www.water-alternatives.org Volume 15 | Issue 3

Amankwaa, G.; Heeks, R. and Browne, A.L. 2022. Water ATMs and access to water: Digitalisation of off-grid water infrastructure in peri-urban Ghana. Water Alternatives 15(3): 733-753

Water ATMs and Access to Water: Digitalisation of Off-Grid Water Infrastructure in Peri-Urban Ghana

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ABSTRACT: Ensuring adequate access to clean water remains a major challenge throughout the world, particularly in off-grid and low-income neighbourhoods in the Global South. Digital water infrastructure such as water ATMs (automated standpipes) has been a common policy response to this challenge, targeted particularly at off-grid citizens in urban and peri-urban areas. Despite growing implementation and interest, however, limited empirical research analysis has been devoted to a consideration of the ways in which water ATM infrastructures are being implemented and how they impact water access in off-grid locations. Drawing on a mix of qualitative methods and a situated sociotechnical approach, the paper addresses this gap by examining how water ATMs are implemented and deployed, and their impacts on water access in a peri-urban community in Ghana. We find water ATMs as incremental infrastructures delivering relatively limited operational-level value, with their deployment and operationalisation shaped through everyday realities, existing community infrastructures, and networks of actors and intermediaries. We highlight how water ATMs produce new sociomaterial realities of water access which are also contested. We argue that digital water infrastructures are not just technical, but that they are, rather, terrains that underlie and are embedded in social, technical and political dynamics. Given the increasing deployment of water ATMs and digital water systems in urban areas of the Global South, we conclude the paper with recommendations for off-grid digital water infrastructure implementation.

KEYWORDS: Water ATMs, digital water innovations, water access, off-grid water, infrastructure, Ghana

INTRODUCTION

Water access in urban and peri-urban areas of the Global South is characterised by two key patterns. First, there is a growing presence of citizens who are 'off-grid'; that is, they live in non-networked settlements or have no connection to the formal water infrastructure (Allen et al., 2017). Second, residents in on-grid locations often have to rely on other, often high-cost, forms of water provisioning due to the intermittent nature of piped water services (Beard and Mitlin, 2021).

In the past decade, in the context of these challenges, the drinking water sector has witnessed an increasing deployment of digital technologies and infrastructure such as 'water ATMs' (automated standpipes), which are intended to ensure affordable water services for off-grid/low-income communities (Chambers and Evans, 2020; Guma, 2021). These may be deployed by new operators or by existing water utilities seeking to improve or expand water services (Boakye-Ansah et al., 2021; Heymans et al., 2014; Komakech et al., 2020). Water ATMs are low-cost, self-contained, automated water vending machines that store clean water and are most often connected to a water purifying plant that uses

groundwater (Dey Sarkar, 2017; Sarkar, 2019a). The water provisioning system itself is quite varied in that water can be delivered through, for example, standpipes, stand-alone dispensing units/kiosks, container booths, or delivery vans with dispensers; water ATMs, however, are either coin-operated or electronic smart-card-operated. Increasing use of prepaid smart cards means that they not only provide a decentralised water supply infrastructure but also allow operators and water managers to observe consumption and improve performance via new digital monitoring systems (Chambers and Evans, 2020; Hoolohan et al., 2021).

Across the Global South, the installation of water ATMs has been rapid in urban and peri-urban locations – alongside some rural initiatives – with implementation occurring in countries like India, Bangladesh, Kenya, Ghana, Malawi, Tanzania and South Africa, where they are significantly augmenting infrastructures of water supply and delivery (Alda-Vidal et al., in press; GSMA, 2019; Schmidt, 2020). There is no specific global data on the prevalence of water ATMs, but water sector evidence suggests that they are being implemented by both private and public water suppliers, sometimes with support from aid agencies (GSMA, 2019). Despite interest in their potential and implementation in some countries, research into water ATMs has been limited. Reflecting the relative recency of this phenomenon, studies on water ATMs have tended to look at implementation and adoption; only a few studies – mostly market research and early pilot studies – have looked at their impacts (GSMA, 2019; Schmidt, 2020). To date, there is very little empirical evidence on the real-world impacts of water ATMs (Amankwaa et al., 2021a).

To help address this gap, we report here from qualitative research carried out in peri-urban Ghana. Ghana was selected for two reasons. It is relatively typical of Global South experiences in terms of its recent adoption and deployment of digital technologies by both private and public water providers in off-grid and on-grid communities and households. More specifically, it hosts water ATM projects that have moved well beyond their pilot phase, and which therefore reflect embedded water technologies. Drawing on a situated sociotechnical approach, the aim of this paper is, first, to understand how water ATMs are implemented and deployed in a peri-urban community. Second, it examines the impact of digital technologies on water services within the realities and lived experiences of off-grid water ATM consumers, as well as the broader outcomes and development implications. The paper adds to the discussions in the Global South on water infrastructure specifically and on off-grid infrastructure more generally. It provides a sociotechnical framing for understanding the impact – technical, social and political – that digital interventions can have on these infrastructures. This paper therefore goes beyond extant contributions that focus on infrastructure and technology through deterministic frameworks; rather, it offers insights into the conceptual notion of digital 'infrastructural incrementalism' and by evidencing the need for a sociopolitical lens for digital water studies. This recognises place-based contexts and shows how the appropriation of digital and (smart) infrastructure is central to the materiality in these contexts; it further shows how these infrastructures are always a process in the making.

LITERATURE REVIEW

Digital technologies and off-grid water networks

The literature on digital technologies in water provision has been replete with assertions and expectations about their role, impacts and (re)configurations in the Global South (Chambers and Evans, 2020; Guma, 2021; Heymans et al., 2014). Studies of the actual impact of information and communication technologies (ICTs) such as digital payments or prepaid technologies on water service delivery have been less extensive (Hanjahanja and Omuto, 2018; Schmidt, 2020). Some studies, however, have explored how these digital systems are being used to try to address problems of inadequate access in urban areas via procedural and technical shifts in water service delivery (Heymans et al., 2014; Hope et al., 2012; Komakech et al., 2020); others have examined the broader sociospatial dynamics arising from digital water systems (Guma, 2019; von Schnitzler, 2008). Overall, this literature has highlighted how digital

technologies have become integral components for addressing some of the problems of water and development.

However, a review of current literature on digital innovations and water services in developing countries finds many gaps (Amankwaa et al., 2021a). The main focus has been on the application of digital to on-grid water systems, leaving an important knowledge gap around digital and off-grid water systems (ibid). Related, interest in, and conceptualisation of, ICT-based infrastructure in the water sector has also often been oriented towards adoption-based or technology-centric frames, with little consideration of how digital technologies are embedded within the types of contexts found in informal and low-income locales (ibid). This is the case despite the fact that water access in the Global South is known to be shaped by political, social, economic and infrastructural dimensions, which in turn affect the deployment of new digital technologies and their materialisations (Guma et al., 2019; Schmidt, 2020). Infrastructural realities in most off-grid locations such as informal, peri-urban areas reflect the heterogeneity and inequalities that are inherent in the multiple ways that people engage in accessing limited services. Yet, the few studies to date focus on either implementation and adoption with limited focus on impact, and existing studies also often neglect the "obvious interplay of the social and the technical" in digital water innovations (Amankwaa et al., 2021a: 636).

This interplay makes it challenging to understand the materialisation of digital developments in the water sector and how they are embedded within the complex and wider cultural, political and material systems that exist in off-grid areas (Guma, 2021; von Schnitzler, 2008). There is thus a need for the adoption of wider sociotechnical elements and framing when analysing digital water innovations in off-grid areas (Hoolohan et al., 2021). As Hoolohan et al. (ibid) argue, digital infrastructures and technologies contribute to changes in the landscape of water infrastructures and thus a pluralistic framing encompassing that landscape is necessary in order to understand digital water innovations. In what follows, we reflect on the theoretical and empirical potential of an engagement with three insights and literatures as analytical strategy: the notions of sociotechnical assemblages, everyday urbanism, and infrastructural configurations.

Mobilising a sociotechnical approach to off-grid digital water infrastructures

Urban scholars have conceptualised infrastructures as sociotechnical assemblages made up of the combination of sociomaterial systems, configurations and practices that shape everyday urban life (Graham and McFarlane, 2014; McFarlane, 2011). This notion also theorises infrastructures as more than just inert, placing emphasis on dynamic, contested assemblages and elements (Lawhon et al., 2018). As part of this, scholars have advanced the notion of sociotechnical assemblage by drawing attention to how humans and non-human elements become enrolled in infrastructures and their arrangements, revealing the infrastructural role played by people's connections and activities (Lawhon et al., 2014; McFarlane, 2011; Simone, 2004). The literature on sociotechnical approaches to ICT-based infrastructure and platforms, in particular, also points to the heterogeneity, contestations and power-laden dynamics that are inherent in the multiple ways that people engage in the everyday making and remaking of (digital) water infrastructures and services (Alda-Vidal et al., in press; Hoolohan et al., 2021; Lawhon et al., 2018).

Within the sociotechnical perspective, technologies are analysed not simply as designed and engineered material technical artefacts but as also encompassing the relationship of agents such as technology producers, infrastructure providers, consumers, regulators and other intermediaries (Walker and Cass, 2007). The complexities of digital water innovations also cannot be understood in solely technological or social terms, yet there have been few studies discussing the hybrid assemblages within which these digital technologies such as water ATMs operate.

Given that people and their activities form part of the sociotechnical assemblages of infrastructure, the notion of everyday urbanism also has relevance when seeking to understand the impact of digital innovation on off-grid water. Everyday urbanism has been used to explain how urban systems work and

how the everyday lives or activities of urban dwellers both shape, and are shaped by, their urban context (McFarlane and Silver, 2017; Myers, 2011). For water and its infrastructures, 'everydayness' refers to the processes, practices, lived experiences and time-space dimensions of accessing and interacting with water infrastructure by users and their households (Peloso and Morinville, 2014). In understanding the everyday, many studies have explained the roles and different practices and conditions at play in access to water supply, such as gendered roles in water-fetching (Harris et al., 2017; Truelove, 2019). An everyday perspective also calls for paying attention to how sociotechnical conditions of infrastructures (re-)engage or mediate the practices of particular groups within or across urban locations (Kemerink-Seyoum et al., 2019; McFarlane and Silver, 2017).

The lens of everyday urbanism especially draws attention to the micro-level activities and impacts of urban digital systems on individuals and households, but these have also been seen to contribute to wider changes in social, technological and material configurations (Chambers and Evans, 2020; Lawhon et al., 2014, 2018). Building on urban political ecology, configurations can be viewed as the "range of infrastructural options potentially available to a person for everyday use" (Lawhon et al., 2018: 726); they are also the visible and hidden complexities that are embedded within arrangements, connections and relations that are dynamic, power-laden and contested (ibid). Within these infrastructural configurations, the role of mediating digital technologies in the operation and management of diverse sociotechnical systems can be viewed as either incremental or disruptive. Incremental technologies and infrastructures are those that are "often in-the-making, undergoing constant adjustments and shifting technological and material configurations" (Silver, 2014: 789). Disruptive on the other hand includes infrastructures or technologies that can fundamentally change not only established infrastructure or technologies but also the rules and business models, the power relations between groups, and broader impacts on society and environment (Harshadeep and Young, 2020; Wehn and Montalvo, 2018). It is of course possible for a given digital technology to be both incremental in the short term but disruptive in the long term.

As noted above, the micro and the macro are connected, with scholars identifying how new forms of power relations, social inequalities, and other wider sociopolitical outcomes emerge out of the day-to-day experience of, and engagement with, (digital) infrastructure (Alda-Vidal et al., in press; Hoolohan et al., 2021; Smith, 2021). Few recent papers have focused on off-grid transitions; however, some have demonstrated how the complex assemblages of people, practices, actors, and macro/meso-level processes that are embedded within prepaid and internet-of-things water technologies perform work that is power-laden and political and which has important consequences for water access and provision in urban Africa (Alda-Vidal et al., in press; Blomkvist et al., 2020; Chambers and Evans, 2020; Guma et al., 2019). Nonetheless, there still remains little emphasis in current research on the situated nature, substance, dynamics and complexity of the relationship between the 'digital' and water.

Integrating concepts of sociotechnical assemblages, people's everyday engagements, and urban infrastructures and configurations, we analyse water ATMs as sociotechnical infrastructures/systems with various actors, arrangements, materialisations and impacts. These different analytical insights make visible the materialities, the everyday value and experiences, and the sociopolitical and broader outcomes of water ATM operationalisations in peri-urban Ghana. Through the lens of infrastructural (sociotechnical) assemblages, we analyse the sociotechnical design, implementation and organisational model of water ATMs (for example, technical functionality, material elements, social context and techniques). By drawing on everyday urbanism, we look at people's everyday experiences and value in operating and using the water ATMs, as well as the micro-level impacts that ATMs have on water access. Via infrastructural configurations, we interrogate the way in which water ATMs are being configured infrastructurally – how they are being utilised in the provision of services leading to new arrangements – and their broader outcomes.

METHODS

Case study context

Ghana has followed global trends in water service delivery and policies. These trends include the promotion of public-private partnerships and cost recovery as essential strategies for achieving sustainability of water supply (MWRWH, 2007), and the use of subsidies to improve access to water services by the poor and thereby help achieve the human right to water. Primarily under the Ministry of Sanitation and Water Resources and working with institutions such as the Water Resources Commission, water service provisioning and delivery in Ghana is the responsibility of two main public actors: Ghana Water Company Limited which oversees urban water supply, and the Community Water and Sanitation Agency in charge of rural and sometimes small town water supply. The state has also collaborated through local government with non-governmental organisations and community-based organisations to finance, develop and manage services at community level (World Bank, 2011). Public sector water provision in rural, peri-urban and low-income areas of Ghana does seek to adhere to the dual concepts of demand-driven implementation and community ownership and management; however, the inability of the public sector to fully address the needs in these locations has resulted in the increasing participation of the private sector and other non-governmental providers such as small water enterprises, micro-utilities, and other private water vendors such as tanker services. Some of these alternative providers have recently begun to roll out innovative approaches to service delivery, sometimes augmenting their existing water provision and sometimes setting up in new locations, especially within peri-urban, low-income and off-grid neighbourhoods. These innovations have included the use of digital water innovations such as water ATMs.

To analyse off-grid digital water innovation implementation and its impact on water users, this study adopts a case study method that enables a detailed sociotechnical analysis of a phenomenon within a given technical, social, economic and political context (Yin, 2013). This necessarily follows from the requirements laid out in the previous section. In order to understand the complexity of the digital water infrastructure assemblages, everyday practices and wider impacts then in-depth, triangulated, quasi-ethnographic research is required. A case study approach is therefore relevant, given that it supports the combination and triangulation of different in-depth data-gathering techniques such as field observations, interviews and policy document reviews.

In this research, Yawkwei – a growing peri-urban community within the Asante Akim South Municipal Assembly in the Ashanti region of Ghana – was selected as the case study site. Yawkwei is on the outskirts of the town of Konongo, which has a total population of c. 40,000 with Yawkwei itself having a population of c. 3000 (AASMA, 2020). Yawkwei is characterised by a heterogeneous water infrastructure that is made up of digitalised community standpipes (water ATMs), other private standpipes and boreholes, and a few households that are connected to treated water via pipes and prepaid water meters. In this study, the main focus was water ATMs (see Figure 1); they constitute the most-used water source in the community since their installation in 2018 by Safe Water Network (SWN)[1], with support from the GSM Association (GSMA), on all of its water standpipes in Yawkwei. Yawkwei was selected on the basis of the following characteristics: it represents an example of an off-grid neighbourhood with heterogeneous water provision that is typical of urban Global South areas; it is a case example of digitalisation of off-grid water services; and, last, the digital water innovation has sustained over a number of years, thus becoming embedded in water services in the community such that it affords evidence of implementation as well as impact.

[1] Safe Water Network (SWN) is a non-profit organisation dedicated to developing and implementing small, financially viable water initiatives. In Ghana, SWN has set up decentralised water initiatives that provide drinking water in a number of rural and peri-urban areas.

Figure 1. Some water ATM standpipes in Yawkwei.

Source: Photo by first author.

Methodology

Field research and data collection was undertaken in three phases, from February to June 2021. The first phase, in February and March, involved an initial piloting of research and research instruments in order to help the first author familiarise himself with the objectives of the entire project and identify areas or study sites of interest regarding off-grid water innovation. From this, two communities were identified: Akuse and Yawkwei; the latter was then selected based on its peri-urban characteristics. The second stage, in the early parts of May 2021, involved visiting the study area; this allowed the first author to familiarise himself with the nature and use of off-grid digital technologies in Yawkwei. The main data collection – the final phase – took place during May and June 2021. This involved a mix of qualitative methods, using in-depth semi-structured interviews and field observation to collect data on the implementation and impacts of water ATMs.

In all, 30 interviews were conducted (see Table 1). Interviews usually started by discussing everyday water access practices and challenges, digital water implementation, the impact of water ATMs so far, and the sociotechnical elements associated with water access and digitalisation. Respondents included 23 water users (19 water ATM users and 4 users of other private water stations)[2] who were purposively but randomly identified and interviewed either at water standpipes or in their homes. The first author also interviewed one mobile money vendor, one SWN community caretaker or operator, one SWN ATM water standpipe vendor, a private vendor at a standpipe, and a borehole caretaker who was also a member of the Community Water Board. Interviews were conducted in the local dialect, Twi, and were recorded after seeking the consent of interviewees. One official from the project implementation NGO (SWN) and one from the Municipal Government Authority were also interviewed to get their perspectives on water ATM implementation, operationalisation, limits and benefits.

[2] Given the gendered nature of water-related tasks in Ghana, all of the interviewed water ATM users were women, and three of the four other water users were women.

Table 1. List of interview respondents.

Respondents	Number interviewed
Water ATM users	19
Users of other private water stations	4
Mobile money vendor	1
Safe Water Network (SWN) community water operator/caretaker	1
SWN standpipe vendor/agent	1
Other private water vendor	1
Community Water Board member	1
Government official	1
SWN official	1

Field observations were also carried out across water ATM points and other off-grid water sources in the community to observe daily water-fetching practices at water points, the operationalisation of water stations, and the amount of time it takes people to access water. Field observations involved two main activities: (1) observing and taking notes on how people interacted with, and operated, water ATMs; how they fetched water and who fetched the water; (2) measuring and taking notes on the time spent in accessing water from the various types of off-grid water infrastructure (water ATM standpipes, boreholes, and private standpipes). This was repeated within a week at similar locations in an effort to determine an average time used and to serve as a validity check. These observations were also useful in understanding the everyday dynamics and experiences of users and others who interacted with water ATMs. Informal observation including of water storage and use was also undertaken during the at-home interviews with water users.

Interview data was translated into English and then transcribed and analysed alongside the field observation notes. In order to refine the final themes for analysis, these two primary data sources were complemented with an analysis of secondary data and policy documents on the topic of water ATMs and of digital water and off-grid water provisioning in Ghana. These sources included annual and research reports by SWN, institutional and company websites, and market reports and blogs by other organisations such as GSMA and the Consultative Group to Assist the Poor (CGAP); these were used to triangulate with the other data and to deepen the understanding of off-grid water technologies and services. The study therefore combined both methodological and data (stakeholder) triangulation. The final analysis and, as laid out next, the findings were then structured in terms of the three sociotechnical thematic domains identified from the literature review.

FINDINGS

Sociotechnical design and assemblages: Water ATMs and material elements

Water ATMs were launched in Yawkwei in 2018 by the Safe Water Network as an infrastructural development project that was designed to strengthen the financial, operational and service delivery performance of water provisioning in this peri-urban location. As one SWN official pointed out, "These systems were actually done to help solve some of the problems of water provisioning in this community such as unreliability. We fitted this so that people can access water anytime they want" (SWN Official No. 1).

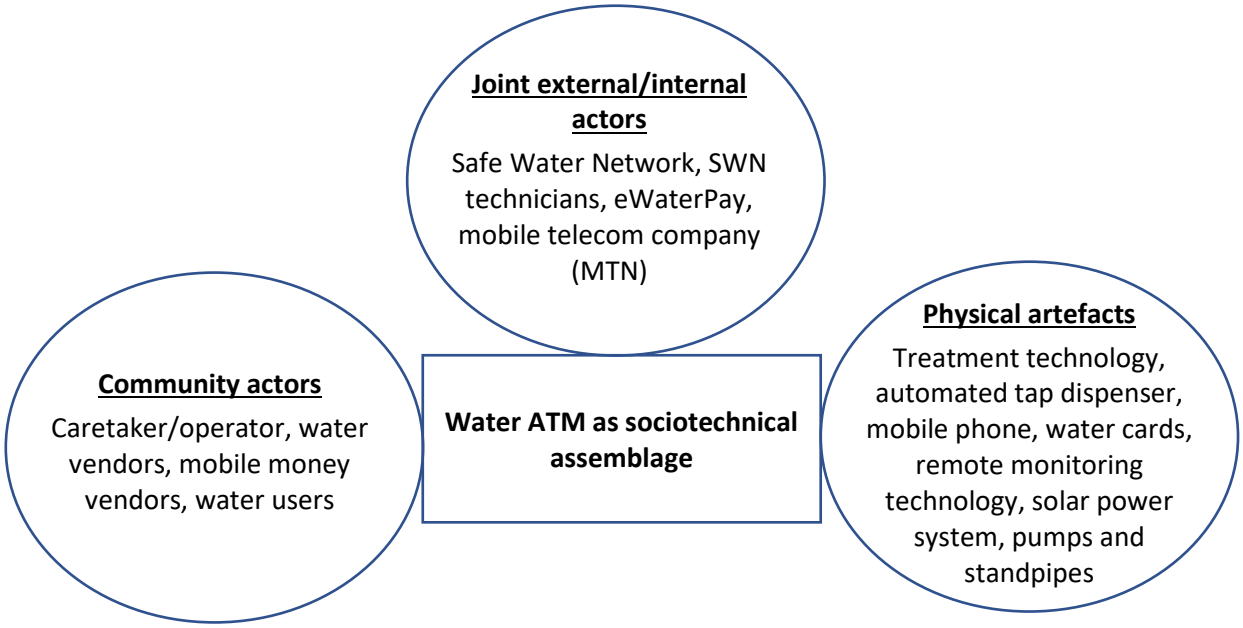
The water ATMs operate through a sociotechnical assemblage of human and non-human actors, intermediaries and artefacts (see Figure 2). In terms of non-human artefacts, the SWN system taps into subterranean groundwater via boreholes, and this is pumped, treated and supplied through overhead storage tanks to standpipes using electricity generated by solar power (SWN Official No. 1). The physical equipment is installed at six water standpipes, five with a single ATM and a main station with two ATMs. The digital infrastructure comprises an electronic water card, a reader, and dispensers; these are part of the physical components of the system which include a solar power system, pumps and standpipes. To obtain water, users place their card on the dispenser's card reader and remove it when the container is full; their card records the amount of water dispensed and is then charged for that number of litres (see Figures 1 and 3). The cards themselves are free; they are provided by SWN, but users start by paying an amount equivalent to the 'water credit' on the card, depending on how much a user can afford. Once that initial credit has run out, water credit is topped up via mobile phone or with a caretaker's help. Any household without a card can register and order a card for free from an SWN representative (Water ATM User No. 2). At the time of the study, all the water ATM installation points were still functional, which is a testament to the sustainability of these innovations in the community from a digital infrastructure implementation perspective. According to a water ATM user, "There are often minor challenges with the use of the stations since they installed them, but I can say that these systems are working properly over the years. Faults are timely fixed" (ATM User No. 12).

As shown in Figure 2, the main actors can be divided into those who are external to the community but reach down into it, and those who are from within the community. In the former category, the Safe Water Network is the Ghana field office of the US-based NGO that designed, implemented and manages the water ATM project. Funding support came through the UK-based global organisation, the GSMA. SWN builds, operates and maintains all of its water services in the community, including the water ATMs, and these are maintained and sustained through the collection of user fees. As discussed below, these fees pay for the employment of community members who are responsible for some day-to-day operation and minor maintenance tasks. eWaterPay is a UK-origin company that provides the digital water cards and the payment system between the cards and the SWN. Mobile telecom companies – mainly MTN – provide the technical infrastructure for mobile payments through their platforms (CGAP, 2018).

Within the community, mobile money agents help convert cash to mobile credit; these can then be converted to water credits on the cards, with a small fee being paid for the initial cash-to-mobile money conversion. Users themselves can top up the credit on their cards by dialling the short code "*700*7#" on MTN. Mobile money agents sometimes assist water ATM users with this process; as one explained, "we support users to top up their water credits, and we do this freely" (Mobile Agent No. 1). A local caretaker/operator is sometimes present at the water station. The caretaker ensures that tanks are filled correctly and assists users with operating the water ATM and with credit top-up onto cards; they also ensure that water ATM standpipes and the station are kept clean. The caretaker is a first point of reference for any user who experiences problems, and they contact SWN if problems arise that they cannot fix. Maintenance staff are technicians who are hired by SWN to help the caretaker fix faults and breakdowns via phone-based guidance or, for more complex repairs, through visits to water ATMs. SWN water vendors[3] also operate at each of the water standpipes. Allocated water credits and water by SWN, they then sell water from the ATMs for cash to community members who lack cards or who have no water credit. They are paid a 20% commission on their sales (SWN Official No. 1).

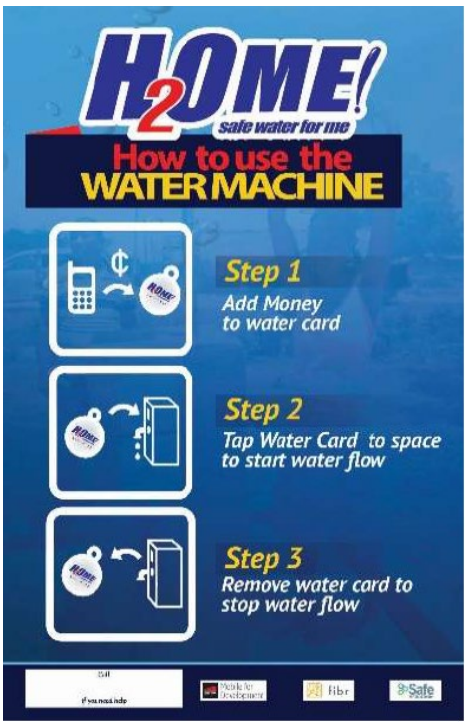
[3] At the time of this study and fieldwork however, only one SWN vendor was still operational and engaging in vending activity.

Figure 2. Schemata of some actors within the sociotechnical assemblage of water ATMs.



Source: Authors.

Figure 3. Steps in using water ATM.



Source: GSMA (2020).

Digital water innovations bring a promise of dematerialisation of the physical and, as part of this, also a promise of disintermediation of human intervention from processes. The former is seen clearly in the dematerialisation of the process of payment for water, which previously occurred using cash. At the same time, however, water ATMs have added physical artefacts – the card, the electronic card reader, the phone – and cash is typically still the origin of water payments before its conversion into phone and then water card credit. As discussed in the next section, digitalisation has designed intermediaries out of the core water payment and collection processes; however, limits to the totality of digitalisation and automation were observed. These included: the caretaker/operator and mobile money agents supporting those who struggled with what should be the automated process of loading of money onto the water cards; the caretaker who sometimes supports those who have problems with what would otherwise be the automated process of obtaining water; the vendor who still sells water for cash to those unable to participate in digitalisation; and the caretaker and technicians who are needed when the technology breaks down.

Other problems with the use of water ATMs led users to draw on social networks and connections within their community. If, for example, users were waiting to get a new card or were unable to top up their own, they would use the SWN vendor's card or borrow the cards of friends or neighbours in order to be able to continue to access water at the ATM; paying vendors in cash or using cash to reimburse those whose cards they borrowed (Committee Member No. 1). All in all, what *could* be a seamless technology-centred, individualised and automated process of consumption is not yet that. Fissures or discontinuities appear in the digitalised fabric into which humans step, in order to maintain water provision. Water ATMs are thus a sociotechnical assemblage of digital and human elements that encompass material technologies and a network of context-specific human relations and interventions.

This also exemplifies the way in which the design and deployment of water ATMs have been integrated into, and customised to, the pre-existing infrastructure and context of the community. SWN's approach sought to build on their existing physical infrastructure as well as the social and institutional infrastructure of the community. In physical terms, SWN mainly added a digital component to the standpipes and pumps that were already in use in the community. As one water ATM user commented, "this station has been here since 2015 or so, even till they came to add the new kits" (ATM User No. 5). In human terms, the caretaker and the five SWN vendors who operated and sold water at the pre-existing standpipes were retained; also minimising the chance that they would act within the community to resist the innovation. Over time, four of the five vendors stopped working, leaving just one SWN vendor, who said that, "I still look after this standpipe and get my commissions from them [SWN] based on the arrangement" (SWN Vendor No. 1). However, this attrition was gradual following implementation and the overall approach has meant that the new systems fitted with existing water-fetching practices and roles within the community. Finally, water ATMs made use of the existing techno-institutional financial infrastructure, including mobile phones and mobile money agents, already present within the community, rather than requiring new infrastructure. From a sociotechnical perspective, the design and implementation of water ATMs was thus deliberately incremental. This was done in order to maximise the viability and sustainability of the innovations: reducing the cost and reducing the chance of resistance or rejection of the innovation by relying on existing sociotechnical infrastructure and melding the new components into that infrastructure.

Having said this, a change has occurred in relation to the complexity of sociomaterial systems and practices compared to prior provision. Where previously standpipes used a single operator from within the community and solely physical artefacts, the new assemblage involves several different commercial providers, some of whom – in the case of eWaterPay (UK origin company) and MTN (a national telecommunications provider) – never physically enter the community. New technologies have also been incorporated, such as digital card readers and water dispensers, mobile phones, and cards. The process of obtaining water is now somewhat more elaborate, with a greater number of artefacts and with dematerialised digital elements.

Overall, this shows the water ATM itself to be an assemblage of heterogeneous sociotechnical elements of infrastructure. Operationalisation integrates that assemblage into the multiple relations, technologies, actors and materialities of the existing infrastructure as per McFarlane's (2011) conception. At the same time, however, the introduction of water ATMs also complexifies that infrastructure, changing the water-provision assemblage from something relatively simple and localised to something much more complex. These new digital systems also widen the scope of the actors and institutions that are drawn into that infrastructure, broadened it to encompass NGOs and the private sector within the community, in Ghana as a whole, and internationally. In the next section, we discuss how ATMs affect the everyday dynamics of accessing water and the value that this infrastructure has delivered.

Everyday experiences and the value of water ATMs

Water ATMs were rolled out primarily to provide utility to two main groups: users and the service provider. Water ATM users indicated that they preferred using water ATMs because they were more reliable, more flexible and more convenient (particularly in terms of saving time) than former or competing types of water provision. The reliability of ATMs is related to the reduced downtime of equipment (see below) but also linked to flexibility of water-fetching scheduling, since there was greater certainty that water could be collected on demand. This arose because water could now be collected without the presence of a caretaker or vendor; something not possible at non-digitalised standpipes. This allowed water to be collected outside the station caretaker's or vendor's hours of business or during those hours if the water station caretaker or vendor was for some reason absent. As one ATM user commented,

> my children are now able to fetch water anytime [after] school even if the station vendor is not at post. It has been helpful for them and myself on how we plan our activities (…). It is a bit of relief because I don't always have to be worried about when the vendor will close (Water ATM User No. 1).

Water collection has thus become less disruptive of other livelihood activities such as work, education, commerce or family events – because it can be planned flexibly to fit the schedule of those activities.

Before installation of the ATMs, water standpipes sometimes witnessed queuing during peak periods or users could also be required to walk further if a vendor was not present to sell water at the nearest water standpipe. Thanks to the greater flexibility of deciding when and where to fetch water, patterns of demand have been smoothed across the day. The efficiency of user access to water has improved because of avoidance of queues, ability to access water at the nearest water standpipe, and due to the faster transaction speed with no cash having to change hands. Due to the nature of this study, it was not possible to obtain definitive timings before and after digitalisation, but a timing-of-use comparison was made via field observations of the different water sources currently active in this community. Through these observations, users were found to spend less time accessing the water from water ATMs – averaging 15 minutes for a round trip from home to water source and back – compared to 29 minutes at the other two non-ATM boreholes in the community. Even this comparison, though, cannot lead to a definitive evaluation for several reasons: there were no queues at any of the locations, the greater transactional efficiency formed only a small part of the overall time required, and most of the difference arose from the fact that water ATMs were located closer to the main density of housing in Yawkwei.

Interviews and observations showed that water accessed from the ATMs was used for many purposes, including drinking, cooking, washing and bathing. Some households reported relying on store-bought water in sachets for drinking because they did not like the taste of the ATM water, for example its "saltiness" (Water ATM User No. 3). Others used (free) rainwater during the rainy season for chores such as washing and bathing. Overall, however, there was significant reliance on the ATM-supplied water within the Yawkwei community.

Alongside transactional time savings and greater flexibility around the timing of water-fetching afforded to users, the digitalisation and datafication of water processes had brought the relation between costs and water more to the fore for users. As one official stated, "this system helps them [customers] know how much balance is left on their cards at water points and how much water they can get from a particular card top up" (SWN Official No. 1). In theory, this provided users with an ability to monitor water expenditure and credit; however, there were few signs that consumers had been using the new possibilities afforded by digitalisation to track and alter their overall water consumption and expenditure to, for example, reduce the total amount of water being used in households.

Instead, digitalisation appeared to have been associated with two changes to water practices. First, more than half of interviewed users stated that they had become more cautious at the point of water collection. Previously, where water was spilled at this point, it was not charged for – essentially, the cost was borne by SWN as the water provider (Caretaker 1). Now, however, this cost and the associated risk had been shifted to the user: if the user spilled water for which they had paid, it was not refunded onto their cards. Second, there has been some overall reduction in the volume of water consumed from the water station following digitalisation (see Table 2 and the discussion below). This was likely related, at least in part, to concerns about spillage; however, it was also related to perceptions among some users that water was marginally more costly at water ATMs. SWN had set the cost of 20 litres at 10 pesewas (Gh₵0.10, or US$0.017, that is, just under two US cents). This was the same as the pre-digitalisation price and was also the same as that charged in the community by other standpipe vendors; hence, in fact, the costs of digitalisation have not been passed on to consumers. Despite this equivalence, some users claimed they were effectively being charged more due to not getting the same volume of water for their money. A quote from one user illustrates the perceived issue (see also Figure 4):

> (…) see, this pipe [water ATM point] is closer to me but the prices of late make me visit the other standpipe by the store. When I use this same container [a 40-litre bucket: see Figure 4], a GH₵1 purchase guarantee five times of that container from other vendors. But instead of getting five times, I only sometimes get four times at same amount when I use the water ATMs. I prefer to walk that distance if I can get an extra container of water (Water ATM User No. 5).

Figure 4. Examples of a 40-litre bucket commonly used for fetching water at water ATMs.

Source: Photo by first author.

The emphasis of user perceptions is notable here. When asked, water users did report the benefits of reliability and flexibility and the consequent reduced stress of water-fetching; however, it was cost-

related issues that dominated. Likewise, respondents (mainly water ATM users) talked far more about the cost of water than about the actuality, and value, of the amount of time saved due to advent of water ATMs. This suggested that respondents valued money more than the time of those – women and girls – involved with water collection.

For SWN (the service provider), the key difference to the pre-water ATM situation has been datafication of water consumption, with the capture, storage and analysis of digital data about many aspects of water system performance including technical performance, water quality, volume dispensed, sales and revenue collection that were previously either recorded manually or not recorded (SWN Official No. 1). One immediate benefit to SWN was a reduction by half in its monitoring costs. The savings were not just in the costs of data collection, transcription and analysis; there was also a reduced requirement for staff to travel out to the water stations to diagnose problems (GSMA, 2017). Average water station downtime was also reduced from an average of 12 hours per month to 8 hours.

Financial impacts were also seen. Before digitalisation, it was the responsibility of the caretaker and SWN vendors to collect payments from users and to record these. As shown in Table 2, there was a significant degree of 'non-revenue water', that is, water unaccounted for due to leakages, wastage and non-payments leading to a mismatch between water dispensed and revenue collected. With digitalisation and formalisation of the payment process and with disintermediation of the caretaker and SWN vendors from that process, a significant improvement has been seen; moving from almost half of water dispensed generating no revenue to now less than one-seventh.

Table 2. Impact of water ATMs on key performance indicators in Yawkwei.

Performance indicator	Before digitalisation	After digitalisation
Average non-revenue water per month	42%	14%
Average overall revenue collected per month	US$308	US$255

Source: GSMA (2020); SWN (2021).

The second row of the table indicates a reduction in the consumption of water at digitalised locations. The decrease is quite significant, given that the one-sixth reduction in revenue collection must be set alongside the roughly one-third reduction in non-revenue water. As discussed above, this likely relates to spillage- and cost-related perceptions among users, though the simultaneous provision of piped connections by SWN to some houses in Yawkwei will also have had an impact.

The current modus operandi of water delivery by SWN therefore contrasts with the relative institutional informality of many processes under the pre-water-ATM regime. Revenue collection often poses a challenge to many water providers in off-grid locations and, in this case, digitalisation has contributed clear operational and financial benefits for the service provider. However, just as we saw no major changes in the way consumers are using water, we found no evidence to date of the service provider using data for anything beyond operational processes such as revenue collection and water access monitoring. In other words, the strategic potential of water data is as yet unrealised.

The above experiences highlight the current value and micro impacts of water ATMs. Water ATMs, to some extent, have impacted the everyday lives and water-fetching practices of users through improved water access; users benefit from increased reliability, flexibility and convenience and enjoy a reduction in the time spent in accessing water. However, we also see the implications of the incrementalist approach noted in the previous section, whereby change is gradual and partial, an accretion rather than a transformation. While this slow process of change increases digital water innovation viability and sustainability, it also means that impact is incremental rather than transformative. For users, impacts on

reliability, flexibility, time and water usage are incremental, and overall water practices are not significantly different from the pre-digital state. For the caretaker and for the water service provider, there are somewhat more significant changes in relation to revenue collection but, beyond this, their everyday and operational practices are relatively enduring.

Broader-scale impacts of water ATMs on the water access landscape are discussed next.

Water ATMs and (re-)configuring water access

Alongside the everyday impacts of water ATMs described in the previous section, we found there to be some broader ways in which these new digital technologies were changing the landscape of water access in Yawkwei. Some residents within poorer households in the community were unable to obtain a water card or could not afford to purchase water credit. They were therefore excluded from direct access to the water ATM and the facilities and conveniences it offered. Although, as noted, the benefits of this were incremental rather than transformative, this will at the margins have increased inequalities within the community; an impact previously associated with some digital water innovations (Hoolohan et al., 2021; Schmidt, 2020; von Schnitzler, 2008).

Unlike this reproduction of consumer inequality, there has been a reduction of relative inequality between consumers and former water intermediaries. Water ATM users are empowered to collect water as and when they please without necessary reliance on intermediary actors like the SWN water standpipe vendors, though the continuing presence of the caretaker at some points mutes this shift. Conversely, the caretaker and erstwhile standpipe vendors have been relatively disempowered by digitalisation. They used to be important gatekeepers who, to some extent, controlled households' access to water. The earlier core financial role of these intermediaries has in part been transferred from them into the digital system, and in part transferred to the mobile money agents who enter the sociotechnical assemblage of water infrastructure where previously they were absent. Digital accuracy of water cards and water dispensing may have reduced arguments with these intermediaries, but it has also reduced their discretion to, for example, top up a container if there was spillage. The SWN vendors have largely disappeared because the technology has rendered their business model obsolete; they are arguably the main losers from digitalisation. The power shift from the caretaker is moderated by actual practices like the use of the vendor's water card during institutional glitches such as either new cards or top-ups being temporarily unobtainable. Having been disempowered by digitalisation, the vendor now facilitates, rather than controls, water access.

Power shifts can also be understood in terms of the new actors brought into the sociotechnical assemblage. These are all now an essential part of water collection in Yawkwei, whether community-based (the mobile money agents), national (the mobile operator MTN), or overseas (eWaterPay). They benefit directly from consumer payments and use of mobile money related services, be it the fee to convert cash to mobile money that is then transferred into water credit, or fees for facilitating payments to SWN. More generally, the introduction of water ATMs is seen to have driven up rates of adoption of mobile money within local communities; this benefits all those who are part of the mobile money ecosystem.

The impacts of digitalisation and formalisation associated with water ATMs have squeezed out some of the former informal, social aspects of water access. The disintermediation of the caretaker and vendors from the payment process and the ability to collect water at any time has had two impacts, as noted by respondents. In general terms, it has made water access a less social activity. Traditionally, water collection is a moment of social gathering and discussion, an opportunity for the exchange of gossip, views and concerns. This has now been noticeably reduced by both the shorter amount of time required at the water point and the new flexibility of use. As one interviewee reflected, "Because we can come here [to the water ATM station] at a preferred time so far as we can get water, we don't regularly meet the usual faces here as we used to do in the past" (Water ATM User No. 4). More specifically, if there are

issues with water access, the caretaker is the first point of contact, but she is not always present which can leave problems unresolved for some time and also create a greater sense of distrust among water users. As one ATM user commented, "Sometimes, I just need someone [a caretaker] to speak to, especially when I feel I've been cheated in my top up" (Water ATM User No. 6). Digitalisation has thus come at the expense of some of the traditional social interaction and social networking, and formalised relations with digital systems and external providers have replaced the informal, in-community relations of the past. While – as discussed above – water collection still at times draws on local social networks when the digital system fails in some way, it is thus still true that digitalisation has to some extent been associated with water access becoming a less socialised, more individualised activity.

Finally, a gendered dimension to these changes was also notable.[4] Previously, other than the male technicians who would occasionally visit Yawkwei to fix a fault, all roles relating to water-fetching were performed by women and girls, as is the case elsewhere in Ghana (Harris et al., 2017). Operation of the public boreholes was also undertaken by women. This remained the case with the water ATMs, but it was thus women's roles in collecting water fees, recording usage and delivering payments to the water provider that had been digitalised out of existence. Specifically, it was four women vendors at the different water standpipes who had lost their livelihoods as a result. This removal of responsibilities and livelihoods appears to have happened without significant resistance; this may be explained by the relatively limited voice that women have in communities such as Yawkwei and, more broadly, by women's roles in water collection but not in water governance (Adams et al., 2018). Digitalisation has also resulted in men entering the water assemblage. There is some (limited) tendency for men to be more associated than women with mobile phone technologies and, for example, to take responsibility for top-up payments onto the water cards.

The foregoing experiences highlight the position of water ATMs as digital infrastructures that create new water access realities and terrains of infrastructural configurations.

DISCUSSION: IMPLICATIONS AND LEARNINGS FROM DIGITALISING OFF-GRID WATER INFRASTRUCTURE

The water ATMs we studied evidence features typical of sociotechnical infrastructures described by the urban, infrastructural and digital water literature (Amankwaa et al., 2021a; Guma, 2021). Drawing on this approach, we discuss our findings and look at what water ATMs mean for water access, as well as their outcomes at the local level and their wider implications.

Recent works have argued for the importance of urban infrastructures as sociotechnical assemblages that are made up of the combination of sociomaterial systems and functioning through people and existing structures (Amin, 2014; Schmidt, 2020). We found evidence of this. The digitalisation of standpipes and their current operationalisation and functioning rely on existing infrastructure (such as pumps, boreholes and groundwater) and modes of water practices. What has become common is leveraging on all existing networks in the water service value chain in the community in combination with the new elements of the digital water supply strategies – demonstrating a case of incrementalism. In response to the calls for more real-world accounts of digital water innovation (Amankwaa et al., 2021a), we found that water ATMs have been implemented to suit specific needs and dynamics and are evolving with the nature of community urbanisation and practices. Similar to arguments made by Guma and Monstadt (2021) and Schmidt (2020), the design and implementation of digital infrastructure such as water ATMs has been fashioned through local dynamics and shaped through different actors and appropriations. There is thus a need to recognise water ATMs as not simply a technical infrastructure but as a sociotechnical assemblage with human and organisational components. This is because, though prepaid systems remove intermediaries involved in service provisioning (Heymans et al., 2014), their functioning is still intermediated through assemblages of actors and systems.

[4] A great majority of interviewees were women and therefore a caveat needs to be added to gender-related findings.

The sustainability of the system – fully operational for four years at the time of writing – is also of note. This sustainability contrasts with the experience of many digital deployments in the Global South, which often fail in their rollout or early implementation stages (Heeks, 2018). As shown by Guma (2021) and Sarkar (2019b), this is a fate from which digital water innovations, including water ATMs, are not immune. This positive outcome we observed can be seen as a manifestation of the system's incremental design and its imbrication into the community's existing sociotechnical infrastructure, including deep-seated sociocontextual and technical elements.

Literature to date has been characterised by a focus on the benefits that water ATMs have for users (Komakech et al., 2020; Sarkar, 2019a). Results from this study can, on the one hand, be seen as rather muted in this regard: they suggest that the limited benefits of water ATMs to customers are an outcome of the incrementalism that has, at the same time, facilitated sustainability. A core impact of prepaid water technologies, for example, is seen as the provision of cheaper drinking water (Heymans et al., 2014). The findings here are contrasting. Setting aside the reluctance of some users – unrelated to digitalisation – to drink the dispensed water because of its taste, the price of water was no lower than it had previously been; some users even argued that it was marginally higher due to issues around the volume of water dispensed. We can see this as being aligned with the argument that prepaid dispensers like water ATMs force users to become "calculative agencies" – increasing the salience of cost in their understanding of water, making water access a more pecuniary task, and leading them to alter and financially optimise their water-fetching practices and consumption behaviours (von Schnitzler, 2008: 916).

This muted impact is reflected in other ways. Given the pre-existence of paid-for boreholes and standpipes, water ATMs have not made much difference to some of the key impacts of digital water innovations that are identified elsewhere in the literature (Hanjahanja and Omuto, 2018; Sarkar, 2019a; Schmidt, 2020). The financialisation of water consumption was already in place in Yawkwei and there was a water market; water treatment systems had previously been installed, negating the claimed health and environmental benefits of water ATMs; and there were also no signs that overall water consumption had changed.

On other hand, through digitalisation, water ATMs have been able to provide improved reliability and access to water with most of these benefits occurring at the operational level. This has, for example, reduced prior restrictions on when customers can access a particular water point, making water access flexible, with water collection now more timesaving and convenient in relation to the users' (and their households') everyday lives and other activities, without access being dependent on an intermediary's hours of business or control. This has been of particular benefit to those involved in water collection, that is, women and girls; this, in turn, provides real-world evidence of what has been claimed by earlier literature: that water ATMs are viable, long-term solutions for marginalised, off-grid communities (Sarkar, 2019a).

Earlier literature has also identified that water ATMs should bring benefits to water-providing utilities (Komakech et al., 2020; Sarkar, 2019a). This study has delineated the various utility performance indicators that register improvements in practice. The benefits of datafication and digitalisation of water payments and dispensing include: reduced costs of monitoring, reduced water-system down time, and significant improvements in the proportion of water dispensed for which revenue is collected. There has been a formalisation of what had been relatively informal processes and practices, leading to some reductions in related opportunism. The study, however, also identified the lack of strategic, transformative use of data by the water service provider.

Such incremental impact is mirrored on the consumer side as well in terms of lack of transformative change or strategic data use. This is sometimes explained by the relative recency of a digital innovation and the sense that this may come in time (Heeks, 2018). Given the four-year lifespan of the project to date, however, a more persuasive argument is that this reflects the incremental design of the water ATMs. This fits with recent writings by Amankwaa et al. (2021b) and Wehn and Montalvo (2018), who

found relatively limited impacts or additional value being delivered by digital water systems where they were built on existing systems and provided only limited upgrades.

In the water literature, the broader (re-)configurations evolving from digital infrastructure have often remained in the shadows of analyses, with calls for them to be highlighted more (Chambers and Evans, 2020). Our findings respond to such calls. Despite their generally incremental impact, the findings demonstrate how water ATMs are creating new, or dismantling old, social, material and technological relations. Water ATMs, for instance, have created a new reality and new configurations of water access via three pathways: the exclusion of former vendors and of households that lack water ATM cards or credit; the minimising of social relations at water points; and the changing roles and power relations that were traditionally associated with water access and collection. These materialisations highlight the imperative of context-specific realities that shape water ATMs and how their use, malfunction and maintenance shape the distribution of ecologies and relations (Schmidt, 2020).

Whether creating or expanding relations, practices and power shifts, water ATMs have introduced new realities and infrastructural interactions – something that is not foreseen and attended to in many digital water deployments (Hoolohan et al., 2021). Water ATM services, for instance, have resulted in the involvement of, and shift of power to, mobile operators; as earlier evidence suggests, this has resulted in increased uptake of mobile money services (GSMA, 2020). These deployments often focus on how to create benefits; they overlook how they interface with the old and existing technologies to create new ways of accessing water, and even how they reconfigure connections between users, providers and infrastructures (Chambers and Evans, 2020). If water ATMs are affecting the sociospatial makeup and inequalities of their context, then these issues must be considered in the implementation of the technologies.

Our findings have implications for many actors. We found, for instance, that water ATMs simultaneously alleviate and exacerbate forms of water access inequality for users and other stakeholders; this applies, for example, to women who previously had jobs as water standpipe vendors or water attendants. Households without water cards experience reduced decision-making power about water access; meanwhile, those who have cards have the power to determine how much water to fetch from ATMs and when to fetch it. In such infrastructure configurations, digitalisation thus helps create power relations that weaken or strengthen users' positions based on their access to water ATM cards in relative terms. Another implication is how water ATMs introduce new burdens and overheads by digitalising customer-intermediary-utility interactions, reducing the power of customers to make complaints about infrastructures as well as limiting the negotiating power of users towards water access. As seen elsewhere in the literature (see Alda-Vidal et al., in press), we found that women who were earlier SWN water vendors had lost their jobs through standpipe digitalisation, removing their livelihood and financial role in infrastructural water work. Not only have water ATMs introduced new realities in water access, they have also "designed the vendor out"; replacing women's low-cost labour with small but important implications for increasing gendered unemployment in the community.

CONCLUSION

There is limited empirical scholarship on the impact of off-grid water digital infrastructures such as water ATMs in the urban Global South. In this paper, we drew on a sociotechnical approach, taking insights from the notions of assemblages, everyday life and infrastructural configurations to analyse the implementation and impacts of water ATMs in peri-urban Ghana. This article contributes to wider academic debates on infrastructural configurations and brings into discussion questions around the value to stakeholders of digital water infrastructure.

We showed that the deployment and operationalisation of water ATMs have increasingly been shaped through everyday realities. A case in point is how the functioning water ATMs are based on already existing infrastructures and networks of actors and intermediaries. This study has advanced an argument

that water ATMs – while typically framed and designed to promote the deployment of new service models – are reflective of the ways in which urban infrastructures materialise in different ways and connect existing infrastructure and institutions. This finding echoes the need to situate decisions to implement off-grid digital infrastructure as not just a matter of engaging with the water service providers; rather, such decisions require engagement with the broader institutional environment in which the service provider operates. By showing the everyday impacts of water ATMs, our findings also raise questions about how the value and outcomes of water ATMs as incremental infrastructures may be shaped by their context of actors and interests. Overall, this paper has foregrounded water ATMs as digital innovations that are shaped through everyday realities and attempt to construct a new reality for water service provision; they reflect a shift from former practices, as well as changes in the relations and contestations of water infrastructure access.

This paper is particularly focused on an analysis of water ATMs in a Global South, off-grid location; however, it has broached new insights into broader issues that can form the basis for additional research. The concept of incremental infrastructures is quite well understood in relation to traditional, physical infrastructure (Silver, 2014; Vasudevan, 2015). The research presented here, however, suggests that it also applies to digital infrastructure or, at least, to the integration of digital and physical infrastructure. Not only are digital water innovations seen as incremental; they are also never settled and are always a process in the making of ongoing marginal changes.

Because of the transformative potential of digital technologies, particularly in the Global South where there is much less inertia from already-installed digital infrastructure, there has been greater hope, or perhaps hype, about digital transformation. We see this in the dominant technocratic discourse on smart urbanism that has originated in the Global North and has come to be applied to the Global South (Marvin et al., 2015). Our research makes a small contribution to counter this. It shows how even digital technologies come to be rooted in everyday realities and practices, existing community infrastructures, and the networks and norms of actors and intermediaries. Transformative potential leads some literature to be almost disdainful of incrementalism, regarding it as some sort of failure (Guma, 2020). Our work, though, illuminates not just the inevitability of digital incrementalism but also its value in terms of the viability and sustainability of interventions.

This study also shows how digitalisation of water delivery – including associated datafication – distributes and redistributes costs, risks and benefits between water-system stakeholders. This ultimately demonstrates why a sociopolitical lens is required for the analysis of water digitalisation; that is to say, all of these contribute towards a redistribution of power which further marginalises, or even excludes, some while empowering others who are able to harness the technology or its data. One fruitful angle on this simultaneous alleviation and exacerbation of inequalities may be the incorporation of concepts of justice into analyses of digital water innovations, since this is currently a prime way in which digital is linked to power and inequity (Hoolohan et al., 2021).

In terms of recommendations for practice, this paper underscores the need for a shift of the focus of digital water developments away from just technical approaches and towards a technically, socially and politically informed view of digital water. It also shows a need to bridge the gap between industry visions and the everyday realities of water services. Such visions should accommodate the complexity of change and its social embeddedness across contexts in order to effectively alleviate some of the social inequities that are rooted in water access. Policymakers, donors, designers and service providers, in their design and implementation of development interventions, should focus attention on the ways in which context and power and everyday practice shape the implementation and outcomes of water ATMs. Shifting this implementation and risk-management approach would require major stakeholders such as governments and donor agencies to rethink current and planned investments in ways that adopt a context and risk logic that is focused on managing the politics and uncertainties of water ATMs.

ACKNOWLEDGEMENTS

The authors acknowledge the financial support for this research provided by the School of Environment, Education and Development at the University of Manchester.

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