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1 **Mapping operation and maintenance: an everyday urbanism analysis of** 2 **inequalities within piped water supply in Lilongwe, Malawi**

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

14
15 **Keywords:** urban water supply, infrastructure, everyday practices, decentering urbanism,
16 Lilongwe

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21 **Introduction**

22 More than a quarter of the 100 fastest growing cities in the world are now in Africa, and
23 the continent's number of urban residents will double over the next 30 years (UN-Habitat,
24 2014)¹. These are well known figures, as is the fact that the rate of urban transition,
25 particularly in Sub-Saharan Africa (SSA), significantly outpaces investment in
26 infrastructure and services (Pieterse and Hyman, 2014). For urban water supply
27 infrastructure, levels of coverage for piped water services have declined over the last 15
28 years while urban population has increased (JMP, 2015). Currently, many cities in SSA
29 provide a smaller percentage of their residents with piped water than they did in 1990 at
30 the start of the Millennium Development Goals.²

31

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

46 colleagues, it tells us even less about the majority of urban space left “blank” outside the
47 network coverage area (Lawhon et al., 2014).

48 The "blankness" of some urban spaces either conceals the relations between water and
49 urban politics or represents those relations inaccurately. Such flawed accounts emphasize
50 the need to explain the role of infrastructure within the production of uneven urban
51 landscapes in a way that reflects a more diverse set of realities (Parnell, 2014; Silver,
52 2014). Building on the recent calls for a production of urban theory which can more
53 accurately and meaningfully capture Southern, African – or even global - urban contexts
54 (Myers, 2014; Parnell & Oldfield, 2014; Roy, 2009; Sheppard et al., 2013), research in
55 cities of both North and South has begun to develop explanatory frameworks for the
56 relations between water and urban inequalities on the basis of more diverse set of
57 experiences. For example, Acevedo et al. (2016) with their historical analysis of water
58 supply interventions in Colombia challenge water sector assumptions around trends as
59 decentralization or corporatization. Ranganathan and Balazs (2015) show the usefulness
60 of North-South comparison in the understanding of periurban water inequalities. Stoler
61 et al. (2012) analyze in metropolitan Accra the persistence of packaged drinking water as
62 one of the main sources of water even in areas ‘served’ by piped system. These are but a
63 few examples of how urban water scholarship is unsettling assumptions of what urban
64 water infrastructure is, how it is made to work, and the complex politics of water it reflects
65 and reproduces, for the majority of the world.

66 One approach to providing a more accurate picture of how water flows through SSA
67 cities, and why, and what this means for urban inequalities, has been the use of a process
68 based analysis: building explanations from empirical observations of what users actually
69 do, the practices they perform. Thus, instead of interpreting local contexts through a

70 global explanatory framework, or seeing the differences in particular contexts as spaces
71 of “exception” (Roy & Ong, 2011), this research uses the very particularities of cities
72 previously located in the margins as exceptions in global frameworks. This approach
73 aligns with the recent move within Science and Technology Studies (STS) to decenter
74 analyses of socio-technical systems from the role of artefact itself (the piped network), to
75 understand how it is made to work through the engagement of both human and non-
76 human actors.

77

78 In this paper we document the everyday practices that make centralized piped water
79 infrastructure system work in the city of Lilongwe, Malawi. We understand practices as
80 activities of everyday life which are situated in a specific context, consist of embodied
81 performance, knowledges, and objects, and may result in forms of change, resistance, or
82 continuity (Pink, 2012; Reckwitz, 2002; Schatzki, 2001). We use this empirical detail for
83 a process based analysis of inequalities in urban water supply in a city where the uneven
84 flow of water through the centralized piped network system reflects and reproduces other
85 inequalities within the city. Population densities, living conditions, access to services vary
86 dramatically between low-income areas (LIAs) and informal settlements (served through
87 a system of kiosks), and the commercial/high end residential areas in the urban core (with
88 in-house connections). Although both are included in access to the city's centralized water
89 supply network which serves 78% of one million residents (NSO, 2008), LIAs have a
90 much higher rate of supply infrequency. To understand why this is so, and what it can tell
91 about politics of water in the city, we follow the everyday practices of the engineers and
92 water utility staff as they do daily maintenance and operational work. Our analysis of how
93 inequalities in water quantity and continuity are produced within the network reveals the

94 political processes at play in technical processes usually ‘black-boxed’ and kept from
95 scrutiny.

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

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

104 The last decade has seen the emergence and consolidation of decentered perspectives that
105 seek to destabilize the application of northern norms across urban theory in order to better
106 explain the dynamics of cities across a variety of contexts (McCann et al., 2013; Sheppard
107 et al., 2013). One approach advocated as a way to decenter from northern based
108 explanatory frameworks is that of an everyday urbanism. This approach uses a process
109 based analysis to understand how cities work and what drives their transformation by
110 taking the richness of the everyday activities of urban dwellers as the basis for urban
111 theory. Parnell and Robinson (2012) identify this approach as a way to recognize and
112 understand the intersection between global processes and local specificities. Ekers and
113 Loftus (2008, 709) see it as a way to turn the attention from more explicit manifestations
114 of power, such large scale infrastructures, to what they define as “the more subtle way in
115 which power works through everyday hydraulic practices [...]”.

116 The empirically detailed, process based, ethnographic research identified as one way
117 through which to decenter the production of urban theory has already led to richly diverse

118 accounts of water access in Southern cities. Not all of this work is explicitly identified as
119 an everyday urbanism, or aligned with this project of decentering. However, the empirical
120 detail of these studies does provide a more accurate documentation of how water is
121 distributed across cities and of what urban water inequalities are, and how they are
122 produced. However, as we review through the literature, current analyses of everyday
123 practices in relation to water in African cities tell us little about how different qualities or
124 quantities of water in the infrastructure network are produced. Perhaps because the
125 absence of large scale infrastructure networks is the norm, process based analyses of
126 water flows dealing with inequalities have placed a central focus on the everyday
127 practices of water users and the co-production of a multiplicity of water provision systems
128 which run outside, or alongside of the centralized network (for example, Allen et al.
129 2016). Where inequalities of water distribution within the piped system are documented
130 (Andreasen & Møller-Jensen, 2016; Nganyanyuka, Martinez, Wesselink, Lungo, &
131 Georgiadou, 2014; Obeng-Odoom, 2012), they are less scrutinized, and less theorized,
132 within the canon of everyday urbanism. This stands in comparison to the work which has
133 been done on South Asian cities (Anand, 2011, 2014; Hossain, 2011; Misra, 2014;
134 Ranganathan, 2014).

135

136 In recent years the analysis of drinking water inequalities in African cities has, more or
137 less explicitly, been influenced by everyday urbanism canon. Boakye-Ansah et al. (2016)
138 analyse the role of everyday practices of monitoring, repairing and operating the water
139 supply network in the production of uneven microbiological water contamination. Both
140 Peloso and Morinville (2014), who document practices of water rationing, and Loftus and
141 Lumsden, (2007), who examine the routine act of collecting water from kiosks and other
142 vendors, analyze the role of these practices in producing, consolidating, or contesting

143 condition of access to urban water supply. For the city of Dar es Salaam, Smiley (2013)
144 documents practices of residents in combining water from the utility with other different
145 sources to identify inequalities in terms of reliability, quality, quantity, and cost.
146 Nganyanyuka et al. (2014) go further, to show how the everyday practices required to
147 secure domestic water supply in Dar es Salaam are shaped by socio-economic class:
148 longer term strategies that involve more complex transactions with higher monetary and
149 non-monetary costs, while low-income residents rely on a number of parallel, shorter
150 term solutions.

151 The analyses of these everyday practices to identify, or explain, inequalities in urban
152 water supply most often start from the water user, with the work of Boakye-Ansah et al.
153 (2016) as an exception. The majority of analyses of everyday water supply practices focus
154 on areas of the city not covered by centralized infrastructure, or on the small-scale water
155 service providers who augment inadequate supply through the network (Allen et al., 2016;
156 Andreasen & Møller-Jensen, 2016). Moreover, while water supply infrastructure at the
157 end of the pipe is seen as incremental, co-produced and flexible – the centralized system
158 itself tends to be represented as fixed once it is in place, despite what is known about
159 daily work required to make water flow and the normality of repair and disruption
160 (Graham & Thrift, 2007). For example, although many studies acknowledge the
161 uncertainties within formally served areas, the (everyday) processes and the relations
162 which produce these differences in supply in the first place are overlooked (Allen et al.,
163 2016; Amankwaa et al., 2014). Analyses of the differences in water flows within the
164 network revert to an identification of purely technical factors (topography influencing
165 pumping capabilities and gravity fed systems). Thus, centralized infrastructure is, in these
166 studies, still primarily seen as a fixed socio-technical system: once it is in place, relations
167 of power shaping water inequalities are tied to its presence or absence, not its operation.

168 This overlooks the relations of power shaping network operation or maintenance and,
169 thus, *how* and *to whom* water flows where infrastructure is present.

170

171 In contrast to the absence of analyses of everyday practices of water providers to make
172 piped infrastructure work in SSA, there have been numerous STS informed analyses of
173 ethnographies of water infrastructure in South Asian cities. Research by both Anand
174 (2011, 2012) and Björkman (2014), document the everyday practices of both water users
175 and providers to show how power works through the everyday practices of putting the
176 infrastructure at work, and what this means for inequalities in water flow within the piped
177 system. Rather than focusing on the piped network itself, the centre of attention is placed
178 on the engagements with the artifacts. This decentered analysis of water infrastructure is
179 echoed by Furlong (2011) and Harman's (2009) work on water from within STS, as they
180 reveal how relations and processes work to alter the utility, reliability, security of the
181 infrastructure itself. They call us to rethink the role of infrastructure itself versus the role
182 of human engagements with the infrastructure to explain the creation and constant
183 maintenance of these divisions between spaces and service areas in the city.

184 While building new explanatory frameworks for water and inequality in South Asian
185 cities, research using this process oriented approach has shown how material inequalities
186 within centralized piped networks are produced through the everyday operation of the
187 infrastructure. Tracing how prejudices towards particular urban groups based in class,
188 religion, race, etc. are infused in the everyday operation of the network, they document
189 how certain urban settlements are either left with no water, or with a more precarious
190 service (Anand 2011, Hackenbroch & Hossain 2012). Statements as to the "impossibility"
191 of water provision in certain areas, rationalized by engineers and water operators through

192 technical criteria such as end of pipe location, undesirable topographic conditions, or lack
193 of financial resources (Anand, 2011; Cohelo, 2004) are shown instead to be political
194 choices. Analyses of everyday practices of operators shows how utility workers
195 materialize the labels and preconceptions over particular water users making more
196 difficult or easy for them the access to water (Anand, 2011, 2012; Cohelo, 2004;
197 Karpouzoglou & Zimmer, 2016). This highlights how the interests, beliefs, expectations,
198 and integrity shape to whom and when water is made available (Anand, 2011, 2012;
199 Hossain, 2011).

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

208 **Re-directing flows through everyday operations of the water supply network in** 209 **Lilongwe**

210 *Mapping inequalities in the centralized water supply network*

211 As process based studies of water supply note for other African cities, drinking water
212 supply in Lilongwe is characterized by inequalities in access, reliability, and affordability.
213 The Lilongwe Water Board, a corporatized public utility, serves 78% of the urban
214 population through its centralized water supply network (NSO, 2008). The remaining

215 residents rely on combinations of self-supply via community stand pipes, private wells,
216 boreholes, springs and streams (NSO, 2008). While we acknowledge the distinction
217 between served and unserved population and its relevance, in this paper we center our
218 attention in the uneven supply concealed within the official figures of the served
219 population. With the intention to bridge the existing gap in process based analysis of
220 water flows in African cities, we focus in processes within the networked system, rather
221 than outside it. Although coverage averages may suggest uniform services, in Lilongwe
222 they hide uneven service levels. First, coverage is ensured through two different service
223 modalities, encompassing different technologies and management models. Of the total
224 population served by the water utility 44%, receive water via in-house connections and
225 56% through water kiosks. Secondly, service levels including continuity of water supply
226 differ from area to area.

227 According to the projections of Lilongwe city Master Plan, the demand for water
228 outstripped the supply capacity of LWB's infrastructure in 2011, affecting the provision
229 of its service. Water resources are drawn from the Lilongwe River, and treated and
230 distributed to customers through a centralized network. Although there is enough water
231 at the dams, the limited treatment capacity restricts daily production, which is insufficient
232 to meet demand. This gap is of approximately 14.000,00 m³/day, 11% of the total
233 production (Hadzovic Pihljak, 2014). As a consequence, provision of water is not
234 continuous across the city. LWB reports an average of 18 hours supply a day (LWB,
235 2012). However, this average of 18 hours is not evenly distributed across the city: while
236 some consumers receive water round- the-clock, others suffer intermittent supply or even
237 lack of water for up to 4-5 days. As Figure 1 shows, the gap is much larger in the southern
238 zone (Figure 1).

239

240 [Insert Figure 1 here]

241

242 When asked to describe the irregularities in water supply LWB employees
243 reported different qualities of service across of the city. The information of what areas in
244 the city receive what amount of water, on what days and times is not formalized within a
245 water rationing schedule, nor is it included by the utility in maps of service delivery. It is
246 rather embedded within the employees' knowledge of the system. Working together with
247 the LWB staff we mapped service levels to identify the areas where they consider the
248 supply to be good (i.e. close to twenty-four hours a day and reasonable levels of pressure)
249 versus the more critical areas of the city (Figure 2). Overall, this map shows that the
250 southern sector of the city is the one with the largest concentration of problematic areas.
251 In fact, according to a LWB Mid-level manager, only four out of fifteen areas served by
252 the water utility in that part of the city (those located closest to the commercial center of
253 the city) receive an average of 18 hours a day during the entire year, while the rest of the
254 areas get an average of 6 hours a day (most of them are LIAs). Further, other forms of
255 differentiation are constituted by the time of the day in which access to water is granted.
256 For example, during a visit to Area 36, one of the LIAs located in the South-East of the
257 city, reported to have received water only at night for the past eight months, a situation
258 experienced also by other LIAs of the city.

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

262 [Insert Figure 2]

263 LIAs of Lilongwe include two categories of residential land: Traditional Housing
264 High Density areas (THAs) and unplanned/informal settlements. THAs emerged as a part

265 of a governmental strategy to develop low-income housing areas (Englund, 2002). They
266 were initially formally planned and plotted by the government in the late 1980s. However,
267 since the early 1990s the plots have been subdivided by owners and subsequently rented
268 and sublet (Englund, 2002; Potts, 1985). Informal settlements started to develop in the
269 1990s as a result of the congestion in THAs and lack of regulation of informal land
270 (Englund, 2002). LIAs account for more than 50% of the residential land in the city
271 (MoLGRD, LCC, & JICA, 2010) and host 76% of the population (UN-Habitat, 2011).
272 They have grown very rapidly in the past decades and are still growing. Housing
273 conditions are very precarious and access to basic services is extremely poor in those
274 areas.

275 ***Explaining the unevenness within the network***

276 The uneven distribution of discontinuity, clearly illustrated by Figure 1 and 2, is very
277 often presented as the result of technical constraints. LWB employees, however, mobilize
278 technical arguments to justify this unevenness. According to them, it is due to differences
279 in the volumes and quality of infrastructure distributed across the city. In this way, they
280 present the different quantities of water availability within the piped water supply system
281 as something static - dependent what number of reservoirs and pumps exist in each area
282 of the city- rather than fluctuating based on their actions and decisions. To explain the
283 differentiated level of services they refer to decisions made by city planners, who
284 determined a larger development of infrastructure in the central and northern sectors of
285 Lilongwe or to the differences in the quality of infrastructures and the construction
286 procedures adopted. According to them, in LIAs pipes are smaller and cannot carry the
287 required flow of water. Service connections are described as exposed and too long (up to
288 100m or more), because houses are located far from the distribution line. Long and

289 exposed distribution lines are more likely to break as “they have to cross roads and they
290 are also broken by vehicles” (LWB operator) and “are prone to vandalism and damages”
291 (LWB operator). While more breakages are acknowledged in LIAs, “the problem in those
292 areas is that the pipes are exposed. People want water but they don't have enough money
293 to pay the connections so they break the pipes to get water” (LWB operator). According
294 to operators, even if pipes break accidentally residents do not report them so they can
295 benefit from the leakage that slows down the reaction capacity of the utility in LIAs.
296 Further, while in planned areas pipes are laid in an orderly fashion following plot
297 planning, in some LIAs “reticulation has been done without any planning because of rapid
298 urban growth, the hydraulic design is not good” (LWB engineer). In sum, infrastructure
299 is described as a fixed asset, which constrains and limits the options and decisions of
300 engineers and plumbers.

301 While these are valid reasons as to why continuity of water supply is so different
302 between areas, we argue that they do not completely explain discontinuity configuration
303 in Lilongwe. In following the day to day practices of LWB engineers, managers, we
304 extend existing analyses of water inequalities in SSA that focuses on engagements of
305 users and infrastructure and presents centralized infrastructure as fixed and inequalities
306 result of its design and construction. In particular, we have found that the original
307 inequalities created by infrastructure development are reinforced by its day-to-day
308 operation and maintenance routines. In a context characterized by technical uncertainty
309 and constant malfunctioning the pumps, tanks, valves, and pipes are subjected to daily
310 maintenance by operators whose decisions re-direct water flows. Consequently, this
311 ensures that specific users evade supply problems. It is these day to day practices which
312 build on the original inequalities that were embedded within the water supply system, as
313 political decisions within and outside the water utility shaped the configuration of the

314 system to disadvantage lower income areas of the city (Tiwale, 2015). In the following
315 sections, we turn to describe these everyday practices of infrastructure manipulation and
316 the principles used for deciding where the water flows and which repairs happen first or
317 more frequently.

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

319 The first strategy of re-directing flows is embedded in the system itself, which provides
320 the technical means to divert water produced for the southern section to the central and
321 northern ones. In principle, the water network is divided in two subsystems with two
322 separate treatment plants and production points, namely Treatment Works I (TWI) and
323 Treatment Works II (TWII). TWI with a capacity of 35000m³/day produces water for the
324 southern zone of the city, where most of the LIAs are located, while TW II with a capacity
325 of 60000m³/day produces water for the central and northern areas of the city. However,
326 the operation of a backup line and valve allows redirecting water from TWI (for the
327 southern zone) to the central and northern areas of the city.

328 In a water supply system [...] you need to have a backup. [...] For that reason, LWB
329 maintained the line between TWI and Mtunthama [i.e. the reservoir that provides
330 water to the commercial center of the city and some high-end residential areas
331 located close to it among others] to supply critical areas in case of emergency (LWB
332 engineer).

333 However, as one of LWB engineers explained, the interconnection that would allow the
334 opposite: water being directed from TWII to the southern zone in case of emergency, “has
335 never been used”, showing a rather unilateral water flow between southern and
336 central/northern zones.

337 Installed for so-called emergencies, this valve is actually operated regularly. The
338 everyday operation of this valve is a contested and negotiated process between different
339 employees and departments. According to a mid-level manager in working in the southern
340 zone of the City, the decision to divert the water from TWI is usually taken in agreement
341 with the Operations Engineer:

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

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

357 LWB management ensures that the operation of this line does not impact
358 discontinuity levels in the South of the city: “the line is not interfering with the availability
359 of water in the southern zone. When there is shortage of water there, we close that valve
360 and when there is enough water we open it again” (LWB Engineer). However, according
361 to a LWB operator

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

365 *Producing differentiated water pressure in the network*

366 The use of connections to high-pressure pipes represents a second example through which
367 the flows of water in the city can be altered. The water supply network in Lilongwe is a
368 combined gravity and pumping system. Water is pumped to the reservoirs located in
369 different parts of the city using pipes at high pressure. From the reservoirs, it is distributed
370 to costumers by gravity. However, on some occasions the gravity system is unable to
371 ensure sufficient pressure for all users. In those circumstances the LWB staff can decide
372 to bypass the reservoirs and connect customers directly to pipes at high pressure. This
373 procedure can be implemented at what LWB staff calls take-off points³. This procedure
374 solves the problem for some users. However, providing them with the pressure they are
375 unable to get from the gravity system, negatively impacts other customers who see their
376 share of water reduced (i.e. those not connected to high pressure pipes) and affects the
377 system in overall (i.e. reservoirs are not balanced, pressure produces stress in pipes and
378 ultimately breaks them, higher energy consumption).

379 LWB staff are aware of the negative implications that the use of connections has
380 for the functioning of the network but at the same time they accept the political reasons
381 behind them.

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

388 This ad-hoc procedure re-directs flows towards consumers that are more capable
389 to negotiate better conditions of access. This was the case during the construction of a
390 new embassy location, as explained by one of the LWB managers.

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

395 Similar prioritizations also occurred in favor of users located in Kanengo
396 Industrial Pole (North of the city) and the presidential houses (the State House, situated
397 in Area 44 and the State Lodge, situated in Area 3) are served through pressurized
398 connections.

399 *Improvising the operation of distribution valves*

400 The operation of distribution valves provides another opportunity to re-direct water flows
401 in the city. Valves are used to control the direction of the flow and, thus, to determine
402 which areas and in which order they will be served. LWB has not developed standard
403 operating protocols for the valves and staff are not required to keep track of their
404 operation. The valves are, thus, operated on an ad hoc basis: “they [i.e. operators] cut off
405 on some areas. When people complain, they open some valves here and close there, but
406 after a while they do not remember which valves they have opened or closed”
407 (International expert). According to some LWB operators, the issue has a very easy
408 solution: if valves were locked and a record of their manipulation was maintained, it
409 would be less likely that anyone could alter the proper functioning of the system.
410 However, according to a LWB operator, staff in charge of the valves “do not accept it
411 because they want to be able to operate them following their interests,” as they respond

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

419 Everyday operation of the valves also encompasses manipulation by customers or
420 informal plumbers, who tamper with valves to get a better supply for themselves or for
421 specific areas. At times, this operation might involuntarily result in further exclusion from
422 supply:

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

427 *Differentiated maintenance and response to breakages*

428 Everyday maintenance decisions configure the way water flows through the city. Those
429 decisions suggest negligence by LWB operators in relation to the needs of LIAs. In terms
430 of reparations, Boakye-Ansah et al. (2016) show that while maintenance in LIAs can take
431 up to three months; in higher-income areas response takes a maximum of three days. The
432 same author also highlights that more maintenance activities take place in higher-income
433 areas, even though more breakages are recorded in LIAs. An employee of the LWB unit
434 explains that some of the main pipes carrying the water to the southern zone of the City
435 were washed away during a flood. Although these elements of the network could have
436 been easily repaired or substituted, LWB was unable or unwilling to repair them.

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

441 Similarly, water shortages in high and lower income areas are treated differently,
442 with obvious impact on continuity of the service. As one of the LWB mid-level managers
443 puts it, “when there is a problem in the high-income areas we rush or we give alternative
444 supply, like water bowsers⁴, but when the same problem happens in those areas you don't
445 send the water bowser”. The differentiated response to emergencies further enhances
446 disparities between areas. In some, the service is continued with bowsers; in others,
447 service is interrupted, with the justification that in LIAs “many people there don't have
448 connections, so they have alternative sources of water anyway” (LWB mid-level
449 manager)

450

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

452 Redirection of flows in the city are not always a product of direct orders from above, nor
453 of formal standard operating procedure, or a coordinated strategy within LWG, but rather
454 a result of everyday improvisation and ad hoc decisions of individuals. Uncovering these
455 processes requires understanding the dynamics of everyday practices of operating and
456 maintaining the water supply network. Understanding these dynamics also requires an
457 explanation of these practices. In our discussions with the LWB employees, we found
458 that the everyday interaction of LWB employees with infrastructure to prioritize or
459 neglect specific users and locations, is shaped by the water utility employee's
460 understandings of the city and their (personal and internalized) sense of who is more
461 entitled to receive (better) services. The perceptions of entitlement are not formalized as

462 the everyday interactions of the engineers with the piped network are not codified in any
463 operating procedure. Rather, the priority of water supply for certain areas of the city, and
464 certain kinds of consumers, is implicitly shaped by indicators of social status, political
465 priorities, and economic necessity of the LWB employees.

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

478 Explicitly, when discussing the rationale for flow redirections with LWB
479 employees, the manipulation of the system and re-direction of flows is based on two
480 assumptions that reflect the implicit sense of who - or what - is important. The first
481 assumption of the LWB employees is that specific areas of the city are more entitled to
482 receive a good service, given the importance of the customers. As a plant operator
483 summarizes, "there are important people there, they can leave the country, they can call
484 the president directly if they do not get water". This reflects the social status - and political
485 connections - of those who 'deserve' better water supply. In stark contrast with this image,
486 customers in LIAs are often unable to negotiate improved access: "high density areas and

487 poor areas are not so influential. [...] Their complaints are not taken as seriously as in
488 other areas” (MoIWD representative). This differentiated treatment is also justified on the
489 ground that “they are used to not getting water at home” (LWB operator) or “have many
490 other problems besides water” (LWB mid-level manager) or, more pragmatically, “do not
491 even have a phone to call and complain” (LWB operator).

492 The second assumption used to rationalize water flows is that low-income
493 dwellers have *different* water needs and they are better able to cope with discontinuous
494 supply. According to an operator working in the South of the city, for most customers in
495 his area six to twelve hours of water supply is enough. He makes this statement based on
496 the fact that there most of the customers receive water from kiosks: residents collect the
497 amount of water needed for daily household activities each morning, and store it in the
498 home. The amount of water collected and stored by each household is determined by what
499 can be physically collected, the volume that can be stored, what can be afforded, and what
500 is available. Thus, households adapt their water needs to what they can access. To
501 supplement this, households in LIAs have alternative sources of water that they can use
502 in case of necessity like private wells or streams. In this way, the inequalities in
503 infrastructure development - specifically, the neglect to invest in public services for
504 poorer areas of the city - come to provide a justification for the inequalities in continuity
505 of the service. Areas of the city served by water kiosks - with few or no household
506 connections - have less water provided to the limited infrastructure that does exist. Based
507 on the number of consumers who rely on a kiosk versus a house connection, supplying
508 water to the kiosks would seem to be more of a priority when thinking about total
509 coverage. However - as we showed, the LWB staff seem instead to base their decisions
510 on calculations, which prioritize giving the most water to a small fraction of the total
511 number of consumers. Similarly, the explanation that low-income households need less

512 water from the utility since they can, if there is no other alternative, rely on other sources,
513 also ignores the fact that alternative sources are often highly contaminated.

514

515 **Conclusion: Transforming the unevenness of water in Lilongwe**

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

521 This analysis fills a gap within current research on water and urban inequalities in
522 African cities, where we know little about the socio-technical processes and social
523 relations producing different quality or quantity of water in the infrastructure network.
524 First, by looking at everyday practices and the infrastructure 'at work' we have shown
525 that it is not only the technology or infrastructure itself that provides the means for
526 differentiation, but also the human engagements with the infrastructure. Further, through
527 the process based analysis we have identified the social relations underlying unequal
528 water distribution patterns in Lilongwe. 'Manipulations' of the infrastructure are shaped
529 by worldviews and assumptions about particular groups that contribute to their exclusion.
530 In this, our work contrasts with findings by Anand (2011, 2012) and Björkman (2014)
531 who find that engineers do accommodate slum needs despite the 'world classing' going
532 on in Indian cities. In Lilongwe, the differentiated access within the LWB network seems
533 to be implicitly accepted by LWB staff, who see lower income residents as needing less
534 water and being better able to cope with discontinuity. What is most striking is that the
535 majority of water operator staff lives in the same urban areas that they disadvantage.

536 Although inequalities of water distribution within the piped system are often
537 documented for cities across the continent, they are less scrutinized, and less theorized,
538 within the canon of everyday urbanism. This is problematic in an era when major
539 development investment is being mobilized to increase coverage of large scale networked
540 water infrastructure in the rapidly growing urban centres of Africa (AfDB, 2015). We
541 believe that understanding how the network is really made to work, by whom, for whom,
542 also reveals “more accurately who runs the cities of the South, how that power is gained
543 and used, and how it might be transformed to be more progressive” (Parnell & Robinson,
544 2012, p. 601).

545

546 For Lilongwe, this requires us to understand the everyday practices of water utility staff
547 as the product of the perceptions, rationalizations, interpretations of utility staff who seek
548 to manage the city's (limited) water as best they can. This means that, like in other cities,
549 access to infrastructure is important for reducing inequalities, but not sufficient.
550 Investment into water supply infrastructure is needed across the continent (AfDB, 2015),
551 but to assume that they will deliver an urban infrastructure ideal is naïve. The majority
552 world will continue with the normality of disruptions in urban infrastructure, and this
553 means that the worldviews and attitudes of those who operate the infrastructure systems
554 will continue to shape distribution. Changing these attitudes is the work for new
555 knowledge engagement strategies between academics, utility managers, and urban actors.

556

557 **Notes**

- 558 1. By 2050 more than half of the continent’s residents will be living in cities: an estimated
559 2.2 billion people; go from 40-60% urbanized (Cilliers et al. 2011)

- 560 2. According to WHO/UNICEF definition, improved sources of water include piped water
561 into dwelling/yard/plot, public tap or standpipe, tube well or borehole, protected dug well,
562 protected spring, rainwater
- 563 3. Take-offs are points of connection between the high-pressure pipes and the distribution
564 system closed by a valve. They originally exist to be used for the maintenance of the
565 system or in case of emergencies.
- 566 4. Water trucks

567

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576

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