Data Use Impact Desktop Study

This desktop study was completed by Global Water Challenge for Akvo in support of the Data to Decisions program. Global Water Challenge is home to the Water Point Data Exchange (WPDx), an online platform for rural water point data sharing, access, and analysis. WPDx hosts an online data repository and playground featuring almost 600,000 water point records from over 80 contributors, and four decision-support tools in development, including: Measure Water Access by District, Prioritize Locations for Rehabilitation, Prioritize Locations for New Construction, and Predict Water Point Status.

Objective

A common hypothesis is that using evidence to inform decisions regarding placement and repair of water points will lead to more impactful investments compared with traditional methods which rely heavily on political pressures and assumptions. The objective of this desktop study is to determine how many additional people could have theoretically received water services (defined as access to a functional water point within a 1km radius) if decisions about water point investments used evidence-based decision-support tools rather than traditional approaches in Sierra Leone.

Approach

A full description of the desktop study methodology can be found in Appendix A. This specific study focused on analyzing the number of people reached with water point investments made during 2012 in 12 districts in Sierra Leone in comparison with the number who might have been reached if the investment decisions had been driven by evidence. This dataset was selected as it included the most complete national inventory data available, though it is acknowledged as an imperfect dataset by the Ministry of Water Resources due to issues with field data collection ad duplication.

Twelve districts were included in the analysis: Bombali, Bo, Bonthe, Kailahun, Kambia, Kenema, Koinadugu, Kono, Moyamba, Port Loko, Pujehun, and Tonkolili. Remaining districts were not included due to lack of data availability.

Data from water point investments made prior to 2012 were downloaded from the Water Point Data Exchange (WPDx) database to provide a baseline of the data which could have been used to inform decisions made in 2012. Data from investments made in 2012 were also downloaded for the

12 districts from the WPDx database. The majority of data was provided by the Ministry of Water Resources, with lesser contributions from non-governmental organizations (NGOs) working in Sierra Leone. A total of 39,111 records were available regarding water points installed prior to 2012 and 2,071 records were available for water points installed in 2012. During the analysis, any existing duplicate points were identified and deleted to avoid double counting.

Using the evaluation and repair priority methods, the number of people reached by water point installations and rehabilitations from twelve districts in Sierra Leone were analyzed and compared with the number of people which could have been reached based on recommendations from the WPDx decision-support tools. The 2012 Sierra Leone dataset did not clearly differentiate between rehabilitations and new constructions. For this analysis, all 2012 water investments were assumed to be rehabilitations and only the Priority Location for Rehabilitations tool was utilized. In general, rehabilitations are much more cost-efficient compared to new constructions, therefore this analysis provides a conservative estimate of cost savings. Cost estimations were determined using an average cost of $1,000 per rehabilitation. For all investments, the number of people reached by each point was capped at a maximum of 500 people (per Sphere guidance).

Results

Across all study districts, there were a total of 1,561 water investments made in 2012 compared to 430 recommended rehabilitations based on the WPDx analysis. The substantially lesser number of recommendations still would have reached substantially greater unserved populations compared with the 2012 investments (109,043 people reached from the WPDx recommendations versus 28,556 reached from the 2012 investments). The reason for this disparity is evident in the clear trend observed in all districts was that the majority of water points installed or rehabilitated in 2012 were located in areas where the surrounding populations were already served by other functional water points (see Figure 1). While these investments may have improved service quality, they did not reach the targeted unserved population. After removing all 2012 points located in areas where nearby populations were already served but other functional points, only 8% of water points installed or rehabilitated in 2012 on the national scale were found to reach unserved populations (individual districts ranged from 2% to 19%, average 9%). See Table 1 for more details.

In all districts, the use of WPDx analysis to inform rehabilitation locations would have resulted in a substantially greater number of unserved populations being served. Overall, WPDx analysis would have conservatively resulted in a 141% increase (individual districts ranged from 19% to 1208%, average 353%). Note that these percentage increases are discounted by 50% per the desktop methodology. See Table 1 for details.

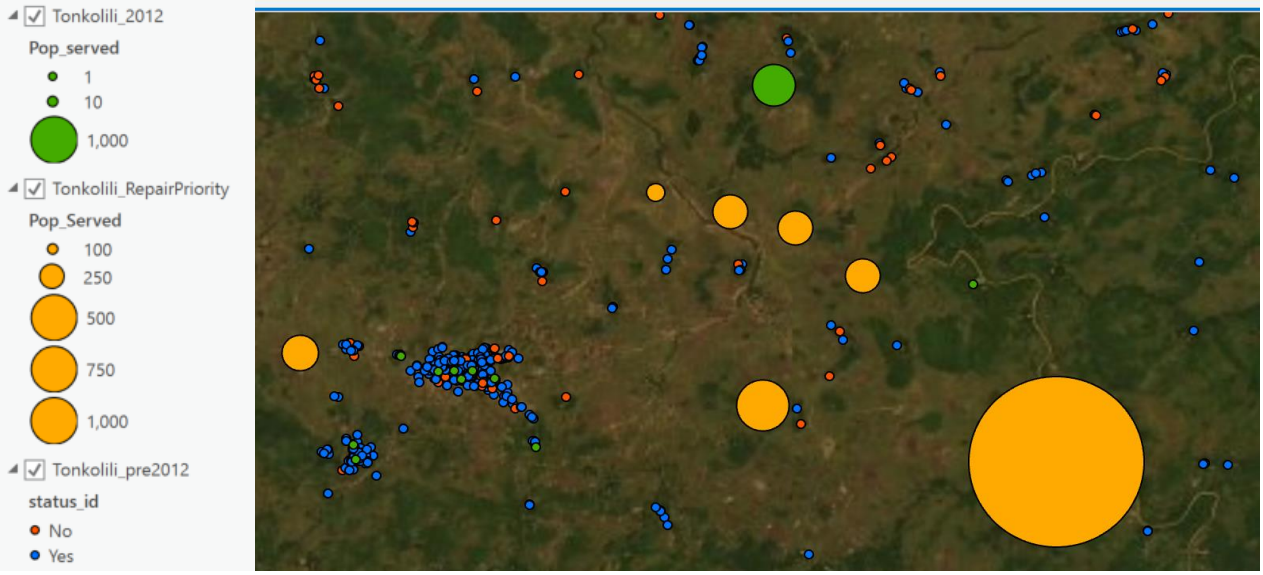


Figure 1. Map image from Tonkolili showing investments and recommendations. In the image, only one of the investments made in 2012 (in green) reached an unserved population (120 people). Conversely, recommended locations for rehabilitation (in orange) would have reached 3,765 according to the analysis.

Table 1. Comparison of populations reached by 2012 investments and WPDx recommended rehabilitations.

	Using actual 2012 water point investments				Using WPDx decision-support analysis		
	Total number of water investments	Number of water investments which reached unserved population	Percent of investments which reach unserved population	Population reached*	Number of Rehabs	Repair priority pop.*	Potential efficiency gains**
Bo	284	5	2%	1372	34	9040	279%
Bombali	96	10	10%	1747	40	8163	184%
Bonthe	93	17	18%	3800	24	6013	29%
Kailahun	96	3	3%	423	22	6719	744%
Kambia	97	5	5%	1552	48	14958	432%
Kenema	308	18	6%	3578	31	6891	46%
Koinadugu	113	10	9%	2642	32	6609	75%
Kono	68	3	4%	224	26	5638	1208%
Moyamba	43	4	9%	1223	46	12283	452%
Port Loko	177	34	19%	5567	42	7771	20%
Pujehun	92	17	18%	5328	25	7336	19%
Tonkolili	94	3	3%	1100	60	17622	751%
Average	130	11	9%	2,380	36	9,087	353%
Total	**1,561**	**129**	**8%**	**28,556**	**430**	**109,043**	**141%**

*Population reached is capped at 500 people per water point.
** To be conservative, the raw percentage increase was decreased by 50%.

Additionally, utilizing the recommended rehabilitations would have resulted in a substantial reduction in both cost-per-person and overall capital costs. On a national basis (total of all study districts), the cost per-person for the 2012 investments was determined to be $54.66 (individual districts ranged from $17.27 per-person to $303.57 per-person, average of $98.16 per-person) compared a national-scale cost of $3.94 per-person (individual districts ranged from $3.21 per-person to $5.40 per-person, average of $3.94 per-person) for the resulting recommended rehabilitations. These figures represent an almost 14-fold cost savings per person, or a reduction of 93% nationally (individual districts range from 81% to 98%, average of 96%). See Table 2 for more details.

Total estimated cost (for all districts) for the 2012 investments was determined to be $1.561M (individual districts ranged from $43,000 to $308,000, average of $130,083) compared to $430,000 (individual districts ranges from $22,000 to $60,000, average of $35,883) for the slate of recommended rehabilitations. These figures represent potential cost savings of 72% (individual districts ranged from -7% to 90%, average of 72%%).[1] The overall costs would likely be substantially higher if new construction costs were considered, assuming an average cost of $10,000 for the installation of a handpump-equipped borehole. See Table 2 for more details.

Table 2. Comparison of costs for 2012 investments and WPDx recommended rehabilitations.

District Name	Using actual 2012 water point investments		Using WPDx decision-support analysis	
	Estimated cost of repair (USD)	Estimated cost per person (USD/pp)	Estimated cost of repair (USD)	Estimated cost per person (USD/pp)
Bo	$284,000	$207.00	$34,000	$3.76
Bombali	$96,000	$54.95	$40,000	$4.90
Bonthe	$93,000	$24.47	$24,000	$3.99
Kailahun	$96,000	$226.95	$22,000	$3.27
Kambia	$97,000	$62.50	$48,000	$3.21
Kenema	$308,000	$86.08	$31,000	$4.50
Koinadugu	$113,000	$42.77	$32,000	$4.84
Kono	$68,000	$303.57	$26,000	$4.61
Moyamba	$43,000	$35.16	$46,000	$3.75
Port Loko	$177,000	$31.79	$42,000	$5.40
Pujehun	$92,000	$17.27	$25,000	$3.41
Tonkolili	$94,000	$85.45	$60,000	$3.40
Average	$130,083	$98.16	$35,833	$4.09
Total	**$1,561,000**	**$54.66**	**$430,000**	**$3.94**

Discussion

The results from this desktop study indicate that data-driven analyses would have resulted both in a greater number of unserved people reached and more cost-efficient investments. Due to some questions regarding the 2012 Sierra Leone inventory data quality, exact figures should be used with

[1] For Moyamba, the recommended number of rehabilitations exceeded the total number of investments made, resulting the -7% figure. Excluding Moyamba, the smallest percent cost savings was 57% for Tonkolili.

caution, but it is clear that using evidence-based decisions would result in order of magnitude efficiencies for both populations reached and cost savings.

There are three key findings from the analysis. First, the study clearly demonstrates that the 2012 water point investment locations were not selected based on need. More densely populated areas were routinely prioritized, even when there were often multiple other working points in the nearby vicinity, while more remote populations remained without service (see Figure 1). There are a range of explanations for this discrepancy, but one logical conclusion would be that people living in more densely populated areas have better access to lobbying and influence over these decisions compared to people living in more remote regions. If the goal of the Ministry and/or district is to reach people who are currently unserved, the proposed data-driven approach provides an objective perspective regarding where to focus water investments in a more equitable way.

The second finding is that data-driven analyses would result in substantial cost savings both on per-person and overall budget scales. These cost savings arise because the recommended repairs focus on reaching the unserved, while the vast majority of 2012 investments were placed where the populations were served by other existing functional water points (so the population served by many of the new points was zero). There are substantially fewer water points rehabilitations recommended by the WPDx analysis, and yet still more people served. The potential cost savings associated with the improved decisions could free up additional funds for further rehabilitation and new constructions, as well as increased preventative maintenance and monitoring efforts.

The third finding is that there is likely a long way to go before the majority of water investment decisions are made with data-driven decisions. While this realization can be discouraging, it is important to recognize that even a small shift towards the inclusion of evidence-based recommendations from this type of analysis is an important step.

In terms of future work, one key area is to gain a better understanding of service levels within the more densely populated areas, especially those which may be served by piped systems not captured in the WPDx database. While one of the goals of Prioritization for Rehabilitation analysis is to prevent focus on areas which are already served, it is important to ensure that the higher population areas are served with an adequate number of points to avoid overtaxing existing points. Another key area for improvement for the analysis would be to gather more information on

rehabilitations versus new construction for a more accurate cost comparison. For this study, by assuming all points were rehabilitated, it is likely that we have underestimated the true cost differential between the actual and theoretical expenditures.

Suggested next steps in terms of recommendations for integrating this type of analysis into the decision processes of Sierra Leone include:

- Coordination between Ministry of Water Resources, district mapping officers and engineers, and NGOs to ensure the WPDx database is up to date ahead of national and district-level planning efforts.
- Completion of Priority Location for Rehabilitation analysis and review ahead of national and district-level budgeting and work-planning efforts.
- Discussion of results with district mapping officers and engineers to confirm results, discuss discrepancies, and make adjustments as needed. With additional inputs, it may be possible to tailor the tools based on new information (i.e., the existence of piped systems).
- Utilization of results to inform budget and workplan decisions.
- Conduct ex post evaluation using desktop methodologies combined with field studies to verify the potential positive impact for districts utilizing recommendations.

Appendix A. Desktop Study Methodology

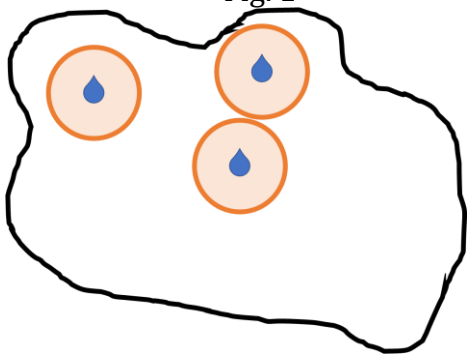
The objective of the desktop study methodology is to determine how many additional people could have received water access (defined as access to a functional water point within 1km) if decisions about water point investments used evidence-based decision support tools rather than traditional approaches. This methodology relies on three key assumptions:

1. All water points in the target area have been captured in the dataset.
2. High resolution population estimates are accurate.
3. Between the time that decisions about water points were made and the time survey data was collected, functionality did not change significantly.

With these assumptions in mind, the following methodology will be used for assessment.

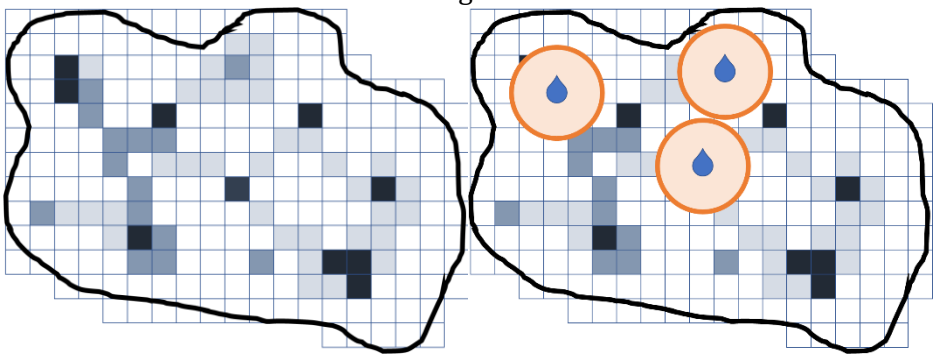
1. All the water points installed in the last calendar year of the data will be removed from the data to get a picture of the water service landscape at the end of the year before the water point survey.
2. All water points that are not an improved source will be removed.
3. All functional water points in a given district will be mapped. If a national estimate of the impact of data is needed, the same process will be repeated for each district. A buffer with a diameter of 1km will be drawn around each water point. In cases where national standards exist on the acceptable distance to water points, this will be rounded to the nearest 100M and used instead of 1km.

Fig. 1



4. The functional water point buffer areas will be layered over high-resolution population data from ESRI's Living Atlas[2].

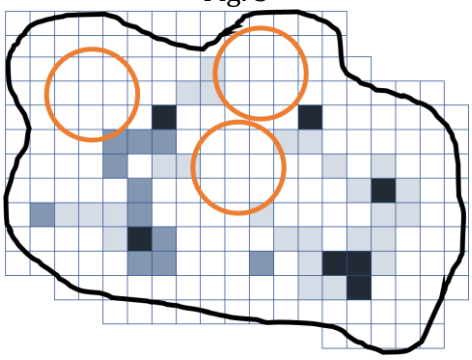
Fig. 2



[2] https://www.arcgis.com/home/item.html?id=0f83177f15d640ed911bdcf6614810a5

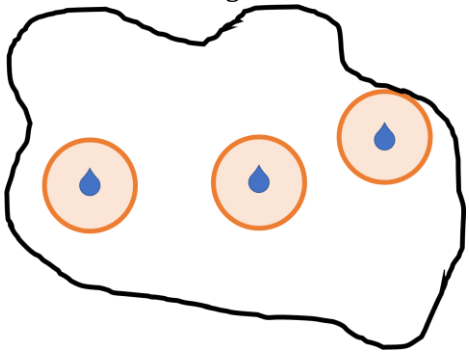
5. The areas around functional water points will be subtracted from the population density layer. The remaining population density layer will now represent the population not yet served with water access.

Fig. 3



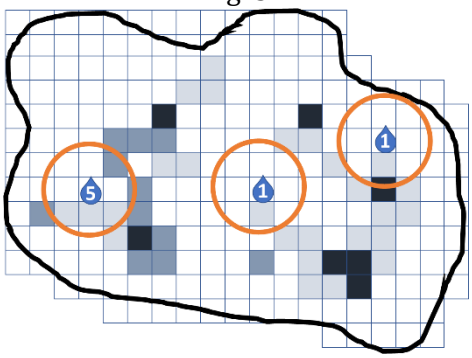
6. All the water points that were installed or rehabilitated in the past year will be evaluated to represent the control scenario of existing decision-making processes. Each water point will be mapped and a buffer with a diameter of 1km will be added. This buffered area will be the areas that received service from new/rehabilitated water points.

Fig. 4



7. The buffer area for new water points will be laid over the population that is not yet served. For each point, the number of people that are not yet served within the buffer area will be counted. This will capture the additional people reached as a result of new or rehabilitated water services. The total impact and average impact will be calculated.

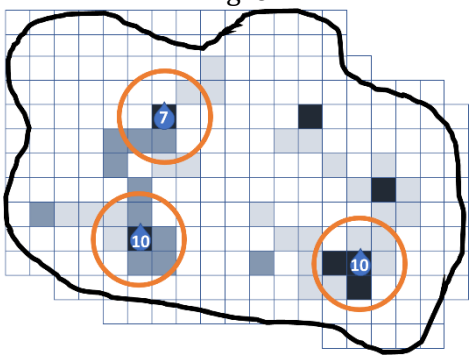
Fig. 5



8. The WPDx repair priority and decision support tools will be used to identify high impact locations for new and rehabilitated water points. If data is available to identify the ratio of new construction vs. rehabilitation, the same ratio will be applied to the WPDx decision support tools. If that data is not available, a 50% split will be estimated, with 50% of the

total number of water points coming from the repair priority tool and 50% coming from the new construction repair priority tool. [Note: for the Sierra Leone analysis, all investments were assumed to be rehabilitations.] Once located, the total new population with access will be counted. In cases where the number of people exceeds local standards, the maximum allowable number of people will be counted. [Note: for the Sierra Leone analysis, raw populations reached according to the analysis were used and not discounted.]

Fig. 6



9. The total numbers of people reached in the control scenario (i.e. without WPDx decision support tools) and data-use scenario (i.e. with WPDx decision support tools) will be compared. The difference between these figures represents the marginal increase in people that could have been reached if WPDx data was used in each district.
10. Recognizing that not all districts will use evidence in their decision-making processes, and that other factors such as political considerations will need to be considered, the maximum possible efficiency of WPDx should be discounted. This will conservatively be discounted by 50%

Appendix B. Full table of results

District Name	Using actual 2012 water point investments						Using WPDx decision-support analysis				Comparison		
	Total number water investments	Number of water investments which reached unserved population	Percent of investments which reach unserved population	Pop. reached*	Est. cost of repair (USD)	Est. cost per person (USD)	Number of Rehabs	Repair priority pop. reached*	Est. cost of repair (USD)	Est. cost per person (USD)	Difference in number of people reached (WPDx - 2012 investments)	Number of People Who Could Have Been Reached (Percentage Increase)	Discounted Percentage Increase (50%)
Bo	284	5	2%	1372	$284,000	$207.00	34	9040	$34,000	$3.76	7,668	559%	279%
Bombali	96	10	10%	1747	$96,000	$54.95	40	8163	$40,000	$4.90	6,416	367%	184%
Bonthe	93	17	18%	3800	$93,000	$24.47	24	6013	$24,000	$3.99	2,213	58%	29%
Kailahun	96	3	3%	423	$96,000	$226.95	22	6719	$22,000	$3.27	6,296	1488%	744%
Kambia	97	5	5%	1552	$97,000	$62.50	48	14958	$48,000	$3.21	13,406	864%	432%
Kenema	308	18	6%	3578	$308,000	$86.08	31	6891	$31,000	$4.50	3,313	93%	46%
Koinadugu	113	10	9%	2642	$113,000	$42.77	32	6609	$32,000	$4.84	3,967	150%	75%
Kono	68	3	4%	224	$68,000	$303.57	26	5638	$26,000	$4.61	5,414	2417%	1208%
Moyamba	43	4	9%	1223	$43,000	$35.16	46	12283	$46,000	$3.75	11,060	904%	452%
Port Loko	177	34	19%	5567	$177,000	$31.79	42	7771	$42,000	$5.40	2,204	40%	20%
Pujehun	92	17	18%	5328	$92,000	$17.27	25	7336	$25,000	$3.41	2,008	38%	19%
Tonkolili	94	3	3%	1100	$94,000	$85.45	60	17622	$60,000	$3.40	16,522	1502%	751%
Average	130	11	9%	2,380	$130,083	$98.16	36	9,087	$35,833	$4.09	6,707	707%	353%
Total	**1,561**	**129**	**8%**	**28,556**	**$1,561,000**	**$54.66**	**430**	**109,043**	**$430,000**	**$3.94**	80,487	282%	**141%**