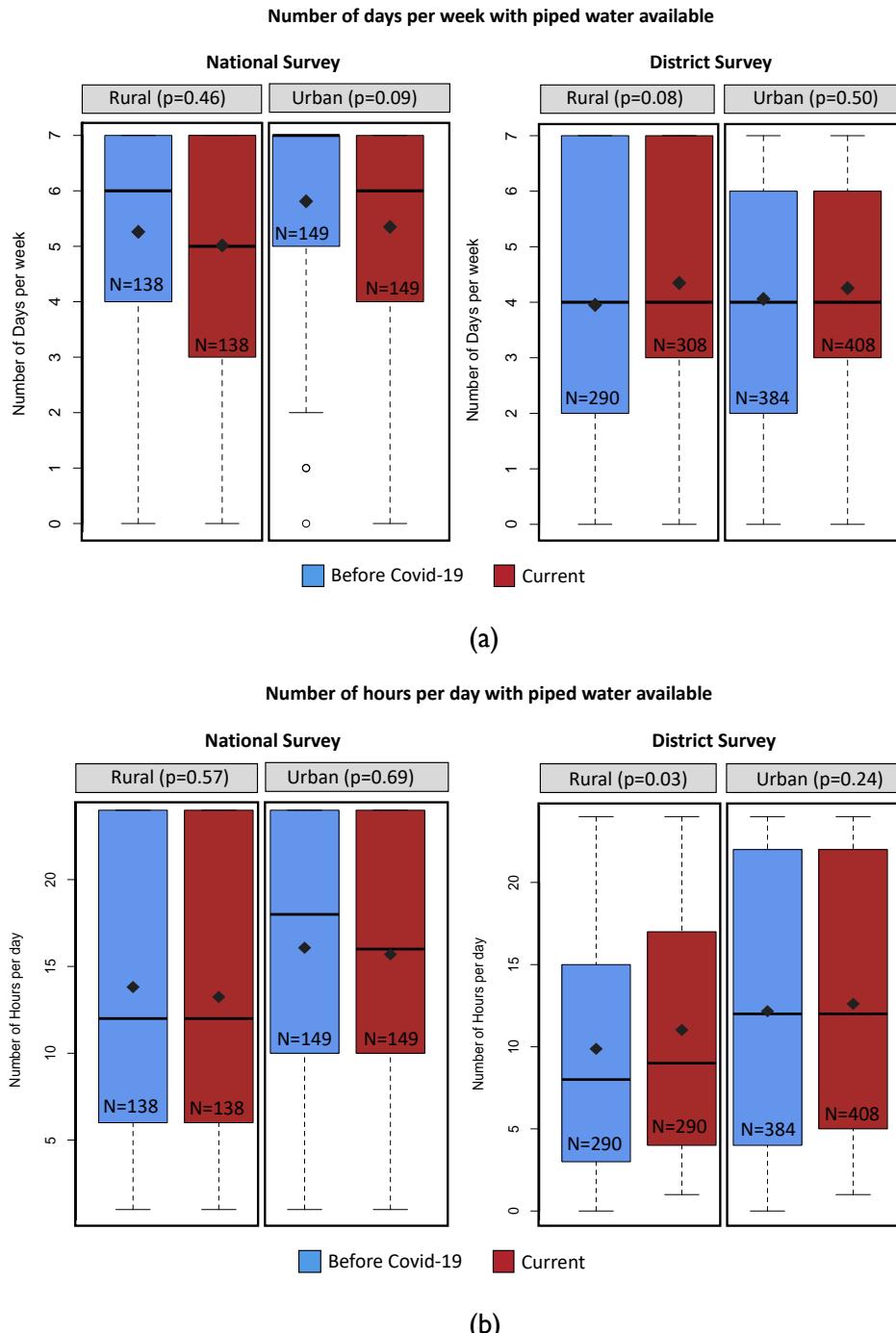
**Figure 4: Water sources.** Drinking water sources of respondents from the District Survey before COVID-19 and currently, for (a) rural and (b) urban respondents.

**Water availability.** Overall, piped water availability was higher for respondents of our national-level survey compared to the district-level survey which we purposively sampled (Figure 6). This was true for urban and rural respondents, both pre-COVID-19 and at present, for both metrics of piped water availability: days per week and hours per day ( $p<0.05$  for each). For example, water was reported to be available for an average of 13 hours per day for rural respondents of the national survey, compared to 11 hours per day for rural respondents of the district survey (Figure 6).

There was also an intriguing difference in the national and district-level survey data with respect to how COVID-19 changed water availability. When comparing the pre-COVID-19 to the current situation, the rural respondents of the district survey reported a modest *increase* in water availability, from 10 to 11 hours per day ( $p=0.03$ , Figure 6). No such difference was observable for the respondents of the national survey.



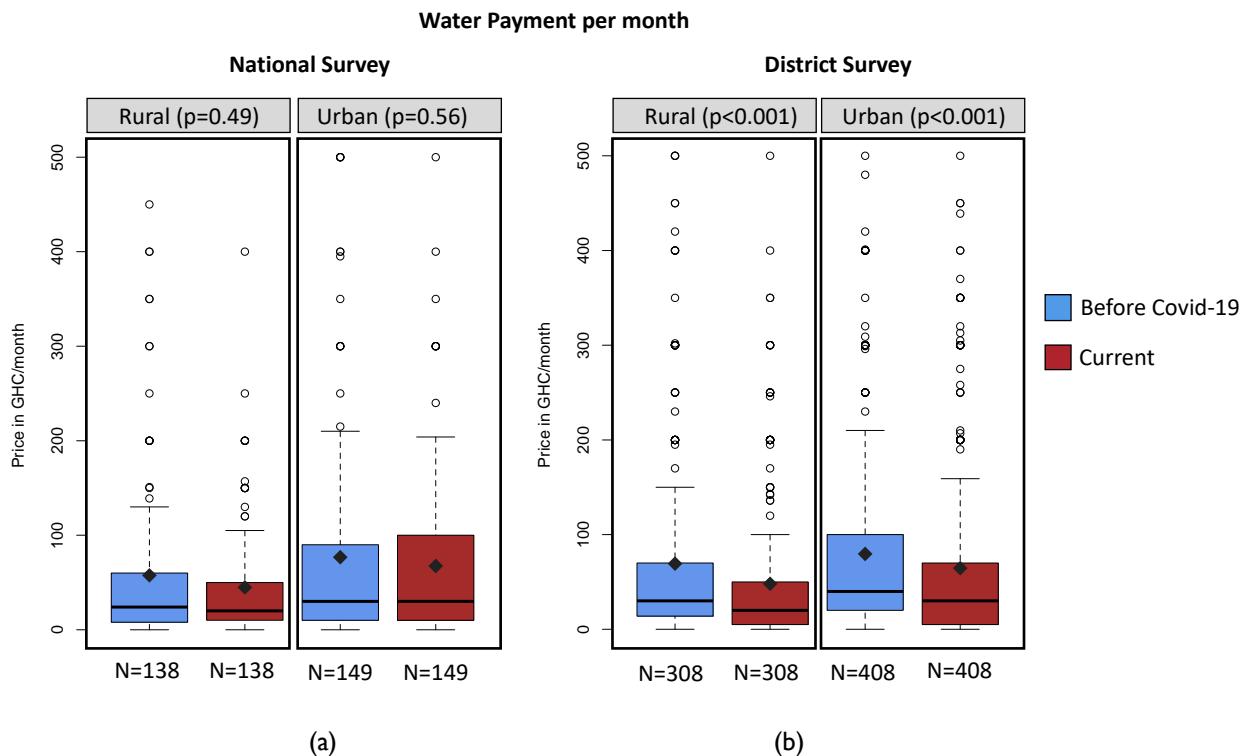
**Figure 5. Sankey diagram of water source changes.** Changes in drinking water modality reported by rural respondents to our district-level SMS consumer surveys. Numbers of respondents for each pre-COVID-19 modality at left, and numbers of respondents for each present modality at right.



**Figure 6: Water availability box-and-whisker plots.** (a) Number of days per week and (b) number of hours per day, with piped water available for the national and the district survey and for rural and urban areas. Boxes represent the interquartile range (i.e., the middle 50 percent of the observations, 25 to 75 percent), the bold black line is the median, and the black diamond the mean. The whiskers represent 1.5 times the interquartile range (12.5 to 87.5 percent). The presented p-value is from Wilcoxon rank sum test.

**Water payments.** Notably, most piped water users—84 percent in both national and district surveys—reported paying some amount for water despite the free water directive. Rural respondents spent an average of 47 GHS (USD 8) per month and urban respondents spent an average of 66 GHS (USD 11) per month (Appendix 3, Table S3.1). However, it is possible that these payments include alternative water sources to piped supplies, such as bottled or sachet water.

Compared to pre-COVID-19, respondents to both surveys reported spending less on water (Figure 7). For the district survey, average monthly payments decreased by 30 percent (from 69 GHS to 48 GHS) for rural respondents and 20 percent (from 80 GHS to 65 GHS) for urban respondents (both  $p<0.001$ ) (Figure 7). For the national survey, no changes in average monthly water payments were compatible with an effect (Figure 7).



**Figure 7: Water payments box-and-whisker plots.** Reported monthly water payments for rural and urban respondents for the (a) national and (b) district surveys. Boxes represent the interquartile range (i.e. the middle 50 percent of the observations), the bold black line is the median, and the black diamond the mean. Each whiskers represent 1.5x the interquartile range. The presented p-value is from Wilcoxon rank sum test.

## 4. CONCLUSIONS

The COVID-19 economic shock, in tandem with the Government of Ghana's ambitious free water directive, have posed obvious challenges to the country's water sector in general, and to its small water piped systems in particular.

Rural piped water providers have collected less revenue; 62 percent of surveyed providers have stopped collecting revenue entirely. Their cash reserves are declining, but those declines do not appear to have yet led to widespread disruptions of service relative to before COVID-19 and the government's measures to alleviate the financial pressures experienced by much of the public. While consumers did report an overall reduction in piped water use (16 percent among rural respondents, some of which may be a result of non-functioning piped water systems), most consumers did not report significant changes in water availability in piped water systems compared to pre-COVID-19 levels.

One plausible interpretation of these findings is that they are encouraging indications of water sector resilience. Customers of the very systems we hypothesized to be the most vulnerable to declines in water access report modest *increases* in water availability since the onset of COVID-19, increases that were not observed more generally across Ghana. By contrast, there is suggestive evidence that the populations we anticipated would be least affected (urban consumers) have seen a slight decline in service ( $p=0.09$  for a Wilcoxon rank sum test showing a decrease in number of days per week with available water following the arrival of COVID-19).

An alternative interpretation is that the baseline, pre-pandemic rural water supply situation was such that service was already so poor that neither the pandemic economic shock nor the government measures that deprived suppliers of months of revenue were sufficient to greatly affect their overall operational and financial health. In other words, it is likely that we did not observe a major change in service delivery because cost recovery was already poor prior to COVID-19.

To whichever interpretation one might subscribe, there are clearly issues that must be tracked carefully: both system operators and consumers report much higher system production, placing increasing wear on equipment, coupled with revenue shortfalls from the free water directive that will at least partially continue through March 2021. The government has been slow to reimburse small rural system operators for foregone revenue, at least partially because the complex reimbursement process requires substantial coordination of multiple stakeholders, and also because so many operators do not keep records of production, consumption, or finances. More widespread system failures may be looming in the future, especially if revenue collection following the eventual termination of the free water directive remains difficult because consumers have become accustomed to free provision. On the other hand, the ability of some operators to continue collecting revenue (and the recognition by consumers that their paying of tariffs is essential to continuing service) is a positive sign, and measures to encourage that practice should be pursued.

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# APPENDIX I - INTERVIEW GUIDES

## Operator Interview Guide

Q1. Who is responsible for this scheme's operation?

- CWSA
- WSMT
- District Assembly
- Private operator
- Institution (school, hospital)
- Social enterprise
- Other

Q2. How many customers (people) do you serve?

Q3. How many private connections in your network?

Q4. How many public standpipes in your network?

Q5. Is your system on grid power?

- If no: Solar? Diesel?

Q6. What is your water source (borehole, lake, river, pond, other)?

Q7. How many pumps do you employ?

Q8. What is the capacity of your pump?

Q9. How many elevated tanks do you have? What is the volume of your elevated tank(s)?

Q10. What was your average daily production pre-COVID?

Q11. What is your average daily production now?

Q12. What was your average daily consumption pre-COVID (from standpipes and private connections combined)?

Q13. What is your average daily consumption now?

Q14. Pre-COVID, in a typical week, on how many days was the water not flowing at all?

- What is the situation now?
- How many days did the water flow in the past week?

Q15. Pre-COVID, in a typical week, on how many days did you have to ration your water (i.e. not serve all customers all day)?

- What is the situation now?
- How many days did you have to ration water in the past week?

Q16. Pre-COVID, on days where the water was flowing, on how many hours was it flowing per day?

- What is the situation now?

- Yesterday, how many hours was the water flowing?

Q17. Have you collected any revenue since the declaration of the free water directive?

- If yes: please explain

Q18. Can you break down your monthly expenses?

- Electricity:
- Personnel:
- Regular maintenance
- Consumables
- Other (specify)
- Total: [Calculate the total and confirm with respondent that it is correct, if not, add more categories or rectify above amounts].

Q19. Have you ever borrowed money from a bank for operations?

- If so, how much?

Q20. Before COVID-19, what was your operating financial surplus or loss every month?

Q21. What was the balance in your bank accounts at the onset of COVID-19?

- Operational account?
- Capital account?
- Sanitation account?

Q22. Did you apply for a reimbursement from CWSA to cover the costs of the free water program?

- If yes, when? [Note if this was a recurring application, for example, monthly, and which months they applied]
- How did you apply? (e.g. directly, or through DA)
- Did you face any challenges when applying for reimbursement? Please describe.
- How much did you apply for? (Note multiple figures if system has applied multiple times)

Q23. Have you been reimbursed by CWSA?

- If yes, how much?

Q24. Just during the period of Covid-19: Have you received any other financial assistance from anyone else?

- If so, what kind (loans, grants, other types of investments)?
- If so, how much?

Q25. How long can you continue to operate with your current cash reserve? [Triangulate the answer with previous answers: Q15, Q16, Q18, Q19].

Q26. Have you ever had to stop operating?

- If yes, how many times, and for how long? For what reasons?

Q27. Have you had to postpone specific expenses since the free water program started? If so, which ones? What are your plans for the future?

## **Implementer Interview Guide**

**Q1.** Which of the following best describes your organization's work? (circle all that apply)

- System design
- System construction
- System operation
- Financial support
- Management support
- System rehabilitation
- System expansion

**Q2.** Can you tell me about the small piped systems that are part of your programs?

- Where are they located?
- How many consumers do they serve? (try to get an estimate of how many customers per system)
- Who operates them?
- Before COVID-19, were they able to cover their operating costs?
- Do you know what fraction of them were able to maintain a cash reserve?
- Can you give a rough breakdown of a typical system's operating costs (electricity, personnel, etc.)

**Q3.** Have the systems complied with the national free water directive?

- If not, why not?

**Q4.** Have the systems associated with your programs applied for reimbursement for lost revenue during the COVID-19 period?

- Please describe the process of requesting reimbursement
- How much of your requested reimbursement have you received?

**Q5.** Can you describe the current financial status of the systems? What do you know of their cash situation?

**Q6.** Have your systems been able to continue operating normally? If not, what has happened?

- Episodic service disruptions?
- Complete service disruptions?

**Q7.** If service has been disrupted, why has that occurred?

- No cash to pay staff.
- No cash to pay electricity.
- No cash to cover other expenses (hardware)
- Other (please describe)

**Q8.** Are there particular regions or settings that are proving more challenging than others?

**Q9.** How have you been coping with the challenges?

**Q10.** What are you hearing from your colleagues in the NGO community and elsewhere about these questions?

## **District Assembly Interview Guide**

1. What has been your experience with collecting data for reimbursements of the free water program?
  - a. What have been the challenges?
2. Have you received any money from CWSA? If yes:
  - a. How much?
  - b. How does this compare with what you expected to receive?
  - c. Have you distributed the money to WSMTs?
    - i. If so, how?
3. During the free water period, did you give assistance to small piped water systems in your district?
  - a. If so, what kind of support did you provide piped systems in your district?
    - i. If financial, how much?
    - ii. If other, what kind of support?
4. Did any water systems run out of money to pay for operational costs during the free water period?
  - a. If so, what happened & why?
  - b. If not, how were they able to keep operating? (probe, for example.: did they collect revenue from somewhere? If so, where?)
5. Were there any additional challenges piped systems experienced outside of finances? If so, please explain.

## APPENDIX 2 - SMS SURVEY INSTRUMENTS

### District-targeted survey

Q #	Q Name	English	Skip Pattern
NA	Optin	GeoPoll: Reply 1 to answer questions on your drinking water and earn #TOPUP# ! No cost to reply. For help reply HELP	1 = BirthYear HELP = HELP
NA	HELP	GeoPoll is a global network of people shaping their community by answering short surveys. Free to respond. Reply STOP to Opt-Out. Visit GeoPoll.com for info	1 = BirthYear STOP = Refusal
NA	Refusal	Thank you for your time, you will be removed from today's survey. For more information or to register for future surveys please visit GeoPoll.com	End poll declined
NA	Ineligible	You are ineligible for this survey. For more information on Coronavirus prevention visit who.int	End poll ineligible
1	BirthYear	In what year were you born? Reply with a four-digit number like 1980.	1900-1919 = Ineligible 1920-2005 = Gender 2006-2020 = Ineligible
2	Gender	Are you male or female? Reply with 1 or 2. 1)Male 2)Female	1-2 = ADM-1
3	ADM-1	What Region do you currently live in? 1)Ashanti 2)Brong-Ahafo 3)Greater Accra 4)Central 5)Eastern 6)Northern 7)Western 8)Upper East 9)Upper West 10)Volta	1 = Ineligible 2 = ADM2_Brong 3-5 = Ineligible 6 = ADM2_Northern 7-9 = Ineligible 10 = ADM2_Volta
4	ADM2_Brong	What District do you currently live in? 1)Asutifi North 2)Asutifi South 3)Dormaa West 4)Kintampo North 5)Nkoranza North 6)Nkoranza South 7)Wenchi 8)Other	1-7 = Urban/Rural 8 = Ineligible
5	ADM2_Northern	What District do you currently live in? 1)Kpandai 2)Nanton 3)Nanumba South 4)Sawla Tuna Kalba 5)Tatale Sanguli 6)West Gonja 7)Zabzugu 8)Other	1-7 = Urban/Rural 8 = Ineligible
6	ADM2_Volta	What District do you currently live in? 1)Afadzato South 2)Central Tongu 3)Ho West 4)Ketu North 5)Kadjebi 6)Other	1-5 = Urban/Rural 6 = Ineligible

## District-targeted survey (continued)

Q #	Q Name	English	Skip Pattern
7	Urban/Rural	Do you live in a urban or rural area? Reply with 1 or 2. 1)Urban area [city/town] 2)Rural area [village/farm]	1-2 = WaterSupply
8	WaterSupply	In the past month, how did you get your drinking water? 1)Tap 2)Standpipe 3)Well 4)Bottled water/sachet 5)Tanker 6)Cart vendor 7)Rainwater 8)Spring/River	1-2 = FlowDays 3-8 = SourceLocation
9	FlowDays	In the past 1 week, how many days was the piped water available? Reply a digit number between 0 and 7.	0-7 = FlowHours
10	FlowHours	On the days when piped water is available, how many hours per day, on average, does it flow? Reply with a one or two digit number between 1 and 24.	1-24 = SourceLocation
11	SourceLocation	Where is the water source that you use? Reply with a number. 1)In my home or compound 2)Neighbor 3)I must walk to it	1-3 = WaterPay
12	WaterPay	How much did you pay for drinking water in the past month, in GHS? Reply with a one, two, or three digit number between 0 and 500.	0-500 = WaterChange
13	WaterChange	Has COVID-19 made it easier or more difficult to get your drinking water?. 1)Easier 2)More difficult 3)The same as before	1-3 = WaterSupplyBefore
14	WaterSupplyBefore	Before COVID, how did you get your drinking water? 1)Tap 2)Standpipe 3)Well 4)Bottled water/sachet 5)Tanker 6)Cart vendor 7)Rainwater 8)Spring/River	1-2 = FlowDaysBefore 3-8 = WaterPayBefore
15	FlowDaysBefore	Before COVID-19, In a typical week, how many days was the piped water available? Reply a digit number between 0 and 7.	0-7 = FlowHoursBefore
16	FlowHoursBefore	Before COVID-19, on the days you receive piped water, how many hours per day, on average, did it flow? Reply with a one or two digit number between 1 and 24.	1-24 = WaterPayBefore
17	WaterPayBefore	Before COVID-19, how much did you pay for drinking water per month, in GHS? Reply with a one, two, or three digit number between 0 and 500.	0-500 = Close-out-Incentive
NA	Close-out-Incentive	GeoPoll: Thank you! You will receive #TOPUP# airtime credit within 2 days. For more information on Coronavirus prevention visit who.int	NA

## National survey

Q #	Q Name	English	Skip Pattern
NA	Optin	GeoPoll: Reply 1 to answer questions on your drinking water and earn #TOPUP# ! No cost to reply. For help reply HELP	1 = BirthYear HELP = HELP
NA	HELP	GeoPoll is a global network of people shaping their community by answering short surveys. Free to respond. Reply STOP to Opt-Out. Visit GeoPoll.com for info	1 = BirthYear STOP = Refusal
NA	Refusal	Thank you for your time, you will be removed from today's survey. For more information or to register for future surveys please visit GeoPoll.com	End poll declined
NA	Ineligible	You are ineligible for this survey. For more information on Coronavirus prevention visit who.int	End poll ineligible
1	BirthYear	In what year were you born? Reply with a four-digit number like 1980.	1900-1919 = Ineligible 1920-2005 = Gender 2006-2020 = Ineligible
2	Gender	Are you male or female? Reply with 1 or 2. 1)Male 2)Female	1-2 = ADM-1
3	ADM-1	What Region do you currently live in? 1)Ashanti 2)Brong-Ahafo 3)Greater Accra 4)Central 5)Eastern 6)Northern 7)Western 8)Upper East 9)Upper West 10)Volta	1-10 = Urban/Rural
4	Urban/Rural	Do you live in a urban or rural area? Reply with 1 or 2. 1)Urban area [city/town] 2)Rural area [village/farm]	1-2 = WaterSupply
5	WaterSupply	In the past month, how did you get your drinking water? 1)Tap 2)Standpipe 3)Well 4)Bottled water/sachet 5)Tanker 6)Cart vendor 7>Rainwater 8)Spring/River	1-2 = WaterSupplyBefore 3-8 = Ineligible
6	WaterSupplyBefore	Before COVID, how did you get your drinking water? 1)Tap 2)Standpipe 3)Well 4)Bottled water/sachet 5)Tanker 6)Cart vendor 7>Rainwater 8)Spring/River	1-2 = WaterCompany 3-8 = Ineligible
7	WaterCompany	Do you get your water from Ghana Water Company Limited (GWCL)? 1)Yes 2)No 3)I don't know	1 = Ineligible 2-3 = FlowDays

## National survey (continued)

Q #	Q Name	English	Skip Pattern
8	FlowDays	In the past 1 week, how many days was the piped water available? Reply a digit number between 0 and 7.	0-7 = FlowDaysBefore
9	FlowDaysBefore	Before COVID-19, In a typical week, how many days was the piped water available? Reply a digit number between 0 and 7.	0-7 = FlowHours
10	FlowHours	On the days when piped water is available, how many hours per day, on average, does it flow? Reply with a one or two digit number between 1 and 24.	1-24 = FlowHoursBefore
11	FlowHoursBefore	Before COVID-19, on the days you receive piped water, how many hours per day, on average, did it flow? Reply with a one or two digit number between 1 and 24.	1-24 = WaterPay
12	WaterPay	How much did you pay for drinking water in the past month, in GHS? Reply with a one, two, or three digit number between 0 and 500.	0-500 = WaterPayBefore
13	WaterPayBefore	Before COVID-19, how much did you pay for drinking water per month, in GHS? Reply with a one, two, or three digit number between 0 and 500.	0-500 = SourceLocation
14	SourceLocation	Where is the water source that you use? Reply with a number. 1)In my home or compound 2)Neighbor 3)I must walk to it	1-3 = WaterChange
15	WaterChange	Has COVID-19 made it easier or more difficult to get your drinking water?. 1)Easier 2)More difficult 3)The same as before	1-3 = Close-out-Incentive
NA	Close-out-Incentive	GeoPoll: Thank you! You will receive #TOPUP# airtime credit within 2 days. For more information on Coronavirus prevention visit who.int	NA

## APPENDIX 3 - ADDITIONAL TABLES

**TABLE S3.I: DETAILED RESULTS OF THE SMS CONSUMER SURVEYS**

Question	Answer	District Survey		National Survey	
		Rural (N - %)	Urban (N - %)	Rural (N - %)	Urban (N - %)
Age	N Median Mean	1023 28.00 29.07	863 28.00 28.97	138 28.50 29.36	149 28.00 29.44
Gender	Male Female N/A	824 – 81% 199 – 19% 1 - <1%	702 – 81% 160 – 19% 1 - <1%	93 – 67% 45 – 33%	97 – 65% 52 – 35%
Region	Ashanti Brong-Ahafo Central Eastern Greater Accra Northern Upper East Upper West Volta Western N/A	212 – 21%  513 – 50%  297 – 29%  1 - <1%	314 – 36%  293 – 34%  256 – 30%	26 – 19% 20 – 14% 7 – 5% 12 – 9% 6 – 4% 4 – 3% 20 – 15% 10 – 7% 14 – 10% 19 – 14%	55 – 37% 22 – 15% 8 – 5% 11 – 7% 18 – 12% 5 – 3% 6 – 4% 5 – 3% 7 – 5% 12 – 8%
Drinking water sources (current)	Tap Standpipe Well Bottled Water – Sachet Tanker Cart vendor Rainwater Spring/river	120 – 12% 188 – 18% 199 – 19% 95 – 9%  33 – 3% 19 – 2% 139 – 14% 232 – 23%	225 – 26% 183 – 21% 84 – 10% 235 – 27%  32 – 4% 16 – 2% 63 – 7% 38 – 4%	45 – 33% 93 – 67%	80 – 54% 69 – 46%
Drinking water sources (pre-COVID-19)	Tap Standpipe Well Bottled Water – Sachet Tanker Cart vendor Rainwater Spring/river	149 – 15% 218 – 21% 207 – 20% 99 – 10%  56 – 5% 22 – 2% 89 – 9% 194 – 19%	224 – 26% 199 – 23% 80 – 9% 228 – 26%  46 – 5% 18 – 2% 37 – 4% 42 – 5%	42 – 30% 96 – 70%	71 – 52% 78 – 48%
Number of days/week with piped water available (current) *	N Median Mean	308 4.00 4.37	408 4.00 4.25	138 5.00 5.01	149 6.00 5.35
Number of days/week with piped water available (pre-COVID-19) *	N Median Mean	290 4.00 3.95	384 4.00 4.06	138 6.00 5.26	149 7.00 5.81
Hours/day with piped water available (current) *	N Median Mean	308 9.00 11.02	408 12.00 12.61	138 12.00 13.24	149 16.00 15.70
Hours/day with piped water available (pre-COVID-19) *	N Median Mean	290 8.00 9.87	384 12.00 12.16	138 12.00 13.81	149 18.00 16.07
Monthly expenditures on drinking water in GHS (current) *	N Median Mean	308 20.00 48.07	408 30.00 64.59	138 20.00 44.89	149 30.00 67.48

Question	Answer	District Survey		National Survey	
		Rural (N - %)	Urban (N - %)	Rural (N - %)	Urban (N - %)
Monthly expenditures on drinking water in GHS (pre-COVID-19) *	N Median Mean	308 30.00 69.30	408 40.00 79.63	138 24.00 57.57	149 30.00 76.78
Location of drinking water source *	In my home or compound Neighbor I must walk to it	75 – 24% 51 – 17% 182 – 59%	222 – 54% 76 – 19% 110 – 27%	35 – 25% 25 – 18% 78 – 57%	61 – 41% 34 – 23% 54 – 36%
Has COVID-19 made it easier or more difficult to get your drinking water? *	Easier More difficult The same as before	78 – 25% 90 – 29% 140 – 46%	134 – 33% 98 – 24% 176 – 43%	34 – 25% 40 – 29% 64 – 46%	35 – 24% 23 – 15% 91 – 61%
<b>TOTAL NUMBER OF RESPONDENTS</b>		<b>1023</b>	<b>863</b>	<b>138</b>	<b>149</b>

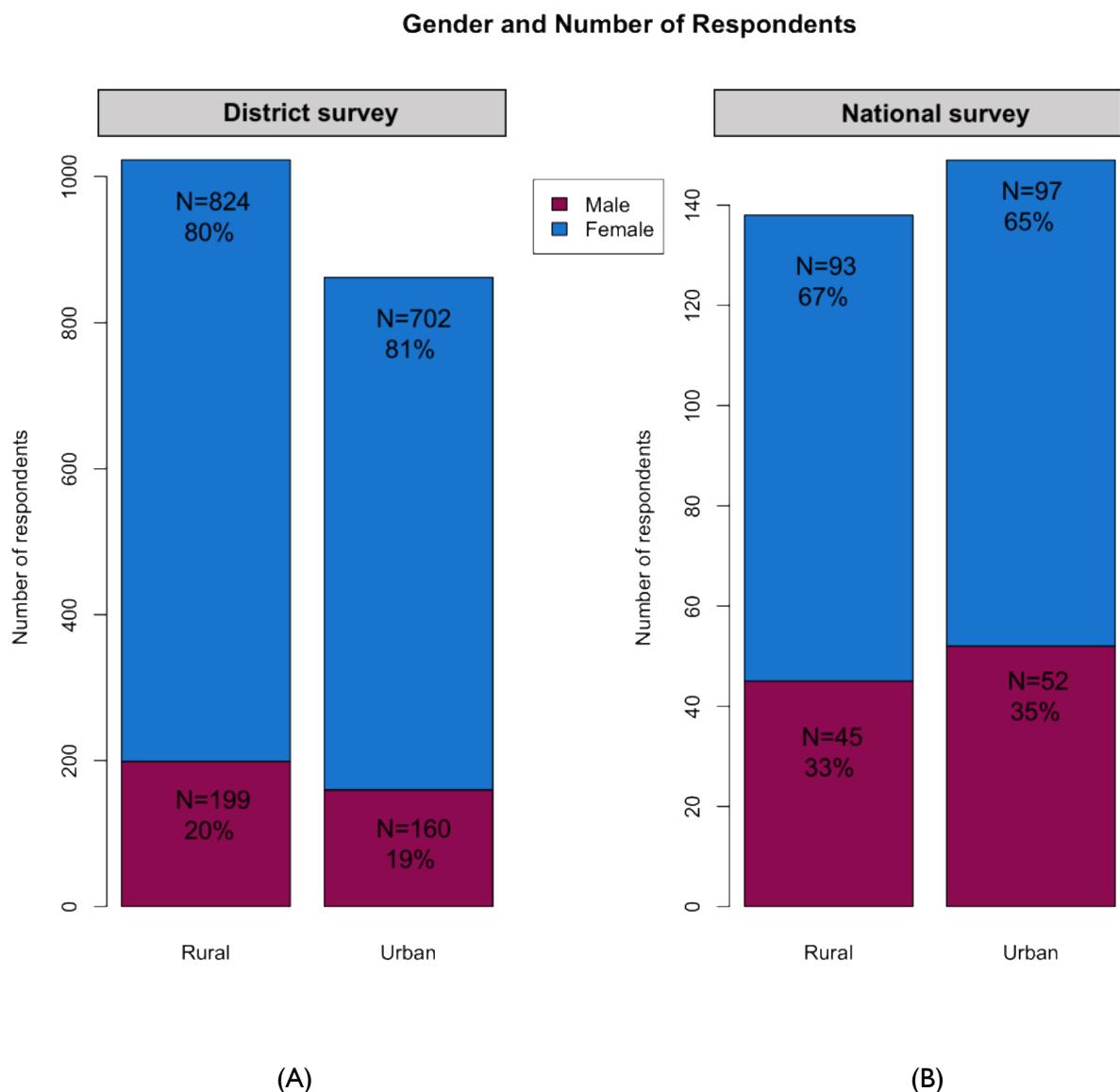
\* For these specific questions, the results of the District survey included only the users of standpipe or tap water.

**TABLE S3.2: RESULTS OF WILCOXON TEST FOR CHANGES IN WATER SOURCE BEFORE COVID-19 AND CURRENTLY**

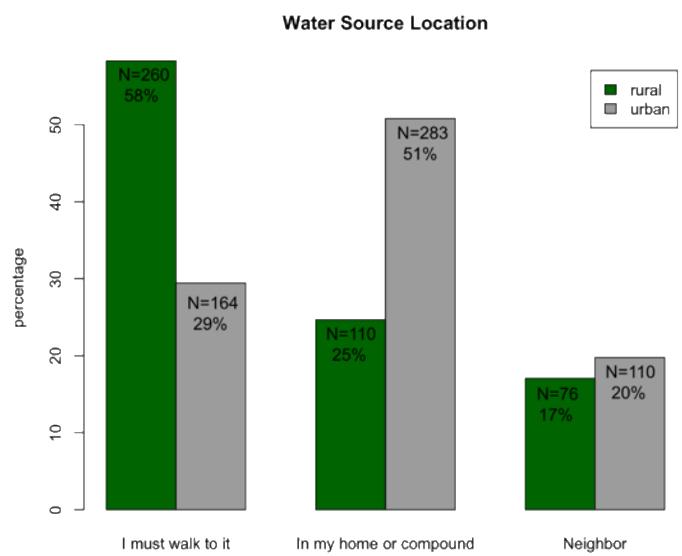
<b>Before COVID-19 / Currently</b>		
<b>p-value (Wilcoxon test)</b>		
	<b>Rural</b>	<b>Urban</b>
<b>Tap Water</b>	p=0.035	p=0.001
<b>Standpipe</b>	p=0.009	p=0.023
<b>Well</b>	p<0.001	p=0.004
<b>Bottled Water or Sachet</b>	p=0.002	p<0.001
<b>Tanker</b>	p=0.001	p=0.002
<b>Cart Vendor</b>	p=0.037	p=0.037
<b>Rainwater</b>	p=0.004	p=0.007
<b>Spring River</b>	p<0.001	p=0.025

## APPENDIX 4 - ADDITIONAL FIGURES

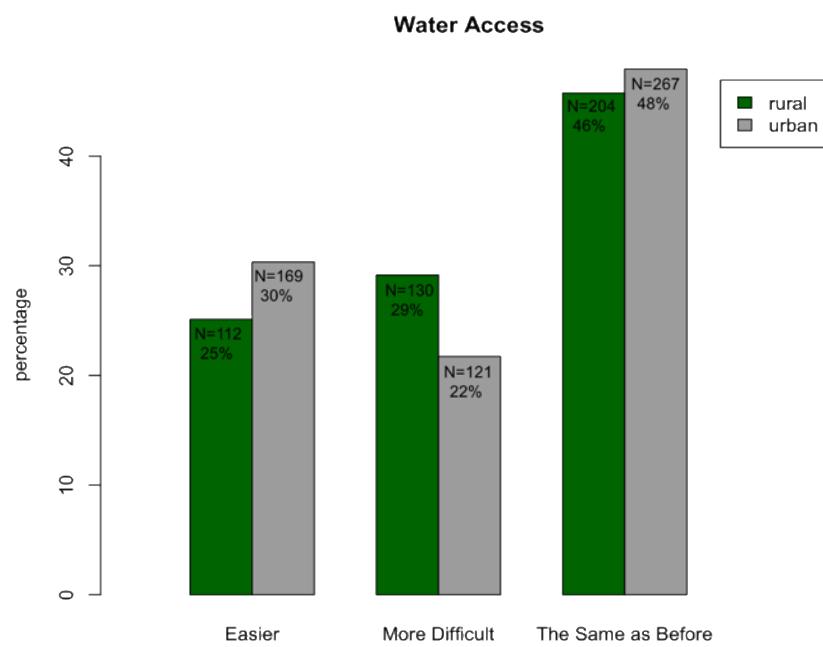
**FIGURE S4.I: DISTRIBUTION OF RESPONDENTS BETWEEN RURAL AND URBAN AREAS AND BETWEEN MALE AND FEMALE FOR (A) THE DISTRICT SURVEY AND (B) THE NATIONAL SURVEY**



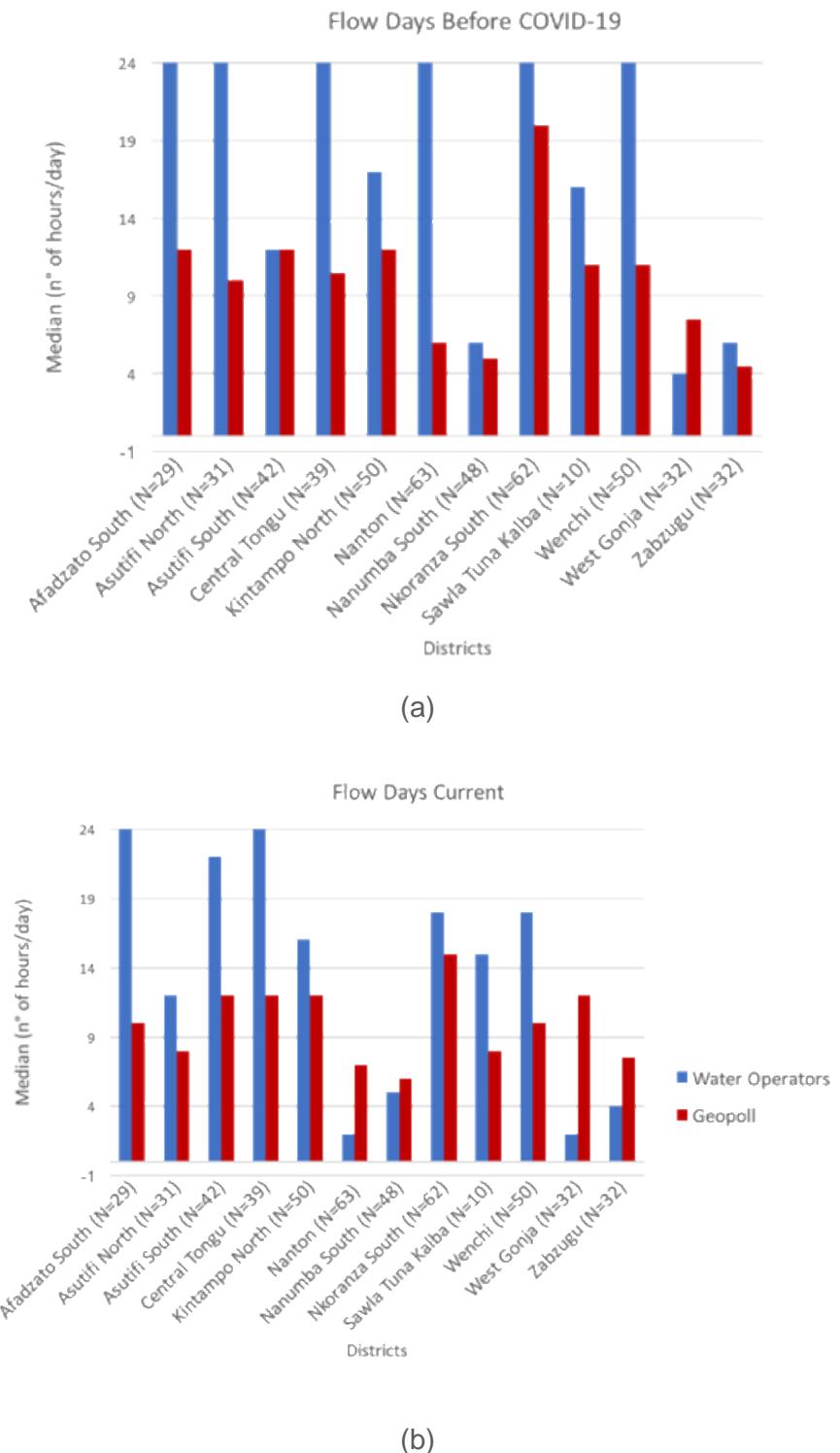
**FIGURE S4.2: LOCATION OF THE WATER SOURCE FOR THE RESPONDENTS THAT ARE USING STANDPIPE OR TAP WATER**



**FIGURE S4.3: CHANGE IN WATER ACCESS.** Respondents were asked if accessing water during COVID-19 was easier, more difficult or the same as before COVID-19



**FIGURE S4.4: WATER AVAILABILITY COMPARISON.** Comparing reported water availability (hours/day) of operator interviews and GeoPoll SMS survey, for (a) before COVID-19 and (b) currently.



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