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Pop-up Infrastructure: Water ATMs and New Delivery Networks in India

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ABSTRACT: Over the last decade, thousands of water ATMs have been installed across the Global South. In India, these vending machines increasingly augment both formal and informal networks of water supply and delivery. This article examines media reports on water ATMs in India in order to survey some of the variance across different water ATM technologies with respect to cost, capacity, and fit with infrastructure networks. It then examines how water ATMs are socially and politically positioned with respect to existing, promised, and incomplete infrastructure projects where they are installed: slums, hospitals, commuting routes, railway stations, rural villages, religious sites, and in 'smart city' initiatives. The analysis considers how water ATMs frustrate the distinctions between formal and informal infrastructure that are often used to describe differences in water networks. The article develops a novel approach to water ATMs as 'pop-up infrastructure' in which the movement of matter is operationally independent from, and only contingently reliant on, existing water delivery networks. Despite their unique aspects, water ATMs produce new common borders among social, material, and political relations to water. These relations are often contested and suggest important areas for future research on water ATMs.

KEYWORDS: Water ATMs, infrastructure, smart cities, urban, rural, peri-urban, India

INTRODUCTION

Over the past decade, water vending machines have popped up across the Global South, such as in Kenya, Ghana, Tanzania, South Africa and Pakistan. Branded as 'water ATMs' and also known as 'any time water' kiosks, these vending machines are significantly augmenting infrastructures of water supply and delivery. The installation of water ATMs has been especially rapid across urban, peri-urban, and rural India; there, thousands of water ATMs can now be found across many states where they are installed near hospitals, parks, schools, temples and tourist sites, as well as on key commuter routes in metropolitan areas such as Delhi, Mumbai, Hyderabad, and Bengaluru. Scores of other water ATMs are distributed throughout slums that are underserved by public infrastructure; there they are often installed to displace informal water networks of private vendors. The growing presence of water ATMs is attracting increased scholarly attention; approaches range from trying to align the social entrepreneurship model that drives some water ATM initiatives with new forms of 'financial engineering' (Macomber, 2013), to assessments of the new types of 'smart technology' used by water ATMs (Sarkar, 2019), to reckoning with installation and uptake challenges (Narayanaswami, 2018; Kumar, 2018). There are, however, few systematic studies that situate the machines amidst larger social, economic or material infrastructures or which examine how the machines differentially affect water relations among the state, citizens and private sector.

This article examines a data set of 370 news items pertaining to water ATMs in India, gathered between 2016 and 2019. In the absence of official data about water ATMs, this study uses data gathered through use of a daily internet search algorithm via Google's alert function. Set to capture any appearance of keywords 'water ATM', the data was then cleaned to eliminate occurrences that were irrelevant to the study (such as Colorado's alternative transfer method – ATM – for water). Recognising that the method does not yield a comprehensive account as many water ATMs have been installed without online news reports, each item was analysed in two steps. The first step catalogued the location of the water ATMs by city (and, where possible, by specific location or neighbourhood), the amount charged for water, the machine's capacity, the installation cost, and the number of installed and announced water ATMs. The second step used content analysis methods to annotate each news item with a qualitative description of the article's main themes, including the agencies or institutions announcing, installing, maintaining, promoting, or contesting water ATMs. Following Krippendorff's (2004) explanation of content analysis as an abductive exercise in making inferences to the best explanation, the study is one of hypothesis generation rather than hypothesis testing. The methods suggest two key limits: the first is that the study cannot, and does not, claim comprehensiveness; the second is that using media reports allows for interpretive insight regarding how water ATMs are framed (see Lakoff, 2010), but only indirectly captures aspects of the use and impact of water ATMs. These limits foreshadow the conclusion, which considers what this type of study suggests for future research.

The second section of this paper situates water ATMs with respect to the entrenched – though increasingly blurred – distinction between formal and informal water infrastructures (Truelove, 2019; cf. Roy, 2009; McFarlane, 2019). I make the case that water ATMs require an approach that does not suppose that they are merely deviations from, or remainders of, either formal or informal water infrastructure. I take this approach, in part, because water ATMs are not confined to the urban networks, dams, or engineering works that often form the core of studies examining formal water infrastructure; however, neither are they adequately explained only as an informal response to the gaps or shortcomings of formal water delivery systems. Engaging a diverse interdisciplinary literature, I define and develop 'pop-up infrastructure' as a conceptual tool for thinking about water ATMs, which are operationally independent from one another and only contingently reliant on existing networks of water infrastructure. The notion of pop-up infrastructure allows for an investigation of how the new spatial, social, and economic dynamics of water ATMs articulate with the machines themselves. Here I draw on the idea of co-production, that "the ways we know and represent the world (both nature and society) are inseparable from the ways in which we choose to live in it" (Jasanoff, 2004: 2). In this case, the notion of pop-up infrastructure allows for an explanation of how the material aspects of water ATMs – their design, technologies and (contested) promise – affect how they are represented in ways that are both formal and informal yet reducible to neither. Pop-up infrastructure also provides two analytical entry points: the first is a temporal juxtaposition of potentially short-lived 'pop-up' sites for economic exchanges for water, against the promise of infrastructure as a long-term material substrate for society; the second considers pop-up infrastructure as a way to think about infrastructures that are purposefully discontinuous with existing water delivery networks and which even cultivate norms disruptive to both formal and informal infrastructure. Despite this disruptive leitmotif, which is typical of what many proponents of 'smart' technologies often claim, water ATMs nevertheless create alternate forms of contiguity – new common borders among physical materials and different social, economic and political relations. The co-production of these new relations depends on factors connected to (but not wholly constrained by) water ATMs themselves, the use, malfunction and maintenance of which shape the distribution of ecologies and relations.

The third section examines how water ATMs are represented with respect to existing water infrastructure challenges and the shifting, contested role of the state within them. Following other studies of how the 'promise of infrastructure' evokes temporal and spatial orderings of future social and material relationships that affect the present (see Anand et al., 2018), I survey how a diversity of such orderings are on offer as water ATMs are positioned with respect to different governance arrangements that intersect across the installation, use, and maintenance of the machines. Socially, many water ATMs are private – public partnerships with government (local and state). Some of these, plus numerous other private initiatives, are an outcome of the 2013 legislation that mandated that 2% of profits go towards Corporate Social Responsibility (CSR) projects in India (Maira, 2013; Sarkar and Sarkar, 2015; cf. Newell, 2005). In this context, the study provides an initial map of how these kiosks fit, or do not fit, with the changing and contested social contract of public water infrastructure. Water ATMs also have economic dynamics beyond being branded through the analogy with bank ATMs. Although some are coin operated, many water ATMs are remotely managed through cloud computing and take payments through forms of smart technology. Frequently, though not always, these are part of smart city initiatives in India, and while some kiosks operate on smartphone applications (apps), the majority rely on smart cards. These payment systems can also require other forms of banking infrastructure that fit with financial inclusion policies, which critics who oppose water ATMs as a form of water privatisation often connect to state rollbacks in the provision of social welfare and public goods.

The fourth section turns to the challenges and contestations of the infrastructural form of water ATMs: the manner in which they pop up is at times designed to fit norms of 'disruption' frequently attributed to IT sectors and cloud-based technologies, biometric monitoring, and the electronic payment systems that are used by many water ATMs. Water ATMs, however, are not always a welcome disruption nor are they always successful even when they are welcomed. Their location, cost and the forms of labour they require is revealing in two related ways: the first is the challenge that water ATMs pose to public infrastructure or the lack thereof, and to social expectations and the right to water service; the second concerns how the burdens of infrastructure are shifted by water ATMs, and the impact this has on how citizens may go about making demands for public goods. The concluding section further develops the idea of pop-up infrastructure and identifies key areas for future research, including an examination of the new calculus of risk and vulnerability that water ATMs introduce to water delivery. Although India represents a prominent case, the infrastructural shift suggested by water ATMs also calls for a more robust examination of these machines elsewhere. Outlining key questions raised by water ATMs provides a tool for thinking about the ways in which new norms of maintenance and care are being layered upon existing water infrastructures, and the role of new technologies in shifting the promises and failures of water delivery.

WATER, INFRASTRUCTURE, AND THE POP-UP

In an influential review, Larkin (2013: 328) states that "[i]nfrastructures are built networks that facilitate the flow of goods, people or ideas, and allow for their exchange over space". Larkin’s (ibid: 329) emphasis on infrastructures as "matter that enable[s] the movement of other matter" fits well with treatments of formal water infrastructure as a physical network that, like roads and electricity grids, forms a substrate for social action. In this review, I examine research on how the unevenness of water infrastructure also affects social relations, or what Swyngedouw (2004) terms 'social power'. Within and beyond India, the control and governance of formal infrastructure is often contrasted with informal means of water access and distribution, particularly with respect to those who are marginalised through intersecting injustices of religion, caste, class, gender, race and ethnicity (see, for example, Baviskar, 1995; Anand, 2012; O’Reilly and Dhanju, 2014; Waldron, 2018; Pauli, 2019). Water ATMs, however, both fit with and challenge the literature that has built up around the formal/informal distinction. After showing how this is the case, the review introduces the notion of pop-up infrastructure.

The physical aspects of water infrastructure have long been central to understanding the formalisation of social, economic, and industrial arrangements regarding water supply and sanitation. Formal, piped water infrastructure for cities, hydropower, and irrigation networks often forms the template for understanding how controlling and connecting physical water systems to populations reflects the aspirations of empire, colonialism, and the forms of direct and indirect social control they entail (cf. Melosi, 2000; Gandy, 2004; Benidickson, 2007; Klingensmith, 2007; Anand, 2012; Carse, 2014; Sneddon, 2015). Geographers have argued that urban water infrastructure not only affects social relations but also makes and remakes nature, from source watersheds to those receiving waste downstream (see, for example, Swyngedouw, 2004; Kaika, 2005; McDonald et al., 2014; Gandy, 2015). Numerous studies of water infrastructure in South Asia identify the spatial aspects of how physical infrastructure is unevenly distributed and itself unevenly distributes water in ways that reflect broader social and political inequalities (for example, Baviskar, 1995; Mehta, 2005; Sultana, 2011, 2013; Alankar, 2013; Birkenholtz, 2013). Bakker (2003, 2010) argued for the 'archipelago' as a spatial analogue for thinking about the discontinuities between formal infrastructure and the gaps and exclusions in which informal networks arise. A more prominent metaphor, however, conceptualises these differences through what Graham and Marvin (2001) describe as a "splintering urbanism" in which infrastructure networks are assemblages. In such assemblages, ideals of standardised and uniform infrastructures give way to heterogenous, hybrid combinations of materials (for example, pipes, water tankers), water sources (wells, reservoirs), and combinations of private or public governance that affect the daily experiences of urban water supply, storm water drainage, and sanitation (Desai et al., 2015; Ranganathan, 2015). Importantly, infrastructure assemblages differ from systems. As Edwards (2010: 12) argues, the distinction between the two is that "the fundamental dynamic of infrastructure development (…) [is] a perpetual oscillation between the desire for smooth, system-like behaviour and the need to combine capabilities no single system can yet provide".

Setting infrastructural assemblages in the context of India, and the Global South more broadly, requires positioning desires for standardisation and "smooth, system-like" behaviour with respect to both postcolonialism and international development (Ranganathan and Balazs, 2015). Many urban centres in postcolonial regions of the Global South have long been characterised by fragmented water infrastructure (see Kooy and Bakker, 2008). It is also no secret that urban water infrastructure in Bombay (now Mumbai), Bangalore (now Bengaluru), and the urban conglomerate itself in Calcutta (now Kolkata) are built on the experiments of British colonialism (Joyce, 2003; Lahiri-Dutt, 2014; Bear, 2015; Bhattacharyya, 2018; Ranganathan, 2018). Projects of empire, and more recently of economic globalisation (i.e. neoliberalism), also affect how water infrastructures are understood with respect to the rights of individuals and communities (Mehta et al., 2014). Anthropologists, for instance, have detailed how those excluded from formal infrastructure networks mobilise water to make material and moral claims for citizenship on postcolonial states; Anand (2017) shows how, in Mumbai, demands made by the urban poor for recognition as citizens frequently mobilise moral and material pressure through demands for water infrastructure (cf. Björkman, 2015). The reverse also holds, as von Schnitzler (2016) demonstrates, when attempts are made to install new forms of water infrastructure that run counter to claims of citizenship, such as the metering of water and the introduction of new water charges in Soweto, South Africa (cf. Chance, 2018). These are especially pertinent considerations owing to how notions of the 'public' that are favoured by international agencies such as the World Bank have layered promises and funding for urban water infrastructure onto earlier colonial developments (Bakker, 2013; see also Rademacher, 2011). In Latin America, water infrastructure is also a site for what Ballestero (2019) describes as an 'ethics of formula' in which calculations by decision makers regarding the costs of delivering water meet the moral economies of water users, notably expectations of reliable, safe, and low cost water service provision.

Infrastructures are not neutral; the 'substrate' they provide is differentially available to, and enforced upon, communities. This produces rifts across scale and time that are relevant to understanding water infrastructure in India, where rapidly urbanising megacities exacerbate demands on peri-urban peripheries, linking water infrastructures across rural and metropolitan spaces (Mehta and Karpouzoglou, 2015). Accelerating forms of urbanism, such as through new smart technologies, are not unique to India's water sector and also affect social and economic relations (see Datta, 2020); as such, processes of rapid urbanisation and the new urban ecologies they co-produce must be examined for how they articulate with existing infrastructural norms and relations regarding identity, gender, and nature (see Rademacher and Sivaramakrishnan, 2013; Mukherjee, 2015). A further need for nuance comes from subaltern urbanisation in India, that is, the numerous new centres that have arisen that are characterised by alternative forms of autonomy relative to those of larger metropolitan centres and existing local – global dynamics (Denis et al., 2012; Sircar, 2018). These subaltern 'census towns' face unique water and sanitation challenges (Hui and Wescoat, 2019); additionally, all of these social dynamics are set in an environmental context in which changes to water availability (quality, timing and quantity) owing to climate change and particulate air pollution are creating new burdens on, and often exposing limits to, existing rural, state, and urban infrastructure in India (O'Brien et al., 2004; Brenkert and Malone, 2005; Srinivasan et al., 2013).

Water ATMs are set in India's complex infrastructural assemblage; they straddle social, political and environmental dynamics in ways that are not adequately characterised by the formal/informal distinction. This is for several reasons. First, water ATMs have been installed across urban and rural locations (often in smaller villages). As such, they require a provisional suspension of the urban ideal whereby formal water infrastructure is a network of water delivery which dissipates in uneven ways from metropolitan cores to peri-urban, and rural spaces. Second, water ATMs are not networked like roads or electricity grids; they provide a substrate for social life that does not constitute the permanent, materially interconnected network usually associated with piped water and, as such, they embody a different temporal horizon. Third, despite their unique aspects, water ATMs are part of many formal state programmes such as private – public partnerships, meaning that they are not informal modes of water delivery either. In fact, the official rationale for water ATMs is often that they can deliver water to poor citizens and marginalised communities that are currently underserved by existing water infrastructure, in that they can undercut the prices charged by informal, private water suppliers or can provide state-sanctioned water services until formal water infrastructure is in place. Fourth, water ATMs individually source and purify water and as such are not vulnerable to the systemic risks of large, continuous networks. This does not eliminate risk; rather, it presents a different risk calculus to water delivery when it comes to issues of water security and vulnerability. Finally, like other infrastructure, water ATMs face challenges over how to standardise their main deliverable: clean, reliable water. This means that the installation of water ATMs by different organisations, using different technologies and a variety of economic and maintenance arrangements, requires rethinking the oscillation between system constraints and infrastructure capabilities. How do water ATMs crisscross formal and informal networks of water delivery? Pop-up infrastructure is a concept designed for thinking to this end.

Figure 1. "Slum residents in Bhubaneshwar use their smart cards to collect water" (The Hindu, 2018a).

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The concept of pop-up infrastructure is, in part, a play on the more familiar notion of pop-up retail, in which small firms open on a temporary basis. The temporal dynamics of pop-ups, however, have also been applied to different government or cultural activities; they provide a way to think through different 'in-between' spaces of social life such as temporary health clinics or the governance of migration (see Harris, 2015; Papada et al., 2019). Similar to pop-up retail, water ATMs are frequently characterised in terms of social entrepreneurship, where private sector innovation is claimed as empowering; as such, they are entangled with broader considerations regarding how new economic ideas affect not only the material delivery of water but also norms of choice, citizenship and responsibility for public goods in India (for a general overview, see Mankekar, 2015). In this context, what distinguishes the concept of pop-up infrastructure is that the movement of matter is both operationally independent from, and only contingently reliant on, infrastructure networks that move similar matter. Water ATMs can 'pop-up' and operate independently of one another, such that malfunctions in one unit have no effect on others, unlike pipes or electricity grids where malfunctions affect the network downstream (or upstream). The units are also only contingently reliant on existing water infrastructure; by this I mean that while in some cases water is sourced from existing water infrastructures, this is not necessarily the case; depending on their design, water ATMs can also source water from borewells, ponds, tanker trucks, rivers, rainfall, and from the atmosphere itself. Despite the features that make them discrete units, however, water ATMs *are* infrastructure; as evidenced below, the units are functionally integrated into the budgeting, design and delivery of state services alongside other infrastructure like housing, schooling, and roads. They are often relied upon to deliver water in ways consistent with the logics of service delivery and public health that characterise piped water infrastructure; politicians and officials lay claim to water ATMs within public policy discourses, citing them as, for instance, solutions to public health crises and school absenteeism and as alternatives to highly priced private and/or informal water vendors. Similarly, when water ATMs fail to function because of breakdown or neglect, those without reliable water demand responses from officials. In this way, in terms of their material and political relations these forms of pop-up infrastructure share with other infrastructure the characteristic of being both ecological and relational. Star's (1999) classic work on infrastructure ties these ecological and relational dynamics to the effects of infrastructure on distributional justice.

Understanding water ATMs in terms of their distributional effects is critical to situating them amidst broader considerations of politics, governance, ethics and the environment. (For an overview of water ethics, see Schmidt and Peppard, 2014.) The media reports examined below frequently make similar claims in order to emphasise the importance of water ATMs, such as by citing the 2018 report by the National Institution for Transforming India (NITI Aayog) which states that an estimated 600 million people are facing high or extreme water stress in India. These were not the only such framings; others include appeals to the UN Human Right to Water and Sanitation, to the need to find ways to reduce the consumption and waste from plastic water bottles, or to broader initiatives like the Sustainable Development Goals (SDGs). Indeed, as tens of thousands of people now queue up to use the machines, the distributive effects of water ATMs, both in terms of their provision of reliable water and their social impacts, position them in ways similar to other challenges of infrastructure and governance; for instance, as the number and type of water ATMs in operation proliferate in India, there are calls for a national policy to standardise and potentially expand this new water delivery model (APN News, 2019). The governance of water ATMs is also complicated by their usage in locations ranging from metropolitan areas to peri-urban and rural areas; there are corresponding political implications from the state through to local gram panchayat levels of government (cf. Wescoat et al., 2019). Finally, in terms of non-state involvement, global investment firms are already testing solar powered water ATMs in slums in order to assess their suitability for climate finance initiatives that address agricultural irrigation in India (Inter Press Service, 2018). In these cases, large-scale water ATMs would replace diesel or electric pumps as part of the international calculus for meeting the climate goals that were agreed to in the 2015 Paris Accord. These new configurations of ecologies and relations mean that although water ATMs are different from existing networks of water delivery in important ways, they also create alternate forms of contiguity; they constitute new common borders with the social, economic and political relations that attend them (cf. Monstadt and Coutard, 2019). Understanding how these new relations are co-produced across the life cycle of water ATMs is critical to identifying areas for further research on how they affect access to reliable, safe water.

WATER ATMS: SOCIAL AND ECONOMIC DYNAMICS

A variety of technological, ownership, and maintenance models characterise water ATMs in India. Different CSR initiatives, state policies, local politics, water demands and existing infrastructures affect if, where, and when they are installed. The unkept promises of previous infrastructure projects also matter, and many official announcements position water ATMs with respect to obligations to deliver safe and reliable water to constituents. Often attended by local and state officials, the inauguration of water ATMs frequently includes announcements of additional units in the future. In these moments, water ATMs share features of what Anand et al. (2018) term the "promise of infrastructure". That is, promises of the bases for social action regarding what water ATMs can deliver in the future are mobilised in the present to facilitate network development. In some cases, the imagined futures water ATMs are meant to provide clash with social expectations, such as when they are offered as alternatives for promised infrastructure that has not arrived on schedule, such as delayed piped water projects. Typically, infrastructure promises are made by states; however, in the case of water ATMs promises may come from numerous sources. There are many private, non-state firms that announce and install kiosks, some of which are part of CSR initiatives; there are also water ATMs installed through public – private partnerships and others by NGOs. To understand these dynamics, this section describes the water ATM as a point of articulation for water infrastructure and examines how its social and economic aspects are represented.

A ubiquitous feature of water ATM reports is their mention of the cost of ATM water. The calculus for water charges varies and often reflects differences of economic geography across urban and rural locations; it can also reflect different private – public partnerships. For instance, in larger centres like Mumbai and Delhi, water ATMs in high-commuter locations like metros and railway stations often charge between Rs2 and Rs5 per litre (US$0.02 to US$0.06), with a surcharge of Rs3 for purchasing a bottle; water is also often available by the glass for a slightly higher per unit rate. These prices are well below bottled water prices but are nevertheless out of reach for many of the urban poor and those in rural areas. In rural areas, prices are often between Rs0.25 and Rs0.50 per litre (US$0.003 to US$0.007), with prices for a 20-litre purchase as low as Rs5 (US$0.07). Most machines include the option of buying 5, 10, or 20 litres at a reduced per litre cost. These larger volumes are indicative of the way in which water ATMs are designed to augment the supply of water to households, with 20-litre bottles (known in many places as 'bubble tops', the blue plastic jugs that are fixtures atop water coolers globally) fillable at lower rates than what is charged by private water vendors. Finally, in a handful of cases water ATMs near schools offer water for free to children who are provided with smart cards that allow 200 to 300 ml per day. Discussed below, there are other cases of free water rations as well.

The costs charged for water are explained in a variety of ways which reflect broader discourses about pricing water to reduce waste and to provide a sustainable model for service delivery. As infrastructure, water ATMs are positioned as a low cost alternative to private supplies, both the 'rickety' water stands on roadsides and capricious water vendors who charge escalating costs in hot seasons (see, for example, Financial Express, 2018a). While coding existing alternatives negatively, water ATMs are often framed in terms of the normative, but unfulfilled, promises of formal, piped water infrastructure. For instance, in August 2018, the year before the city of Chennai made global headlines as its reservoir ran dry, the Avadi municipality announced that it would install 46 water ATMs, each with its own borewell, to serve 40,000 families daily; the ATMs could be accessed using smart cards acquired by registering with the municipality. As reported, sources in the municipality "claimed that this move is to compensate for the

100-crore [US$13.9 million] piped water supply project which is yet to be completed" (The New Indian Express, 2018a). In this case, providing low cost water via water ATMs provides a form of 'compensation' for delayed fulfilments of state infrastructure promises. Although this did not go uncontested, promoters of water ATMs positioned them as a viable alternative to delayed, large-scale piped water infrastructure projects. Alternately, opponents claim that the temporal arguments regarding delays are part of shifting accountability for promised infrastructure development away from the state; for instance, politicians in Bengaluru who inaugurated the installation of water ATMs in slums in the hope of more votes in an upcoming election received a sharp editorial rejoinder from the Times of India (2018a). The paper argued that while the machines offset the "unscrupulous practice" of arbitrary price hikes by private retailers, the machines are a "short-term remedy" to "drinking water piped home". Taken up below, these contestations must also be situated with respect to a variety of different infrastructure costs and cost-recovery models.

A fuller picture of the variegated nature of water ATMs can be gained by looking at machine costs. The per unit and installation costs of water ATM units is typically between Rs6 and Rs10 lakhs (US$8300 and US$13,900). The higher end of per unit installation costs reaches Rs12 lakhs (US$16,600) while some units are only Rs4 lakhs (US$5500). The highest per unit cost in the data set was Rs25 lakhs (US$34,700), and this was in the Avadi municipality project mentioned above. The least expensive units are mobile water ATMs such as those installed on rickshaws; these units only dispense water and do not purify it, and cost about Rs3 to Rs3.5 lakhs (US$4150 to US$4850). These differences reflect a number of factors. First, water purification techniques carry different construction costs. Often reverse osmosis (RO) methods are used in combination with multistage ultraviolet radiation (UV) to purify water and reduce levels of total dissolved solids. Second, water ATMs often have different energy systems and different energy requirements, with some units using solar panels while others are connected to electricity grids. Third, water ATMs have different capacities to produce and store clean water; most of the units were found to have a production capacity of 1000 to 1500 litres per hour, but many smaller ones operated in the range of 500 to 3000 litres per day. Larger units, some of which approximate small-scale community RO facilities, produce up to 40,000 litres per day. Fourth, storage capacities are similarly variable, from small mobile units of several hundred litres to the more common sizes of 1300 to 5000 litres, sometimes with a 'chilled water' compartment of 300 to 500 litres. Fifth, water ATMs take up space; in many contexts, arrangements for installing units often include subsidized or gifted plots of land by the municipality, often plots of up to 400 m^2; in other cases, such as in Gurugram (formerly Gurgaon), private companies who volunteer to build water ATMs on their own premises are offered free advertisement space by the municipal corporation (Times of India, 2018b).

Design differences, different pricing structures, and variance in overall usage mean that the estimated recovery costs per water ATM is two to three years at the low end and three to five years for machines with smaller marginal returns, depending also on factors of maintenance and repair. In many cases, however, installation costs and water prices are just two aspects of media representations of a broader moral economy taking shape with respect to water ATMs. Often set between the ideals of public water delivery and private water sales, this new moral economy also creates new infrastructure promises for local communities. For instance, because water is necessary for life and for a host of livelihood activities and because many of the promises of piped water infrastructure remain unfulfilled, water ATMs are often presented not only as a compromise solution to water delivery but also as a potentially reliable source of employment and revenue. The operation of individual water ATMs usually employs two to three people. In addition to units displaying water quality data on digital screens which consumers can consult, numerous media reports also indicate that having an operator on site engenders trust in water ATMs and increases use. For some CSR initiatives, the aim is to transfer ownership and maintenance to local communities over time. For instance, the firm Tata Steel has set up water ATMs in Bhailgarha village (Jharkhand) near one of its operations. The project is designed to benefit 161 families, with each family paying Rs60 (US$0.84) per month to two women’s self-help groups. This fee provides revenue for the 15 women trained to operate and maintain the units (India Education Diary, 2018). Similar proposals to have water ATMs run by self-help groups in Hyderabad are part of the promise by CSR initiatives to support local economies. In other cases, where different partners are involved, maintenance and operation may be split differently; in Manesar village near New Delhi, the village has provided land and owns the project but Waterlife India has committed to operating and maintaining the water ATM for the ten years following its installation by the Maruti Suzuki company (The Hindu Business Line, 2018). Some of this emerging moral economy is shaped by the machines themselves; for instance, a water ATM set up in Nagpur through a CSR initiative only distributes water in 1-, 5-, or 20-litre increments. Run by a women's self-help group whose members work in shifts to attend to the machine and who have a mandate to not waste water, any purchase in excess of what an individual's container can hold is captured and given away freely, often to students or labourers (The Hitavada, 2019).

One of the effects of these diverse arrangements is that water ATMs do not fit with temporal expectations referenced to promises of public piped water infrastructure; rather, they represent an alternate horizon in which the time pressure presented by failed or delayed infrastructure leads to positioning water ATMs as alternative infrastructure. In other cases, water ATMs are explicitly referenced to the decay of previously functional public standpipes; for instance, after water ATMs were installed in Mumbai's commuter areas, a plan from the Brihanmumbai Municipal Corporation (Municipal Corporation of Greater Mumbai) to install them more broadly in the city was critiqued for having first shut down 2500 drinking water facilities in "the last decade" only to now bring the "same concept back by charging the citizens" (Mumbai Live, 2019). In addition to the issue of water pricing, water ATMs are strongly associated with norms connected to 'smart city' initiatives which use cloud computing to monitor water quality and to track usage via smart cards. These initiatives are increasingly studied by critical scholars for the types of power relations that attend the technologies, infrastructures, and shifting social and political relationships (Datta and Odendaal, 2019). These processes also often reach beyond national borders through networks of global finance; for instance, several social enterprise organisations publicise the investment partnerships and capital inputs of international firms and universities from the United States, Japan and Israel. They also frequently position water ATMs as an innovative technological solution to India's water challenges by citing international sources for statistics on water scarcity and to position water ATMs with respect to various forms of social impact investing or strategies for 'green growth'. For instance, the company Swajal Water has set up about 400 water ATMs in 14 states since its founding in 2014; funded in part through partnerships under the social impact models of the Renewable Energy and Efficiency Partnership (www.reeep.org), it uses an "internet of things" (IoT) model to connect a number of water ATM features. In this case, cloud-based computing allows for remote monitoring of machine operations, including solar energy produced on site in rural locations, as well as the tracking of individual purchases through radio-frequency identification (RFID) smart cards (Financial Express, 2018b). Another company, JanaJal, operated 450 water ATMs across India in 2017 and received US$5 million from the US social impact fund, Tricolor Cleantech Capital (Financial Express, 2018b).

The positioning of water ATMs in reference to information technology has also been facilitated by a number of India's 'smart city' initiatives, such as in a project to digitise Nilavarapatti, a village in the southern state of Tamil Nadu with about 4279 people and 1400 households. After setting up the entire village under the country's new Aadhaar system, which is a requirement for receiving social welfare subsidies, the initiative digitised everything from drivers to milk vendors and customised a water ATM to sell water at Rs1 per litre (US$0.01) (The Hindu, 2018b). More often, however, water ATMs are rolled out in piecemeal fashion even in smart city programmes; in Delhi, for instance, water ATMs have been part of broader 'smart toilet' initiative that includes a number of other services that dispense health and sanitation products (Times of India, 2017a). In at least one case, in Khammam in the state of Telangana, wastewater from a water ATM at the railway station is used in sanitation facilities (The Hans India, 2018). In Hyderabad, water ATMs are part of 178 'loo cafes' that provide a variety of services including banking, washrooms and eateries (Telangana Today, 2018).

Water ATMs also produce new spatial relationships to water infrastructure that reflect a range of social and economic dynamics. Although the companies that produce water ATMs often cite their location in numerous states, the units themselves are often clustered to maximise use or according to local political factors or fear of vandalism; many are placed, for instance, in areas of high footfall on commuter and rail routes and near key tourist sites, temples, schools and hospitals. In water planning in Shimla (Himachal Pradesh), officials asserted that among various piped and water-tanker delivery challenges, water ATMs for tourists should be prioritised (The Pioneer, 2018a). In Haryana (Chandigarh), by contrast, the government announced that water ATMs would be installed "every 400 metres" as part of its policy to provide clean drinking water at public places in cities (Times of India, 2018c). Across this spatial diversity, particular populations are frequently targeted for water ATMs; in urban and peri-urban areas these are often slums, while rural villages are often 'adopted' by different company-led CSR initiatives. In Bhubaneshwar (Odisha), water ATMs were also set up in rental housing complexes built for "migrant construction workers" (Times of India, 2017b). The overall result is that water ATMs, depending on their location, provide water for a number of new infrastructure geographies that range from stopgap measures to piped water projects, to enclaves targeted for new smart city initiatives, to those based on different forms of urban, rural, labouring and tourist mobilities.

This survey of the diverse ways that water ATMs articulate with social and economic dynamics presents a number of insights into these new forms of water infrastructure and foregrounds a number of contestations that they have given rise to. Indeed, one refrain that emerges from social entrepreneurs regarding water ATMs combines claims for decentralised water provision with a rejection of one-size-fits-all solutions to water challenges (Business Today, 2019). The positioning of water ATMs as bridging centralised and decentralised water provision can also be seen in terms of what Datta (2019) refers to as the temporality of the 'moral state'. Here, the past promises of piped water infrastructure and the waiting and petitioning that attends them is augmented by promises of newer, faster rollouts – new temporalities – of water delivery that fulfil state obligations to provide water; for instance, when water ATMs are packaged as part of smart city initiatives that are envisioned with respect to anticipated futures, water ATMs become part of both finding a solution to unkept infrastructure promises and changing the nature of what keeping those promises looks like. In this sense, they augment existing moral economies of piped water provision. Contestations over such shifts come to the fore in particularly stark form when water ATMs do not deliver as promised. Before moving on to consider contestations over water ATMs, it is worth highlighting that water ATMs are frequently described as 'fully automated' and manageable remotely through computing technologies. In this sense they are framed as smooth-running systems, but as infrastructure they require upkeep. As such, CSR-installed water ATMs often target women-led self-help groups as a source of labour and then frame this work as entrepreneurial empowerment. As Kar’s (2018) study of urban microfinance shows, however, the 'empowerment' of women through new entrepreneurial programmes often produces new demands for labour that are highly gendered. In the case of water ATMs, not only does water still need to be carried home from them, but the technical discourse of 'maintenance' does not capture the types of care that these new technologies require or the relational work entailed in organising this type of work (see Wajcman, 2000; Suchman, 2007). Further, there are potentially significant social ramifications associated with uncritically extending ideals of empowerment to water infrastructure; for instance, previous research on women’s self-help groups in India has revealed the challenges in confronting the gendering of water provision as feminine while infrastructure is marked as masculine (Panda, 2015). The next section considers some of the new physical and social contiguities that water ATMs produce.

WATER ATMS: CONTESTATION, DISRUPTION, AND DISREPAIR

The water ATMs popping up across India are not always a welcome addition to the infrastructural mix. This section highlights a number of contests that have been reported. These reports do not exhaust or fully capture contestations over water ATMs, but they do provide a basis for generating hypotheses regarding where and how new ecological and relational dynamics are co-produced in response to water ATMs (which is taken up further in the conclusion). Here the focus is on explanations of where and how water ATMs are situated amidst existing ecological and relational infrastructures of water provision. One theme cutting across these concerns has to do with how media reports characterise the nature of water challenges in India and use global statistics and international sources of knowledge production alongside stories that present water ATMs as a legitimate infrastructure option. I begin with an example.

In September 2018, the Bhubaneswar Municipal Corporation (BMC) announced that despite having 40 water ATMs lying unused or defunct, it would install an additional 50 machines (The Telegraph, 2018). Controversy had dogged the water ATM initiative from the start as officials promoted water ATMs as a viable response to an outbreak of jaundice. In December 2016, the BMC had announced a partnership with a private firm for a five-year contract to provide water ATMs in slums, where 2500 smart cards were to be distributed and holders could purchase up to 20 litres of water per day for Rs0.30 per litre (US$0.004) (Times of India, 2016). By January 2017, the deadline for the water ATMs was already forecast to be missed, an especially concerning outcome given the public health crisis that had sparked calls for action and to which the first water ATM trial was credited as a solution; although four water ATMs had been procured, they had yet to be installed (The Telegraph, 2017). Throughout the spring of 2017, water scarcity in Bhubaneswar kept water ATMs in the news as the capacity to deliver water was strained (OdishaTV, 2017). By April, water ATMs were being installed but were not well used, which prompted trials of free water with a deposit of Rs25 for a smart card (Times of India, 2017c). In addition to locations in slums, water ATMs were installed in parks, a new social equity centre, migrant labour rental units (mentioned above) and, in response to the demands of a student union, near the Rama Devi Women's University (Orissa Diary, 2017; Times of India, 2017d, 2017e). Barely 18 months after the flurry of activity had begun, however, the 40 water ATMs sat idle as the ideal of pop-up infrastructure faltered. The Bhubaneswar case points to a number of considerations regarding the costs of water, the uptake of new technologies for water delivery, and the location and maintenance of water ATMs through private contracts for ostensibly public goods. A similar story took place in Ranchi, the state capital of Jharkhand, where a private company charged with installing ten water ATMs missed deadlines, forcing the state to re-tender contracts for a planned rollout of 141 kiosks (Daily Pioneer, 2017).

What happened in Bhubaneswar? Like other forms of infrastructure, there were delays in construction; in addition, some of the units had been installed incorrectly and did not function properly. Both delays and malfunction are common enough to water infrastructure projects, but there were other factors as well. First, the uptake by users was slow. Eventually, the idea of charging a deposit for smart cards was abandoned and a publicity push highlighting free water was undertaken. Next, the local government committed to an additional 50 new water ATMs as a solution to municipal challenges, again with a private firm but with changes to maintenance and a firm-led publicity campaign. Here, the government displayed a kind of temporal envisioning of the future that is common enough to infrastructure projects that do not initially succeed but which continue to be pursued. By 2019, the increase in daily consumption through water ATMs in the city was around 12,000 litres, with individuals allowed ten free litres per day (Orissa Post, 2019a). Free water only explains part of the change, however; another significant factor was a targeted redistribution of where water ATMs were located, from those favoured by the company that had been contracted to install the units to locations where demand was higher (Orissa Post, 2019b). One report highlighted that a water ATM installed near a transgender slum not only provided more accessible water (individuals often had more than one card allowing for additional free water) but also aided in health and sanitation (Citizen Matters, 2019).

The decision to make some of the water from Bhubaneswar's water ATMs free highlights one important contestation. Charging for water, even at the subsidised prices offered by water ATMs, is often criticised as a creeping form of commodification. Water ATM operators report that when first installed, or when first encountered, many customers demanded free water. The South Asia Network on Dams, Rivers and People (SANDRP) argues that "ATMs are essentially a way of privatising water supply" (The Hindu, 2018a). Here, water ATMs fit more broadly with critiques of water supply as a business, a position long advanced by international expert networks and development agencies within and beyond India as the mechanism for delivering 'water for all' (Goldman, 2007). These international discourses frequently find place in the framing of water challenges, with citations of the Sustainable Development Goals alongside statistics on the tens of millions of people in India lacking sufficient water. Yet the picture is more complicated than previously studied forms of water privatisation; for instance, when the city of Guwahati (Assam) announced 20 new water ATMs, a protest by the Mohanagar Unnayan Samity organisation drew attention both to the fact that water is a human right and that the smart city pitch for water ATMs was an attempt to "hide the gross failure of not completing (…) four mega drinking water projects" that had been started in 2009 and were still only 50% complete (The Sentinel, 2018). Similarly, different ownership models transferring control to communities offer 'public' water a new social valence that pivots from the state. Operating under a UN-sanctioned *Global Green Growth Initiative*, for instance, water ATMs in Savda Gherva slum (New Delhi) are intended to form "decentralised, neighbourhood solutions" (Inter Press Service, 2018). These solutions promise water at a fraction of the price that many urban poor currently pay, which creates space for new explanations of the 'moral state' that, while not providing equality in public service provision, claim water ATMs as a means towards that end.

Contestations over costs do not only revolve around pricing water; there are also considerations around the machines and the community-run schemes themselves. A women's self-help group in Suradevi, a village in Maharashtra, reportedly earned Rs500,000 (US$7000) in six months from water ATMs by selling water commercially, in part owing to an agreement that a private company would provide free maintenance during the first year (Times of India, 2017f); it is when maintenance arrangements come to an end, however, that the challenges of water ATMs mount. For instance, reports indicate that of the 16,000 water ATMs built in the state of Karnataka, there are over 1000 that are dysfunctional, and estimates of the number of units that are not working are as high as 2400. These machines earn about Rs3000 per month (US$42) on average, but the uneven costs of running them and the lack of clear maintenance contracts result in many being uneconomical. For instance, although most of these water ATMs generate enough revenue to cover electricity costs (Rs750 per month; US$10.50), many require frequent and expensive changes to the membranes; these membranes wear out from purifying hard water sources and cost approximately Rs30,000 (US$420). Owing to the decentralised local panchayat governance, there is contestation over potential redistribution schemes that would use funds from more profitable units to maintain costlier water ATMs. In this case, where several thousand jobs are also now attached to the units, proposed solutions often fall back on calls for the state to house water ATMs under a single government agency (The Hindu, 2018c). The other solution that some advocate is charging more for water in order to cover the maintenance costs and to end the provision of so-called 'cheap water'. Here, local and state governments face infrastructure dilemmas familiar to water governance: reliable delivery of water, the redistribution of revenue, the maintenance of infrastructure, and the security of employment for people working in the water sector.

The locations of water ATMs are also contested and, as the machines become more established, maintenance issues are increasingly important. Local residents in Delhi, for instance, worried that the planned installation of water ATMs near popular footpaths would lead to large queues that might force people to walk on dangerous roadways (The Hindu, 2018d). Only after activists protested the encroachment of the units onto public space did officials require the contractor to relocate the water ATMs (The Hindustan Times, 2019). In Lucknow (Uttar Pradesh), the inauguration of 20 mobile water ATMs that were designed to provide employment to differently abled people was delayed when police and the regional transport office were reluctant to register e-cart units to individuals without driving licenses (Times of India, 2017g). In these and similar cases – such as opposition by private vendors whose livelihoods may be threatened by water ATMs – both the physical and social spaces of water ATMs matter critically to the distribution of social and material goods. These locational differences also matter with respect to technology and the remote management of water ATM units via cloud computing. One of the arguments for smart card payments, for instance, is that it makes machines less susceptible to vandalism and theft. Many local residents may resist water ATMs not only because they do not want to pay for water but because they do not understand or trust either the technology or the "agency responsible to maintain" the units (The Pioneer, 2018b). Similarly, maintenance involves a host of local and remote considerations, from ensuring adequate water and energy supplies to individual machines, to changing membranes and filters, to managing wastewater produced during the purification process, to delivering on the promise that cloud computing and remote monitoring can reliably ensure the quality of water and schedules for upkeep on water ATMs. These concerns all centre on the new kinds of risks and vulnerabilities that water ATMs introduce to water delivery networks. In Chennai, for instance, water shortages in 2019 meant that free water promised via water ATMs was not available to people who had ration cards that allowed them 20 litres per day (The New Indian Express, 2019). Both location and maintenance are key aspects of the distributional effects – both relational and ecological – of actually moving water through water ATMs.

CONCLUSION: CARING FOR POP-UP INFRASTRUCTURE

Water ATMs are pop-up infrastructure. They operate independently from one another, are only contingently reliant on infrastructure moving similar matter, and create new relations and ecologies as they distribute water. Representations of the machines in media reports co-produce new contiguities as both formal public water infrastructure and that of private vendors are situated alongside CSR initiatives, start-ups infused with global capital, women's self-help groups, cloud-computing technologies, smart city initiatives, and delayed or abandoned piped water infrastructure projects. The considerable diversity in the design of machines, the contexts in which they are installed, and their representation in the media provide a partial picture of how water ATMs produce new social, material and technological relations. The variability and range of conditions under which water ATMs are installed and function also provides impetus for a broader research agenda to further study these machines in India and elsewhere in the Global South. In this conclusion, I outline areas for research in which justice, ethics and care should be intrinsic to future research on water ATMs. To this end, I follow anthropologists who treat water as a total social fact; in this approach, water is a phenomenon that is so fully embedded in society that a change to one element of its ecology and relations – its physical and social infrastructure – creates knock-on effects for a host of other social institutions (Orlove and Caton, 2010; cf. Mauss, 1990).

The conceptual value of pop-up infrastructure is that it provides a tool for thinking through how ecologies and relations are manifested through water ATMs in ways that are crucially different from those of other types of water infrastructure. First, as pop-up infrastructure, water ATMs are not intended to cross from the public to the domestic sphere; in this way they contrast sharply with piped water connections or electricity grids that enter into homes. Nor can a similar demand for distributional justice be appropriately applied to them; the nature and capacity of water ATM units is such that they serve catchments of commuting, shopping, tourist, labouring or neighbourhood populations and not individual residences. While water ATMs may constitute a type of infrastructure that is out of place with respect to the norms of piped water delivery, they are solidly in place from the perspective of pop-up infrastructure as a discontinuous assemblage of operationally independent points designed to enable matter to move to the end user. Second, although water ATMs are only contingently reliant on other water infrastructure, they are nevertheless entangled with a variety of non-water infrastructures. These connections vary, but a common and important aspect of water ATMs is their connectivity by cloud computing to information infrastructures and electricity grids for water monitoring, economic transactions, and the power required to purify and dispense water. Frequently positioned with respect to the 'internet of things' (IoT) and to India's broader programmes regarding smart cities (see Datta, 2015; Kumar, 2019), advocates of water ATMs often situate them as a positive, disruptive and entrepreneurial force with respect to existing normative expectations regarding the physical connectivity of water infrastructure. They are, however, often contested for precisely these reasons; water ATMs facilitate the co-production of new norms that may displace infrastructure promises for, and obligations regarding, the provision of water to citizens. Third, water ATMs require water. The micropolitics of how and where water is sourced can create significant variance at the scale of hours, days, weeks and months, depending on the reliability of supply, the capacity of the machines themselves, and their installation and maintenance. Treating water ATMs as pop-up infrastructure provides a tool for thinking through local politics without naturalising notions that the ecologies and relations of each machine are idiosyncratic, or that decentralisation is best pursued through forms of entrepreneurship that are premised on claims that there is no one-size-fits-all model. Understanding water ATMs as infrastructure allows for a broader approach to understanding their diverse effects on ecologies and relations. Finally, water ATMs augment temporal expectations of infrastructure in two ways. On the one hand, they are often framed as a stopgap measure through which to deliver water in lieu of the completion of large waterworks; on the other, water ATMs create new expectations. They articulate with both the drive for modern 'world-class' international cities and with shifting and uneven modes of delivering state welfare subsidies through new forms of banking and financial infrastructure (see Ghertner, 2015; Lahiri-Dutt, 2015a; Kar, 2017a). In this sense, pop-up infrastructure also allows water ATMs to be conceptually connected to developments in urban, peri-urban and rural India beyond the water sector and with respect to the politics of the city, of public welfare, of labour and of gender.

The maintenance requirements of water ATMs suggest that they are also matters of care that crisscross social, material, and technological relations (cf. Puig de la Bellacasa, 2017); for instance, media stories on water ATMs reference issues of water quality and public health, from the jaundice case cited above to the reduction of school absenteeism by 90% where solar powered units have been installed (India Today, 2018). Like other new technologies, the work required for water ATMs to function is not free of human labour even if it is represented as such; Günel (2019), in her study of how solar panels in the deserts of the Arab Gulf are dusted off by hand, shows how 'fully automated' technological solutions often require various types of labour. Social scientists have yet to study in detail the distribution of social relationships that come into play with the installation of water ATMs; these relationships constitute a driving concern that is unique to water ATMs as 'pop-up infrastructure'. In practice, the target population for the maintenance work that water ATMs require is frequently women's self-help groups, who are themselves framed through discourses of social entrepreneurship in CSR initiatives and the media. Like other programmes of women's empowerment, however, understanding the gendered nature of labour and care for water, and the role of water ATMs in household economies – including the shifting calculus of risk after pro bono maintenance arrangements expire – is critical to understanding initiatives promoting such entrepreneurship (cf. Kar, 2018). Further, the diversity of arrangements for water ATMs means that general theorisations about the types of care required to maintain the machines will not be sufficient. What will matter is understanding how the specificity of different contexts, different environments, and intersecting relational differences articulate with multiple actors and social relations, from states, to NGOs, to corporate CSR initiatives, to public – private partnerships. These each have different effects on the delivery of water and on how caring for water ATMs will affect promises of other infrastructure such as reliable and safe piped water connections.

Water ATMs also entangle water provision with new infrastructures. Notably, the evolution of software technologies and electronic payment systems has been eyed warily in media reports, which compare failed water ATMs to India's fraught programme on demonetisation (The New Indian Express, 2018b). The vulnerabilities and risk calculus for such technologies combine with the shifting governance logics regarding the delivery of social subsidies through new forms of banking infrastructure; the reduced cash availability for the poor, and often particularly for women, is a significant effect of the shift to smart technologies and should be taken into consideration in an overall analysis (Kar, 2017b). In this context, the installation, location, maintenance and cost arrangements of water ATMs all have distributional effects on justice; for instance, the promise to provide water to catchments rather than to households does not alleviate the (typically gendered) work required to haul water for daily domestic uses (Lahiri-Dutt, 2015b); neither does it address the types of social inequalities that have rendered other public sources of water inaccessible based on issues of caste, ethnicity, race or religion. Shifting distributions of responsibility for water delivery are a key area for further study both in cases where water ATMs provide a measure of success in meeting moral and material obligations for service provision and where their installation may delay or defer equality in public water delivery.

Finally, water ATMs are also increasingly part of global networks operating at the intersections of capital, climate, and governance. Locally, water ATMs are often given an environmental rationale in terms of how they will reduce the use of single-use plastic water bottles, such as by railway passengers (e.g. The Navhind Times, 2019). More broadly, raising funds for 'green growth' through international financial networks or receiving legitimation through UN-sanctioned programmes means that water ATMs must also be understood globally; in this context, the use of social impact bonds and the potential for selling credits on foreign carbon markets means that the claimed utility of water ATMs as a response to climate risks must be closely scrutinised. Decentralised water provision shifts the distribution of water risk and vulnerability but does not eliminate it. This is of particular concern owing to the requirements of markets themselves, which standardise exchangeable units (i.e. CO_2 equivalents) in ways that can potentially have a significant and unequal effect on local contexts where water ATMs are installed. Further, the social dynamics of international arrangements for funding initiatives operate on norms and principles that are often at a distance from the many different sociocultural institutions and contexts where water ATMs are installed elsewhere in the Global South: Kenya, Ghana, Tanzania, South Africa, or Pakistan. Under the banner of climate resilience, global discourses of 'water security' and the 'water – energy – food nexus' are driven by international financial networks and modes of governance that shape their municipal-level strategies (Schmidt and Matthews, 2018); like other studies of this relationship between international finance and local action, research into water ATMs must carefully scrutinise the types of arrangements through which water infrastructure is financed and delivered (see also Williams et al., 2019). Decentralized infrastructure that nevertheless reinforces top-down initiatives linking environment and economy often create power contests within local water economies. Further, the control of water ATMs that operate independently and in remote locations can also create new security challenges such as who controls the machines and who benefits from controlling access to them.

Water ATMs are an increasingly important part of social life in urban, peri-urban and rural water delivery networks but there has not yet been a sufficient academic study of them. This study has surveyed how water ATMs are represented. In practice, it is vital to understand the material and moral aspects at work in the politics of who gets water and how; water ATMs, however, also harbour a diversity of temporal characteristics and physical capacities that challenge received understandings of what infrastructure is. The notion of water ATMs as pop-up infrastructure helps to identify these. Water ATMs also shift the distribution of employment and sociopolitical relations around water delivery networks; these shifts occur across the lifecycle of procurement, installation, and maintenance. At each stage, and as water ATMs proliferate in number and type, different types of responsibilities and obligations arise. As pop-up infrastructure, water ATMs suggest that a significant new kind of contingency is increasingly underpinning the ecologies and relations that affect the essential place of water in social, economic and individual life. Across and throughout the new social, material and ecological contingencies associated with water ATMs there are new risks, vulnerabilities and ethical concerns regarding the networks and infrastructures that move this life-giving substance.

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