

RESEARCH BRIEF, SEPTEMBER 2020

FROM DATA TO DECISIONS

WATER QUALITY MONITORING PROGRAMS IN SUB-SAHARAN AFRICA

INTRODUCTION

Most countries maintain regulatory requirements for testing of drinking water supplies to guide treatment procedures and ensure safe water delivery to consumers. It is unclear, however, whether the water quality test results reliably reach senior institutional managers, the regulators that required such testing, or other stakeholders who could act to improve water systems. Because testing water quality is expensive and time-consuming (Crocker & Bartram, 2014; Delaire et al., 2017; Wright et al., 2014), it is important to maximize the cost-effectiveness of testing programs. This study describes and assesses the formal and informal systems used by institutions with regulatory requirements for testing drinking water quality in six sub-Saharan African countries to organize, analyze, and transmit information about drinking water quality.



METHODS

This study engaged monitoring institutions in sub-Saharan Africa that were part of The Aquaya Institute's Monitoring for Safe Water (MfSW) research program (2012-2016), which was designed to build capacity for conducting monitoring of water safety in sub-Saharan Africa (Peletz et al., 2013). Monitoring institutions in this study included: i) piped water suppliers responsible for performing operational monitoring of the quality of their sources, treatment processes, and distribution systems; and ii) surveillance agencies responsible for monitoring all supplies of drinking water from any source type at the point of consumption within their geographical jurisdiction. The Aquaya Institute provided MfSW participating agencies with financial resources to incentivize the compilation and sharing of microbial data. The incentive-based design of the MfSW program likely influenced information flows; as a result, the data represent a 'best case scenario' of water quality data sharing.

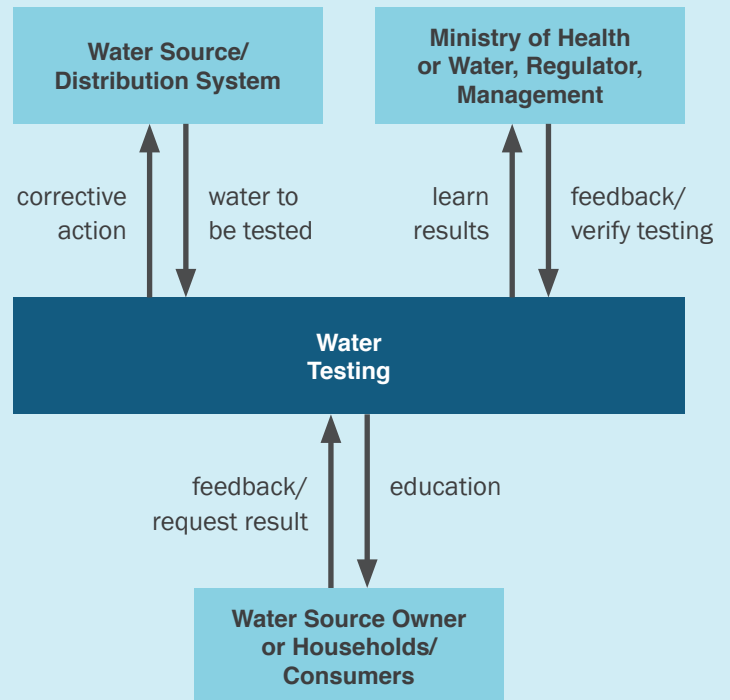
Twenty-six agencies took part in this project across six countries (Ethiopia, Guinea, Kenya, Senegal, Uganda, and Zambia): 11 piped water suppliers and 15 public health surveillance agencies (Fig. 1). From 2012-2016, the MfSW program collected qualitative and quantitative data on microbial water quality monitoring activities among the engaged monitoring institutions. In 2019, we revisited the seven Kenyan institutions to further examine successes and challenges to information flows and data use three years after the completion of the incentive-based study. We additionally interviewed Kenyan county and national stakeholders and regulators.

To analyze the transmission of water quality data, we first defined a data sharing framework and then systematically mapped information flows within MfSW institutions (i.e., water suppliers and surveillance agencies) and national regulatory

**FIGURE 1:
MAP OF THE SIX PARTICIPATING MFSW
COUNTRIES.**



**FIGURE 2:
GENERAL DATA FLOW DIAGRAM FOR
SUPPLIERS AND SURVEILLANCE AGENCIES.**



institutions. Subsequently, we used these data flow diagrams (DFDs) to evaluate trends, connections, and barriers to the flow of information within and between institutions. Finally, we developed recommendations to improve flows of water quality information and better support water safety management at institutional, local government, and national levels.

RESULTS

Our DFDs for the 26 institutions showed that suppliers and surveillance agencies used similar structures for collecting and sharing water quality information (as generalized in Fig. 2). Institutions collected samples, recorded source information in the field, and tested the samples in the field and/or laboratory. Subsequently, they recorded, compiled, and transferred test results to a location where they could be digitized. Finally, they summarized data in reports that were passed to external entities (e.g. senior managers, regulators, ministries or other stakeholders). In parallel, they applied the water test results to guide actions that addressed contamination: for example, communicating with water source owners/consumers, or performing corrective actions to the water source/distribution system.

1) Internal flows. Figure 2 generalizes the internal and external data flow processes. Institutions generally collect a sample, report results to external entities, and communicate with water source owners or customers and perform corrective actions. All institutions reported compliance or summary data to external entities; however, they only reported general water safety information (i.e., the water is safe/unsafe/contaminated) to water source owners or customers.

All monitoring institutions recorded drinking water quality data in paper-based systems in the field and in the lab by lab technicians and assistants (water suppliers) or public health officers (surveillance agencies). Institutions eventually digitized handwritten microbial data¹ into Word or Excel, though this process occurred at different points in the sampling program as determined by computer or internet availability. One agency noted, “We do not have a dedicated computer for our office so we share with other departments. It would be more efficient to have a computer at the laboratory so that data can be digitized immediately” (Kenyan water supplier).

¹ All agencies digitize microbial data which is needed for compliance reporting. A subset of these agencies digitizes all water quality data, while others keep physical and chemical test data in hardcopy.

**TABLE 1:
SUMMARY OF DATA REPORTING TO EXTERNAL ENTITIES, INCLUDING THE NUMBER
OF MONITORING AGENCIES SHARING DATA AND THE TYPES OF DATA SHARED¹.**

¹ '-' indicates that no institutions reported this practice.

Type of Agency	Suppliers (n=11)					Surveillance (n=15)				
	Send	F.b.	TYPE			Send	F.b.	TYPE		
			Compliance	Raw	Other			Compliance	Raw	Other
National Administrative Unit										
Ministries	3	-	1	-	3	12	1	12	2	5
Independent Regulator	6	5	4	-	2	-	-	-	-	-
Boards/National Management	3	1	2	-	1	-	-	-	-	-
Local Government Unit										
Ministries	1	1	-	-	1	9	2	6	3	2
Upper Management ²	9	7	4	4	2	5	4	1	4	-
Medical Management & Health Staff	-	-	-	-	-	6	1	3	1	2
Other Government ³	3	-	1	-	2	-	-	-	-	-
Non-Governmental Stakeholders										
Local Meetings	-	-	-	-	-	9	-	4	1	4
Outside Organizations	1	-	-	-	1	3	-	1	-	2
Public	1	-	1	1	-	-	-	-	-	-

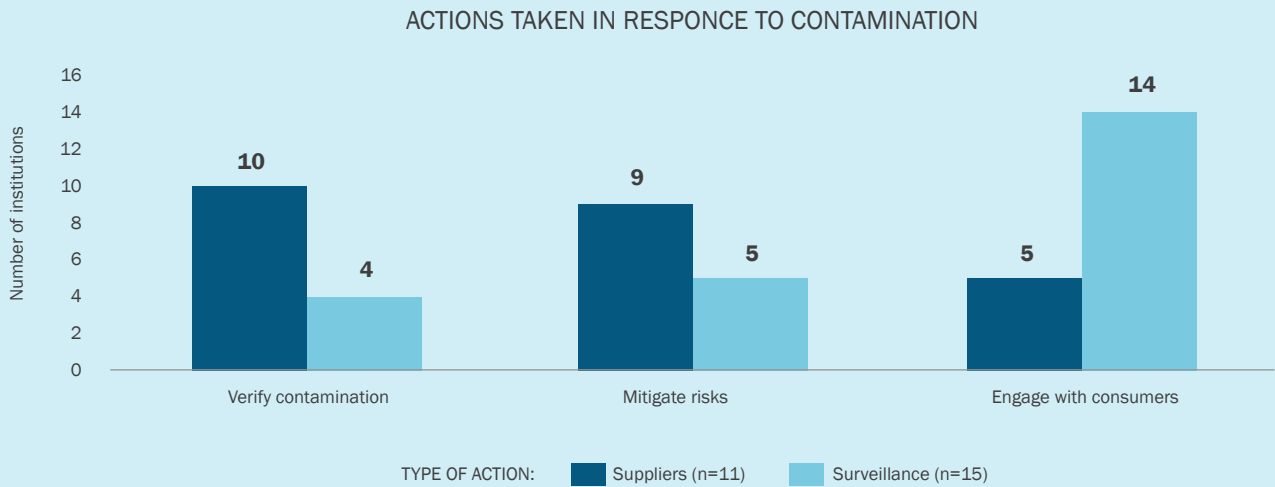
1 – Other reporting types include different parameters, centralized data, localized data, unique data, source type or accompanying larger report. 2 – Upper Management includes managing directors (suppliers) and county public health officers or directors of public health (surveillance). 3 – Other government includes Water Services Boards, epidemic committees, and other county, district and province level committees and contacts. F.b. – feedback.

In Kenya, suppliers typically hand-carried data from laboratories to offices where managerial and monitoring and evaluation staff then spent significant time digitizing results. Similarly, Kenyan surveillance agencies often hand-delivered paper records from sub-county public health offices to county offices. Some suppliers only reported to high-level supervisors in the case of contamination issues or outbreaks. In response to contamination, less than half of agencies contacted management, with others only doing so with multiple or repeated exceedances. Feedback to contamination within water suppliers was typically in the form of a phone call with instruction for laboratory staff.

2) External reporting. Almost all (24/26) monitoring institutions reported to at least one external agency: national-level ministry, independent regulator, or national management body (Table 1). Suppliers more often reported to centralized agencies, while surveillance agencies reported results to a wide variety of both local government units and other stakeholders, including health staff, epidemics committees, village committees, non-governmental organizations, and donors. We observed

a range of final reporting formats, though monitoring institutions typically reported compliance summaries (percent of planned samples completed or percent of samples within compliance) (Table 1). Institutions with limited computer and internet capabilities couriered hardcopy compliance reports to external entities; otherwise reporting occurred via email or submission into a national online reporting system. It was rare for external entities to provide feedback after they received results (Table 1). Most of the feedback occurs between the water regulator and suppliers in Kenya and Zambia, while surveillance agencies receive minimal feedback beyond upper management (i.e., county public health officers or directors of public health) despite their transmission of data to many other Local Government Units and stakeholders (Table 1). Feedback on compliance reports from external entities was often simply approvals, if an issue arises, requests for mitigation were made either by letter or phone call. Feedback from regulators can be in the form of enforcement, though this was not very common. For example, the regulator in Kenya ranks water suppliers on a variety of performance metrics

**FIGURE 3:
NUMBER OF MONITORING INSTITUTIONS REPORTING VARIOUS ACTIONS
IN RESPONSE TO CONTAMINATION.**



in an annual impact report, and this is the only form of feedback received according to interviewees.

3) Responses to contamination. When institutions detected contamination, they all reported acting on the results by verifying contamination, mitigating risks, and/or engaging with consumers. All suppliers reported verifying contamination or mitigating risks, with most (8/11) reporting to do both. Almost all surveillance agencies (14/15) engaged with consumers, whereas approximately half (7/15) reported verifying contamination and/or mitigating risks (Fig. 3). While many actions were taken based on the results of single samples, there was little synthesis of data to understand water quality trends, geographic variability, or other use of data for long-term or large-scale planning.

CONCLUSIONS

Flows of water quality information within institutions followed similar processes in all six countries. Since all institutions had systems for transmitting water quality data, interventions to improve the use of these data should address deficiencies in existing procedures, such as increasing the availability of computers and spreadsheet programs, rather than implementing entirely new reporting systems, such as mobile phone- or cloud-based systems. We determined that the key challenges to information flows were the limited analysis of data, lack of feedback mechanisms between institutions and external entities or with consumers, and the poor enforcement of data sharing requirements.

Through this study we identified several recommendations for improving the management of drinking water supplies. First, strengthening enforcement of water quality testing and reporting regulations (e.g. building accountability) could increase demand for information and promote the sustainability of data collection systems, as indicated by our analysis of reporting to national-level agencies in Kenya. The second is to build staff capacity, both within monitoring institutions and within national ministries and regulators, for managing, digitizing, and understanding data. Increased use of water quality data, for example through temporal or geographic trend analyses, could also increase demand for accurate and timely data. These types of improved syntheses can be facilitated by increased digitization of data (e.g., using simple spreadsheet software) and guidance for summarizing data and generating descriptive statistics and graphs. These additional analyses can improve information flows to recipients who do not have the expertise or time to digest water quality test results, and who currently only see basic statistics such as number of tests or percent compliance. Finally, monitoring programs can improve efficiency by layering multiple types of data along with their water quality data. Data on water supply performance, affordability, and access to sanitation (safety, equity, affordability, and waste management) are also relevant for service provision. Making these links between water quality management and other relevant information systems can support overall water safety.

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