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Rethinking the economics of rural water in Africa

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Abstract Rural Africa lags behind global progress to provide safe drinking water to everyone. Decades of effort and billions of dollars of investment have yielded modest gains, with high but avoidable health and economic costs borne by over 300m people lacking basic water access. We explore why rural water is different for communities, schools, and healthcare facilities across characteristics of scale, institutions, demand, and finance. The findings conclude with policy recommendations to (i) network rural services at scale, (ii) unlock rural payments by creating value, and (iii) design and test performance-based funding models at national and regional scales, with an ambition to eliminate the need for future, sustainable development goals.

Keywords: Africa, drinking water, Sustainable Development Goals, water policy

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I. Introduction

The economics of providing drinking water appear simple and compelling. Drinking water is a human necessity with a daily demand and no real substitutes, with the scale

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of service delivery lending itself to a natural monopoly, which should lead to financial sustainability. Yet, appearances are often deceptive. Globally, 2.1 billion people lack 'safely managed' drinking water, including 785m people without 'basic' drinking water services, of whom four out of five live in rural areas (UNICEF/WHO, 2019). Though the majority of the rural water-insecure live in Africa and Asia, there are also small and enduring geographies of exclusion elsewhere in the world, including Australia, Europe, and North America, disproportionately affecting indigenous people and ethnic groups (Sadler and Highsmith, 2016; Filčák *et al.*, 2017).

Policy instruments for universal drinking water are well established but difficult to execute. The Sustainable Development WHO devote one of their 17 targets to universal and safe drinking water for everyone by 2030. This is a daunting challenge given only one in five countries below 95 per cent coverage in 2015 is on track to meet basic drinking water services by 2030 (UNICEF/WHO, 2017). Basic drinking water services are specified as improved sources within 30 minutes of the household and secondary to 'safely managed' drinking water services, which are on-site, on-demand, and free of contamination (*ibid*). The latter reflect the piped water standards in most industrialized countries and conditions where there are economies of scale, effective regulation, population density, and affordable tariffs. In rural Africa, rarely do these conditions hold.

The estimated, annual capital costs of delivering safely-managed drinking water in rural areas in Sub-Saharan Africa by 2030 is estimated at over US$5 billion per year, higher than costs for urban delivery in any other global region, including industrialized regions (Hutton and Varughese, 2016, p. 14). As a proportion of gross regional product, the cost of basic water services in Sub-Saharan Africa is estimated to be more than three times higher than any other region (*ibid*). This gloomy arithmetic compounds the region's pedestrian progress compared to the rest of the world, with over 336m rural people living without basic drinking water in 2017 (UNICEF/WHO, 2019).

The ambition of the Sustainable Development Goal includes schools, hospitals, and healthcare facilities, which are not covered in estimated global costs of delivery (Hutton and Varughese, 2016). The first global assessment of water supply coverage in facilities estimates 29 per cent of rural health facilities without water services in 2016 (WHO/UNICEF, 2019) and 42 per cent of rural schools without water services (UNICEF/WHO, 2018). What these figures point to is the greater scale and scope of the Sustainable Development Goal challenge in addition to the well-established monitoring of 'household' access to drinking water. Unsatisfactory progress in supplying drinking water to rural African communities over decades, with a new focus on water for rural facilities, presents an unprecedented scale and scope of the challenge where rethinking the economics of rural water in Africa may contribute to improving economic design of policy interventions. We explore why rural water is different, identifying characteristics of scale, demand, institutions, and finance..

II. Why are the economics of rural water different?

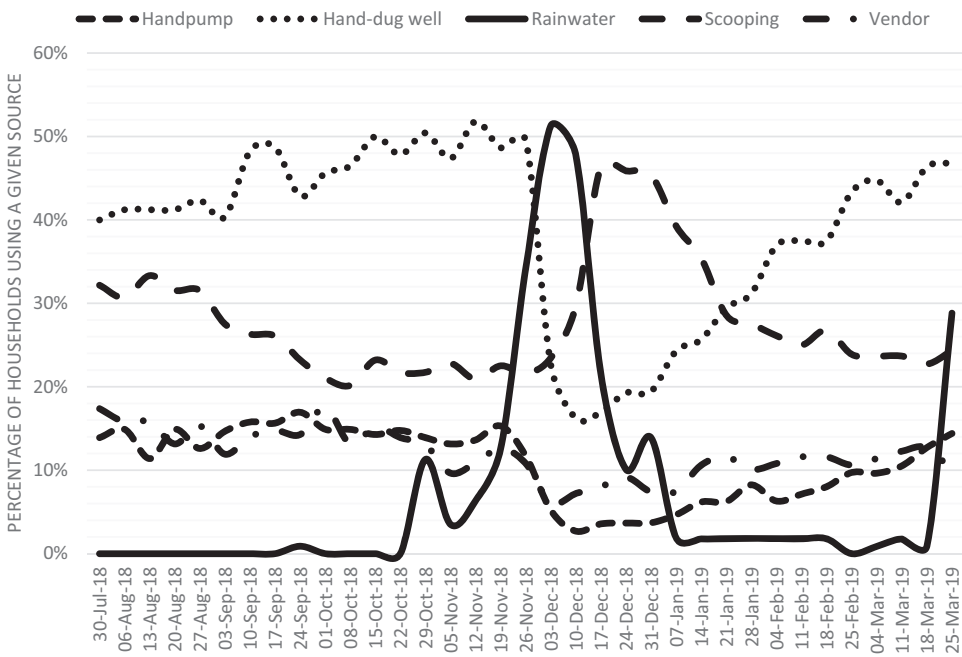
Any articulation of rural water policy must take into account that the economic challenge differs from urban water supply in terms of scale, demand, institutions, and finance. First, the scale at which rural water delivery has been executed has largely been that of the community level, with a few hundred people served by one waterpoint, in

contrast to the network of urban piped systems serving many thousands of people. In effect, rural water policy transfers operational, institutional, and financial risks to individual communities (Hope and Rouse, 2013). Pooling these risks is increasingly feasible with institutions and service providers, which bundle multiple waterpoints supported by information from the rapid advance of automated monitoring systems using *in situ* sensors (Thomson *et al.*, 2012*a*; McNicholl *et al.*, 2019; van der Wilk, 2019).

Scale is both a physical and institutional phenomenon. A piped network is as much an institutional construct as a physical artefact. The formal and informal rules which are devised to contract, license, price, and regulate the delivery of drinking water to an urban population can be applied in a rural context. What differs is the degree of institutional coordination across the delivery network. For example, multiple rural settlements can form a network of supply nodes managed and regulated by a rural service provider (or utility) under public, private, or hybrid ownership and management arrangements. The institutional design of the information and monitoring systems will differ from a singular piped network, but the architecture of designing rules, contracts, and agreements is fundamentally the same.

Second, rural water demand fluctuates as households choose between multiple, off-site waterpoints of differing quality from rainwater harvesting, dug wells, handpumps, ponds, kiosks with public taps, vended water, or private tap connections. The notion of a singular water supply as monitored through national representative surveys used for global monitoring simplifies the complex choices people make on a daily basis (Figure 1). Individual

Figure 1: The fallacy of a singular, rural drinking water source—daily water sources chosen by households in rural Kenya, July 2018–March 2019



Source: Sonia Hoque and Rob Hope.

choices are shaped by dynamic interactions between water cost, price, and value. Rainfall variation, groundwater quality, and other environmental factors influence demand by season and location. In particular, productive use of domestic water supplies is common, with high demand for watering livestock in times of drought (Elliott *et al.*, 2019). Third, institutions for rural water rarely allocate or manage risks and responsibilities effectively. Fragmented waterpoints are not networked in a coherent architecture of planning, management, and monitoring. Institutional accountability is often low, service delivery is unquantified and largely unknown, and infrastructure fails regularly and is fixed slowly (Foster *et al.*, 2019; McNicholl *et al.*, 2019).

Finally, finance and funding to meet the ambition of the Sustainable Development Goals requires new ideas on how sector funds from government, donors, and users are generated and allocated to create and sustain verifiable outcomes. With one in four rural waterpoints broken at any one time and two in three rural people not paying for water, the investment case relies more on the moral imperative rather than economic logic (Mattes *et al.*, 2008; Foster *et al.*, 2019). With reducing information asymmetries made possible through technology, performance-based models are becoming a possibility and institutional accountability more tangible (Thomson and Koehler, 2016; McNicholl *et al.*, 2019). Institutions and information which reveal and improve coordination problems reduce the separation between government, the private sector, and water users, which is a key aspect of rethinking rural water policy (Koehler *et al.*, 2018).

III. Policy positions and economic challenges

(i) Defining policy positions

The case for universal and safe drinking water services as a non-discriminatory, public service is founded on cumulative evidence of economic, political, and health benefits for society (Langford and Russell, 2017).

The hazard and costs of unsafe water on life and productivity demonstrate the critical role water plays in all societies which seek to flourish. Ensuring safe and adequate water was an existential priority in Mayan, Persian, Mughal, and Roman societies, which spurred innovations in the institutions and infrastructure, and inspired the municipal, public piped systems that largely remain with us today (Scarborough, 2017). The failure to deliver safe water creates significant health costs for the rich and poor alike. As a consequence, public finances have been marshalled in major infrastructure investments over the last 150 years, of which some of the earliest remarkably remain functioning, though creaking and leaking, in many cities today.

Given the public benefits, but the uncertain private incentives to invest, an ideal public policy would aim to ensure no one is excluded, and drinking water use by one person does not diminish use by another. For example, Kremer *et al.* (2011) make the case for infrastructure investments in natural springs in rural Kenya, which are estimated to reduce faecal contamination by up to 66 per cent, with child mortality falling by one-quarter. This reflects drinking water as a merit good, justifying public provision where individual choices may lead to underconsumption with social costs from public health costs in addition to the private burden.

Progress to achieve this public policy goal has been slow and uneven. The world met the Millennium Development Goal (MDG) 3 years early, with 89 per cent of people with 'improved' access in 2012, increasing from 84 per cent in 2000. Inevitably, this separated the industrialized world from developing regions, and urban from rural (UNICEF/WHO, 2017). For example, in 2015, the base year for the Sustainable Development Goals, the North America and European region remained at a constant 99 per cent coverage of improved access compared to Sub-Saharan African, which increased from 45 to 58 per cent. In terms of piped water supplies, North America and Europe had 94 per cent coverage in 2015 (89 per cent in rural, 98 per cent in urban) compared to 24 per cent in Sub-Saharan Africa (17 per cent in rural, 56 per cent in urban). Behind the avalanche of metrics and targets are the enduring inequalities and policy puzzles of how to improve and sustain universal and safe drinking to leave no one behind. The Sustainable Development Goals (SDG) take up the challenge of the narrower MDG focus on developing regions and proportional reduction in inequalities to a universal SDG creed of universality and non-discrimination.

Public policy has been influenced by the ideology of drinking water as an economic good and water as a human right, with tensions between individual rights and consumer choices (Seymour and Pincus, 2008) and increasingly the metaphysical and cultural nature of water (Strang, 2004; Zenner, 2019). The Dublin Statement on Water and Sustainable Development (United Nations, 1992) identified managing water as an economic good as one of four guiding principles as part of inter-governmental preparations for the UN Conference on Environment and Development in Rio de Janeiro later that year. The explicit recognition of the value of water and managing water as an economic good with affordable pricing made reference to drinking water as a basic right. However, the narrative positioned economic considerations ahead of legal rights, consistent with the prevailing policy and practice of demand management and the faith that market forces and consumer choices could allocate scarce resources efficiently. Such an outcome-orientated approach is consistent with the instrumental nature of economic thinking and evaluating social choices by results. In the historical context, this was also in a time of significant political upheaval in Africa and Asia, where national governments were often inheriting limited public services geared to serve a minority, colonial elite which lived predominantly in urban settlements.

A decade later the United Nations Committee on Economic, Cultural and Social Rights adopted General Comment No. 15, which explicitly recognized an international human right to water and sanitation. Departing from a consumer-choice approach, the general comment treated drinking water as a social and cultural good with non-discriminatory access and affirmed the rights of individuals and groups, particularly women, to participate in decision-making. In 2010, the United Nations' General Assembly, through resolution 64/292, recognized the human right to water and sanitation, and acknowledged that clean drinking water and sanitation are integral to the realization of all rights (UNGA, 2010). The right to drinking water is achieved by non-discriminatory access to sufficient, safe, physically accessible, and affordable services. In 2015, the SDGs devoted one of their 17 targets (SDG6.1) to universal and safe drinking water for everyone by 2030. This global political commitment acknowledges the substance of the human right without the legal obligation.

The political resolution of the human right to water and sanitation had the support of 122 countries with 41 countries abstaining. A number of the largest and longest financial supporters of development assistance to water abstained in the vote, including Canada, Denmark, Japan, Sweden, UK, and USA (UNGA, 2010), mainly for procedural rather than substantive reasons. The resolution has no binding legal force which raises the question on the degree to which the type of social or economic exclusions are most suited to a legal right. For example, it has been argued that: 'the exercise of freedom and protection of rights is proportional to the strength and institutional organization of civil society' (Osiatyński, 2009, p. 71). In the context of 'fragile states' where government may be an impediment to more accountable and legitimate provision of basic services, the role of civil society may be as—or more—important in service delivery, particularly for marginalized and vulnerable groups. This is acknowledged by advocates of the human right to water who recognize 'a human rights' perspective is not a solution by itself' (Langford and Russell, 2017, p. xvi).

(ii) The economics of rural water

Rural waterpoints provide services to communities, schools, clinics, hospitals, and other facilities. The SDGs set targets and metrics to monitor rural drinking water progress primarily under SDG6 (drinking water) and SDG4 (learning environments). Progress is being made to harmonize data and reporting, but structural and procedural issues emerge from the national level in policy, planning, finance, and management, which provide some indications as to why rural water has not been historically considered as a networked system of rural waterpoints. The political economy of this situation lends itself to valuing what we measure rather than measuring what we value, belying people's daily drinking water choices. People drink water at home, in markets, at school, or at a health clinic. For a child with safe water at home but no water at school, current monitoring may tell us the letter of global progress but not the spirit of global ambition. Here, we focus on the economics of community water supply but return to the facilities issue, which is a critical dimension of how we may rethink rural water policy.

Rural water supply in Africa is commonly characterized and documented by community management of a shared, off-site water supply system used by a few hundred people for domestic, and often productive, purposes with limited to no regulatory oversight. This simple caricature disguises a number of economic and policy issues that guide progress towards improving services and reducing inequalities. Matters are complicated by demographic, climatic, economic, and political considerations, all of which also have an influence on rural water demand.

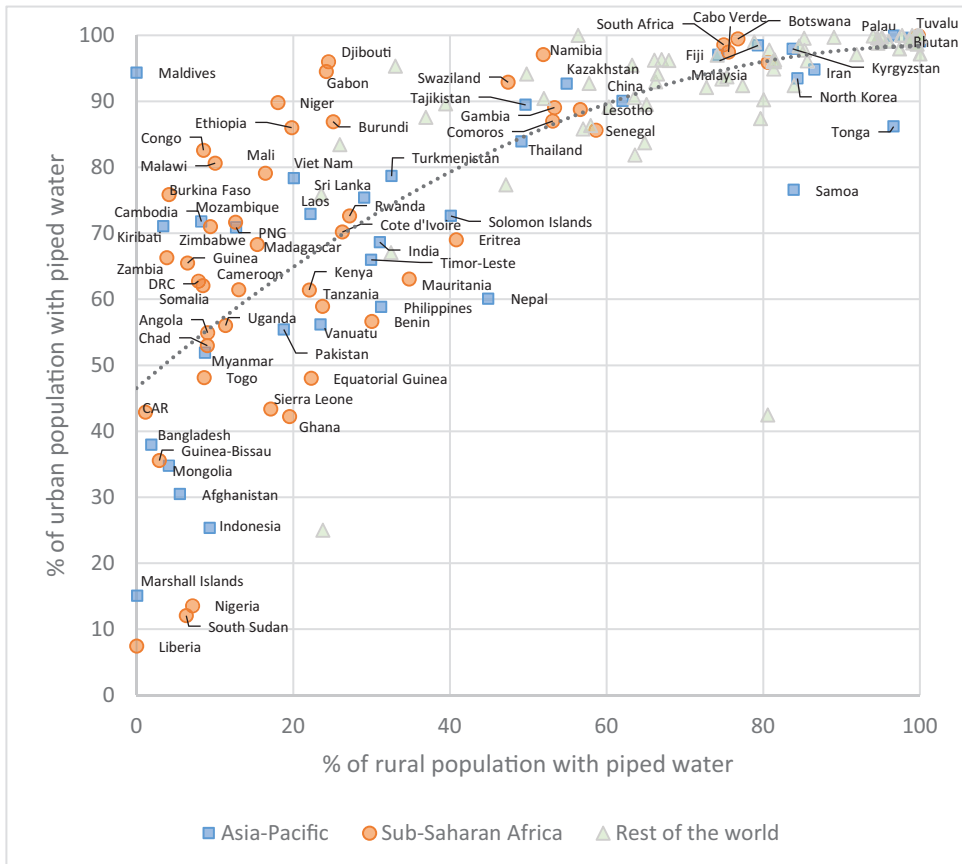
Scale and population density are necessary conditions for urban piped schemes where high-quality services can be delivered to the homes of many thousands of people. The economic logic of one supplier to avoid duplicating costs (storage, treatment, delivery, waste, billing, customer services) makes it a natural monopoly, which can reduce costs and raise standards for consumers, if properly regulated. Rural water at the community level lacks scale and provides a lower-quality service due to the physical time and effort required to collect water from off-site supplies, such as handpumps or kiosks.

A logical aspiration may be to service rural areas with piped water. History gives a note of caution concerning the prospects of piped water as a response for rural areas. In

the 15 years to 2015, piped coverage in rural Africa increased 4 percentage points to 17 per cent. In comparison, the Central and Southern Asian region increased rural piped coverage by 1 percentage point to 29 per cent. In the same period, piped water coverage in urban Africa fell 11 percentage points to 56 per cent. The Central and South Asia region also had a reduction in urban piped water coverage by 5 percentage points to 67 per cent (UNICEF/WHO, 2017, p. 105). Hard-fought gains were ephemeral and the prospect of universal piped water coverage, particularly in rural areas, has an uncertain foundation if history is any guide to the SDG future. Plotting urban versus rural piped water for Africa and Asian countries, there is a tendency for rural piped provision to lag behind urban access (Figure 2). While a static illustration, it suggests individual waterpoints will remain a major component of rural water infrastructure during the SDG period, with the most remote and often vulnerable populations dependent on their performance.

The difference in capital costs between piped water systems and individual waterpoints varies substantially. Where reliable surface water is available with storage and

Figure 2: Mind the gap—urban and rural piped water coverage in Africa and Asia in 2015



Source: The authors, using data from UNICEF/WHO (2017).

gravity flow, the relative costs of piped water are greatly reduced compared to pumping groundwater. The energy costs of pumping using diesel or grid electricity are major variable costs. Again, they will vary by depth and type of system which is shaped by local hydrogeological systems with low pH or saline groundwater requiring stainless steel pipes to avoid corrosion. The rapid advance of solar pumping has created an opportunity to reduce some, but not all, of these energy costs. In the lowlands of Ethiopia, boreholes can be drilled to 1 kilometre or more to reach groundwater with costs proportional to depth. In contrast, handpump-equipped boreholes are often drilled between 20 and 70 metres with a region of US$10,000 per installation. Water testing and appropriate treatment is required in most national policies but not monitored or regulated effectively. These costs are minor compared to installation and operations, but critical in contexts with harmful chemicals such as fluoride or arsenic, or where salinity limits user acceptability and payment.

Often piped water tariffs are lower than those of handpumps. However, averages are misleading as the seasonal spike from droughts can escalate water prices to over US$20 per m^3 for weeks, making it more expensive than piped water in Tokyo, New York, or London. More commonly the figure of US$1 per m^3 is considered a break-even baseline for piped water schemes in urban Africa (Banerjee and Morella, 2011). This figure broadly aligns to the rural price for water from piped schemes or handpumps. However, demand is not constant and often piped schemes and kiosks are not operated in wetter periods to reduce labour costs. This muted and seasonal demand—and payment—for rural piped water has made the economics of piped provision difficult without an exclusive service area and sufficient demand, or an agreed subsidy. It is not uncommon in urban and rural contexts for energy costs to be subsidized by government for political purposes, masking the true cost of delivery. The well-rehearsed case of South Africa providing a free 'human reserve' of $6m^3$ per household per month after the end of apartheid promised social reform guided by political rather than economic logic, and this has been reproduced in the political calculus of elections in other countries (Koehler, 2018). Water has, and will likely always remain, a political as well as an economic good with bleak prospects for any policy which does not recognize this.

The economics of pricing rural water is inevitably political, but has often lacked sufficient attention to the characteristics of varying user demand, despite early evidence of the challenge (World Bank, 1993). Seasonality of demand has also been recognized but not adequately addressed in water pricing and infrastructure choices. There is increasing empirical evidence that users largely use waterpoints in the dry season and their local payments are biased to this period. There are common rural payment approaches including pay-as-you-fetch, pay-when-breaks, monthly fee, or no payment. In the coastal Kenyan context, roughly half of households pay a monthly fee, a third do not pay, a quarter pay-as-you-fetch, and the remainder pay-when-breaks. The pay-as-you-fetch model generates more revenue, leads to more expenditure, and has an overall higher net income than the alternatives, and critically leads to 10–20 fewer downtime days per breakdown (Foster and Hope, 2017).

The productive use and payment relationship suggests a 'water-pays-for-water' hypothesis. The idea is that water used for economic activities, such as watering livestock or small-scale irrigation, would generate income to be available to pay for the water services. Households who reported using waterpoints for small-scale irrigation or watering

livestock have revealed more regular payment behaviours in Kenya (Foster and Hope, 2016). The sometimes narrow conceptualization of waterpoints as sources of domestic water ignores this key characteristic of water demand, particularly in semi-arid or arid landscapes where pastoralism is a major livelihood activity. Recent advances in automated monitoring of rural waterpoints reveals major increases in usage patterns in drier spells and drought conditions when alternative supplies are no longer available (Nagel *et al.*, 2015; Thomson *et al.*, 2019). Another positive predictor of payments is waterpoint proximity which relates to demand and avoidance of the considerable time costs of walking to and queuing for water, largely by women and girls. The criterion for 'basic water' is collection should be no more than 30 minutes for a round trip to reflect not only the distance but the time costs, particularly in times of scarcity and increased demand on limited infrastructure.

Affordability is a key determinant of pricing which remains a concept in search of consensus (Hutton and Andres, 2018). Setting a price which secures an acceptable water service at a reasonable price and does not prejudice consumption of other basic services is not simple. With an estimated two out of three rural water-users in 19 African countries not paying for water (Mattes *et al.*, 2008), there is compelling evidence that infrastructure supply weakly aligns to consumer demand. One bench-mark of an affordable price has been estimated to be 3–5 per cent of total household expenditure (UNICEF/WHO, 2017). However, this benchmark only has value if you have relevant data for monitoring and regulation.

Regulating affordability is well-established in industrialized countries but almost entirely absent in rural Africa. Setting an affordable tariff is a balancing act between legal obligation, policy coherence, political expediency, economic efficiency, and social inclusivity. These forces rarely push in the same direction all of the time. Economic regulation of drinking water services must be an independent and enforceable institutional function to be able to hold government to account. Where regulation is absent or merged into policy or service delivery functions it creates a conflict of interest: the incentive to mark your own homework favourably is strong.

(iii) Institutional design and performance

Institutional design is central to the economic performance and social outcomes of rural water services. Institutional design affects the management of operational risks and information flows, asset ownership and management, service delivery models, monitoring and regulation, and financial sustainability. The contextual nature of these issues is influenced by climatic, environmental, and cultural factors.

Water security is an outcome measure of the interactions and trade-offs between water services and water resource systems (Grey and Sadoff, 2007). It will vary by social and environmental context with recognition of how climatic and hydrological conditions influence and shape water service delivery. Managing competing demands from agriculture and industry are also relevant for sustainably delivering services over time (Ferrer *et al.*, 2019). The SDGs consist of distinct targets: safe and affordable drinking water for all (SDG6.1); improving water quality (SDG6.3); increasing water use efficiency and reducing water scarcity (SDG6.4); and protect and restore water ecosystems (SDG6.5). The complex interaction between these targets and the means of reaching

them make it inevitable that some actions towards achieving one target may diminish progress on others.

Institutions can promote solutions to such coordination problems. However, this is a non-trivial challenge which promotes the idea of a locally appropriate and politically acceptable water security outcome. In rural contexts, water access, pollution, scarcity, or competition will vary in significance and salience promoting a locally defined, water security outcome. Institutions offer the formal and informal rules to identify, collect, and share information, create incentives, and sanction behaviour. This may be strengthened through existing social and cultural norms, codified by law and contracts, and scaled through adapting and adopting best practice.

Community management has been the primary institutional model for rural water in Africa since the 1980s (Arlosoroff *et al*, 1987). The burden of risk is located locally and is independent of other similar waterpoints, effectively putting all the risk on to individual communities, often those least equipped to manage that risk. Many waterpoint risks are often idiosyncratic, so insurance logic suggests pooling these idiosyncratic risks to reduce them, although this will not reduce systemic or chronic risks, such as drought, or saline intrusion into coastal groundwaters. Economies of scale would also suggest that pooling waterpoints and managing them collectively rather than individually is likely to be more efficient and effective. Economies of scale would accrue from allocating responsibilities, and specialization in professional maintenance and management which would reduce the local costs subject to the scale of operations and information asymmetry. Emerging evidence suggests performance can be improved through such a model, reducing breakdown times from a month or more to less than 3 days (McNicholl *et al.*, 2019).

Improving the allocation of institutional, operational, and financial risks depends on reducing information asymmetry and understanding the political economy of the sector. Information asymmetry may influence institutional design due to the tyranny of distance (Blainey, 1966). When first conceived, community management was a principled and pragmatic response given few alternatives in rural Africa in the 1980s. Today, with the increasing reach and reducing cost of information transfer, the assumptions of three decades ago no longer hold, making fragmented community management certainly no longer necessary, and arguably no longer desirable. For government and donors, limited to no data has meant billions of dollars of investment have largely been under-evaluated in terms of whether the goals of translating infrastructure (means) into water services (ends) have been achieved.

Measuring performance by expenditure has now been replaced with the growth of spot-checks as illustrated by a dataset of over 400,000 waterpoints visited in Africa in the last decade or so (Foster *et al.*, 2019). This represents an incremental step with data providing an asset inventory, but gives limited insight to service performance, and is not a useful management tool given that the data are out-of-date almost as soon as they are published (Thomson, 2012*b*). In the context of Africa's data advances in the rapid expansion of mobile networks, mobile handsets, and mobile money platforms since 2007, continuous monitoring through *in situ* sensors and monitors have been piloted on handpumps in rural Africa since 2011 (Thomson *et al.*, 2012*a*) with trials showing that these new data streams can support operational units with simple but effective estimates of hourly or daily usage (Nagel *et al.*, 2015; Thomson *et al.*, 2019).

The value of these data, which must be considered against the additional costs of continuous monitoring, are three-fold. First, accountability is enhanced in the performance and sustainability of infrastructure investments. Accountability works at multiple levels in terms of a principal investor (donor, government, NGO) knowing the system is working and what level of usage is being achieved against expected performance. In addition, data sharing can allow a regulator to monitor performance to determine if investments are being made wisely, given competing alternatives. Publicly shared data can reduce the prospect of 'white elephants' as all stakeholders from tax payers, citizens, and users, to governments and investors can validate that claims are matched by results. This need not be universal in monitoring all systems but could sample random or sentinel waterpoints including critical public infrastructure, such as schools, clinics, and places of worship.

Second, planning can become more transparent. Without information on observed demand of waterpoints, it is left to political processes to decide where a new investment is located. This is an imperfect process at best with evidence that elite capture is common. Further, where infrastructure is used heavily there can be a case of upgrading to a higher service level. The additional costs may be justifiable based on the demand and current financial performance. Improving planning will improve accountability and provide a platform for an improved investment case.

Third, reducing information asymmetry lowers or reveals financial risk for existing and non-traditional investors. The investment case for rural water has been largely met through large public transfers for decades, mainly through overseas development assistance. While this is justifiable on several grounds, the results have not attracted non-traditional investors, partly due to the vacuum of even the most basic information on sector performance, such as a country knowing the number or location of water supply infrastructure. The moral case has long outweighed the financial or economic case. Africa needs to urgently improve its operational performance and financial case for investment. Improving efficiency of current infrastructure and management of existing funds is the first place to start, rather than a flawed logic of seeking greater budgets to be spent in the same haphazard fashion.

Asset ownership and management arrangements also influence prospects for rethinking the investment case. The existing stock of handpumps in Africa is around 1 million corresponding to about 8 billion US dollars of invested capital. This is a vast public transfer which has occurred in a largely uncoordinated manner over several decades. UNICEF is one of the main agencies investing and supporting rural water services in over 50 countries with an estimated investment in rural water supplies of roughly US$1.7 billion between 2006 and 2015, split evenly between humanitarian and development assistance (UNICEF, 2018, p. 47). UNICEF is candid in stating that the 'monitoring and reporting system is not set up to track the sustainability of achieved results' with a 'growing body of evidence which is still scattered and of sub-optimal quality' (UNICEF, 2018, p. 141).

In contrast, most government and non-government organizations do not report investment expenditure or discuss monitoring. The majority of rural waterpoint assets are transferred from government to communities in Africa. While it is assumed that these assets become community owned, this transfer can be legally questionable, and there is evidence that waterpoints can be then privatized by the individual or family on

whose land the pump is located, or the waterpoint becomes a club good with a membership group controlling access on membership, financial, or other terms (Koehler *et al.*, 2015). These terms may be equitable and inclusive, but there is limited information or monitoring by government, donors, or other stakeholders to identify and correct exploitation or exclusion.

In this context, the decision to improve the management and performance of waterpoint service rests with local owners. It is therefore a voluntary decision rather than an obligation for the local water-users to consider or contract external service providers, if they exist. While community waterpoints can be well managed, there are well-documented cases of poor financial management where fees are collected but not available when needed due to challenges in storing and managing cash prudently and honestly. The incentives for local managers to divert a source of regular cash income from their community of users to other uses are real. The process of changing ownership from community to government is feasible but slow and political, as in the case of experience in West Africa (Ndaw, 2015). Contracting procedures could progressively address asset ownership and contracting challenges if government and donors adopted a networked and long-term approach to monitoring and managing rural water services at a sensible operational scale with exclusive service areas. Information asymmetry reproduces poor practice with investment decisions driven to increase infrastructure access rather than water service sustainability.

Performance-based, service delivery models have emerged in rural Africa despite the unfavourable institutional environment (Narkevic and Kleemier, 2010; McNicholl *et al.*, 2019). West Africa, with a more established culture of private-sector engagement in the water sector, has made more progress than the public-sector approach common to much of East and Southern Africa. It is important to note that the private sector nests within an institutional framework led by the government and, though far from perfect, allows performance to be evaluated and improved over time. Monitoring and regulation is also emerging but has been of marginal interest for decades as the common conceit is that rural communities are superior in delivery systems than professional urban utilities which have always required regulation. In part, this is an economic logic of delivering water services at least cost in rural areas. Institutions cost money and take time to build. Monitoring is not costless and though least-cost approaches are being introduced through spot-check monitoring this often targets narrow political concerns for perceived value-for-money in donor countries and does not guarantee building long-term, local capacity and information systems to be sustainable.

(iv) Financing rural water

Financial sustainability for the rural water sector has long-recognized sharing costs between government, donors, and users. What is now labelled as blended finance or hybrid finance (Money, 2018) was anticipated in the International Decade of Drinking Water Supply and Sanitation in the 1980s (Falkenmark, 1982). The challenge has not been to recognize the different forms and share of funding to finance rural water but to develop the institutional arrangements to allocate financial and operational risks and responsibilities to deliver sustainable services. Community-based management was transparent in its early institutional model, with donors and governments funding the

infrastructure and communities paying for operation and maintenance. Information asymmetry largely disguised the unsatisfactory nature of the model which did not predict the challenges for communities raising and storing local funds for unpredictable breakdowns, with limited or absent supply chains for spare parts across often unstandardized waterpoint technologies. Operational efficiencies were consequentially low with more funds spent on 'training' communities to do better which ignores the limits of the model and repeats investment mistakes.

Allocating financial risks and responsibilities more fairly and efficiently requires institutional and information investments to meet three primary conditions. A first condition is institutional enforcement of a coordinated infrastructure system in terms of managing existing investments and planning new interventions at an appropriate political or geographic scale. This is a government responsibility which has been distracted by donor influence in short-term infrastructure projects rather than institutional strengthening and coordination. A second condition is to deliver a satisfactory level of water service delivery for which users will pay at least a share of the costs on an ongoing basis in a wider network of delivery coordinated by government. Local water-users must recognize and know that everyone is being treated equally with a socially acceptable approach to recovering costs. A third condition is to implement effective monitoring and regulation of service delivery and financial management, including user payments. The latter will determine financial options in terms of improving current funding allocations to optimize donors meeting priority obligations to reach the most marginalized and not cannibalize specific cases where commercial or impact investors may crowd-in new funds. For example, this may include larger rural, piped systems serving a few thousand rather than a few hundred people. In addition, non-traditional finance for performance-based outcomes from private sector supporting SDG delivery or the new portfolio of solidarity funds linking water-related consumption in industrialized countries with social outcomes in developing regions. Without credible monitoring and verification these new funds are not tractable.

A value-based logic would promote improved understanding of financial risks and returns. In the absence of information the risk calculus is unknown, potentially misallocating low-risk finance to high-return investments. For example, international donors with an explicit mandate to reduce poverty may inappropriately allocate funds to support or underwrite large, rural piped schemes where there may be a case for commercial investment. Concessionary finance would not compete with commercial finance to support remote and scattered waterpoints where there is no commercial case for investment, but where the social and economic case is compelling and consistent with development mandates.

IV. Policy priorities

Three policy priorities emerge from our analysis. First, networking rural services to reflect the opportunities of scale, advances in monitoring technologies and data to support and guide regulation and policy, and to promote professional service delivery providers. This is a daunting challenge in a dynamic environment of donors, NGOs, philanthropists, researchers, and more, all trying to 'do good' with often large short-term

investments and limited future accountability. Governments are often painted as corrupt and inefficient, working with inadequate local budgets leading to dependency on external funds and patronage; until and unless government and public action have the means to coordinate a more accountable system, the prospects for progress look dim. Second, unlocking water payments for consumers requires creating value. Contrary to a least-cost model for rural water, more emphasis should be on understanding and responding to consumer demand, as well as monitoring and eliminating inequalities and discriminatory practices. Third, where value is created and services delivered and monitored, performance-based funding models provide one pathway to longer-term, financial sustainability. None of these three proposals is simple, but each is being advanced separately, and in combination they provide a coherent and replicable policy framework to progressively achieve sustainable services at scale.

(i) Networking rural water services

Rural water institutions need to develop networked services with inclusive and sustained social impacts. A core argument we make is that institutional fragmentation in the design, funding, and delivery of rural water creates minimal value for rural consumers. Recognizing the opportunity of networked services in policy and law is a foundational step in seeing rural water as delivering safe water services to people at a relevant political scale rather than building infrastructure with uncertain user demand, limited financial sustainability, and inadequate management. Scale matters in designing an exclusive and coherent water supply network that includes community, healthcare, schools, and other rural facilities. We have documented emerging evidence that maintenance service providers can provide professional services for one million rural water consumers in Burkina Faso, Central African Republic, Kenya, and Uganda (McNicholl *et al.*, 2019). However, any realistic path to sustainability at scale requires overcoming governance challenges and creating value for water consumers to unlock payment behaviours.

A lack of institutional accountability is one characteristic of government failure in rural water service delivery. Authority ultimately rests with government to ensure accountability, and while this may be absent, weak, or divided, it is a necessary condition to determine the rules and liability for accountability. While authority may be easy to locate in a central ministry, accountability chains become opaque as multiple ministries and levels of government often take part or full responsibility for delivering drinking water services. Sub-national government may not be fully accountable to central government, particularly with decentralized authority and responsibility that features across much of Africa.

The large and fluctuating constellation of non-government actors from donor agencies, NGOs, foundations, academia, faith-based groups, and private enterprise also influence accountability pathways. Some of these actors act as *de facto* government in rural areas providing water services. The coordination challenges are daunting as local priorities may buffer against external goals, the latter often commanding larger budgets. The political economy of these differing interests often shapes policies and interventions which may poorly serve rural water users. The '*anti-development state*' thesis (Lockwood, 2006) points to elite capture of resources as investments are allowed to fail and the plight of the poor soon attracts another project's investment and contracting

cycle. Without government accountability and commitment, prospects in the future are unlikely to be any brighter.

Accountability through greater transparency in information and reporting is now increasing, though slowly. Africa's rapid adoption and application of mobile technologies has proved how to reduce information asymmetries and financial transaction costs through mobile payment systems. Governance structures are less adept but essential in harvesting and sustaining these potentially large institutional benefits. Sentinel exemplars to illustrate progress and delivery of universal service delivery at scale will be a necessary and politically motivating platform for wider awareness and adoption. The barriers to adoption are real and entrenched, with a decadal time-frame a narrow window to redress and transform rural water systems accustomed to failure and disappointment.

A more inclusive institutional approach would consider the role of markets and the private sector to complement the existing focus on government and communities (Koehler *et al.*, 2018). If an outcome-orientated approach is favoured, market dynamics offer a least-cost solution to deliver these goals guided by clear policy and regulation. Reallocating risks and responsibilities between institutional actors, particularly reducing the burden on communities, supported by regulation and monitoring, would be a major departure from current thinking and practice in much of Africa, notwithstanding examples of notable progress in some countries.

Rethinking the institutional landscape suggests there is a credible space for rural utilities to act as a regulated monopoly providing networked services. Following the argument of networking multiple waterpoints, a contracted and exclusive service provider would offer expertise and economies of scale in maintaining and managing a portfolio of existing and new water supply infrastructure. Government would licence a rural utility using performance-based contracts to ensure reliable, safe, and accessible services, tailored to the local financial, environmental, and political context. Facilities such as schools, hospitals, clinics, and places of worship may provide the initial architecture to build out services to benefit neighbouring communities over time. This institutional approach is premised on two conditions: (i) water users value and pay for improved services, and (ii) performance-based models can attract long-term and sustainable funding.

(ii) Unlocking payments by creating value

The political economy and behavioural economics of why rural people pay for water is critical in delivering and sustaining networked services. The paradox of water supply infrastructure investments in delivering an essential public service but creating limited value for consumers based on their payment behaviours is a matter requiring careful examination. Dismissing non-payment due to affordability alone is a partial and unsatisfactory response (Hoque and Hope, 2019). A behavioural approach would focus first on the water services people value and will pay for (Hope, 2015; Hope and Ballon, 2019). This may not neatly align to external policy perspectives and received wisdom, but is an essential characteristic of redefining practice to promote more sustainable outcomes. The gendered inequalities in rural water services would place a particular emphasis on understanding the characteristics of water provision which create value

for women and girls (Das, 2017). Within a budget constraint, which aspects of water quantity, quality, proximity, and reliability are the priority preferences of consumers, particularly women and girls, and how may these be constrained or modified by intra-household dynamics and power relations?

The replication of urban water tariff systems in terms of monthly payments does not align to rural economies with regard to seasonal peaks of work, income, and rainfall. Infrastructure investments which assume a regular, daily consumption over time also do not reflect rural practices. Designing services around local demand and value may identify alternative models which may create higher value and promote financial sustainability. Non-payment for water services has important implications for affordability and water pricing. Do people not pay because they have no service, cannot afford the service, or do not value the service? Water-use behaviours are poorly understood and relate to the political economy in a household where cooperative conflict may lead to gendered inequalities in intra-household decision-making. Women and children disproportionately bear the negative externalities of a lack or failure in a safe, reliable, and close water service. Whether the household consensually decides to under-invest in an improved water source and internalize potential health or immediate travel costs is a matter of uncertainty. Assuming payments are contingent on service delivery, there may be an understandable logic why people choose not to pay.

The economic compass of rural water needs to transition from a least-cost approach to one of value creation. This requires a political and institutional shift, with governments taking a more accountable and authoritative role in ensuring investments create and sustain value for consumers over time. With information asymmetry everyone can hide in the dark by intention or by chance. Value has political salience when aligned to user preferences. The payment made by rural consumers for a quantified service level provides a compelling and verifiable metric of value.

(iii) Performance-based funds for networked services

Unlocking the payments of the rural poor will support progress in designing performance-based funding models. The political discourse in estimating the global funding deficit fails to adequately recognize the current poor performance in delivering and sustaining water services in rural Africa. With cross-country estimates indicating an operational funding gap of up to 90 per cent for rural handpumps (McNicholl *et al.*, 2019), there is a need for more realism on the nature and scale of the subsidy needed to sustain services and develop new management models. A rural water subsidy can be performance-based, and progressively reduced, if governance systems promote networked services that benefit from economies of scale, both in geographic scale and to include rural facilities, with a priority on delivering consumer value to increase user payments over time.

Government contributions for operational costs will require political acceptance of a network services' approach and a shift from building to also maintaining infrastructure. Donors and civil society groups will have political influence in supporting, deflecting, or ignoring a coordinated approach in funding networked services. This shift is a non-trivial exercise where claiming ownership of a new and tangible intervention, albeit short-lived, is easier to communicate to domestic funders and tax payers compared to

membership of a less glamorous but collaborative intervention, and likely better value for money.

Performance funds will require blending government, consumer, and other funds in an accountable and acceptable, long-term financial vehicle. The growing interest in output-based funds from development partners and social investment funds provides a platform for designing funds based on transparent metrics of service performance consistent with government policy and priorities. The emergence of Water Services Maintenance Trust Funds in Kenya suggests there is private-sector support for performance-based funding provided government and rural people contribute and the results are objective and verifiable. Performance funds will—and should—hinge on user payments and service delivery metrics which are now realistic with *in situ* sensors and mobile money systems.

Monitoring incurs additional costs which need to create equivalent or greater value. A wider conceptualization of the value proposition by financial, economic, and social impacts would be achievable with improved data quality. With most waterpoints failing within a handful of years from construction, extending the lifespan of infrastructure through professional maintenance services for the projected duration would increase the financial return on investment. Ancillary benefits would likely accrue in terms of reduced collection times, avoidance of water tankers during droughts, attracting higher user payments, and avoiding unnecessary capital investments for replacement infrastructure. Further, decision-making for rehabilitation, upgrading, or new infrastructure provision would be informed by quantifiable data on operational and financial performance. Where demand and need were greatest, or water scarcity or water quality risks are higher, planning and investments could avoid the mistakes of the past and promote a more accountable and legitimate approach. The challenge and opportunity in the immediate future is to demonstrate, validate, and replicate performance-based models at scale which can create value to rural people, ensure institutional accountability with local political acceptability, and provide sustainable finance for decades rather than years.

V. Conclusion

For policy-makers it would be ill-judged not to worry about water policy in rural Africa and to think as the continent is rapidly urbanizing that the rural challenge will therefore be more tractable in the future. While trends clearly point to major growth in small towns and cities, by 2050 there will be an estimated 909m people living in rural areas, a 43 per cent increase compared to 2015 (UNDESA, 2018). Add to this context the predictions of climate variability and extremes, where floods and droughts will place water supply infrastructure under enormous pressure, and may increase unpredictable population movements from water-related stress and conflict, then the rural context matters greatly from the point of view of human decency and social cohesion, and, by consequence, political expediency. By recognizing that rural water in Africa has specific characteristics by scale, institutions, demand, and finance, we argue that rethinking the economics of rural water will prioritize policy to (i) network rural services at scale, (ii) unlock rural payments by creating value, and (iii) design and test performance-based funding models at national and regional scales with an ambition to eliminate the need for future, sustainable development goals.

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