

Akallah, J.A. and Hård, M. 2020. Under the historian's radar:
Local water supply practices in Nairobi, 1940-1980.
Water Alternatives 13(3): 886-901



Under the Historian's Radar: Local Water Supply Practices in Nairobi, 1940-1980

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ABSTRACT: By presenting oral history material from two informal settlements in Nairobi, Kenya, the article illustrates how inhabitants during the period 1940 to 1980 acquired and used water on a daily basis. The authors' observations challenge established paradigms in the history of technology as well as Science and Technology Studies (STS), most notably the Large Technological System (LTS) model. To understand the realities of the supply situation in cities in both the Global North and Global South, we must look beyond such systems; historians must complement material from official archives, utilities, ministries and other authorities with further sources. Interviews with urban inhabitants can help us to modify standard LTS perspectives, and the experiences of ordinary citizens can enable us to develop an alternative view of 'urban resilience' as a concept. Rather than passively being supplied with the necessities of daily life by public or private providers, inhabitants themselves successfully acquired those necessities. Interviews indicate that, compared to customers with access to the centralised water system, so-called slum dwellers exhibited a relatively high level of resilience in terms of water provision.

KEYWORDS: Water provision, large technological system, history of technology, Nairobi, urban resilience

We had a wheelbarrow, we had some debes (metal containers), so I used to go to the river and fetch water for the home. (...). So water was not a problem [I-MS].¹

INTRODUCTION

Since the 1983 publication of Thomas P. Hughes' *Networks of Power*, historians of technology and scholars in the field of Science and Technology Studies (STS) have successfully employed the concept of 'large technological system' (LTS) to analyse the establishment and growth of modern networks of provision in areas such as energy, water, communication and transportation (Hughes, 1983). Authors have convincingly shown how complex energy, water supply, telecommunication and traffic networks have contributed to the making of the modern world (van Laak, 2018). Whereas some researchers investigate the importance of local infrastructure to the expansion of cities, other researchers take a regional, national or even transnational approach (Summerton, 1992; Kaijser, 1994; Högselius et al.,

¹ Detailed information about our interviews can be found at the end of this paper. Interviews are referred to as, for example, '[I-MS]' (interview with Mwalimu Suleiman) and are listed at the end of the text using these initials. Interviews were recorded and transcribed. To guarantee anonymity, all interviewees have been given neutral names. The choice of interviewees was done purposefully on the basis of age, gender and knowledge of the subject. The researchers and their assistants used their personal contacts to identify the individuals believed to possess the relevant information. Before participation, the purpose of the research was explained to interviewees, and they gave their consent. In advance, we had received a research permit from the Kenya National Commission for Science, Technology and Innovation (NACOSTI).

2016). Common metaphors in this literature are evolution, development, and momentum (Hughes, 1987). As in other areas of the history of technology and STS, an overwhelming majority of works present case studies from Europe and North America.

In this article we complement the existing literature on the history of technology and STS by investigating the history of water supply and usage in low-income areas in Nairobi, Kenya. On the basis of interviews with inhabitants of informal settlements, we show how people managed to acquire water despite not having access to the centralised water provision system. Our focus is on the period from the 1940s through the 1970s. We argue that the concept of large technological system is of limited use when analysing this history, as the centralised water supply network of Kenya's capital never gathered enough 'momentum' to serve the poorest part of the population. We demonstrate empirically that, despite the sluggishness of 'development', inhabitants of informal settlements experienced few problems accessing water. Employing oral history methods, we reach out to actors whose voices are seldom heard in official sources. Our interviews suggest that inhabitants who remained independent of the centralised system experienced a comparatively high degree of resilience in the area of water provision.

Our observation aligns with Clapperton Chakanetsa Mavhunga's (2017: xi) argument that an STS perspective rarely applies to African cases. What implications, then, does the limited value of the LTS model have for the analysis of Nairobi and possibly of other so-called megacities in Africa, Asia and Latin America? We suggest that historians interested in investigating events and experiences in such cities should employ innovative methods; a deep study of, as it were, *Water Alternatives* requires alternative approaches. After all, the experiences of people who were not connected to the central water supply rarely find their way into archives held by public utilities or municipalities, and informal settlements are often blind spots on maps drawn by urban planners. Oral history methods thus have considerable potential, at least for relatively contemporary topics. Interviews with inhabitants from the two informal settlements of Kibera and Mathare in Nairobi provide us with important insights into the daily experience of their quest for water beyond the networks.² The image of water provision and use presented by our interviewees directly contradicts the conclusions found in the standard literature; indeed, our findings, as presented in this article, challenge historians of technology and STS scholars to rethink established interpretive frameworks.

Our findings also complement conclusions in the emerging discourse on 'critical infrastructures' and resilient cities (Engels, 2018). We discovered that the inhabitants of areas that were not served by the centralised water network exhibited a higher degree of resilience than did the inhabitants who were served by, and depended on, the centralised water supply system. Our interviews indicate that the introduction of piped water made residents in informal settlements more vulnerable to water shortages than they had previously been. As long as inhabitants had access to a multitude of different sources of water, they remained more resilient than they became after attaining access to the central water supply. Having access to large technical systems may increase our level of comfort but it may also, simultaneously, make us more vulnerable.

Historian of technology David Nilsson has investigated the development of large technological systems in the Global South. In his doctoral dissertation and other works, Nilsson (2011, 2016) touches on the topic of how water provision networks in Kenya and Uganda were created and expanded. Adopting an LTS theoretical framework, Nilsson describes the "sequential development" of centralised urban water supply throughout the 20th century in these two East African countries (Nilsson, 2011: 28). According to the standard LTS interpretive model, technological systems go through phases of 'establishment' and 'expansion' (Hughes, 1987). Once they have gathered 'momentum', large-scale technical systems tend to continue to expand in an effort to overcome resistance and problems of various kinds ('reverse salients'). Nilsson concludes that during the colonial era, "the trajectory of large-scale urban water supplies in

² Numerous researchers have carried out interview projects in Kibera and other so-called slum areas; for the sake of brevity, we refer only to Bodewes (2005).

colonial Kenya and Uganda seem to follow a 'typical' LTS progression" (Nilsson, 2011: 50). Given the "technological inertia" of the system, this progression continued well into the post-independence phase (Nilsson, 2011: 63). Also adhering to the LTS narrative, Ezekiel Nyangeri Nyanchaga (2016) provides a detailed history of Kenya's waterscape and the evolution of its supply system throughout the 20th century. In Nyanchaga's analysis, colonial water governance and water production take centre stage, local voices are barely heard and alternative technologies are seldom discussed.

In a co-authored article, Nilsson and Nyanchaga (2009) divide the history of 20th century water provision – in Kenya and Uganda in general and in Nairobi in particular – into four phases. During the first decades of British rule, the main actor was the government-owned Uganda Railway Company. After Kenya became a formal colony in 1920, public works departments took on the task of erecting centralised water supply systems in several towns. In Nairobi, the municipal council took over the responsibility from the railway company. After World War II, this tendency towards stronger "political control over water policy and water development" continued with even greater intensity. Of particular relevance to us is Nilsson's suggestion that the period on which we focus in this article, 1940 to 1980, was a one of "state hegemony" (Nilsson and Nyanchaga, 2009: 112). The final phase, from roughly 1985 onwards, was characterised by attempts by the state to create new organisational structures that would guarantee better supply and ensure cost recovery.

Although he hails from urban studies rather than the LTS tradition, Mathew Gandy takes a similar approach, discussing various examples of 'the bacteriological city'. Gandy pits 'the modern' against 'the traditional' in order to point out the failures and dilapidation of the water and sanitation infrastructures in most cities of the Global South (Gandy, 2006). Referring to Lagos and Mumbai, Gandy notes that the decayed or never-completed infrastructure systems of the 'bacteriological' era have been superseded by a proliferation of alternative solutions that range from tank lorries for the poor to bottled water for the rich. Although Gandy's perspective captures the fragmented character of the water and sanitation landscapes, his research fails to acknowledge local inhabitants' agency in creating what he calls 'alternatives'. In most cases, Gandy regards such alternatives as reactionary mechanisms that aim at meeting the deficits occasioned by either the 'incomplete centralized system' or the rundown network of supply.

Why do LTS and urban studies scholars of the Global South perpetuate these deficiency histories (cf. Monstadt and Schramm, 2017)? We suggest that inadequate theorisation and biased methodologies often set the stage. By overlooking the daily use of technology and various social groups' experiences of their material surroundings, established story lines fail to provide insight into the complexity of the urban landscape. As in most areas of colonial historiography, the main sources that historians of technology usually consult are those produced by the colonisers; archival material relating to Western technologies and public works is considerably easier to access than sources showcasing traditional techniques and local practices.

We claim that the adoption of LTS as a theory or a model prevents the historian and the STS scholar from delivering a full-fledged analysis of past and contemporary events. Inevitably, a system builder will be the first to enter the picture, and a number of companies, organisations and institutions will follow. In most cases, the state and the legal framework will be given the greatest consideration. What happens beyond the system boundaries tends to be of only limited concern. Those actors who do not belong to the large technical system proper, play only minor roles. Marianne Kjellén is one of the few scholars who acknowledge the centrality of individually devised ways of water provisioning. That said, in her book on Dar es Salaam, Kjellén continues to depict local initiatives as "alternatives" that "undermine and divert resources away from the collectively devised industrial form of piped water provision" (Kjellén, 2006: 3, 252).

To counterbalance the biases in earlier historical research, we assert the need to look beyond centralised water supply systems. Expanding the scope of the research to include oral sources is one way

to go. Interviews can capture people's everyday experiences as active users and producers and not merely as passive consumers of publicly provided water. We ask how those elements of Nairobi's complex water situation that exist outside of the centralised water supply network were designed and reproduced by the inhabitants themselves. Well into the 20th century, waterscapes in European and North American cities were much more diverse than they are today. Urban waterscapes in the Global South continue to be diverse. As Michelle Kooy and Karen Bakker emphasise in their study of Jakarta, the city, "has, since its inception, been characterized by a high degree of fragmentation of access to 'public' services, and in particular water supply" (Kooy and Bakker, 2008: 1843; cf. Furlong and Kooy, 2017). This observation underscores the need to look beyond large technological systems for a fuller understanding of the role of water in the urban landscape.

ORAL HISTORY AS A METHODOLOGICAL APPROACH

It is common for historians of Africa to employ oral sources, in addition to using often incomplete written material (Falola and Jennings, 2003; Cooper, 2005). Partly influenced by anthropological methods, a handful of historians of technology in Africa have made extensive use of oral sources (Hart, 2016; Grace, 2013; Twagira, 2015; Streit, 2018; Mavhunga, 2014). Among the works which address water provision, geographer Marianne Kjellén's dissertation, entitled *Water Access and Distribution in Dar es Salaam* (2006), is one to which we call attention. In seeking to provincialise water supply in the Global South, as Kathryn Furlong and Michelle Kooy (2017) propose, we need a methodological discussion about how best to harness relevant data. Considering that oral sources give voice to the everyday experiences of ordinary people, interviews should be viewed as a complement to the information provided by the analysis found in documents. Accordingly, in her book on hydropower dam construction in Tanzania, historian May-Britt Öhman (2007) does employ interviews. We therefore cannot claim to be the first historians of technology – or the first urban scholars – to make use of oral material; however, we do suggest that historians working in the LTS tradition have seldom utilised the interview approach to research.

To indicate the potential of oral history for the study of water provision and use, we refer in this article to six semi-structured, qualitatively oriented interviews (Abrams, 2010; Perks and Thomson, 2016), each of which was in-depth and ranged between one and two hours. We present information given by male and female interviewees who were old enough to remember the circumstances around water provision before and after Kenya acquired independence in 1963. The interviewer posed open-ended questions, asking the interviewee to focus on the supply and use of water, as well as on various modes of sanitation. The interviewees were free to digress, to associate, and to make connections to other topics. They were asked to reflect freely on their personal experiences; questionnaires were not used. In one case, we engaged a translator. The interviewees were selected based on their age and place of birth. One of our researchers was a periodic resident of Kibera, and our expert research assistant – who was also our Nubian-language translator – was a permanent resident; as such, we were able to contribute first-hand ethnographic knowledge. Our background ensured a high degree of understanding and made misinterpretations relatively unlikely.

Our interest concerned the period of from 40 to 80 years ago. An acknowledged problem associated with oral history is interviewees' biased or hazy memories. It is common knowledge among social scientists and historians that interviewees often provide answers they believe will please the researcher; and, of course, we all forget events. Interviewees' memories are also often tainted by later developments.

We argue that despite the vagaries of human memory and interview bias, the oral information relevant to our research question has a high degree of certitude. Since we were interested in the interviewees' personal memories of their everyday lives and repetitive events, it is not very likely that they provided us with false information. If we as historians are interested in the routines of daily life, then we should be able to rely on oral information about personal experiences. Accounts of daily practices

generally have a high degree of accuracy, and if we record similar narratives of everyday life from independent interviewees, then our inferences ought to be convincing. It seems indubitable, for example, that our interviewees regularly swam in the local river and that they carried home water containers as part of a daily routine. Had we been interested in one-off events, or had we wanted to focus on particular people or explicitly political issues, we may have drawn a different conclusion. Indeed, when Mwalimu ('Teacher') Suleiman, one of our interviewees, described the long, contentious history of the Nubians in British East Africa and in Kenya, he appeared to be recounting a view of the past that is clearly inflected by the interests of his ethnic group (Balaton-Chrimes, 2015).

In our study, we use oral history methods to challenge established views of water provision in colonial and postcolonial settings. Our interviews show how actors outside of the centralised water supply system managed to access water of varying degrees of quality. To take seriously the experiences of these individuals is to turn the historian-of-technology gaze to actors who seldom find their way into established archives or government reports. We argue that the centrality of the LTS tradition in our discipline has rendered invisible some users who are not served by the system. Unless we make concerted efforts to approach such users by means of interviews or by retrieving new kinds of sources, their modes of water provision will remain under the historian's radar.

We complement established narratives in the history of technology by highlighting ordinary users and their efforts to satisfy their daily needs. Although we do acknowledge the analytic power of the LTS model in many studies of Europe and North America, we claim that its usefulness is highly limited when applied to phenomena in the Global South. By focusing on ordinary users, we follow up on studies on European material on which one of us previously collaborated (Oldenzien and Hård, 2013), and by bringing African actors into the history of technology we strive to contribute to the emerging scholarship on this continent and its inhabitants (Mavhunga, 2017).

'COOL WATERS': NAIROBI'S CENTRAL WATER SUPPLY SYSTEM

In the wake of the so-called scramble for Africa, the British government created the East Africa Protectorate in 1895. Twenty-five years later, this territory, also known as British East Africa, became the Colony and Protectorate of Kenya, an act that officially established it as a dominion of the British Crown. In 1905, the colonialists decided to turn Nairobi, at that time a simple railway depot, into the protectorate's capital (Maxon, 1980; Médard, 2006). Before the arrival of the Europeans, the Nairobi area had been used as grazing land and for subsistence cultivation by the Maasai and Kikuyu ethnic communities. The name Nairobi is, indeed, an adaptation of what the Maasai referred to as *enkare nyrobi*, (cool waters). Desperately in need of water for its steam locomotives and staff, the Uganda Railway Company took the lead in establishing the pioneering waterworks (Akala, 2019).

The selection of Nairobi as a railway centre was predicated on the presence of the Nairobi River. Initially, the railway company harnessed water from a small dam in the Chiromo area and diverted it to the railway company site by gravitational means (Smart, 1950). As Nairobi transformed from a railroad depot to a town, the dam proved insufficient. To compensate for this, one of the railroad company's assistant engineers, William Ross McGregor, designed a major water supply and treatment plant at Kikuyu Springs. Assisted by workers, most of whom were of Indian descent, McGregor managed the construction project, which entailed building a pipe network that extended from the springs to the city. Completed in 1906, the system included reservoir tanks and pumps. It remains one of Nairobi's main sources of water to this day.

To meet the steadily growing need for water, several other initiatives were undertaken. In 1911, the private Muthaiga Water Company – the first of its kind in colonial Kenya – was founded. Independent of the existing municipal system, which was managed by the railway corporation, the company built its own connection network, serving approximately 500 households with water (KNA: AG/43/103). In addition, multiple non-networked supplies were designed across Nairobi. The Prince of Wales School (currently

the Nairobi School), for example, which educated the children of European railway officers, sunk boreholes and reservoirs to provide both its own premises and adjacent areas with water (KNA: RN/6/38). In the eyes of the authorities, however, these were seen as temporary measures. Hewing to the European exemplar of centralised supply systems, in 1922 the municipal corporation bought the Kikuyu Springs plant from the Uganda Railway Company at a cost of £20,000 and, subsequently, acquired the Muthaiga Water Company.

As Nairobi's population continued to increase, the city began to explore more distant sources. Embracing the European vision of growth and centralisation, the authorities proposed to abstract water from the Ruiru River, 40 kilometres from the city centre (Smart, 1950). To reduce the dependency on the Kikuyu reserves, in 1938 the Ruiru River Works were completed and commissioned. This project boosted the available amount of water, though its extremely high construction costs meant that only Europeans and wealthy Indians could enjoy the luxury of having water piped into their homes. Following a typical LTS expansion pattern, one catchment area after the other was added to the system: the Aberdare Range, Mount Kenya, and the Rift Valley. Today, the Nairobi City Water and Sewerage Company receives most of its water from the Tana River Basin north of the city via three reservoirs: the Sasumua Dam on the Chania River (1956), the Thika Dam (1994), and the Chania-B Dam (1998). At the time of construction, the huge Thika Dam was expected to more than double the amount of available water, providing enough to meet Nairobi's growing water needs until at least 2005 (Syagga and Olima, 1996).

By transferring European technologies to the colonies without appreciating the social and environmental differences between the Global North and the Global South, these large, centralised systems were set up to fail (Broich, 2007). Concerns about the quality of water in the colonial cities pertained to the entire African continent. Whenever appropriate, such concerns were voiced in support of novel engineering solutions. J.W. Simpson, who had been appointed by the colonial administration to conduct a study and make recommendations for improved sanitation, issued a blanket condemnation of indigenous wells and ponds in Accra, Ghana, describing them as "poor and inadequate" (Bohman, 2010: 76).

The vision of centralised water supply systems has its roots in Edwin Chadwick's idea of the 'sanitary city' and Joseph Chamberlain's notion of the 'civic gospel' (Susser and Stein, 2009; Gehrke, 2016). Martin V. Melosi (2000) notes that the shift from recognising water of diverse quality and composition to a single, scientifically defined form of pure water, influenced the development of urban water supply systems throughout the world. In nations south of the Sahara Desert, however, the expansion of water supply networks and other large technological systems remained piecemeal. Rather than creating so-called networked cities with ubiquitous electricity cables, telephone lines, water pipes and sewerage conduits, colonialists reproduced highly fragmented cityscapes (Coutard and Rutherford, 2016). In most of Africa, 'modernisation' projects did nothing more than reinforce divides between modern and traditional (indigenous) ways of life (Boahen, 1986; Gandy, 2004).

Just like consumers in the pre-independence era, today's consumers in Nairobi cannot rely only on the centralised water supply system. In recent years, reduced precipitation resulting from climate change has made the situation exceptionally difficult (Goswami, 2019). Supported by non-governmental organisations, local communities continue to drill new boreholes (Chakava et al., 2014) and, although the water quality is often questionable, industrial enterprises, hotels, greenhouse flower farms and private individuals also dig their own wells and boreholes. According to some estimates, there are 3000 commercially run boreholes in Nairobi today; many of them are used to supply tank lorries, which provide consumers with water at exorbitant prices (Omulo, 2019).

BEYOND LARGE TECHNOLOGICAL SYSTEMS

The reliance on boreholes, wells and other decentralised water solutions is not a recent phenomenon. Our interviews in the informal settlements of Kibera and Mathare indicate that Nairobi inhabitants have

for decades made use of water supplies beyond the large technological system. Although both areas are sometimes referred to as slums or shanty towns, their structures and histories differ. Kibera has a long history as a colonial military base, a circumstance that offered its inhabitants – originally Nubian war veterans – a certain degree of semi-autonomy. The valley of Mathare, by contrast, is an area where, starting in the 1960s, cooperatives and communal organisations gradually acquired land and developed various supply infrastructures.

A contemporary map of Nairobi depicts the southwestern suburb of Kibera as an unobtrusive collection of minor streets and alleys south of the Royal Nairobi Golf Club and west of the Wilson International Airport. The settlement was created in the 1910s as a residential area for Sudanese Nubian soldiers who had been part of the King's African Rifles regiment in Kenya (Parsons, 1997). Plots of land were allotted to the soldiers as a reward for their service in World War I. For reasons that have been much debated, the soldiers did not receive formal land titles, only permits that gave them the right to settle in the area (Githahu, 2009). At the time, Kibera was a bosky area of 4000 hectares, where some 600 Nubians had settled. Following a traditional practice, Maasai and Kikuyu pastoralists continued to bring their cattle and goats to Kibera to graze (KNA: PC/CP.9/15/5).

Our second so-called slum area is Mathare Valley, a settlement situated along the Mathare and Gitahuru Rivers. The nationalist movement that won Kenya's independence from Britain in 1963 targeted land redistribution as one of its main political goals; the newly installed government demanded that local inhabitants buy back the land from the departing colonialists. Given that it was impossible for most individual Africans to raise the required capital, communal action became the viable solution. In 1969, the first inhabitants decided to form a cooperative to buy the land on which they were squatting, thus spreading the financial burden across the members of the cooperative (Andvig and Barasa, 2014). Although still faced with deprivation, the Mathare Valley of the late 1960s blossomed with innovative grassroots activities of provisioning, especially those related to water and sanitation. 'Self-help' had become the slogan and practice of the day (Republic of Kenya, 1965). Inhabitants pooled their resources and harnessed local techniques and indigenous knowledge (Amis, 1984; Hake, 1977; Etherton, 1971).

In the pilot study we present in this article, we interviewed a total of six Kibera and Mathare residents, two women and four men. Our interviewees were born between 1939 and the late 1960s; we were interested in how the interviewees (and their families) accessed water during their childhood and adolescence. We were struck by the congruity of the interviewees' recorded experiences. Well into the early 1970s, the inhabitants of these informal settlements reported feeling satisfied with the water supply arrangements. To secure enough water for drinking, washing and hygiene, a certain degree of planning and foresight was required. The transportation of the water to the inhabitants' homes involved physical labour. In comparison, those Europeans and other wealthy people who enjoyed the luxury of running water in their houses certainly lived a more comfortable life; still, the 'slum dwellers' we interviewed told us stories of abundance ('water was not a problem') and high quality ('the water was very clean').

Although the number of interviews is limited, we still believe it is justified to draw certain conclusions from the sample. Like many other historians who work with oral sources, we do not aim for statistically representative samples (Thompson, 1978); rather, we aim to include eyewitnesses whose accounts would otherwise have been absent from the 'official' records. We are struck by the discrepancy between our interviewees' stories and the accounts we find in the scholarly literature on urban water in the Global South. Historians of technology, urban historians, and environmental historians all are prone to crafting narratives that highlight sanitary problems, the expansion of centralised water supply systems, and deficient provision – especially to the poor.

'WATER WAS NOT A PROBLEM'

The quote at the beginning of this article describes one of the available sources of water in Kibera in the mid-1950s. The quote is taken from an interview with Mwalimu Suleiman, a retired Nubian teacher who was born in 1946. Suleiman painted a favourable picture of the supply situation, telling us that, "in Kibera we had lots of sources of water". After school, Suleiman was regularly sent down to the Kortumbro River to obtain water for domestic washing and cleaning, and on 'washing day' – Thursday afternoons – women and children collected clothes and went to the river to wash and bathe. Allegedly, the river was hardly polluted, and it never dried up. According to Suleiman, "people even drank the river water, and they were not sick. The only health effect, we would say, drawn from the river water at that time was fluoride, which tainted the teeth" [I-MS].

Despite this statement, Mwalimu Suleiman, his family, and their neighbours apparently preferred to get drinking water from elsewhere. As he went on to tell us, "there were three sources. One, there was a tap at the DC's [District Commissioner's] place. All residents of Kibera could go and fetch water there. They were selling it at 2 cents (...) per *debe* [a reutilised, cleaned, oil or gasoline container holding twenty litres]". The second water source, Suleiman told us, was the water point that had been installed by the County Council in the early 1950s, close to Kibera Primary School. If water from these two sources was for some reason not accessible, dwellers had yet a third option, which was to stock up at the nearby railroad station, however this option depended on personal connections. If your family knew Africans employed as domestic workers in European households, it was sometimes possible to sneak in and fill a *debe*. Suleiman told us that, a "tap was something that you'd never dream of. We see it, we see it in *muzungu's* [white people's] house, not African houses" [I-MS].

In addition to river water and piped water, "there were several wells in different part (sic) of Kibera". The total number of wells is unclear, but the interviewee indicated that in the early 1960s there must have been at least eight. In Kibera's Korogorno area, for example, the local population could access good quality water from dug wells. According to Suleiman's account, these shallow wells had a backup function in that they made inhabitants less vulnerable, as it were. Wells were primarily used during the dry season, when the river was low or when tap water was unavailable. Most wells were considered to be clean, but they required regular maintenance and there was always the risk of the wells becoming polluted by nearby latrines. To avoid having to walk long distances to get water, it was also common practice in Kibera to harvest rainwater. Suleiman explained that, "during the rainy season, all homes had gutters. And we used to have *pipas* (cisterns), big *pipas* that would harvest those (sic) water, rainwater. And this water also always lasted for a very long time" [I-MS].

A continuous supply of water was of importance not only for the activities of daily life. It was also necessary for what was likely the most important economic activity in Kibera: the manufacture of Nubian gin, a high-proof beverage. Initially, this so-called *chang'aa* was made for private consumption, but it soon became a commercial success far beyond the borders of the settlement (de Smedt, 2009). Before distillation, a brew of water, molasses and flour had to undergo fermentation for about two weeks. Water was critical in the production process, and large-scale distillation would mainly take place along the river. In 1938, the District Commissioner for Nairobi, Major A.W. Sutcliffe, observed that the manufacture of Nubian gin required substantial amounts of water, both for making the brew and for cooling the distillation plant (KNA: MAA 2/1/31/76a). Although Sutcliffe suggested that the health hazards involved would justify connecting Kibera to the water mains, the authorities did not accept his line of reasoning. Reflecting on the fact that by the 1940s Kibera produced most of Nairobi's locally distilled liquor, Suleiman's assertion that "water was not a problem" seems convincing [I-MS].

In the course of the late 1950s or the 1960s, the comfortably sufficient water supply came to an end: "Then came the business of water". Suleiman recalls how innovative individuals organised small pickup lorries, loaded them with containers, filled these containers at the water kiosk, and then sold the water for a price 5 to 15 times higher than the price charged at the tap by the municipality [I-MS]. Water became

a commodity for which people were expected to pay a commercially set price. Then as now, commercialisation hit the poorest of the poor the most.

State policies contributed to the commodification of water. As a tactic of the authorities' slum clearance policy, the British designed new housing estates with piped water, "sewage system and whatnot and everything", according to Suleiman. These estates were directly connected to the "main water pipe from Dagoretti to Kibera". Although Suleiman could still remember seeing lions, hyenas and dik-diks down by the river, the once-wooded area (*kibra* means 'forest' in the Nubian language) had, by the 1950s, become an increasingly deprived part of the city. When the first state-sponsored housing projects were erected in the 1960s, they were meant to improve the living standards of the local population: "That is the first time we saw water inside the houses". Still, few Nubians opted to move into these buildings, Suleiman told us, and those who did "were sort of semi-, semi-mzungus, so to speak" [I-MS].

Mwalimu Suleiman was not the only interviewee who testified to the satisfactory nature of the water supply in the first two decades after World War II. Although born 15 years later than Suleiman, Jafar Musa told a very similar story: "We used to fetch water from that river. We also depend on rain during rainy seasons and also a well, which was dug. (...) Water was not a problem at that time". The river always had enough water, and its water "was very clean, and we used to drink it without even boiling or treating it" [I-JM].

Similarly, another interviewee who was born in 1942 and who goes by the single name of Jakob, described how the river "provided clean water for us. We used to have small containers called *debes*, which we filled with water and carried on our heads and took it home. Every day we were supposed to go down the river twice a day" [I-J].

Jakob gives us more detailed information about the traditional, somewhat gendered system of water supply:

We Nubians we had wells which was called *biri* in our language. Our grandparents dug wells outside our houses. These wells had extensions like a trough whereby when the water in the well is full it could drain easily on the trough, and that's where the female children were supposed to draw water and pour in their *debes* [I-J].

In addition, Jakob's family "harvested rainwater with big drums, which were called *pipa*", a technology that appeared to contain some risk [I-J]. Simon Juma, who at the age of ten, in 1949, came to Kibera with his grandfather, explains that "the only water that we used to boil was the rainwater because of the gutters, which were not that clean. Some other people used to filter the rainwater by use of a clean piece of cloth" [I-SJ].

As in Kibera, the inhabitants of Mathare Valley harnessed water from one of the rivers in the area; as the population density increased, however, pollution forced them to turn to other means of provisioning. In this situation, cooperative forms of ownership enabled them to come up with solutions that remind us of more recent water tenure models (Hodgson, 2016). According to Mama Wanjiru, who was born in the late 1960s, a communal approach enabled people to access services. "Many people pooled funds to dig shallow wells. The shareholders were also engaged in instituting water drains (...). [Their] contribution involved also volunteering labour since most people were poor" [I-MW]. Like Kibera, Mathare Valley was known for its *chang'aa*. Rather than being just a source of water for domestic use and bathing, the river's shore developed into a site for indigenous industrial production and various kinds of craftmanship.

The cooperative spirit of the pioneering years soon ended. The agenda that had informed the grassroots mobilisation for land and water tenure and for self-provisioning was destroyed by profit-seeking individuals and companies who put up rental structures for commercial purposes or to serve a particular political clientele. Jason Corburn (2013) notes that the companies that erected residential buildings in Mathare Valley provided very few services and that the failure of the commercial landlords

to provide their tenants with sufficient necessities triggered a new wave of innovation. As an outcome of the landlords' neglect, the inhabitants learned how to mobilise their own capabilities and to take advantage of available local resources (Etherton, 1971).

For Andrew Hake, a British citizen who worked closely with the National Council of Churches, the concept of self-help came to define Nairobi at this time. To underscore the point that Mathare Valley and other neighbourhoods had become pioneers of localised and bottom-up approaches, Hake optimistically calls Nairobi a 'self-help city'. He documents how the city had begun to generate its own internal economy, which made people increasingly independent of modern urban business structures (Hake, 1977; SOAS: PP. MS 46: 4: 17, 4: 18). Through neighbourhood organisations, families drilled communal boreholes, dug wells, constructed run-off drains, and put up shared bathrooms, cesspools and toilets; residents whose houses had corrugated iron roofs set up rain collectors, and water kiosks offered water to residents. Although the Mathare River slowly but surely became unsuitable for domestic use, it remained an important source of water for brickmaking, as residents struggled to construct and provide affordable housing for themselves.

The 1971 cholera outbreak in Nairobi helped to jolt the Nairobi City authorities into extending the centralised water supply network to some points in Kibera and Mathare Valley. "We did not have piped water until *maji ya kipindupindu* came", Mama Amina recalled [I-MA]. *Kipindupindu* is the Swahili word for cholera, and Mama Amina referred to the 'time of cholera' rather than to a specific year or years – which is common practice in African oral traditions – to mark the arrival of centralised water. Before *kipindupindu*, the Nairobi City Council had adamantly refused to provide centralised water services to the informal – in their view, unauthorised – settlements of the city, as such a move would be tantamount to legitimising the existing 'illegal' situation (Patton, 1988).

The notion of self-help generated a rethinking of the modern pattern of large-scale industrialisation and centralised decision-making; it began in an era when people had begun to nourish hopes of being able to both design their own neighbourhoods and participate in local governance. Mathare Valley provides both a romantic narrative and a tragedy at the same time. On the one hand, it won acceptance and encouraged the government to change their undisguised strategy of slum clearance; on the other hand, as Nilsson (2016) demonstrates, the government failed to seize the opportunity to incorporate people-centred plans that originated from below. Instead of promoting collaborative approaches and the optimism of the self-help concept, the government in general, and its National Housing Corporation in particular, emphasised centralised networks and other modern solutions. Instead of incorporating local, small-scale, and bottom-up technologies, the authorities contributed to the fragility that we still witness today.

THE CRITICALITY OF CENTRAL SUPPLY SYSTEMS

In a 2016 article, Nilsson modifies the LTS approach and complements it with other theories. He notes that in many African cities, the centralised water supply system never reached a point where it gained "momentum" (Nilsson, 2016: 497). In contrast to his earlier arguments, Nilsson now contends that we cannot take for granted that infrastructures in Africa develop in the same way as in Europe or North America. He admits that "LTS theory seems to fit certain parts of the historical trajectory of water networks in Africa, but not all" (ibid). Still, in a 2017 contribution to *Water Alternatives*, Nilsson and his co-author Pär Blomkvist continue to focus on the municipal system; when they touched on "local alternatives" they suggested that such solutions only "started appearing" in recent decades (Blomkvist and Nilsson, 2017: 290). As we have shown, local solutions always existed.

LTS narratives on developments in the Global South usually focus on recurring water shortages, the continuous quest for new sources and the construction of new dams to store water for the dry season. This narrative, which highlights the 'deficient' character of African cities, may correctly depict the muzungu world, but it does not capture the Nubians' world. In 1944, for example, the Nairobi City Council

asked consumers to "Stop Watering the Garden" and "Forget about Washing the Car".³ In Kibera, where nobody owned a car, water abundance reigned well into the 1960s.

From Mwalimu Suleiman and Jakob's accounts of water practices during their childhoods, it becomes clear that people's daily experiences with water did not take place in a homogenous waterscape. The multiplicity of sources connotes a differentiated system of the supply, use, nature and meaning of water. River water was used predominantly for bathing and washing, and the community prioritised the safety of the shallow wells by addressing the health concerns of water usage as follows:

The use of pit-latrines meant the risk of contamination of water, especially in the wells. Hence the community poured paraffin in the latrines and whenever the smell of paraffin would be detected in the water from a particular well, that well would be condemned and closed [I-MS].

In the 1960s, water became a serious challenge for the dwellers of Kibera. Like Suleiman, Jakob ties these problems to the process of commodification:

The problem of water came actually after people started selling piped water. That's when we shifted to piped water and sometimes it ran dry. This is the time we fully depended on piped water only, and when the taps ran dry, there were no other sources because no one could go to the river again and the wells got dry because no one cared for them by removing the sand after accumulating in the well [I-J].

Jakob connects the advent of centrally supplied tap water to the fact of water now having a price tag. As long as they fetched water in the river or at the wells, "people respected water sources (...) and no-one could dare dump waste on this water". After the Kibera inhabitants turned to tap water, they apparently became more "careless"; they no longer bothered to keep the river clean and, after residents became accustomed to the comfort of piped water, they no longer cared to maintain the wells. The outcome of this process, in Jakob's view, was that the population became dependent on a single source of water, one which, unfortunately, proved to be unreliable and insufficient. Whereas water was not a problem during Jakob's – and the other interviewees' – childhoods, water did become a problem from the late 1960s onward.

One way of interpreting the problems Mwalimu Suleiman mentioned, as well as the changes Jakob described, is to adopt a vocabulary that is associated with the phenomenon of 'critical infrastructures'. This concept has received considerable attention in politics and the media in recent years, sometimes in connection with nationwide power blackouts in the Global North and sometimes in connection with potential terrorist threats (Moteff, 2012). The concept has also found its way into both the history of technology and STS (Högselius et al., 2013; Engels, 2018). Some scholars have applied it to the analysis of failed infrastructures on the African continent, mostly in the context of energy provision (Silver, 2015).

Two aspects are of central importance in discussing the criticality of technical infrastructures: vulnerability and resilience (Dunn Caveltly and Balzacq, 2010). As a particular system of provision becomes ubiquitous and increasingly important, society becomes more and more dependent on the system working in a predictable manner; if the system fails, then societal processes come to a standstill. In other words, systems become 'critical' to the society in question and, in the process, a society that depends on infrastructure becomes more vulnerable. If a certain technical system becomes more vulnerable – for instance, as a result of insufficient maintenance – then society also experiences a higher degree of vulnerability.

One way out of this precarious situation is to increase the degree of resilience – both of technical systems and of society as a whole. If an infrastructure is consistently maintained and failures immediately repaired, then it – and the society it serves – exhibit a high degree of resilience. It is also possible for inhabitants to develop appropriate resilience strategies; in regions with frequent power blackouts, for example, shop owners and factory managers acquire diesel engines as a backup or people make sure

³ Macmillan Library, Nairobi: Nairobi City Council Minutes, Vol. XI, 30 June 1944.

they have enough candles or lamp oil to last them through the blackout. Today, some individuals may make sure they have a fully charged power bank in the nearest drawer.

What relevance does this brief theoretical exercise have for the case of water supply and usage in Nairobi? Our hypothesis is that the degree of vulnerability grew along with the expansion of the centralised water supply system; this is the story that the Nubians tell us. When the number of standpipes in Kibera increased, the population chose to abandon the sources of water that they had used in preceding decades. At that time, they had access to several sources of water – river, rain and well water – in addition to piped water in several places. Metaphorically speaking, water supply in Suleiman's childhood was like a patchwork quilt with various fabric patterns and sections; it was this multitude of possibilities that made life comfortable for the Nubians. In relation to water, Jakob's story described a situation with a high degree of resilience: if the river ran dry, there was always water in the well. The problem in the 1960s and 1970s does not seem to have been 'state hegemony', but rather a form of 'piped hegemony'. Had the inhabitants of Kibera continued to use and maintain their old sources – their patchwork of possibilities – they may have been able to maintain a higher degree of resilience for a longer period. Our historical analysis of Mathare Valley also supports this conclusion. Indeed, analyses of the contemporary situation in Nairobi conclude that "many urban poor dwellers (...) need to access self-supply from a range of sources" (Chakava et al., 2014: 115).

CONCLUSION

We believe an LTS perspective seduces historians and STS scholars into overlooking non-centralised forms of water provision. Usually, the LTS researcher zeroes in on state-orchestrated, large-scale engineering solutions and substantial investments, and the daily activities that Mwalimu Suleiman and his fellow Nubians describe thereby fall under the radar: washing clothes and bathing in the river; fetching water in debes with a wheelbarrow; digging local wells with your own hands; collecting rainwater in pipas. Given that these practices evolve apart from large technological systems, they rarely make their way into works written in the LTS tradition. On the rare occasion that these practices do appear in the public record, they are usually labelled 'alternative', which renders the centralised model of water provision as the norm (Nilsson, 2011: 91).

Our interviewees from Kibera and Mathare Valley depicted a manageable world in which access to water was neither a quantitative nor a qualitative issue; this was a world that seems to have survived into the late 1960s. Although limited in number, our thorough, qualitative interviews open a door to a world that is usually inaccessible to historians of technology. The world we find in national, ministerial, municipal and corporate archives is different from that of our interviewees. True, Kibera, Mathare Valley, and other low-income areas do appear in archival documents – usually under the heading 'informal settlements' – but such areas are depicted primarily as problematic, illegal, or both. If inhabitants do manage to make their mark in such archives, their lives, needs and views are filtered through the eyes of authorities and larger organisations.

In the archival world we encounter in Nairobi, London and elsewhere, the bulk of the material emerges from governmental bodies and large companies. According to that narrative, in the early part of the 20th century, these institutions built dams and drilled boreholes, then slowly but surely designed a centralised water supply network (Akala, 2019), and from these early initiatives, a large, well-documented technological system emerged. This standard history is, in other words, an archival artefact, a reflection of historians' reflex to use large-system-related documents, rather than self-help narratives, as primary source material.

When informal settlements appear in the standard narrative, they are usually associated with deficient supplies and intransigent problems. The world beyond the network is treated as a marginal area, and its inhabitants are said to have a high degree of vulnerability; as long as they remain outside the large-scale networks, inhabitants' lives are said to be precarious. We challenge this view; indeed, the

world outside the system may be much less vulnerable than the world within it. (A power blackout, by definition, only hits those who depend on that network.) As our interviewees taught us, as long as they and their families relied on multiple sources of water, the daily supply "was not a problem". In the 1950s, the inhabitants of Kibera exhibited a high degree of resilience when it came to water supply; later, when the centralised system of provision began to make its way into the settlement, inhabitants' level of vulnerability increased. When the importance of the old water sources declined, residents found themselves more and more dependent on fewer sources. Resilience, we conclude, tends to be higher in a world where the patchwork of possibilities is still intact, not torn apart.

We suggest that historians of technology and STS scholars are well advised to tell narratives that reflect this patchwork quilt of options – or what Kooy (2003) calls an archipelago. We need to keep our eyes open for sources that take us beyond the familiar world of engineers, machines and systems. Even a limited number of semi-structured interviews provides the historian of technology with insights into practices outside the modern world; historical understanding is not a function of statistical corroboration. During the decades discussed in this article, people at the bottom of the economic and social ladder did not interact with urbanity as just passive, dormant players. Informal settlements served as melting pots for sociotechnical creativity. Oral material accentuates the complementary nature of resource provision. Complementarity within the spatio-technical character of cities like Nairobi represents and acknowledges the diverse systems of public service access, including water and sanitation. As Kooy and Bakker (2008) suggest, urban fragmentation does not have to be a negative state of affairs.

ACKNOWLEDGEMENTS

The research for this article was supported by a fellowship, financed by the German *Hans-Böckler-Stiftung* (Grant PK039). The actual writing was made possible by the generous financial support of the Technical University of Darmstadt and the European Research Council (Horizon 2020: ERC Advanced Grant No. 742631).

INTERVIEWS

Note: All names below have been given to the interviewees by the authors.

[I-J] Jakob, male, born 1942; interviewed in Swahili on 15 August 2016 in Kibera, Nairobi, by Jethron Ayumbah Akallah.

[I-JM] Jafar Musa, male, born 1961; interviewed in the Nubian language on 15 August 2016 in Kibera, Nairobi, by Marjan Mohammed, who also translated the interview into English.

[I-MA] Mama Amina, female, born 1950; interviewed in Swahili on 31 July 2016 in Kibera, Nairobi, by Moses Mukhwana.

[I-MS] Mwalimu Suleiman, male, born 1946; interviewed in English and Swahili on 3 August 2016 in Kibera, Nairobi, by Marjan Mohammed.

[I-MW] Mama Wanjiru, female, born late 1960s; interviewed in Swahili on 24 August 2016 in Mathare, Nairobi, by Jethron Ayumbah Akallah.

[I-SJ] Simon Juma, male, born 1939; interviewed in the Nubian language on 3 August 2016 in Kibera, Nairobi, by Marjan Mohammed, who also translated the interview into English.

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