IRC

THE HAGUE, THE NETHERLANDS | 12 – 14 MARCH 2019

All systems go!

Strengthening water quality monitoring systems in Asutifi North, Ghana

Paper for the WASH systems symposium

A. Karon, C. Delaire, C. Mcleod, R. Peletz, R. Khush (Ghana)

50 years of IRC.
WASH systems that transform lives.

This paper was drafted by A. Karon, C. Delaire, C. Mcleod, R. Peletz, R. Khush for the All systems go! WASH systems symposium, The Hague, The Netherlands, 12-14 March 2019.

Cite this publication as follows. Karon, A., Delaire C., Mcleod, C., Peletz, R., Khush, R. 2019. Strengthening water quality monitoring systems in Asutifi North, Ghana.

For all proceedings of the All systems go! WASH systems symposium, please check https://www.ircwash.org/proceedings

In Asutifi North, a mostly rural (68%) district in central Ghana with a population of ~65,000, the Aquaya Institute is working within existing water service provision structures to enhance the use of water quality testing for the assurance of publicly provided safe drinking water. To learn how to effectively strengthen safe water service provision in Asutifi North, Aquaya has employed a systematic, research-driven strategy that can be instructive for water stakeholders in other low resource contexts. Aquaya's approach includes several steps (Figure 1): 1) institutional mapping, 2) embedding a researcher, 3) field data collection, 4) economic and feasibility assessment, 5) shortlisting intervention, 6) select and test intervention(s) with local stakeholders, 7) propose water quality testing structures to district stakeholders, 8) build a water quality monitoring system, and 9) evaluate efficacy, improve and sustain. Aquaya presents how this process was employed and led to the selection of a system strengthening approach to improve one aspect of water service provision and how it addresses key sustainability constraints that other water quality monitoring interventions commonly overlook.

Introduction

Although access to basic water services has expanded globally, many water systems continue to struggle with sustainability and reliability, let alone safe management. Recent studies have given us insight into the factors that are commonly associated with successful management of water systems in low resource settings (e.g. adequate demand for service, efficient use of resources, community engagement, etc.) (Marks et al. 2018, World Bank 2017). We have learned that the determinants of safely managed drinking water service provision in these areas are both variable and complex.

Water quality monitoring is essential to ensure and manage water safety. However in Africa water quality testing activities are insufficient to meet regulatory requirements, especially for small water systems and in rural areas (Peletz et al., 2016). Programmes for strengthening water quality monitoring typically focus on hardware (laboratory space and equipment) and personnel training, but fail to address other factors critical for sustaining monitoring activities: support for operating expenses, enforcement of regulations and effective use of data. Recent research suggests that water quality testing interventions that intensively focus on increasing staff knowledge, motivation and leadership would be more impactful and sustainable (Peletz et al. 2018). The Aquaya Institute has spent years researching the determinants of effective and operationalised water quality monitoring systems. Now, in the district of Asutifi North in Ghana, Aquaya is working with local government, water system managers and existing laboratories to apply this research toward developing a system for water quality monitoring that complies with national regulations while addressing the key barriers to sustainability. This paper presents the approach that Aquaya has developed to identify, design and test interventions to achieve this goal.

Setting

Asutifi North is a mostly (68%) rural district located in the Brong Ahafo region in central Ghana. The district ranks 56 out of 216 according to UNICEF's development indicators (UNICEF 2017). The economy is primarily driven by agriculture, but the district also houses a gold mine operated by a multi-national corporation. Serving an estimated population of 65,000, the water infrastructure in Asutifi North includes four public small piped water systems and a mix of public and private point sources (mechanised boreholes and hand pumps) (Asutifi North District 2018). Management capacity is very low in almost all cases and an estimated 40% of water systems will break down in a year (Asutifi North District 2018). Water quality testing is minimal or non-existent, falling short of the minimum regulatory testing frequencies (for piped systems: one test per month per 5,000 people; for point sources: two times per year) (CWSA 2011, GSA 2013). Beginning in 2017, the district began a partnership with multiple implementing partners, including Aquaya, to develop a long-term vision and master plan for achieving Sustainable Development Goal 6 (Asutifi North District 2018, WHO/UNICEF 2017).

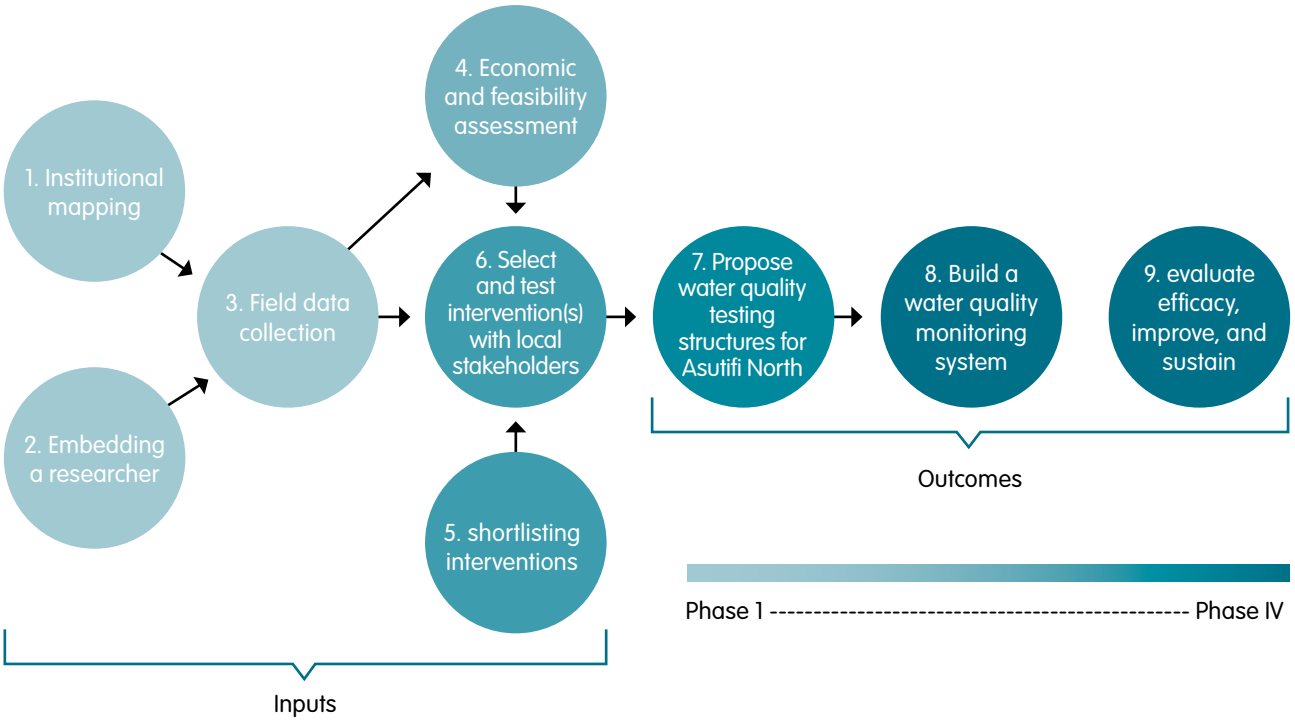
Approach

The approach that Aquaya has developed to strengthen water quality monitoring - and more broadly water safety management - in Asutifi North is systematic, participatory and research driven. It comprises nine steps, going from a multidimensional (institutional, capacity, economic) diagnostic to the design and testing of interventions (Figure 1).

Step 1: Institutional mapping

We first conducted a desk review on the Ghana WASH sector (12 legislative acts and regulations, 17 national policies, strategies and plans, 3 government manuals,

Figure 1. Aquaya process diagram



9 national guidelines and frameworks, 8 government reports, 24 external sector reviews, and 1 other publication) to understand the institutional framework governing water service provision and map the key responsibilities at the national and district levels. We then validated our institutional map (Figure 2) through in-person interviews with sector stakeholders at the national, regional and district level.

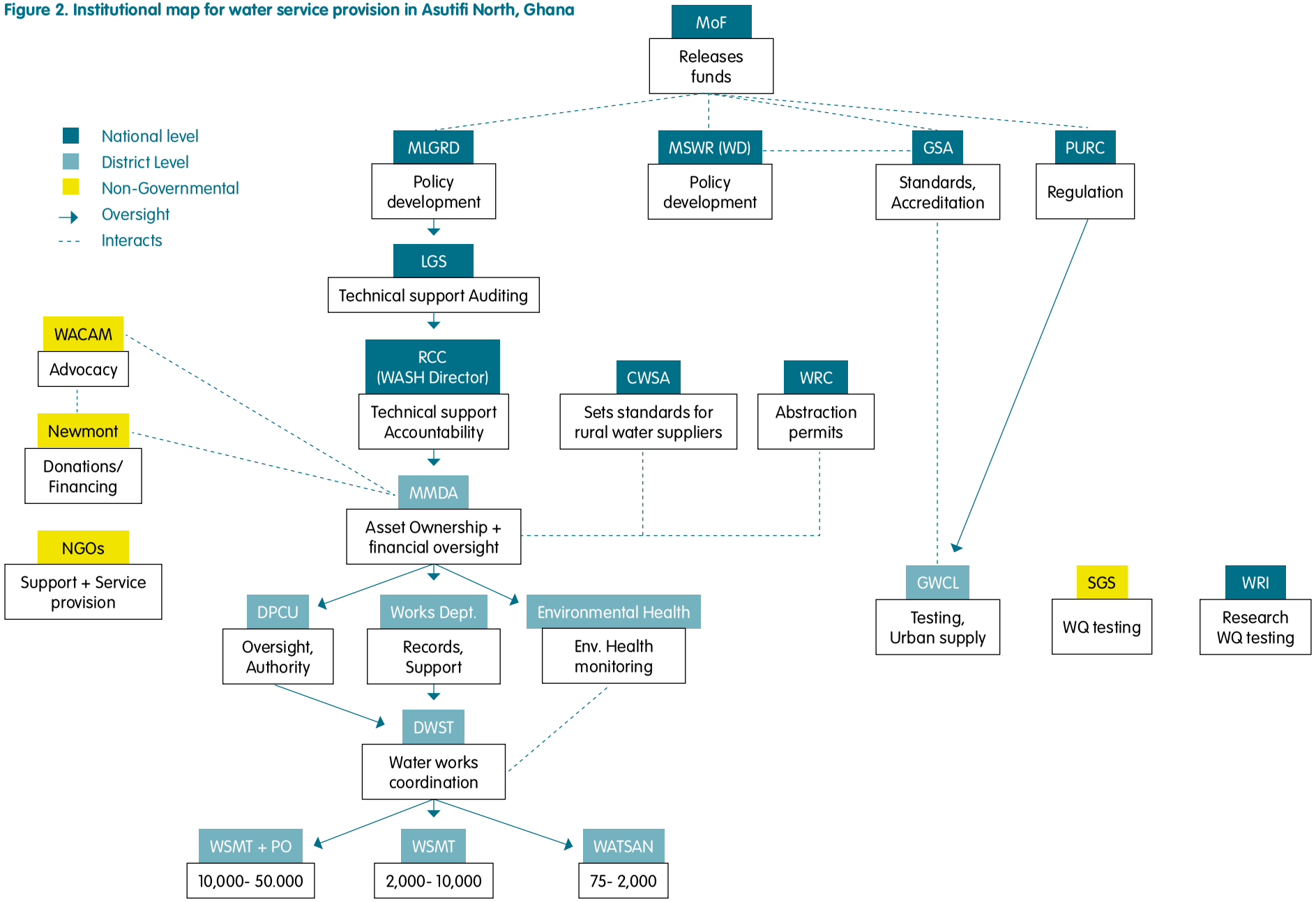
We identified that district assemblies receive minimal direct support and oversight from the national level for water service provision, despite the existence of the Ministry of Sanitation and Water Resources (MSWR) that houses several technocratic agencies with regional presences. Previously the Community Water and Sanitation Agency (CWSA) was in theory responsible for providing technical assistance and regulating compliance of water systems (e.g. ensuring adequate management and safe water provision) at the district level, it has recently undergone structural changes that limit its ability to perform these roles. As a result, many district assemblies (DA), which hold the legal mandate to meet national standards in terms of safe drinking water provision, currently operate largely in silos. Furthermore, no agency has a clear mandate to perform water quality surveillance at the district level and so far there is no organisation planning to fill CWSA's former role.

Step 2: Embedding a researcher

We deployed a staff member to work in the district capital full time and build strong relationships with local stakeholders several months prior to the commencement of field work. During the initial three months, the Aquaya staff member worked from the district planning office, which allowed Aquaya to receive regular feedback from local government on the research process while also providing support to the DA's relevant day-to-day activities when needed. Under this mutualistic arrangement, the DA provided a staff member to assist with community identification and entry during data collection, while the Aquaya staff member, upon request, reviewed and provided feedback on official DA reporting to the national level.

Embedding a researcher allowed us to gain a deep understanding of DA functions and procedural rules beyond what was available in written documentation. For example, we now understand the complicated and inefficient chain of communication for authorising funds to repair broken water systems, which sometimes results in repair times longer than six months. Importantly, this working arrangement also helped develop trust between the research team and senior leadership at the DA, which creates a favourable environment for implementing and testing interventions in the future.

Figure 2. Institutional map for water service provision in Asutifi North, Ghana



Step 3. Field data collection

To assess the current state of water service provision in Asutifi North (specific research questions are listed in Table 1), we conducted the following data collection activities: seven focus group discussions with residents, 13 in depth interviews with water system managers, 59 surveys with water point caretakers, analysis of 77 water samples, and the collection of 10 water system's financial records. Water samples were analysed for E. coli in accordance with US EPA method 1604 (USEPA 2002). We also conducted semi-structured interviews with lab managers at five different environmental laboratories across Ghana to determine their overall capacity and the feasibility for them to conduct water quality testing in Asutifi North.

Table 1. Research questions that guided field data collection

Research questions
1. What are the economics of water service provision in Asutifi North?
2. What is the capacity and motivation of water system managers with respect to service provision and water safety?
3. What are the perceptions and expectations of district residents with respect to water quality?
4. What is the microbial and chemical quality of water sources?
5. What role(s) does the mining company play in water service provision?

The key findings of our field data collection are as follows:

1. Despite poor revenue collection, piped water systems can afford water quality testing with user-generated revenue but lack a motivating force to do it and often have difficulty authorising funds.
2. Most point sources do not have regular revenue collection and were unable to pay for their most recent breakdown (76%) even when they reported collecting money from community members after breakdowns (Figure 3).
3. The district assembly does not have the resources to bear the full costs of water quality monitoring for all the water systems.
4. Employee/member compensation is very low at all water sources.
5. Water management teams have received little to no training on water quality and are unfamiliar with water quality indicators.
6. Residents generally perceive water quality to be good (with the exception of communities served by water systems built by the mining company).
7. Residents recognise the authority of the district assembly in enforcing payment of water tariffs.
8. We found indicators of fecal contamination in over 45% of water samples, underscoring the need for regular disinfection and water quality monitoring (Figure 4).
9. The mining company regularly tests and treats point sources in the communities where it operates but the results are not shared with users or with the district assembly.

In summary, the system supporting water service provision is hampered by inefficiencies, low capacity, and inadequate funding, which leads to low consumer satisfaction with services. Furthermore, prevalent microbial water contamination was previously unknown and unaddressed. Nonetheless, consumers, water managers, and DA officials are supportive of water safety improvement measures. In communicating our findings to the DA we created strong buy-in around the need for sensible water quality monitoring and increased revenue generation at water systems. We find that the overall context in Asutifi North is favourable to the creation of a water quality monitoring system focused on water systems with the highest revenue potential.

Figure 3. Payment structures for community point sources

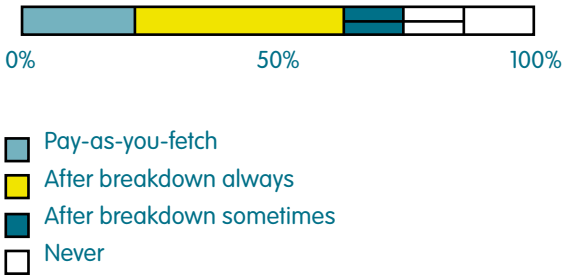
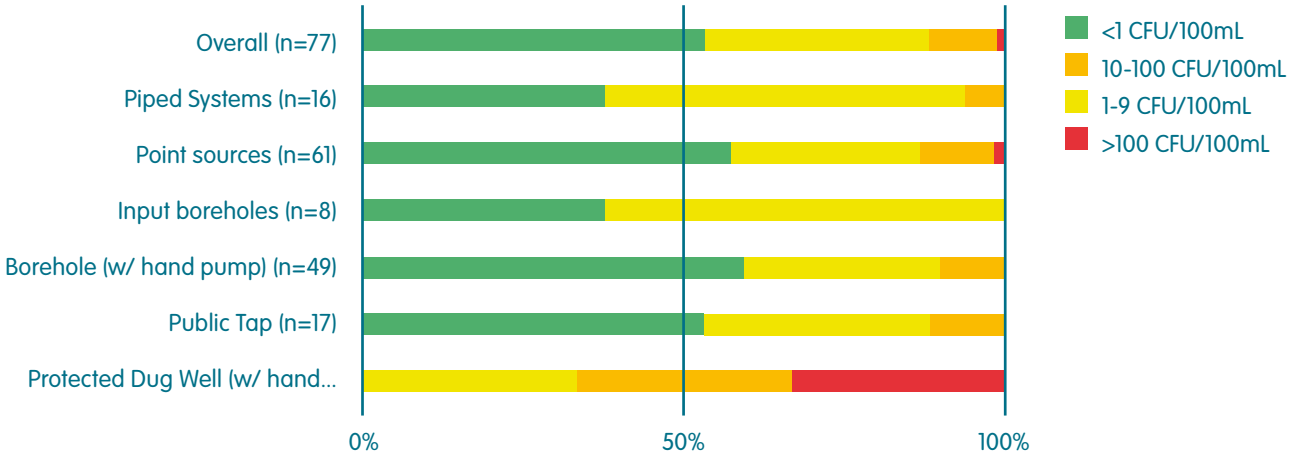


Figure 4. Distribution of E. coli concentration among water systems randomly sampled by Aquaya in Asutifi North district



Step 4: Economic and feasibility assessment

To identify the most appropriate approach to water quality monitoring in Asutifi North, we compared the costs, feasibility and sustainability potential of several testing regimes. As shown in Table 2, a testing regime is defined by the entity which is collecting the samples (water system manager, district assembly, or Ghana Water Company Limited (GWCL) laboratory) and the entity analysing the samples (same options). For each testing regime, we estimated the costs of laboratory equipment, consumables, labour and transport, were consistent with the methodology in Delaire et al., 2017. Among the 175 water systems in the district, our analysis only included the 40 systems located in population centres of 1000+, which we assumed have the largest revenue base and therefore the highest potential to bear monitoring expenses. The results of our cost analysis are presented in Table 2.

We found that centralised sampling and testing by GWCL's laboratory (Option 4 in Table 2) is the most cost-effective regime for water quality monitoring in Asutifi North. Additionally, when considering other factors, we determined that this regime is preferable with respect to existing capacities, quality assurance, sustainability, logistical complexity, political barriers, data management and impact on water safety (Table 2). We also identified the next best regimes for water quality testing in the event that the primary choice would not be possible (Options 5 and 6 in Table 2).

Our analysis also shows that water quality testing at the frequency required by national standards would cost a substantial portion of current water system revenue therefore emphasising the need to improve revenue collection. For example, the annual cost of testing for point sources at Ghana Standards Authority (GSA) frequencies (cost: ~$80 per system/year), would surpass 1/5th of the total annual revenue for 83% of point sources for which revenue records were available. Additionally, while the piped systems operate at enough of an annual surplus to afford monthly testing as per GSA guidelines, in their lowest performing months, the net revenue is lower than the cost of testing would be.

We shared the results of this analysis with the DA's senior leadership to solicit their feedback. To date, the DA leadership has verbally approved our proposed testing regime.

Step 5. Shortlisting interventions

Through Aquaya team brainstorming, we created a general list of 27 intervention ideas aimed at mitigating financial and motivational barriers to water quality monitoring. After assessing the feasibility of these ideas in the specific context of Asutifi North, we eliminated 13 of them. We then established a set of criteria to score the remaining intervention ideas, using our findings from the earlier steps (Table 2). We retained the six intervention ideas that received the highest scores in the final shortlist of resource-oriented interventions and testing-oriented interventions (Table 3).

FIGURE 5. PROCESS DIAGRAM FOR INTERVENTION IDEA SELECTION AND DEVELOPMENT

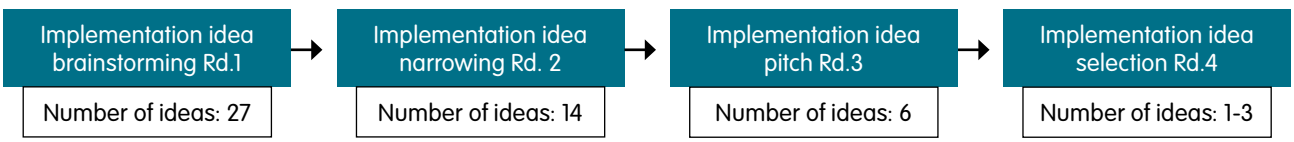


Table 2. Rating of water quality testing structures for Asutifi North District

Testing structures					Primary factors				Secondary factors				
Scenarios	**Roles**	**Water managers**	**DA staff**	**Regional lab**	**Ongoing costs**	**Existing capacity**	**Quality Assurance**	**Sustainable**	**Upfront costs**	**Logistical complexity**	**Political barriers**	**Data management**	**Impact on water quality**
1. Decentralised	Sampling	X											
	Testing	X											
2. Semi-centralised	Sampling	Piped	Point sources										
	Testing	Piped	Point sources										
3. Centralised DA	Sampling		X										
	Testing		X										
4. Centralised GWCL	Sampling			X									
	Testing			X									
5. Centralised hybrid	Sampling		X										
	Testing			X									
6. Centralised split GWCL + DA	Sampling		Piped	Point sources									
	Testing		Piped	Point sources									

Table 3. Retained intervention idea shortlist description

Intervention category	Intervention	Description
Resource-oriented interventions	DA certified kiosks	Deploy branded kiosks with DA certification to be used by water system vendors at points of sale to reduce non-payment by users.
	Information and Communications Technology (ICT) facilitated payment and marketing	Develop a mobile based platform to accept water bill payments and share information about the water system with users (e.g. test results, repairs, finances).
	Fund matching	Begin a programme that matches a certain percentage of user-generated water system revenue.
Water quality testing interventions	Auto-enrolment in testing	Create an agreement between the DA and a laboratory that automatically enrols water systems to have periodic water quality testing done.
	Electronic reminders for testing	Develop a platform that sends out SMS messages to water system managers, reminding them to order a water quality test throughout the year.
	Benchmarking with rewards/ sanctions	Develop a set of benchmark indicators to measure water system performance and provide rewards to high scoring systems or sanctions to low performing systems

Step 6: Select and test intervention(s) with local stakeholders

We are currently developing a detailed proposal to implement the shortlisted interventions. We will refine this proposal through consultations with the district assembly and other stakeholders, such as water and sanitation management teams (WSMTs), community representatives at the district general assembly, and other implementing partners in the district.

During the intervention(s), Aquaya will monitor revenue generation over time and solicit feedback from the management teams about how their jobs have been impacted by the programme(s). We expect to evaluate the efficacy of the intervention(s) after six months.

Steps 7-9: Establish a robust water quality monitoring programme

We will launch the water quality monitoring programme within Asutifi North. Following evaluation of our intervention after six months, we will tailor our intervention in the district as necessary and scale it where appropriate. We will continue to monitor key performance indicators (e.g. revenue collected, number of water systems tested, follow-up action taken as a result of positive tests) over the course of two years.

Impact to date

Aquaya's approach appears to have increased the district assembly's interest in water quality. Multiple district stakeholders have requested meetings to discuss steps forward for addressing water quality issues and future testing. One of the piped system WSMTs ordered its first water quality test in over a year. We have also fostered strong, positive relationships between Aquaya and the DA and between Aquaya and the water system managers. These relationships will prove critical as Aquaya seeks to build support for an intervention that requires financial commitments in a resource-limited environment. It will also provide a platform for Aquaya to work with water system managers to begin applying water quality information toward the provision of safe water.

Challenges and limitations

While we have been encouraged by the early results and engagement of the district assembly, our approach has limitations. Applying implementation research to systems strengthening programmes is both resource and time intensive. In depth engagement with local stakeholders also requires navigating the local politics, which can delay or derail consensus building. Additionally, our close affiliation with the DA may have biased the information that we collected from water system managers. Finally, although district stakeholders affirm their commitment to water quality monitoring, we do not yet know if the final system for water quality monitoring and management will continue to be sustained beyond our presence in the district.

Conclusion

By investing resources in understanding key capacities and bottlenecks in Asutifi North, we have identified innovative approaches to strengthening water quality monitoring that build upon existing motivations and competencies while allowing for evaluation and adjustment over time. In contrast to traditional interventions that tend to fail when trained staff leave or supplies run out, our approach seeks to address key sustainability constraints such as revenue generation and reliance on institutions rather than personnel. Our approach to strengthening water quality management systems may prove useful in other system strengthening contexts.

Acknowledgments

The authors would like to extend thanks to the Conrad N. Hilton Foundation, IRCWASH, World Vision, Safe Water Network, Netcentric Campaigns, Centers for Disease Control and Prevention, Asutifi North district assembly, and the University of Energy and Natural Resources.

References

- Asutifi North district assembly, 2018. Water sanitation and hygiene (WASH) masterplan: Asutifi North district, Ghana, Accra, Ghana: IRC Ghana and Asutifi North district assembly.
- Community Water and Sanitation Agency, 2011. Legislative Instrument 2007, Accra, Ghana: CWSA.
- Delaire, C., Peletz, R., et al, 2017. How much will it cost to monitor microbial drinking water quality in sub-Saharan Africa? Environmental Science and Technology, 51(11), 5869-5878.
- Ghana Standards Authority, 2013. Ghana standard GS175-1:2013, 4th Ed., Accra, Ghana: GSA.
- Marks, S.J., Kumpel, E., et al, 2018. Pathways to sustainability: a fuzzy-set qualitative comparative analysis of rural water supply programs, Journal of Cleaner Production 205, 789-798.
- Peletz, R., Kumpel, E., et al, 2016. To what extent is drinking water tested in sub-Saharan Africa? A comparative analysis of regulated water quality

monitoring, International Journal of Environmental Research and Public Health, 13(3), 275.
- Peletz, R., Kisiangani, J., et al, 2018. Why do water quality monitoring programs succeed or fail? A qualitative comparative analysis of regulated testing systems in sub-Saharan Africa. International Journal of Hygiene and Environmental Health, 221(6), 907-920.
- United States Environmental Protection Agency, 2002. Method 1604: total coliforms and Escherichia coli in water by membrane filtration using a simultaneous detection technique, Washington, DC, USA: USEPA.
- WHO/UNICEF, 2017. Progress on drinking water, sanitation, and hygiene: 2017 update and SDG baselines, Geneva, Switzerland: World Health Organization and UNICEF.
- World Bank, 2017. Sustainability assessment of rural water service delivery models: Findings of a multi-country review, Washington, DC, USA: World Bank.

Keywords

Water, testing, monitoring, sustainability, systems, quality.

Contact details

Andrew Karon
Address: P.O. Box 1603, San Anselmo, CA 94979
Tel: +233 551 322 160
Email: ajkaron@aquaya.org
www: www.aquaya.org

Caroline Delaire
Address: P.O. Box 1603, San Anselmo, CA 94979
Tel: +44 734 293 8835
Email: caroline@aquaya.org
www: www.aquaya.org

50 years of IRC.
WASH systems that transform lives.