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## **Mapping operation and maintenance: an everyday urbanism analysis of inequalities within piped water supply in Lilongwe, Malawi**

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**Abstract:** In this article we analyze the production of inequalities within the centralized water supply network of Lilongwe. We use a process based analysis to understand how urban infrastructure is made to work. We explain the disparity in levels of service by tracing the everyday practices of those who operate and maintain the infrastructure. This extends existing analyses of everyday practices in relation to urban water inequalities in African cities by focusing on formal operators, rather than water users, and looking within the networked system, rather than outside it. Findings show that these practices work to exacerbate existing water stress in urban poor areas of the city. We conclude reflecting on how understanding these practices as the product of the perceptions, rationalizations, interpretations of utility staff who seek to manage the city's (limited) water as best they can, offers insight into what is required for a more progressive urban water politics.

**Keywords:** urban water supply, infrastructure, everyday practices, decentering urbanism, Lilongwe

## **Introduction**

More than a quarter of the 100 fastest growing cities in the world are now in Africa, and the continent's number of urban residents will double over the next 30 years (UN-Habitat, 2014)<sup>1</sup>. These are well known figures, as is the fact that the rate of urban transition, particularly in Sub-Saharan Africa (SSA), significantly outpaces investment in infrastructure and services (Pieterse and Hyman, 2014). For urban water supply infrastructure, levels of coverage for piped water services have declined over the last 15 years while urban population has increased (JMP, 2015). Currently, many cities in SSA provide a smaller percentage of their residents with piped water than they did in 1990 at the start of the Millennium Development Goals.<sup>2</sup>

Where urban water supply infrastructure does exist and 'improved' access has been counted towards MDG targets, we still do not know if piped water supply is safe, or sustainable, or equitable (Nganyanyuka et al. 2014; Obeng-Odoom 2012; Onda, LoBuglio, and Bartram 2012). As David Satterwaite (2016) reviews for the South more broadly, the categorization of access to water under the MDGs as either "'improved'" or "'unimproved'" conceals the reality that in the majority of cities access to an "improved source" of piped water does not provide quality safe for drinking, and may only be provided for a few hours a day, or a few hours a week. This echoes what Sylvie Jaglin noted: counting an 'improved source' of water via a 'connection' masks the diverse realities of what connection means in the majority of African cities (Jaglin, 2008). As she and others have shown, taking the centralized infrastructure network as the axis for any analysis of inequalities in urban water tells us little about different water qualities, quantities, and continuities inside piped network system (Graham et al. 2015; Jaglin 2008; 2014). Moreover, as noted by Anne Marie Lawhon and colleagues, it tells us even less

about the majority of urban space left “blank” outside the network coverage area (Lawhon et al., 2014).

The “blankness” of some urban spaces, and the relations between water and urban politics subsequently concealed, or inaccurately represented and explained, emphasizes the need identified within urban geography to explain the role of infrastructure within the production of uneven urban landscapes in a way that reflects a more diverse set of realities (Parnell, 2014; Silver, 2014). Building on the recent calls for a production of urban theory which can more accurately and meaningfully capture Southern, African – or even global - urban contexts (Myers, 2014; Parnell and Oldfield, 2014; Roy, 2009; Sheppard et al., 2014), research in cities of both north and south has begun to develop explanatory frameworks for the relations between water and urban inequalities on the basis of more diverse set of experiences. For example, Acevedo et al. (2016) with their historical analysis of water supply interventions in Colombia challenge water sector assumptions around trends as decentralization or corporatization. Ranganathan and Balazs (2015) show the usefulness of North-South comparison in the understanding of periurban water inequalities. Stoler et al. (2012) analyze in metropolitan Accra the persistence of packaged drinking water as one of the main sources of water even in areas “served” by piped system. These are but a few examples of how urban water scholarship is unsettling assumptions of what urban water infrastructure is, how it is made to work, and the complex politics of water it reflects and reproduces, for the majority of the world.

One approach to providing a more accurate picture of how water flows through SSA cities, and why, and what this means for urban inequalities, has been the use of a process based analysis: building explanations from empirical observations of what users actually do, the practices they perform. Thus, instead of interpreting local contexts through a global explanatory framework, or seeing the differences in particular contexts as spaces

of “exception” (Ong, 2011), this research uses the very particularities of cities previously located in the margins as exceptions in global frameworks. This approach aligns with the recent move within Science and Technology Studies (STS) to decenter analyses of socio-technical systems. There, they call for decentering of analysis from the role of artefact itself (the piped network), to understand how it is made to work through the engagement of both human and non-human actors.

In this paper we document the everyday practices which are used to make centralized piped water infrastructure system work in the city of Lilongwe, Malawi. We use this empirical detail for a process based analysis of inequalities in urban water supply in a city where the uneven flow of water through the centralized piped network system reflects and reproduces other inequalities within the city. Population densities, living conditions, access to services vary dramatically between low-income areas and informal settlements (served through a system of kiosks), and the commercial/high end residential areas in the urban core (with in-house connections). Although both are included in access to the city's centralized water supply network which serves 78% of the city's one million residents (NSO, 2008), low-income areas have a much higher rate of supply infrequency (Boakye-Ansah et al., 2016) . To understand why this is so, and what it can tell about politics of water in the city, we follow the everyday practices of the engineers and water utility staff as they do daily maintenance and operational work. Our analysis of how inequalities in water quantity and continuity are produced within the network reveals the political processes at play in “technical” processes usually “black-boxed” and kept from scrutiny.

The research for this paper was conducted over a period of four months in 2014. Data was collected using qualitative methods that included literature reviews, in-depth interviews, participatory mapping, and a focus group discussion. A total of 38 semi-structured interviews were conducted with Lilongwe Water Board (LWB) employees from operators to managers. In addition, a large amount of data was collected through participant observation: following employees in their daily activities and conducting several visits to points along the centralized networked system.

### **Everyday Practices and urban water inequalities: A review for African cities**

The last decade has seen the emergence and consolidation of decentered perspectives that seek to destabilize the application of northern norms across urban theory in order to better explain the dynamics of cities across a variety of contexts (McCann et al., 2013; Sheppard et al., 2013). One approach advocated as a way to decenter from northern based explanatory frameworks is that of an everyday urbanism. This approach uses a process based analysis to understand how cities work and what drives their transformation by taking the richness of the everyday activities of urban dwellers as the basis for urban theory. Parnell and Robinson (2012) identify this approach as a way to identify and understand the intersection between global processes and local specificities. Ekers and Loftus (2008, 709) see it as a way to turn the attention from more explicit manifestations of power, such as large scale infrastructures, to what they define as “the more subtle way in which power works through everyday hydraulic practices [...]”. McFarlane, Desai, & Graham (2014, 990) identify how analyses of everyday urbanism reveal the urban experience of “attempted control, power and exclusion”, as it represents “the key domain through which practices are regulated and normalized as well as an arena for negotiation, resistance and potential for difference”.

The empirically detailed, process based, ethnographic research identified as one way through which to decenter the production of urban theory is precisely the type of scholarship which has already led to such richly diverse accounts of water access in Southern cities. Not all of which are consciously identified as an everyday urbanism, or aligned with this project of decentering, but in their empirical detail providing a more accurate documentation of how water is distributed across cities: both what urban water inequalities are, and how they are produced. However, as we review through the literature (below), current analyses of everyday practices in relation to water in African cities tells us little about how different qualities or quantities of water in the infrastructure network are produced. Perhaps because the absence of large scale infrastructure networks is the norm, a process based analysis of water flows to analyse inequalities has placed a central focus on the everyday practices of water users and the co-production of a multiplicity of water provision systems which run outside, or alongside of the centralized network (for example, Allen et al. 2016). Therefore, although inequalities of water distribution within the piped system are often documented by scholars for cities across the continent (Andreasen & Møller-Jensen, 2016; Nganyanyuka, Martinez, Wesselink, Lungo, & Georgiadou, 2014; Obeng-Odoom, 2012), they are less scrutinized, and less theorized, within the canon of everyday urbanism. This stands in comparison to the work which has been done on South Asian cities (Anand, 2011, 2014; Hossain, 2011; Misra, 2014; Ranganathan, 2014).

We briefly review here the use of this analysis for inequalities in African cities, and compare it with work on urban water inequalities in South Asian cities. Boakye-Ansah et al. (2016) analyze the role of everyday practices of monitoring, repairing and operating the water supply network in the production of uneven microbiological water

contamination. Both Peloso and Morinville (2014), who document practices of water rationing, and Loftus and Lumsden, (2007), who examine the routine act of collecting water from kiosks and other vendors, analyze the role of these practices in producing, consolidating or contesting condition of access to urban water supply. For the city of Dar es Salaam, Smiley (2013) documents practices of residents in combining water from the utility with other different sources to identify inequalities in terms of reliability, quality, quantity and cost. Also for Dar es Salaam, Nganyanyuka et al. (2014) go further, to show how the everyday practices required to secure domestic water supply are shaped by socio-economic class: longer term strategies that involve more complex transactions with higher monetary and non-monetary costs, while low income residents rely on a number of parallel, shorter term solutions.

The analyses of these everyday practices to identify, or explain, inequalities in urban water supply most often start from the water user, with the work of Boakye-Sarpong et al. (2016) as an exception. Analyses of everyday practices in relation to water provision which are done most often focus on the water flowing outside the network, in areas of the city not covered by centralized infrastructure, or on the decentralized/small scale provider water services used to augment inadequate supply through the network (Allen et al., 2016; Andreasen and Møller-Jensen, 2016). Moreover, while water supply infrastructure at the end of the pipe is seen as incremental, co-produced and flexible – the centralized system itself tends to be represented as fixed once it is in place, despite what is known about daily work required to make water flow and the normality of repair and disruption (Graham & Thrift, 2007). For example, although many studies acknowledge the uncertainties within formally served area, the (everyday) processes and the relations which produce these differences in supply in the first place are overlooked (Allen et al., 2016; Amankwaa et al., 2014). Analyses of the differences in water flows within the

network reverts to an identification of purely technical factors (topography influencing pumping capabilities and gravity fed systems). As a result, in the majority of existing analyses of water inequalities produced through studying everyday practices, centralized infrastructure is still primarily seen as a fixed socio-technical system: once it is in place, relations of power shaping water inequalities are tied to its presence or absence, not its operation. This overlooks the relations of power shaping network operation or maintenance and, thus, *how* and *to whom* water flows where infrastructure is present.

In contrast to the absence of analyses of everyday practices of water providers to make piped infrastructure work in SSA, there have been numerous STS informed analyses of ethnographies of water infrastructure in South Asian cities. Research by both Anand (2011, 2012) and Bjorkman (2014), document the everyday practices of both water users and providers to show how power works through the everyday practices of putting the infrastructure at work, and what this means for inequalities in water flow within the piped system. In this work, the STS analysis of the infrastructure focuses on how engagements with the artifact make it work, rather than the piped network itself. This decentered analysis of water infrastructure from within STS is echoed by Furlong (2011) and Harman's (2009) work on water from within STS, as they reveal how relations and processes work to alter the utility, reliability, security of the infrastructure itself. They call us to rethink the role of infrastructure itself versus the role of human engagements with the infrastructure in order to explain the creation and constant maintenance of these divisions between spaces and service areas in the city.

While building new explanatory frameworks for water and inequality in South Asian cities, research using this process oriented approach has shown how material inequalities within centralized piped networks are produced through the everyday operation of the

infrastructure. Tracing how prejudices towards particular urban groups based in class, religion, race, etc. are infused in the everyday operation of the network they document how particular urban settlements are either left with no water, or with a more precarious service (Anand 2011, Hackenbroch and Hossain 2012). Statements as to the “impossibility” of water provision in certain areas, rationalized by engineers and water operators through technical criteria such as end of pipe location, undesirable topographic conditions, lack of utility resources etc. (Anand, 2011; Cohelo, 2004) are shown instead to be political choices. Analyses of everyday practices of operators shows how utility workers materialize the labels and preconceptions over particular water users making more difficult/easy for them the access to water (Anand, 2011, 2012; Cohelo, 2004; Karpouzoglou & Zimmer, 2016). This highlights the how interests, beliefs, expectations, integrity etc. shape to whom and when water is made available (Anand, 2011, 2012; Hossain, 2011).

These insights/examples of process oriented analyses of water infrastructure in South Asian cities, together with the rich history of process oriented research in African cities, suggest the possibility – and need – to pay more empirical attention to how urban inequalities are maintained not only through the construction of infrastructure, but the daily operation and maintenance. Attending to the engagement with infrastructure across both small and large scale (decentralized and centralized) systems, and by water users and water operators, can do more to reveal how inequalities are reproduced, or challenged. We now turn to do this for the city of Lilongwe, Malawi.

### **Re-directing flows through everyday operations of the water supply network in Lilongwe**

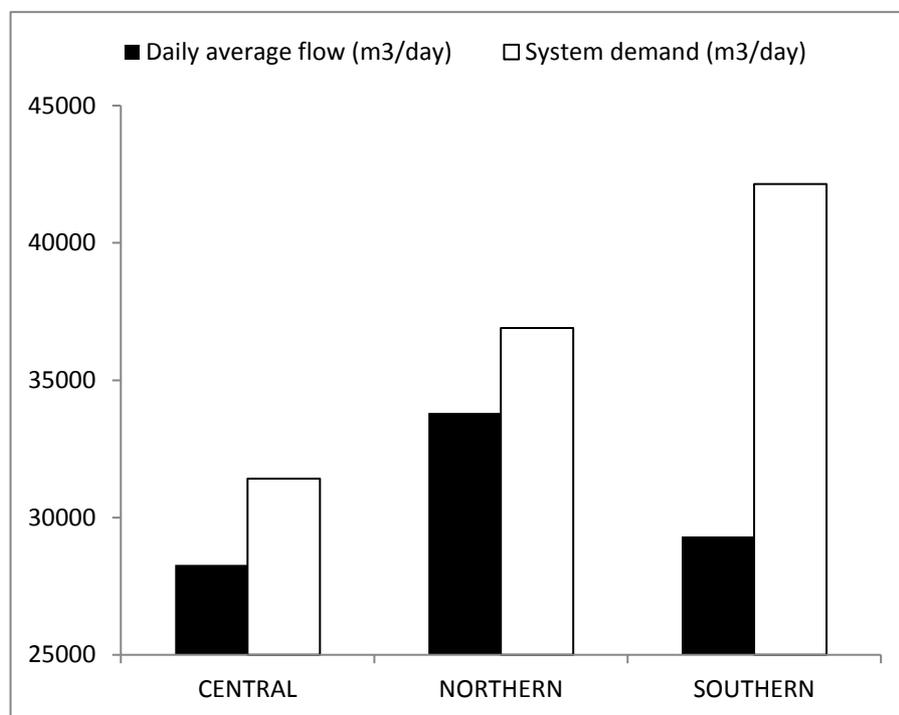
### ***Mapping inequalities in the centralized water supply network***

As process based studies of water supply note for other African cities, drinking water supply in Lilongwe is characterized by inequalities in access, security/reliability, and affordability. The Lilongwe Water Board, a corporatized public utility, serves 78% of the urban population through its centralized water supply network (NSO, 2008). The remaining residents rely on combinations of self-supply via community stand pipes, private wells, boreholes, springs and streams (NSO, 2008). While we acknowledge the distinction between served and unserved population and its relevance, in this paper we focus on uneven supply concealed within the 78%. With the intention to bridge the existing gap in process based analysis of water flows in African cities we focus in processes “within” the networked system, rather than outside it. Although this coverage may suggest uniform services, this number conceals uneven service levels within the same service modality. First, coverage is ensured through two different service modalities, encompassing different technologies and management models. Of the total population served by the water utility, 56% are served through in-house connections and 44% through water kiosks. Secondly, service levels including continuity of water supply differ from area to area.

According to the projections of Lilongwe city Master Plan, the demand for water outstripped the supply capacity of LWB’s infrastructure in 2011, affecting the provision of its service. Water resources are drawn from the Lilongwe River, and treated and distributed to customers through a centralized network. Although there is enough water at the dams, the limited treatment capacity restricts daily production, which is insufficient to meet demand. The gap between production and demand is of approximately 14.000,00 m<sup>3</sup>/day, 11% of the total production (Hadzovic Pihljak, 2014). As a consequence of this gap, provision of water is not continuous across the city. LWB reports an average of 18

hours supply a day (LWB, 2012). However, this average hides the fact that the gap between the current flows of water and the estimated demand of the customers is not evenly distributed across the city: while some consumers receive water round-the-clock, others suffer intermittent supply or even lack of water. As Figure 1 shows, the gap is much larger in the southern zone (Figure 1).

Figure 1. Chart: System flows and demand distribution per area (m<sup>3</sup>/day). (Source: Authors based on: MIWD & LWB, 2010)

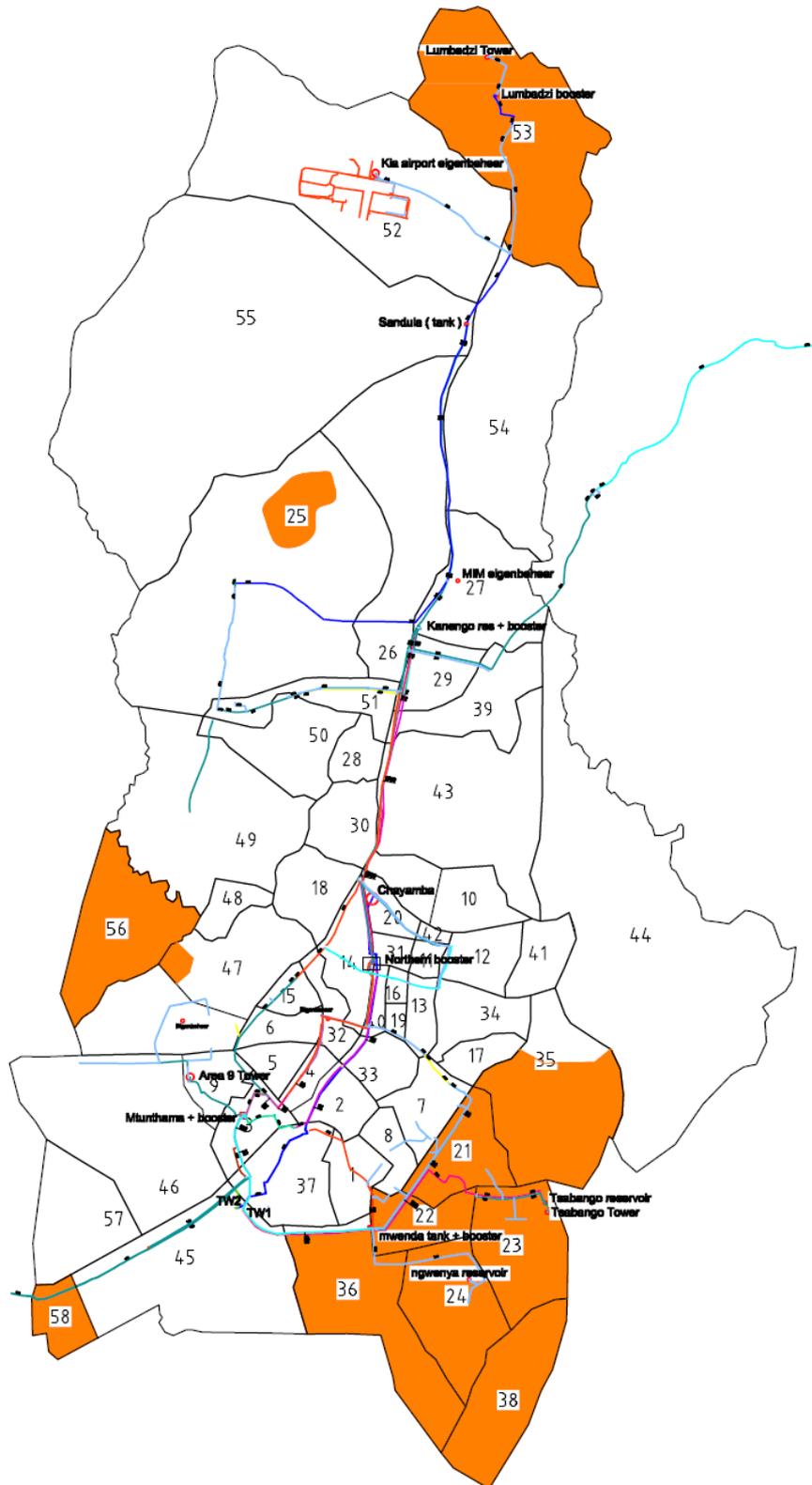


When asked to describe the irregularities in water supply LWB employees reported different qualities of service across of the city. This knowledge of what areas in the city receive what amount of water, on what days, is embedded within the employees,

as it is not formalized within a water rationing schedule, nor present within maps of service delivery by the utility. Working together with the LWB staff we mapped the service levels (Figure 2a), to show urban areas where the supply is considered by LWB staff to be good (i.e. close to twenty four hours a day and reasonable levels of pressure) (blank) versus areas the more critical areas of the city (colored). Overall, this map shows that the Southern Zone is the one with the largest concentration of problematic areas. In fact, according to a LWB Mid-level manager, only four out of fifteen areas served by the water utility (those located closest to the commercial center of the city) receive an average of 18 hours a day during the entire year, while the rest of the areas get an average of 6 hours a day (most of them are LIAs). Further, other forms of differentiation are constituted by the time of the day in which access to water is granted. For example, during a visit to the southern zone of the city customers in Area 36, one of the LIAs in Lilongwe, reported that for the past eight months they have been receiving water only at night, a situation experienced also by other high-density low-income areas of the city.

Figure 2 shows a marked socio-spatial distribution of water discontinuity: most of the areas with major problems are classified as Low Income Areas (LIAs) (in color) by the land use map of Lilongwe City (MoLGRD, LCC, & JICA, 2010).

Figure 2. Hotspots for water supply source (Source: Authors)



Low Income areas of Lilongwe include two categories of residential land: Traditional Housing High Density and unplanned/informal settlements. Traditional Housing High Density areas emerged as a part of a governmental strategy to develop low income housing areas (Englund, 2002). They were initially formally planned by the city, but over the years the plots have been subdivided by owners and subsequently rented and sublet (Englund, 2002; Potts, 1985). Informal settlements started to develop in the 1990s as a result of the congestion in THAs and lack of regulation of informal land (Englund, 2002). Low income areas of Lilongwe account for more than 50% of the residential land in the city (MoLGRD, LCC, & JICA, 2010) and host 76% of the population (UN-Habitat, 2011). They have grown very rapidly in the past decades and are still growing due to rural urban migration. Housing conditions are very precarious and access to basic services is extremely poor in those areas.

### ***Explaining the unevenness within the network***

The uneven distribution of discontinuity, clearly illustrated by Figure 1 and 2, - as we argue in line with STS informed analyses of ethnographies of water infrastructure in South Asian - is not as very often presented the mere result of technical dysfunctions. Rather, as this studies point, it is the product of how the infrastructure is both planned and made to work. LWB employees, however, mobilize technical arguments to explain this unevenness, explaining the flow of water as the results of different quantities and qualities of the infrastructure in different areas of the city. In this way, they present the different quantities of water availability within the piped water supply system as something static - dependent on what area of the city one lives in and what number of reservoirs and pumps exist - rather than fluctuating on the basis of their actions and decisions. To explain the

differentiated level of services they refer to decisions made by city planners who determined a larger development of infrastructure in the Central and Northern Zones in comparison to the Southern Zone or to the differences in the quality of infrastructures and the construction procedures adopted. According to them, in LIAs pipes are smaller and cannot carry the required flow of water. Service connections are described as exposed and too long (up to 100m or more), because houses are located far from the distribution line. Long and exposed distribution lines are more likely to break as "they have to cross roads and they are also broken by vehicles" (LWB operator) and "are prone to vandalism and damages" (LWB operator). While more breakages are acknowledge in LIAs "The problem in those areas is that the pipes are exposed. People want water but they don't have enough money to pay the connections so they break the pipes to get water" (LWB operator). According to operators, even if pipes break accidentally residents do not report them so they can benefit from the leakage what slows down the reaction capacity of the utility in LIAs. Further, while in planned areas pipes are laid in an orderly fashion following plot planning, in some LIAs "reticulation has been done without any planning because of rapid urban growth, the hydraulic design is not good" (LWB engineer). In sum, infrastructure is described as a fixed asset, which constrains and limits the options and decisions of engineers and plumbers.

While these are valid reasons as to why continuity of water supply is so different between areas, we argue that they do not completely explain discontinuity configuration in Lilongwe. In following the day to day practices of LWB engineers, managers, we extend existing analyses of water inequalities in SSA that focuses on engagements of users and infrastructure and presents centralized infrastructure as fixed and inequalities result of its design and construction. In particular we have found that the original inequalities created by infrastructure development are reinforced by its day-to-day

operation and maintenance routines. In a context characterized by technical uncertainty, continuous improvisation, and constant malfunctioning and disrepair, pumps, tanks, valves, and pipes are subjected to maintenance, repairs and other operational decision and manipulation on daily basis, allowing to re-direct water flows and ensuring specific users and areas of the city to evade supply discontinuity problems. It is these day to day practices which build on the original inequalities that were embedded within the water supply system, as political decisions within and outside the water utility shaped the configuration of the system to disadvantage lower income areas of the city (Tiwale, 2015). In the following sections we turn to describe these everyday practices of infrastructure manipulation and the principles used for deciding where the water flows and which repairs happen first or more frequently.

*Re-directing flows (through the “back-up” line)*

The first strategy of re-directing flows is embedded in the system itself, which provides the technical means to divert water produced for the Southern zone to the Central and Northern zones of the system. In principle the water network is divided in two subsystem with two separate treatment plants and production points, namely Treatment Works I (TWI) and Treatment Works II (TWII). TWI with a capacity of 35000m<sup>3</sup>/day produces water for the Southern zone of the city, where most of the LIAs are located, while TW II with a capacity of 60000m<sup>3</sup>/day produces water for the central and northern areas of the city. However, the operation of a backup line and valve allows redirecting water from TWI (for the Southern Zone) to the Central and Northern areas of the city.

In a water supply system [...] you need to have a backup. [...] For that reason LWB maintained the line between TWI and Mtunthama [i.e. the reservoir that provides water to the commercial center of the city and some high-end residential areas

located close to it among others] to supply critical areas in case of emergency (LWB engineer).

However, as one of LWB engineers explained, the interconnection that would allow the opposite: water being directed from TWII to the Southern Zone in case of emergency, “has never been used”, showing a rather unilateral water flow between Southern and Central/Northern Zones.

Installed for so-called emergency situation, this valve is actually operated regularly. The everyday operation of this valve is a contested and negotiated process between different employees and departments. According to the Southern Zone Manager, the decision to divert the water from TWI is usually taken in agreement with the Operations Engineer:

when we have a problem in the southern zone, pipe bursts, lack of electricity, or the reservoirs are full we let the headquarters know so they can send more water to Mtunthama [i.e. the reservoir that provides water to the commercial center of the city and some high-end residential areas located close to it among others] instead of letting the water stay in our reservoirs (LWB Mid-level manager).

However, most of the time, decisions about the valve are taken unilaterally. As one of LWB engineers explains, “there are no written rules about how this should be done. It is decided by the Operations Engineer case by case, to solve emergencies.” For example, “sometimes they decide to open when they need to increase the supply in the [rest of the] city” (LWB Mid-level manager.). While there are technical explanations for the use of this line, the diversion of the flow also responds to the prioritization of some areas: “priority areas are not in these areas of the city [i.e. Southern Zone]” (LWB engineer). Decisions on where to direct the water are made “in terms of who is the critical customer. Unluckily for users in the southern zone, these critical users are not located there” (LWB Engineer).

LWB management assures that the operation of this line does not impact discontinuity levels in the Southern Zone: “the line is not interfering with the availability of water in the Southern Zone. When there is shortage of water there, we close that valve and when there is enough water we open it again” (LWB Engineer). However, according to a LWB operator

When they open this line we suffer a lot. We are not always informed when this is going to happen. Sometimes my supervisor sends me to investigate what is happening when we see the levels in the reservoirs going down (LWB Operator).

#### *Producing differentiated water pressure in the network*

The use of connections to high-pressure pipes represents a second example through which the flows of water in the city can be altered. The water supply network in Lilongwe is a combined gravity and pumping system. Water is pumped to the reservoirs located in different parts of the city using pipes at high pressure. From the reservoirs it is distributed to costumers by gravity. However, in some occasions the gravity system is unable to ensure sufficient pressure for all users. In those circumstances the LWB staff can decide to bypass the reservoirs and connect customers directly to pipes at high pressure. This procedure can be implemented at what LWB staff calls take-off points<sup>3</sup>. This procedure solves the problem for some users. However, providing them with the pressure they are unable to get from the gravity system, negatively impacts other customers who see their share of water reduced (i.e. those not connected to high pressure pipes) and the system in overall (i.e. reservoirs are not balanced, pressure produces stress in pipes and ultimately breaks them, higher energy consumption).

LWB staff are aware of the negative implications that the use of connections has for the functioning of the network as a whole while at the same time they accept the political reasons behind them.

Instead of filling the reservoirs most of the water is taken along the way, and this things happen behind the operations, our friends in the zone offices are responsible for distribution, if someone somewhere makes a lot of noise they opt to tap them water from the pumping main which is not recommended. [...]They have to deal with the customers, they are the ones exposed and they cannot deny them water (LWB Engineer).

This ad-hoc procedure re-directs flows towards consumers that are more able to negotiate their access and avoid discontinuity. This was the case of the Chinese Embassy, as explained by one of the LWB managers

They came into my office and I said no, I am not going to connect you from that line [i.e. Pressurized line] I cannot. [...] They were not happy; they went and meet the General Manager. The GM took some time to make the decision but we have done it (LWB Mid-level manager).

Similar prioritizations also occurred in favor of users located in Kanengo Industrial Pole (North of the city) and the President, whose residences (the State House, situated in Area 44 and the State Lodge, situated in Area 3) are served through pressurized connections.

#### *Improvising the operation of distribution valves*

The operation of distribution valves provides another opportunity to re-direct water flows in the city. Valves are used to control the direction of the flow and, thus, to determine which areas and in which order will be served. LWB has not developed standard operating protocols for the valves and staff are not required to keep track of their operation. The valves are, thus, operated on an ad hoc basis: “they [i.e. operators] cut off on some areas. When people complain, they open some valves here and close there, but after a while they do not remember which valves they have opened or closed” (International expert). According to some LWB operators, the issue has a very easy solution: if valves are locked

and record of their manipulation is maintained, it will be less likely that anyone could alter the proper functioning of the system. However, according to a LWB operator, the operators in charge of the valves “do not accept it because they want to be able to operate them following their interests,” as they respond to a department that is more exposed to customers and therefore to external pressures.

This once more results in prioritizing solutions for that are more effective or able to negotiate their access or those who have personal connections with LWB employees. As a LWB operator bluntly explains, if there is no water in an area where “my colleagues or my relatives stay, you tend to switch water to this area”. Similarly, during maintenance and repair, valves are operated to redirect the flow and benefit specific critical customers like, for example, big hotels (LWB Mid-level manager).

Everyday operation of the valves also encompasses informal or illegal manipulation by customers or informal plumbers, who tamper with valves to get a better supply for them or for specific areas and contribute to the confusion in the network. At times, this operation might involuntarily result in further exclusion from supply:

When there are problems with supply they might think that has been LWB staff that has closed the line, they [i.e. users] touch the valves and it turns out that there is no water because there is a lack of water in the reservoirs so they are actually closing their own supply (LWB Operator)

#### *Differentiated maintenance and response to breakages*

Everyday maintenance and response to breakages (or the lack of thereof) contribute to create the current configuration of water flows through the city. Those decision point towards negligence of LWB operators towards LIAs. In terms of reparations, Boakye-Ansah (2015) shows that while maintenance in LIAs can take up to three months; in higher-income areas response takes a maximum of three days. The same author also

highlights that more maintenance activities take place in higher-income areas, despite the fact that more breakages are recorded in LIAs. An employee of the LWB unit explains that some of the main pipes carrying the water to the Southern Zone of the City were washed away during a flood. Although these elements of the network could have been easily repaired or substituted, LWB was unable or unwilling to repair them:

I think we could pump more water to Mwenda, Nwenya [i.e. Tanks located in the southern zone that provide water to LIAs]. Maybe the reason was the money, the designs were done, we presented them, but they preferred to invest the money in other parts of the network (LWB operator, 2014).

Similarly, water shortages in high and lower income areas are differently treated, with obvious impact on continuity of the service. As one of the LWB Mid-level Managers puts it, “when there is a problem in the high income areas we rush or we give alternative supply like water bowser<sup>4</sup>, but when the same problem happens in those areas you don't send the water bowser”. The differentiated response to emergency further enhances disparities between areas. In some, the service is continued with bowzers; in others, services is interrupted, with the justification that in LIAs “many people there don't have connections, so they have alternative sources of water anyway” (LWB Mid-level manager)

### **Rationalizing re-direction of flows in the city of Lilongwe**

Redirection of flows in the city are not always a product of direct orders from above, nor of formal standard operating procedure, or a coordinated strategy within LWG, but rather a result of everyday improvisation and ad hoc decisions of individuals. Uncovering these processes requires understanding the dynamics of everyday practices of operating and maintaining the water supply network. Understanding these dynamics also requires an

explanation of these practices. In our discussions with the LWB employees, we found that the everyday interaction of LWB employees with infrastructure to prioritize or neglect specific users and locations is shaped by the water utility employee's understandings of the city and their (personal and internalized) sense of whom is more entitled to receive (better) services. The perceptions of entitlement are not formalized as the everyday interactions of the engineers with the piped network are not codified in any operating procedure. Rather, the priority of water supply for certain areas of the city, and certain kinds of consumers, is implicitly shaped by indicators of social status, political priorities, and economic necessity of the LWB employees.

While we acknowledge that the category of LWB employees is not uniform and power, knowledge, interests etc. differs among individuals, the perceptions of LWB employees suggest in general the internalization of obvious socio-spatial differentiation built into the city since its origins (Potts, 1985; Myers, 2003). In the promotion of the "garden city" imaginary, city planners have continually strived to separate high density low-income areas, perceived as an undesirable view, from the city center and its services and infrastructures (Potts, 1985). These socio-spatial separations between areas in the city remain. Therefore, practices of particular individuals working at LWB are reinforcing the marginalization of low-income residents, disadvantaged in access of other public infrastructure. This spatial and social engineering, influences prioritization of water supply to certain areas, which, in turn, reinforces these stark visual reminders of the differences between areas of the city and relative importance of the different residents.

Explicitly, when discussing the rationale for flow redirections with LWB employees, the manipulation of the system and re-direction of flows is based on two assumptions. These assumptions reflect the implicit sense of who - or what - is important. The first assumption of the LWB employees is that specific areas of the city are more

entitled to receive a good service, given the importance of the customers. As a Plant Operator summarizes, “there are important people there, they can leave the country, they can call the president directly if they do not get water”. This reflects the social status - and political connections - of those who "deserve" better water supply. In stark contrast with this image, customers in LIAs areas are often unable to negotiate improved access: “high density areas and poor areas are not so influential. [...] Their complaints are not taken as seriously as in other areas” (MoIWD representative). This differentiated treatment is also justified on the ground that “they are used to not getting water at home” (LWB operator) or “have many other problems besides water” (LWB Mid-level manager) or, more pragmatically, “do not even have a phone to call and complain” (LWB Operator).

The second assumption used to rationalize water flows is that low-income dwellers have *different* water needs and they are better able to cope with discontinuous supply. According to an operator in the Southern Zone, for most customers in his area six to twelve hours of water supply is enough. He makes this statement based on the fact that in the southern zone most of the customers receive water from kiosks: residents collect the amount of water needed for daily household activities each morning, and store it in the home. The amount of water collected and stored by each household is determined by what can be physically collected, the volume that can be stored, what can be afforded, and what is available. Thus, the household adapts its water needs based on what a household can access. To supplement this, households in the Southern Zones have alternative sources of water that they can use in case of necessity like private wells or streams. In this way, the inequalities in infrastructure development - specifically, the neglect to invest in public services for poorer areas of the city - come to provide a justification for the inequalities in continuity of the service. Areas of the city served by

water kiosks - with few or no household connections- have less water provided to the limited infrastructure that does exist. Based on the number of consumers who rely on a kiosk versus a house connection, supplying water to the kiosks would seem to be more of a priority when thinking about total coverage. However - as we showed, the LWB staff seem instead to base their decisions on calculations which prioritize giving the most water to fewer number of consumers. Similarly, the explanation that low income households have "less need" since they can, if there is no other alternative, rely on other sources, also ignores the fact that alternative sources are often highly contaminated.

### **Conclusion: Transforming - the unevenness of water in Lilongwe**

In this paper we have traced the routines of water supply staff as to identify the systematic disadvantaging of Lilongwe's sub-urban areas through the operations and maintenance of the infrastructure systems. We have shown how their everyday decisions and practices contribute to produce highly differentiated water supply in the LWB network.

This analysis fills a gap within current research on water and urban inequalities in African cities, where we know little about the socio-technical processes and social relations producing different quality or quantity of water in the infrastructure network. First, by looking at everyday practices and the infrastructure 'at work' we have shown that it is not only the technology or infrastructure itself that provides the axis of differentiation, but also the human engagements with the 'malleable' infrastructure. Further, through the process based analysis we have identified the discursive construction underlying unequal water distribution patterns in Lilongwe. 'Manipulations' of the infrastructure are shaped by worldviews about particular groups that contribute to their exclusion. For Lilongwe, the differentiated access within the LWB network seems to be

implicitly accepted by LWB staff, who see lower income residents as "having less need", or "better able to cope" with discontinuity. What is most striking is that the majority of water operator staff lives in the same urban areas that they disadvantage.

Although inequalities of water distribution within the piped system are often documented for cities across the continent, they are less scrutinized, and less theorized, within the canon of everyday urbanism. This is problematic in an era when major development investment is being mobilized to increase coverage of large scale networked water infrastructure in the rapidly growing urban centres of Africa (AfDB, 2015). We believe that understanding how the network is really made to work, by whom, for whom, also reveals "more accurately who runs the cities of the South, how that power is gained and used, and how it might be transformed to be more progressive" (Parnell & Robinson, 2012, p. 601).

For Lilongwe, this requires us to understand the everyday practices of water utility staff as the product of the perceptions, rationalizations, interpretations of utility staff who seek to manage the city's (limited) water as best they can. This means that, like in other cities, access to infrastructure is important for reducing inequalities, but not sufficient. Investment into water supply infrastructure is needed across the continent (AfDB, 2015), but to assume that they will deliver an urban infrastructure ideal is naïve. The majority world will continue with the normality of disruptions in urban infrastructure, and this means that the worldviews, attitudes of those who operate the infrastructure systems will continue to shape distribution. Changing the mindsets of water utility staff, to change how they understand the degree of water needs, or worthiness of requests, between different kinds of residents, – we suggest – requires the type of research approach called for by Parnell and Pieterse (2014). As they argue, in order for academic research to be

responsive to Africa's complex and problematic realities, requires a knowledge engagement between academics and policy makers, urban officials.

## Notes

1. By 2050 more than half of the continent's residents will be living in cities: an estimated 2.2 billion people; go from 40-60% urbanized (Cilliers et al. 2011)
2. According to WHO/UNICEF definition, improved sources of water include piped water into dwelling/yard/plot, public tap or standpipe, tube well or borehole, protected dug well, protected spring, rainwater
3. Take-offs are points of connection between the high-pressure pipes and the distribution system closed by a valve. They originally exist to be used for the maintenance of the system or emergency situations.
4. Water trucks

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