Producing water scarcity in São Paulo, Brazil

DOI:

[10.1016/j.polgeo.2018.04.007](https://doi.org/10.1016/j.polgeo.2018.04.007)

Document Version

Accepted author manuscript

[Link to publication record in Manchester Research Explorer](#)

Citation for published version (APA):

Millington, N. (2018). Producing water scarcity in São Paulo, Brazil: The 2014-2015 water crisis and the binding politics of infrastructure. *Political Geography*, 65. <https://doi.org/10.1016/j.polgeo.2018.04.007>

Published in:

Political Geography

Citing this paper

Please note that where the full-text provided on Manchester Research Explorer is the Author Accepted Manuscript or Proof version this may differ from the final Published version. If citing, it is advised that you check and use the publisher's definitive version.

General rights

Copyright and moral rights for the publications made accessible in the Research Explorer are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Takedown policy

If you believe that this document breaches copyright please refer to the University of Manchester's Takedown Procedures [<http://man.ac.uk/04Y6Bo>] or contact uml.scholarlycommunications@manchester.ac.uk providing relevant details, so we can investigate your claim.

Producing water scarcity in São Paulo, Brazil: The 2014 Water Crisis and the Binding Politics of Infrastructure

**Nate Millington
African Centre for Cities
University of Cape Town
Environmental and Geographical Science Building
Rondebosch, 7701, South Africa
nate.millington@uct.ac.za**

In 2014, political intransigence combined with a severe drought to push São Paulo, Brazil, to the edge of a profound water crisis. In this paper, I consider the response to the crisis on behalf of the state government. I analyze the suite of actions taken to cope with scarcity, focusing specifically on the state's employment of pressure reductions in the water pipes as opposed to a formal rationing. I argue that despite the state government's claims that only a small minority was going without water, the reality was that water shortages were being felt throughout the city and residents of the urban periphery were being disproportionately impacted. Uneven experiences of scarcity were produced by the combination of existing inequities in city's water infrastructure and the differentiated abilities of residents to store water in small-scale reservoirs commonly referred to as caixas d'água. Understanding the co-production of water (in)security in crisis contexts has implications for how we understand the nature of contemporary urban governance and the techno-politics of the contemporary city, and offers insight into scholarship on the political ecologies of the state and the distributed nature of governance. Additionally, it suggests that more research is needed into the critical role played by adaptive technologies of water storage in the hydrosocial cycle.

1. Introduction

In 2014 and 2015, the city of São Paulo came to the edge of a profound water crisis, as drought combined with political intransigence to result in the city's reservoirs being reduced to single digit percentages. While the state and its largest city were able to narrowly avoid a full-scale rationing as rains returned in 2015, the possibility that the city would need to embrace formal water restrictions marked the city's political life in the lead up. As the crisis deepened, civil society organizations demanded more transparent management of the city's water supply, but these demands went largely unmet. Instead, a broad hydrological paradigm of large-scale treatment and delivery remained entrenched as rains returned in 2015 and 2016.

In this paper, I analyze the state government of São Paulo's response to the 2014-2015 water crisis. I describe and discuss how the crisis was responded to by the state government, which included changes to the fee structure and the usage of water that had previously been deemed necessary for the health of the reservoirs. I focus primarily, however, on the state's employment of pressure reductions in the water pipes. In lieu of a formal rationing, the state government chose to employ pressure reductions in order to slow consumption. This was part of a broader narration of the crisis on behalf of the state's water company that situated the crisis in a multi-year drought and located possible management responses in existing infrastructural dynamics. Pressure reductions were juxtaposed with the possibility of a citywide rationing that would have employed regularly scheduled water cuts.

The combination of pressure reductions with changes to the fee structure meant that, in the words of the state governor, "nobody went without water" in the leadup to the crisis (G1, 2015). In spite of claims made that water shortages affected under 1% of the population, however, water shortages marked the city in 2014 and 2015 and were especially

pronounced in peripheral neighborhoods. Between January and June 2014, for instance, peripheral neighborhoods reduced their water usage at a rate of nearly double the wealthier urban core (Leite, 2014). I argue in this paper that differentiated experiences of scarcity were not necessarily due to specific intent on behalf of the state government. Rather, scarcity was produced by the combination of existing inequities in city's water infrastructure and the differentiated abilities of residents to store water. By embracing what was seemingly the most technically viable solution to the crisis—pressure reductions—the state government effectively kept water flowing to the urban core at the expense of the city's periphery. This is due to the distance of peripheral communities from treatment centers but also due to the uneven presence of small-scale reservoirs commonly referred to as caixas d'água (hereafter referred to as caixas) in homes and apartments. Caixas are mandated by law in all new construction, but their installation requires degrees of consolidation that are often missing in the urban periphery. As such, while the state repeatedly drew on the assumed presence of caixas, they are an uneven technology. Residents were repeatedly reminded of the importance of the caixa for withstanding scarcity, but class, geography, and infrastructural consolidation limit access to them. As a result, the state's usage of pressure reductions in the pipes disproportionately affected those with limited ability to store water through small-scale reservoirs.

In making this argument, I draw from Urban Political Ecology and Science and Technology Studies in order to highlight the role played by networked infrastructures in producing specific outcomes associated with crisis and scarcity. Paying attention to infrastructural dynamics makes clear that the experience of water crisis in 2014 and 2015 was co-produced through infrastructural inequalities, which combined with differentiated capacities for adaptation to produce uneven experiences of scarcity. This has implications for

how we understand the nature of contemporary urban governance and the techno-politics of the contemporary city, and offers insight into contemporary scholarship on the political ecologies of the state and the distributed nature of contemporary governance (On techno-politics, see Bakker, 2010; Michell, 2002; Von Schnitzler, 2016; On the state, see Angel & Loftus, 2017; Harris, 2017; Kelly-Richards & Banister, 2017; Grundy-Warr *et al*, 2015; Meehan, 2014; Ramutsindela, 2017; Robbins, 2003). Specifically, paying attention to the operationalizing of politics in and through infrastructure allows for more nuanced analyses of state practice that take seriously the historical legacies of infrastructural provisioning in contemporary practice and their connection to broader patterns of inequality. State practice is both productive of and constrained by infrastructures (See Anand, 2017; Meehan, 2014), and the materiality of São Paulo's circulatory system was critical to the experience of differentiated scarcities.

This paper highlights the critical role played by technologies of storage in the functioning of urban infrastructural systems. I prioritize the role played by one specific technology of infrastructural adaptation in order to highlight the interweaving of small-scale adaptive technologies of storage in the context of the broader functioning of São Paulo's water management system. This co-production of uneven water access demonstrates the critical importance of adaptive infrastructures that allow for storage in responding to infrastructural inequity and breakdowns in service delivery. While work on water infrastructure has largely focused on the circulation of water through concepts such as flow, São Paulo's experience indicates the critical importance of water storage for understanding the functioning of urban water systems as well as for understanding related dynamics of infrastructural equity. In São Paulo, the ability to store water was critical both for withstanding scarcity but also for how the state understood the possibilities for action in the context of drought and rainfall

uncertainties. This has implications for understanding what Ferguson (2015) calls the “politics of distribution” in a context of increasing climatic uncertainty (See too Cohen, 2016).

The structure of the paper is as follows. In the next section, I situate the study though first sketching a brief history of the city’s hydrological regime and broader fluvial dynamics. Next, I locate the paper in the conceptual literatures that background and inform it and describe the methods used in the research process. I then describe the forms in which the state responded to the water crisis, focusing primarily on the reduction of pressure in the water pipes. In the following section of the paper, I argue that while the state claimed that few were going without water, the reality was that many were facing water shortages and that peripheral residents were disproportionately affected. I draw out this argument to consider how the crisis and its response was mediated through infrastructural inequities, which combined to produce a situation where enforced scarcity in the periphery subsidized water usage in the urban core. I focus on hydrological infrastructure at the city scale as well as at the household level, and analyze the role played by small-scale reservoirs (caixas) in producing differentiated experiences of scarcity. I conclude the paper by situating São Paulo’s water crisis within broader concerns around contemporary crisis brought on by global climate change.

2. Situating São Paulo

2a. Providing Water in São Paulo

The social geography of São Paulo is intimately linked to its water management regime, and inequality is inseparable from the city’s fluvial landscape. In spite of increasing spatial heterogeneity, the city remains marked by a division made between an urban center and an

expansive periphery, one that grew extensively throughout the second half of the twentieth century (See Caldeira, 2001, 2016; Holston, 1991, 2008; Keck, 2002; Kovarick, 2009; Rolnik, 1997). São Paulo juxtaposes a vertical urban core that is serviced relatively well by infrastructures of energy, water, and waste with a broadly horizontal urban periphery, marked by the spread of dense, single-story neighborhoods built through processes of autoconstruction and eventual consolidation (See Caldeira, 2016; Holston, 2008). While the dynamics of inequality no longer correspond to a strict center/periphery divide, the city remains marked by the histories of unequal development and their infrastructural corollaries. Environmentally, the city's inequality has serious implications for water pollution and degradation. Long-standing processes of central city expulsion pushed many of the city's poorest residents towards areas of environmental protection, including reservoirs, riverbanks, and green spaces. This puts pressure on fragile ecosystems at the same time as it exposes residents to toxicity and environmental hazards such as flooding. In these ways, the management of the city's water supply and related dynamics of flooding and scarcity are intimately linked to its uneven landscape of inequality.

Located at the point of contact between the Tietê River and two of its tributaries, the Pinheiros and the Tamanduatei, São Paulo grew in the space between rivers. Both the Pinheiros and the Tamanduatei flow into the Tietê, which then flows westward out of the city and into the interior of São Paulo state. São Paulo is located not at the end of the river's course, but instead at its beginning. As such, due to the city's location in the headwaters of the Tietê, the historical flashiness¹ of the river has led to flooding during high flow and insufficient water supply during extended periods of low flow. São Paulo is crisscrossed by

¹ The flashiness of a stream refers to the speed at which river flow increases and decreases during a storm event.

hundreds of rivers but water scarcity is and has been a real problem since the city's founding (On the history of water management in São Paulo, see de Sant'Anna, 2007; Jacobi, Fracalanza & Silva-Sánchez, 2015; Jorge, 2006; Abers & Keck, 2014; Seabra, 1987; Ribeiro, 2011; Silva, 2012). The Alto-Tietê basin, in which São Paulo is located, has an estimated water availability of around 200 m³ per inhabitant per year, dramatically less than the international standard for water stress of 1,500 m³ per inhabitant (Silva, 2012: 112; See also Porto, 2012; Ribeiro, 2011). This puts São Paulo residents of São Paulo at risk of absolute scarcity even under normal conditions.

The result is that, like other places where water stress is chronic, a system of intensive infrastructural provisioning is necessary to manage and supply water. São Paulo's water needs are subsequently met by three primary reservoir systems: the Cantareira, located to the north of the city, which provides for 45% of the city's water needs, the Alto-Tietê, located to the east of the city, which provides 20.5%, and the Guarapiranga, located in the southern periphery, which provides 19%. Each reservoir system is itself a system of smaller reservoirs, and the rest of the city's water is provided by three smaller systems (Cotia, Rio Claro, and Rio Grande). Before being distributed to the population, water from these reservoirs is treated at eight treatment stations scattered throughout the region. Most dramatically, Guaraú, which treats the water from the Cantareira system, is responsible for supplying water to roughly nine million people.

Water in São Paulo is managed by SABESP [The Basic Sanitation Company of the State of São Paulo], a public/private water company formed in 1973. SABESP is currently a publically traded entity in which the state owns slightly more than 50 percent (and has since 1994). SABESP manages the provisioning of water and the collection and treatment of sewage for 33 of the 39 municipalities that make up the metropolitan region of São Paulo,

and provides bulk water to the other municipalities (some of which supplement this water with local reserves). Currently, the majority of São Paulo's residents received piped water, and water availability per capita in the years leading up the drought was over 300 litres per capita per day. Yet per capita water availability does not always mean that water is being delivered in egalitarian ways (See, e.g., Bakker, 2010; Rodina, 2016, Swyngedouw, 2004). Local topographies and land use dynamics yield uneven systems of water provisioning and water access, meaning that many in the urban periphery suffer from inconsistent water supply.

Changes to the city's climate at both the local and global scale are currently altering the city's long-standing water paradigm. Long described as a city of drizzle [garoa], São Paulo is increasingly marked by long periods of scarcity broken up by intense rain events. It is predicted that extreme rainfall events will only increase in the years to come, even as the city has faced five consecutive years of reduced precipitation (See Coelho et al, 2015; Dias et al, 2012; Nobre et al, 2010). Dias et al (2012) observe that the city has seen an increase in days of intense rainfall alongside a decrease in days with rainfall of less than 4 mm (See too Xavier et al, 1994; Sugahara et al, 2009). They point out that while increases in extreme rain events during the dry season are intimately linked to "global climatic oscillations" (717), the situation during the wet season is more complex, suggesting the importance of local effects such as heightened temperatures due to urban heat island effect. Additional studies have called attention to the importance of deforestation at both the regional and national scale, which both alters precipitation dynamics while also contributing to the lessening of local water retention capacities (See Cohen, 2016). As such, while the effects of global climate change on São Paulo's rainfall patterns are still being understood, it appears clear that the coexistence of scarcity with excess will mark the city in the years to come.

2b. Conceptual Overview

As a research project grounded in the field of Urban Political Ecology (UPE; See Bakker, 2010; Gabriel, 2014; Heynen, 2013; Rademacher, 2011; Ranganathan, 2014; Swyngedouw and Heynen, 2003; Swyngedouw, 2004), this paper begins from the understanding that urban environmental questions need to be situated within specific political and social dynamics. While theorizations of UPE often focus specifically on socio-material or metabolic analyses of cities, in this paper I instead focus on the intersections of infrastructure, inequality, and water in order to understand how political responses are operationalized in and through the urban socio-natural landscape. This draws from and contributes to contemporary scholarship focused on the political ecologies of infrastructure.

Focusing on infrastructure involves a commitment to understanding the important role played by often-invisible infrastructural systems in the production of contemporary urban space and associated patterns of life (See Amin, 2014; Anand 2011, 2017; Bakker, 2010; Carse, 2012, 2017; Chu, 2014; Furlong, 2014; Gandy, 2014; Graham, 2009; Graham and Marvin, 2001; Graham and McFarlane, 2014; Kaika, 2005; Kaika and Swyngedouw, 2000; Larkin, 2013; Ranganathan, 2015; Silver, 2014). The broad scholarship in the “infrastructural turn” (Graham, 2009, 10) has theorized infrastructure as an example of the socio-natural processes that produce cities (Kaika, 2005; Graham, 2009), has looked at the uneven distribution of and access to urban circulatory systems (Swyngedouw, 1996, 2004; Gandy, 2008; Graham and Marvin, 2001), the dynamics of infrastructural breakdown (Chu, 2014; Nye, 2010; Ranganathan, 2016), the importance of repair and banal repetition in the production of the urban (Barnes, 2017; Thrift, 2005; Graham and Thrift, 2007), the political implications of infrastructure for urban residents in the global south (Amin, 2014; Bakker, 2010; Gandy, 2008; McFarlane and Rutherford, 2008; Ranganathan, 2014; Silver, 2014) and

the conditions by which infrastructure comes to be naturalized or made visible (Benson, 2015; Kaika and Swyngedouw, 2000, McFarlane & Silver, 2016). Infrastructural theorists drawing more directly from the social studies of science have focused on the political and ecological implications of infrastructures of standardization (Bowker and Star, 2000; Carse and Lewis, 2016; Easterling, 2014). Researchers interested in infrastructural co-production have drawn attention away from a strict focus on formal service providers in order to better understand the complex configurations of actually-existing infrastructural systems in the global north and south (See Ahlers *et al*, 2014).

This project expands on infrastructural scholarship in two specific ways. First, it contributes to existing work on the political ecology of state practice that highlights the co-constitution of state intent and the material technologies of power. Drawing from Meehan (2014) and Anand (2017), in particular, this paper understands state practice as one that is constituted by specific technologies, tools, and infrastructures. Meehan (2014) notes, drawing from the work of Graham Harman, “objects like rain barrels, reservoirs, and federal laws are not equally real, but are equally *objects*-capable of affecting and producing the world in distinct and sometimes forceful ways” (216; See too Bijker, 2007). Infrastructures act in the world, in ways that both co-produce the operation of power while also opening up space for material contestation. This calls attention to the political geographies of the environment and the contemporary nature of the state while being clear that infrastructures are not final determinants but rather one broader component in the “contested socio-ecological processes” that produce the state (Angel & Loftus, 2017: 6; See too Harris, 2012; 2017; Kelly-Richards & Banister, 2017; Grundy-Warr *et al*, 2015; Meehan, 2014; Ramutsindela, 2017; Robbins, 2003). As Anand (2017) notes, “Infrastructures are flaky accretions of sociomaterial processes that are brought into being through relations with human bodies,

discourses, and other things (sewage, soil, water, filtration plants). They are processes always in formation and...always coming apart” (Locations 441-443 in Kindle version).

In São Paulo, the usage of pressure reductions as opposed to whole-scale rationing constituted a form of political engagement that enrolled the infrastructural landscape in the operationalizing of politics. This is indicative of what Carse (2017) has recently referred to through his understanding of droughts as “infrastructural events” that stitch together the local with the global through complex negotiations across scales (See too Carse, 2012). São Paulo’s water crisis can be understood through an approach that takes seriously the materiality of the system itself, the constraints that underpinned possibilities and deepened differentiated effects. The constraints built into the city’s hydrological system—the historical geographies of the city’s infrastructures—should be understood as the forms through which the state’s response to scarcity were operationalized. Infrastructures are obdurate and hard to change, even in crisis contexts. Through its focus on the material technologies of circulation and storage, this paper subsequently calls for an understanding of governance that locates state power in the material technologies of service delivery. In doing so, this paper echoes Barnes’ (2014) call for “a [water] politics anchored not in an alarmist narrative of global crisis and potential wars, but in the everyday practices of managing canals, opening dams, dredging channels, turning on faucets, operating pumps, and irrigating fields” (See too Barnes, 2017; Chu, 2015; Graham and Thrift, 2007; Thrift, 2005; Von Schnitzler, 2016).

Second, this paper contributes to contemporary scholarship in infrastructure by focusing not on water flows but rather on adaptive technologies of water storage as critical to understanding the operation of water infrastructures. Specifically, by focusing on the usage of caixas, it highlights the importance of small-scale reservoirs for mediating differentiated experiences of water scarcity. While technologies such as rain barrels and reservoirs figure

into understandings of the hydrosocial cycle (Budds, 2009; Meehan, 2014; Swyngedouw, 2004), engagements with water governance remain largely oriented around the idea of water's circulation (See, e.g. Anand, 2017; Bakker, 2010; Swyngedouw, 2004). Yet equitable water access is dependent on multiple technologies of storage, whether in the form of large and small-scale reservoirs, tankers, or cisterns (See Bijker, 2007; Burt & Ray, 2014). While pipes provide the primary visual metaphor for understanding watery infrastructures, water is as much stored as it is in motion. Focusing on technologies of storage subsequently has implications for understanding the functioning of contemporary urban infrastructures and for better articulating the relationships between household water usage and urban or regional scale water provisioning.

2c. Methods

In order to understand the complex dynamics of São Paulo's water management infrastructures, this paper draws from 22 months of fieldwork in São Paulo between 2013 and 2016. I followed the thread of water throughout the city but maintained a continual reference point in the city's eastern periphery. I conducted roughly 45 semi-structured interviews with water professionals, state officials, and neighborhood activists throughout São Paulo. These included representatives of small-scale social movements active in the city's eastern periphery as well as employees of the Department of Water and Electrical Energy (DAEE), the São Paulo Housing and Urban Development Company, and the environmental secretaries at both the state and municipal level. These were complemented by a variety of informal conversations, walking tours, observations of meetings, and extensive discursive analysis of texts, representations, and policy documents. I participated in multiple events related to the state government's response to the water crisis, organized by academic, professional, and civil society bodies.

3. The 2014-2015 Water Crisis and its Response

In 2013 and 2014, rain bypassed São Paulo's primary water catchment areas. The result was that the city and its surrounding municipalities became dependent on reservoirs with available water percentages in the single digits. According to documents and discourses associated with SABESP, the formation of a zone of high atmospheric pressure blocked the arrival of weather fronts from the Amazon and the Southern Atlantic and South Pole, altering the region's climatic dynamics. The result was that in the region that supplies water to the Cantareira reservoir, only 444 mm of rain fell during the 2013 and 2014 rainy season, much less than the average yearly rainfall of 995 mm (SABESP, 2015). The situation worsened throughout 2014. By the end of January 2015, the primary reservoir in the city, the Cantareira, was operating at 7% percent capacity, and the city teetered on the edge of a full-scale water crisis. Plans circulated about the possible evacuation of much of the city and residents began to complain vocally about recurrent water shortages. In January 2015, the city began to discuss the possibility of a rationing that would have involved four days without water for every two days with it (Estadão Conteúdo, 2015).

As rains bypassed the city throughout the lead up to the crisis, SABESP took a series of emergency measures to protect against the threat of scarcity. They reacted primarily in four ways. First, SABESP offered a reduction in cost for those who diminished their water consumption. Between February and November 2014, consumers who lowered their water usage by twenty percent were given a thirty percent reduction in their bills. In November this bonus was amplified to include those who reduced their consumption between fifteen and twenty percent. Second, they tapped water from what is referred to as the *dead volume* (or *technical reserve*) within the Cantareira system. This refers to the water that exists below the pumps and was previously ignored when reservoir levels were tallied. SABESP would add to

this volume twice in 2014, on May 15 and October 24. By taking water from the Cantareira system that was previously not considered water, at least statistically, the dead volume had the effect of conjuring water where there was none previously. At the same time, the quality of the water in the dead volume was roundly questioned, as was the ultimate effect on the health of the reservoirs themselves. Increasing levels of water-borne diseases in 2014 and 2015—what one reporter referred to as a ‘hyperendemic’ of diarrhea—suggest that the dead volume led to issues of water pollution and contamination (See Martín, 2015c). Third, the state began to move water between the reservoirs, specifically from the Guarapiranga into the Cantareira at largely unknown levels. Drawing from the Guarapiranga was designed to offset federal regulations that reduced the amount of water that could be extracted from the Cantareira itself.

Lastly, and perhaps most polemically, SABESP began to reduce the water pressure in the city’s pipes, primarily at night. Pressure reductions were justified by the leakiness of the pipes themselves, through which roughly 30% of the city’s water is lost. By lowering the pressure in the pipes, SABESP argued that less water would be lost to leaks, while residents would not be forced to go entirely without water. In part, this was due to the fact that residents were assumed to have caixas installed in their homes, which would allow for 24 hours of water storage. SABESP argued that pressure reductions eliminated the need for a formalized rationing in the city and meant that the state was merely employing a routine strategy to reduce water losses from leaking pipes. SABESP argued that pressure reductions would limit the losses of water from leaks while giving most residents consistent access. The decision to pursue pressure reductions in lieu of a formal rationing was articulated as a routine component of water management that would preserve water quality in the system and protect against contamination due to depressurization. In describing the technique,

SABESP noted that it has been in use in São Paulo since the 1990s (SABESP, n.d). The logic was broadly articulated as a technological requirement to preserve the city's reservoirs from collapse, and an environmental alternative to formal rationing that prevented the sorts of problems associated with citywide rationing and cutbacks. As SABESP themselves note:

With the advance in hydraulic machinery and data transmission, it is possible to accompany in real time the quantity of water utilized in a specific region and remotely calibrate the existing pressure in the local tube in order to reduce the quantity of water lost in leaks and illegal hookups [fraudes]. SABESP has applied this technology in São Paulo's system of water provisioning since the 1990s. With the drought that occurred in 2014/2015 this action was intensified, being an extremely important part of SABESP's strategy to confront the crisis, with the objective of avoiding the collapse of the reservoirs and contributing to the management of water supply until the return of normal rain patterns (SABESP, n.d; translation by the author).

Jerson Kelman, the new president of SABESP, gave a more detailed explanation of pressure reductions in a January 2015 editorial (Kelman, 2015). In the text, he credits drops in water consumption that were reported throughout the year to the sacrifices made by civil society. Kelman notes that, "the bulk of the population already reacted by lowering consumption, before being subjected to a restriction (2015)." This "change in behavior" was motivated by the "knowledge of the necessity of confronting the worst drought in history, at times motivated by the desire to take advantage of the fee bonus."² He goes on to note that there are cases in which the change occurred not by choice but due to the forced lowering of pressure, but he reiterates that this was "necessary to diminish the leaks in underground pipes: it is a preventative measure designed to avoid a worse problem, which would be the exhaustion of the underground water that supplies the big reservoirs."

He notes that the alternative of a "pure and simple" rationing runs the risk of contamination in the water pipes when they are shut off, which would require a more

² The price reductions that were offered in exchange for lowered consumption.

rigorous monitoring of water quality on the part of SABESP. In exceptional cases affecting much less than 1% of the population, he clarifies, some residents lost access to water for days, a product of the lack of a caixa that, in his analysis, affects both the rich and poor. He notes that these localized cases will be managed by the distributing of caixas to residents, and concludes by asking:

Can you describe this situation as a rationing? It depends. For those who belong in the minority that, at this point, do not have water, the answer is certainly positive. But, the term “rationing” is used, in general, when you force collective consumption through the total interruption of service for some hours of the day or when you impose individual quotas on consumption. That is not what SABESP has done, but could be forced to do, if it continues to not rain in the right places and in the necessary quantities.

Kelman’s op-ed downplayed the crisis even as concerns on behalf of civil society picked up. As the question, ‘tá faltando água em casa?’ [Do you have water at home?] became increasingly common throughout the city, the state continued to downplay water shortages. In fact, it was only in 2015 after months of denials that the state governor of São Paulo Geraldo Alckmin would admit that some were going without water: “Rationing [*acionamento*] already exists,” he noted on January 14, 2015:³ “When the federal water agency says you need to reduce withdrawals from 33 to 17 [cubic meters of water per second] from the Cantareira [reservoir system], it’s obvious that there is *restriction* [restrição].”⁴ This was the first mention of rationing by the state governor, and he would very quickly backpedal days later. But Alckmin was right that there was no formal rationing in São Paulo. There was, instead,

³ For many, the delays in clearly responding to the crisis were a direct response to the fact that Alckmin was up for reelection and was trying to downplay the situation as a result. His decision to select new departmental heads for SABESP and the Secretary of Water Resources only after the election was over suggests the truth of these accusations (see Cohen, 2016; Cruxen, 2016).

⁴ This is a reference to a decision made by the National Water Agency [ANA] and São Paulo’s Department of Water and Electrical Energy [DAEE] to reduce the amount of water taken from the Cantareira system in early 2014. Water governance in São Paulo can feature overlapping jurisdictions whose ambits are not always clear (See, e.g. Abers and Keck, 2014; Keck, 2002; Porto, 2012; Silva, 2012), and the relation between ANA and SABESP proved fraught during the crisis. Nevertheless, the responsibility of managing the crisis largely fell on SABESP and São Paulo’s state government.

restriction, which enabled SABESP to avoid being characterized as having put São Paulo under a system of enforced rationing. The term is subsequently a case study both in the particularities and evasiveness of state discourses but also in what Li (2007) refers to as the “rendering technical” of political solutions.

SABESP’s response to the 2014-2015 crisis was to focus on the environmental causes and describe the response in technical terms, to effectively situate the state’s response in the socio-ecological landscape itself and the infrastructures of circulation that provide water to residents. Kelman’s editorial articulated SABESP’s response in technical terms, and its causes in ecological ones. In response to critiques of their management of the crisis that were raised by civil society actors throughout 2014 and 2015, SABESP stated throughout the crisis that they adequately responded to the earlier warnings and were prepared but that the drought of 2013 was worse than any that had been predicted or could have been prepared for. Indeed, in a meeting on July 22, 2015, Kelman noted that SABESP was prepared for an 84-year drought but not a 300+ year one.⁵

4. Differentiated Scarcities and the Politics of Infrastructure

While the state framed water shortages as rare, the on-the-ground reality was that shortages were being felt across the city and that cuts to water supply were disproportionately felt by low-income residents and those located outside the urban core. Residents of the periphery lowered their water usage between January and June 2014 at a rate of nearly double the wealthier urban core (Leite, 2014), and polling data throughout 2014 and 2015 made clear that peripheral residents were facing water shortages at much

⁵ In response to the criticisms that have been cast on SABESP, they responded by claiming that they had invested 1.2 billion *reais* in improvements to the system between 2008 and 2013, including 11 large projects that were completed by 2014. They also noted that water losses from pipes had been reduced from 29.8% in 2007 to 25.4% in 2013 (Brandt & Leite, 2014; See also Serapião, 2014).

higher rates. While the data on peripheral water reductions was interpreted by SABESP as voluntary, a desire to save money on water bills, the degree to which peripheral residents reduced their consumption suggests otherwise. As Carlos Thadeu de Oliveira of the Brazilian Institute for the Defense of the Consumer noted in a 2014 article:

The balance shows that poorer and more remote neighborhoods economized more. It is in these regions that we see more complaints about water shortages. I don't believe that the rich are less sensitive to the crisis. I think this must be a consequence of the rationing that is being done in some regions (in Leite, 2014).

In explaining the logic behind pressure reductions (which were framed in strict opposition to rationing; see Cohen, 2016), SABESP argued that pressure reductions could potentially lead to shortages but only for a fraction of the population (much less than 1%, blamed on elevation and the lack of a caixa; See SABESP, nd). A poll from October 20, 2014, however, found that in fact 60% of São Paulo residents had gone without water at some point in the thirty days before the study. While the data does not break down into class or geography, it does distinguish between *apartamentos* [apartments] and *casas* [houses]. Given the broader urbanization processes in São Paulo, it is reasonable to approximate that apartments are representative of wealthier residents whereas *casas* are a stand-in for middle or lower income residents (with exceptions, of course). The poll found that 67% of *casas* had gone without water, whereas only 26% of *apartamentos* had. Polling done in April 2015 found that 35% of city residents had suffered water cuts on five or more days per month, while 14% had experienced water scarcity for up to 4 days per month (Datafolha, 2015). Most importantly, the polling found a distinctly classed nature to the cuts, with 42% of residents earning up to two minimum salaries experiencing water cuts in comparison to 19% for residents with incomes above 10 minimum salaries.⁶

⁶ Income in Brazil is measured in comparison to the minimum wage. Those earning above 10 minimum salaries would subsequently be earning 10* what the poorest formal worker earns.

This quantitative data was matched by journalistic and qualitative encounters with scarcity in the city. Journalists in the city encountered similar stories throughout 2014 and 2015 (See Cesare, 2014; Krepp & Brenha, 2015; Martín, 2015a, 2015b; Estadão Conteúdo, 2014; Rigby, 2015a, 2015b; Romero, 2015; Souza, 2015). In February 2015, for instance, Rafael Italiani discussed water shortages of up to six days in the Santa Etelvina housing project in the Cidade Tiradentes neighborhood. I encountered water scarcity as a researcher in the eastern periphery of São Paulo in 2014 and 2015. At meetings with the Movement for the end of Floods that I attended in the Fall of 2014 in the neighborhood of Itaim Paulista, for instance, participants offered extensive commentary on the water shortages that were by then common. At a meeting in October 2014, nearly all the residents noted that they did not have water at night.

While there was no formal rationing of water in the urban periphery of São Paulo, the combination of less capacity for water storage, further distance from treatment centers, and more precarious hookups meant that peripheral residents suffered longer periods of scarcity. The lowering of pressure, the purported schedules of which were only released in January 2015 after considerable legal demand, combined with the uneven presence of local reservoirs and the precarity of many peripheral water connections to create what was affectively an arbitrary and structurally unequal rationing of water that most dramatically affected peripheral residents. Peripheral communities are often located at the end of the water distribution network, meaning that pressure reductions can reduce the ability of water to arrive. SABESP reiterated the degree to which pressure reductions were complicated by combinations of elevation and distance from treatment centers, but their technical framing of the crisis and response ignored the degree to which these dynamics were concentrated in peripheral communities and materialized in peripheral homes.

Urban infrastructures express inequality and contribute to differentiated experiences of urban service delivery. The uneven experience of scarcity demonstrates how the technical solution to water crisis intersected with existing infrastructural dynamics in São Paulo to produce differentiated outcomes. São Paulo's fluvial infrastructure is a deeply unequal system, one that links together housing inequality, financialized housing provisioning that yields favelas and irregular allotments, and uneven access to water and sewage into what Ioris (2012) refers to as "multiple scarcities." These inequalities are stitched into São Paulo's landscape in dramatic ways, and implicated in the approach to water taken by SABESP. As such, while SABESP may have handled the water crisis in the form that was most technically sophisticated given the constraints built in the system, it did so in a way that was pre-determined to affect the urban periphery most dramatically. This is suggestive of the material forms through which politics circulates, the infrastructures that mediate and produce uneven effects, the techno-politics of urban water management (Bakker, 2010; Meehan, 2014; Von Schnitzler, 2016).

In this sense, São Paulo's broader hydrological infrastructure can be articulated through Winner's (1980) nuanced navigation of the complex relationships between the technical and the political. As he notes:

These are instances in which the very process of technical development is so thoroughly biased in a particular direction that it regularly produces results counted as wonderful breakthroughs by some social interests and crushing setbacks by others. In such cases it is neither correct nor insightful to say, 'Someone intended to do somebody else harm.' Rather, one must say that the technological deck has been stacked long in advance to favor certain social interests, and some people were bound to receive a better hand than others (126).

Winner's provocation reveals the complex interweaving of the political and the infrastructural in the city's crisis response. More specifically, the city's water crisis makes clear that the explanations for the crisis provided by the state and civil society—one

purportedly ecological, mediated by infrastructural limitations, and another purportedly political, mediated by histories of financing and misplaced priorities—need to extend past these binaries to instead raise questions about the deep relationships between the technical and the political within contemporary urban risk governance. The infrastructural interventions made by SABESP should be seen not just as attempts to technologize existing histories of uneven service provisioning but rather as the terrain of politics itself.

Decoding the logics of infrastructural service delivery is a means of engaging with the multi-modal, expansive nature of governance in the contemporary moment, of understanding the historical and landscape-level processes that stitched into the contemporary functioning of socio-technical systems. The usage of pressure reductions as opposed to whole-scale rationing constituted a form of political engagement that enrolled the landscape in the operationalizing of politics. This is indicative of what Carse (2017) has recently referred to through his understanding of droughts as “infrastructural events” that stitch together the local with the global through complex negotiations across scales. São Paulo’s water crisis can only be understood through an approach that takes seriously the materiality of the system itself, the constraints that underpinned possibilities.

This can be demonstrated by an analysis of the caixa, which reveals that infrastructural inequality is critically mediated by adaptive technologies of storage. In particular, the uneven presence of small-scale reservoirs —caixas—was critical to how the crisis was responded to and whose consumption was cut. Caixas are reservoirs of varying sizes, largely built from polyethylene. They are not a universal technology, but instead a broader reflection of the overlapping dynamics of formality, informality, and inequality that mark the city’s landscape. They are a point of contact — an intermediary infrastructure — between the household and the system of large-scale provisioning that marks the city’s water

sector. They are a noticeable component of the urban periphery, and are often perched on top of houses throughout the city's autoconstructed lower-income neighborhoods (See figure 1). In these neighborhoods, the visibility of caixas can serve to reflect degrees of consolidation since their installation requires dwellings that are able to withstand considerable weight. Shacks, for instance, would be unable to withstand the weight of a caixa, whereas a home constructed with brick would be able to. In apartment buildings, Caixas are often invisible but play a critical role in water security. Since 1992, caixas have been mandated by law in all residential units, with a recommended capacity of 24 hours per dwelling. Most apartment buildings are, subsequently, built with caixas installed. Smaller dwellings, however, especially those that predate the law from the early 1990s, are often not.

Caixas were critical to experiences of scarcity in two specific ways: First, they allowed for SABESP to argue that reduced pressure would not lead to water shortages due to the ability of residents to store water on site for 24 hours. In response to complaints about water shortages during the crisis, SABESP repeatedly reiterated the importance of the caixa for withstanding the possibility of scarcity brought on by pressure reductions in the pipes. SABESP drew regularly on the importance of the caixa for withstanding the crisis, calling attention to the 24-hour requirement built into law (See, e.g. SABESP, n.d.; Oliveira, 2016).

Second, caixas materially impacted residents abilities to withstand scarcity. Those with caixas in their homes were able to store water onsite, effectively avoiding shortages. For those seen to be too poor to afford a caixa, SABESP created a program that delivered caixas to residents who needed them. Prioritizing residents who made below three minimum salaries, SABESP promised to distribute 25,000 caixas. Not responsible for installation, SABESP would deliver them to residents who signed up, under the agreement that if they were not installed in thirty days they would be recollected. With an initial delivery date of

June 2015—over a year after the dead volume had first been tapped into—the program was delayed twice throughout the year. September 2015 estimates were that 15,000 caixas were ultimately distributed throughout the metropolitan region (See Iory, 2015).

Explaining the delay, SABESP noted that the difficulties had to do with the “complexity of the regions” as well as the availability of the residents to receive the equipment (Iory, 2015). While many homes in the periphery have caixas installed, they are by no means a universal technology. Indeed, the infrastructural requirements for placing a heavy and expensive reservoir on the top of your roof requires degrees of consolidation and formalization that are not universal in the city’s peripheral landscape. As such, the ability of wealthier residents to withstand scarcity through infrastructural augmentation was determined both by income but also broader dynamics of neighborhood consolidation. For many who inhabit formal apartment buildings, caixas are a part of the invisible infrastructure of daily life. For poorer residents, they are pieces of a hydrosocial cycle that need to be bought, delivered, and installed on low incomes. Infrastructure here extends past the landscape of water provisioning to include the broader networks of home building and neighborhood development that mark the urban periphery. To distribute and install caixas requires sustained layers of infrastructural provisioning that are often lacking, especially in recently built parts of the periphery.

While inequality is built into the city’s pipes more generally, the uneven ability to withstand scarcity hinged on the ability to use and benefit from adaptive infrastructures, in this case small-scale reservoirs. As Cohen (2016) notes, scarcity is and was produced by the combination of storage capacity, topography, and distance: “when the total water supply is zero-sum and declining, tanks are a technology of systematically unequal distribution, not just individual convenience. Topography plays a supporting role. If the poor are getting less,

then that leaves more water for the rest, and vice versa” (273). Simple technologies of storage allowed for wealthier residents located in more formalized neighborhoods to better withstand scarcity throughout 2014 and 2015, often through technologies that were largely invisible.

Prioritizing the role played by caixas subsequently calls attention to the critical role played by residents’ differentiated capacities to store water in the context of produced scarcities. While the pipe – and related terms such as flow and circulation – has largely dominated theorizations of water infrastructure, storage is critical to understanding the everyday experiences of scarcity. As Meehan (2014: 217) notes, drawing on Furlong (2011: 460, 467), “mediating technologies—or “small devices that can be added to an infrastructural network with the intention of modifying its performance”—may re-engineer ‘fixed’ water networks into malleable objects that alter socio-technical conditions in significant ways.” The role played by caixas in the state’s response to crisis subsequently highlights the critical degree to which the capacity to store water combined with existing infrastructures to produce differentiated experiences of scarcity.

5. Conclusion: The Return of Rain

In 2015 rains returned to São Paulo. As the city began to plan for the possibility of a full-scale collapse in water stores, rain continued to fall. Reservoir levels recovered throughout 2015, and attention began to shift elsewhere. In March 2016, with reservoir levels largely recovered, the governor of São Paulo declared the crisis officially over. While long-term concerns about the water in São Paulo remain, they have largely disappeared from the public sphere. This is in spite of the fact that São Paulo’s water crisis was very nearly catastrophic. Had rains not returned in sufficient volumes in 2015, there was no next step.

In this paper, I focused on the response by the state government of São Paulo to the water crisis that affected the city in 2014 and 2015. I considered the suite of actions that the state utilized, and focused specifically on the usage of lowered pressure reductions in the water pipes in lieu of a formal process of rationing. I argue that the state response disproportionately affected the urban periphery, a product not necessarily of wholesale political intent but rather the infrastructural histories and inequalities embedded in the city's socio-technical landscape of water management. I argue that this has implications for understandings of the techno-politics of contemporary urban water governance in crisis contexts. I further suggest that studies of urban water infrastructure could benefit from deeper engagement with the adaptive politics of storage. A focus on infrastructure reveals the complex interplay of the political and the technical in the management of urban water systems, and offers insight into the processes through which histories of uneven service delivery intersect with contemporary decision-making.

Infrastructure and inequality are co-constituted and infrastructures are hard to change. In post-colonial and Southern cities, histories of uneven service delivery intersect with intermediary infrastructures, adaptive technologies that enable some residents to withstand material lack and others not. In the case of São Paulo, the caixa is an instantiation of deeper histories of inequality embedded in the landscape itself. The story of the caixa subsequently demonstrates the broad pattern of class-based rationing that was facilitated by the city's particular interweaving of the political and the technical. The ability to augment large-scale infrastructural systems with small-scale adaptive infrastructures is limited by economic status, but critical for being able to withstand water scarcity. This broad geographical dynamics of the crisis subsequently demonstrate that while Kelman may have been right that only a minority were affected by water scarcity, he both downplayed the numbers of affected and

their geographical and class positioning within the city. Kelman was right that not everyone went without water for multiple days, but he ignores the classed (and raced) dynamics of who constitutes this particular minority. This makes clear that while the lowering of water pressure may have allowed the city to sidestep formal rationing, it meant that the urban periphery in effect subsidized the rest of the city until the rains returned.

This has implications for an urban future marked by the increasing visibility of climate change and associated climate crisis at global and local scales. Seeing crises as what Carse (2017) calls an “infrastructural event” allows for more nuanced, historically situated understandings of crisis to emerge (See Swyngedouw, 2010). These narratives locate moments of breakdown in everyday practices and enduring inequalities, and suggest pathways forward that draw from civil society mobilizations around water security, transparency, and inequality. In this sense, this paper was written with inspiration from the countless critics, activists, and artists who shaped its ideas throughout 2014 and 2015. While broadly unable to ensure that the crisis yielded tangible changes to the state’s water management regime, continued efforts to politicize water in both electoral and aesthetic registers are reminders that residents are concerned about water even as the state has declared the water crisis officially over.

Mobilizations around water have considerable implications for a future marked by climatic uncertainty and the apparently increasing regularity of environmental crisis. The new socio-ecologies of a changing climate are pushing existing infrastructures to their edges, requiring new investments and technologies that are out of reach for many cities (especially in the global south). São Paulo’s near crisis suggests a form through which environmental crises will materialize in the years to come: through uneven experiences of imposed scarcity, modulated in and through existing infrastructural configurations. As Cohen (2016) notes,

São Paulo's crisis exemplifies how unequal top-down rationing was contested below by new coalitions pressing for other kinds of rationing. These contestations will mark global south cities in the decades ahead as climate change reworks existing urban ecologies and their associated infrastructures. As climate change starts to rewrite the cities we live in, there is inspiration to be taken from the capacity of people to intervene into the landscapes that form the backdrops to our collective lives. Crises are historical products, produced through the histories that are materialized in the landscapes we inhabit. The only way forward in an increasingly precarious planetary moment is to remake those landscapes.

Figure 1: Caixas d'água in Jardim Romano, eastern periphery of São Paulo. Photograph by the author.

References

- Abers R. N. and M.E. Keck (2014) *Practical Authority: Agency and Institutional Change in Brazilian Water Politics*. Oxford University Press: Oxford.
- Ahlers et al (2014) Informal space in the urban waterscape: Disaggregation and co-production of water services. *Water Alternatives* 7(1): 1-14.
- Amin, A. (2014). Lively infrastructure. *Theory, Culture & Society*, 31(7-8), 137-161.
- Anand, N. (2011). Pressure: The politotechnics of water supply in Mumbai. *Cultural Anthropology*, 26(4), 542-564.
- Anand, N. (2017). *Hydraulic City: Water and the Infrastructures of Citizenship in Mumbai*. Duke University Press, Durham.
- Angel, J., & Loftus, A. (2017). With-against-and-beyond the human right to water. *Geoforum*.
- Bakker, K. (2010). *Privatizing water: governance failure and the world's urban water crisis*. Cornell University Press, Ithaca.
- Beck, U. (1992) *Risk Society: Towards a New Modernity*. Sage, London.
- Barnes, J. (2014). *Cultivating the Nile: The Everyday Politics of Water in Egypt*. Duke University Press, Durham.
- Barnes, J. (2017). States of maintenance: Power, politics, and Egypt's irrigation infrastructure. *Environment and Planning D: Society and Space*.
- Benson, Etienne. 2015. "Generating Infrastructural Invisibility: Insulation, Interconnection, and Avian Excrement in the Southern California Power Grid." *Environmental Humanities* 6:103–130.
- Bijker, W. E. (2007). Dikes and dams, thick with politics. *Isis*, 98(1), 109-123.
- Bonduki, N (2014) A responsabilidade pela crise da água. Folha de São Paulo, 15 October. Available at: <http://www1.folha.uol.com.br/opiniao/2014/10/1532689-nabil-bonduki-a-responsabilidade-pela-crise-da-agua.shtml>
- Bowker, G. C. and S.L. Star (2000). *Sorting things out: Classification and its consequences*. MIT press, Cambridge.
- Brasil Wire (2015) Cantareira: a new word for when politics is put ahead of public interest. *Brasil Wire*, January 15. Available at: <http://www.brasilwire.com/cantareira/>
- Budds, J (2008) Whose scarcity? The hydrosocial cycle and the changing waterscape

- of La Ligua Basin, Chile. In: Goodman, M., Boykoff, M., Evered, K. (Eds.), *Contentious Geographies: Environmental Knowledge, Meaning, Scale*. Ashgate, Surrey, pp. 59–78.
- Burt, Z. and Ray, I. 2014. Storage and non-payment: Persistent informalities within the formal water supply of Hubli-Dharwad, India. *Water Alternatives* 7(1): 106-120
- Caldeira, T. P. (2001). *City of walls: crime, segregation, and citizenship in São Paulo*. University of California Press, Berkeley.
- Caldeira, T. P. (2016). Peripheral urbanization: Autoconstruction, transversal logics, and politics in cities of the global south. *Environment and Planning D: Society and Space*.
- Carse, A. (2012). Nature as infrastructure: Making and managing the Panama Canal watershed. *Social Studies of Science*, 0306312712440166.
- Carse, A. (2017). An Infrastructural Event: Making Sense of Panama's Drought. *Water Alternatives*, 10(3), 888-909.
- Carse, A. and J. Lewis (2015). Towards a Political Ecology of Maritime Transportation: Infrastructural Zones, Standardized Environments, and Collective Action. *Environment and planning A*.
- Cesare, D. (2014). Bairros de SP têm falta de água, mas Sabesp nega racionamento. R7 Notícias, May 15. [WWW document]. URL <http://noticias.r7.com/sao-paulo/bairros-de-sp-tem-falta-de-agua-mas-sabesp-nega-acionamento-15052014>
- Chu, J. Y. (2014). When infrastructures attack: The workings of disrepair in China. *American Ethnologist*, 41(2), 351-367.
- Coelho, C. A., Cardoso, D. H., & Firpo, M. A. (2016). Precipitation diagnostics of an exceptionally dry event in São Paulo, Brazil. *Theoretical and Applied Climatology*, 125(3-4), 769-784.
- Cohen, D.A. (2016) The Rationed City: The Politics of Water, Housing, and Land Use in Drought-Parched São Paulo. *Public Culture* 28(2 79).
- Cruxen, A.C. (2016). Fluid dynamics : politics and social struggle in São Paulo's water crisis (2014-2015) Massachusetts Insititute of Technology, Master's Thesis.
- Datafolha (2015) Crise Hídrica em São Paulo PO813823 28 e 29/10/2015. [WWW Document]. URL <http://media.folha.uol.com.br/datafolha/2015/11/04/crise-hidrica.pdf>
- de Sant'Anna, D (2007) *Cidade das águas: Usos de rios, córregos, bicas e chararizes em São Paulo* (1822-1901). Editora Senac, São Paulo.
- Dias, M. A. S., J. Dias, L.M. Carvalho, E.D Freitas, and P.L.S. Dias, P. L. S. (2013). Changes in extreme daily rainfall for São Paulo, Brazil. *Climatic Change*, 116(3-4), 705-722.

Domingos, R (2014) CPI questiona Sabesp sobre método de cálculo de perdas de água. G1 São Paulo. [WWW document]. URL <http://g1.globo.com/sao-paulo/noticia/2014/09/cpi-questiona-sabesp-sobre-metodo-de-calculo-de-perdas-de-agua.html>

Easterling, K. (2014). *Extrastatecraft: the power of infrastructure space*. Verso Books, London.

Estadão Conteúdo (2014) Governo sabia da insuficiência do Sistema Cantareira desde 2004. Estadão Conteúdo, February 17. [WWW document]. URL <http://noticias.uol.com.br/cotidiano/ultimas-noticias/2014/02/17/governo-sabia-da-insuficiencia-do-sistema-cantareira-desde-2004.htm>

Furlong, K. (2014). STS beyond the “modern infrastructure ideal”: Extending theory by engaging with infrastructure challenges in the South. *Technology in Society*, 38, 139-147.

G1 (2015) Veja o que Alckmin disse sobre racionamento durante crise hídrica. G1, January 1. [WWW document]. URL <http://g1.globo.com/sao-paulo/noticia/2015/01/veja-o-que-alckmin-disse-sobre-acionamento-durante-crise-hidrica.html>

Gabriel, N. (2014) Urban political ecology: Environmental imaginary, governance, and the non-human. *Geography Compass* 8.1, 38-48.

Gandy, M. (2008) Landscapes of disaster: water, modernity, and urban fragmentation in Mumbai. *Environment and planning A* 40.1, 108-130.

Gandy, M. (2014) *The fabric of space: water, modernity, and the urban imagination*. MIT Press, Cambridge.

Goldman, M. (2007). How “Water for All” policy became hegemonic: The power of the World Bank and its transnational policy networks. *Geoforum* 38(5), 786-800.

Graham, S. (2009) *Disrupted cities: when infrastructure fails*. Routledge, London.

Graham, S., & McFarlane, C. (Eds.). (2014). *Infrastructural Lives: Urban Infrastructure in Context*. Routledge, London.

Graham, S. and S. Marvin (2001). *Splintering urbanism: networked infrastructures, technological mobilities and the urban condition*. Routledge, London.

Graham, S. and N. Thrift (2007). Out of Order Understanding Repair and Maintenance. *Theory, Culture & Society* 24.3, 1–25.

Grundy-Warr, C., Sithirith, M., & Li, Y. M. (2015). Volumes, fluidity and flows: rethinking the ‘nature’ of political geography. *Political Geography* (45), 93-95.

Harris, LM (2012) State as socionatural effect: variable and emergent geographies of the state in southeastern Turkey. *Comp. Stud. S. Asia Afr. Middle East* 32 (1), 25–39.

- Harris, L.M. (2013) Variable histories and geographies of marketization and privatization. In Harris, L. M., J.A Goldin and C. Sneddon (Eds). *Contemporary water governance in the global South: scarcity, marketization and participation*. Routledge, London.
- Harris, L. M. (2017). Political ecologies of the state: Recent interventions and questions going forward. *Political Geography* 58, 90-92.
- Hecht, G (2012) *Being Nuclear: Africans and the Global Uranium Trade*. Cambridge: MIT Press.
- Heynen, N. (2013) Urban political ecology I: The urban century. *Progress in Human Geography* 38.4, 598-604
- Holston, J. (1991), Autoconstruction in Working-Class Brazil. *Cultural Anthropology*, 6: 447–465.
- Holston, J. (2008) *Insurgent citizenship: Disjunctions of democracy and modernity in Brazil*. Princeton University Press, Princeton, NJ.
- Ioris, A. A. (2012). The geography of multiple scarcities: Urban development and water problems in Lima, Peru. *Geoforum* 43(3), 612-622.
- Iory, N. (2015). Sabesp atrasa entrega de caixas-d'água à população pobre na Grande SP. Último Segundo. [WWW document] URL: <http://ultimosegundo.ig.com.br/brasil/2015-09-26/sabesp-atrasa-entrega-de-caixas-dagua-a-populacao-pobre-na-grande-sp.html>
- Jacobi, P. R., Fracalanza, A. P., & Silva-Sánchez, S. (2015). Governança da água e inovação na política de recuperação de recursos hídricos na cidade de São Paulo. *Cadernos Metrópole*.
- Jorge J (2006). *Tietê, o rio que a cidade perdeu: São Paulo 1890-1940*. Alameda, São Paulo.
- Keck, M. (2002). Water, water, everywhere, nor any drop to drink. In P. Evans (ed.), *Livable cities?: urban struggles for livelihood and sustainability*, University of California Press, Berkeley.
- Kaika, M. (2003). Constructing scarcity and sensationalising water politics: 170 days that shook Athens. *Antipode*, 35(5), 919-954.
- Kaika, M. (2005). *City of flows: Modernity, nature, and the city*. Psychology Press.
- Kaika, M., & Swyngedouw, E. (2000). Fetishizing the modern city: the phantasmagoria of urban technological networks. *International Journal of Urban and Regional Research* 24(1), 120-138.
- Keck, M. (2002). Water, water, everywhere, nor any drop to drink. In P. Evans (ed.), *Livable cities?: urban struggles for livelihood and sustainability*, University of California Press, Berkeley.
- Kelman, J. (2015) A Sabesp racionaliza água? *Folha de São Paulo*, January 22.

- Kelly-Richards, S. H. and J. Banister (2017) A state of suspended animation: Urban sanitation and water access in Nogales, Sonora. *Political Geography* 58, 104–113.
- Kowarick, L. (2009). *Viver em risco*. São Paulo, Ed, 34.
- Krepp, A. and H. Brenha (2015) 'Racionamento' não oficial já atinge vários bairros de São Paulo. *Folha de São Paulo*. [WWW document]. URL: <http://m.folha.uol.com.br/cotidiano/2014/03/1426187-acionamento-nao-oficial-ja-atinge-varios-bairros-de-sao-paulo.shtml#>
- Larkin, B. (2013). The politics and poetics of infrastructure. *Annual Review of Anthropology*, 42, 327-343.
- Leite F (2014) Periferia de São Paulo poupa dobro de água do que Jardins. Estado de São Paulo, August 28. [WWW document]. URL: <http://sao-paulo.estadao.com.br/noticias/geral,periferia-de-sao-paulo-poupa-dobro-de-agua-do-que-jardins,1551211>
- Li, T. M. (2007). *The will to improve: Governmentality, development, and the practice of politics*. Duke University Press.
- Lobel, F (2015) Brasil desperdiça 37% da água tratada, aponta relatório do governo federal. *Folha de São Paulo*, January 21. [WWW document]. URL: <http://www1.folha.uol.com.br/cotidiano/2015/01/1578007-brasil-desperdica-37-da-agua-tratada-aponta-relatorio-do-governo-federal.shtml>
- Lute Pela Água (2015) FALTA DE ÁGUA E A GRANDE CRISE SOCIAL EM NOSSO PAÍS. Lute Pela Água, June 4. [WWW document]. URL: <https://lutepelaagua.wordpress.com/2015/06/04/falta-de-agua-e-a-grande-crise-social-em-nosso-pais/>
- Martín M (2015a) “Não há redução de pressão. A Sabesp está fechando o registro.” *El Pais*, February 7. [WWW document]. URL: http://brasil.elpais.com/brasil/2015/02/06/politica/1423183657_198414.html
- Martín M (2015b) 2015b A vida com três horas de água. *El Pais*, May 14. [WWW document]. URL: http://brasil.elpais.com/brasil/2015/05/11/politica/1431372136_255217.html
- Martín M (2015c) Durante a crise hídrica, casos de diarreia se multiplicam em São Paulo. *El Pais*, July 16. [WWW document]. URL: http://brasil.elpais.com/brasil/2015/07/10/politica/1436557827_946009.html
- McFarlane, C., & Silver, J. (2017). The Poolitical City: “Seeing Sanitation” and Making the Urban Political in Cape Town. *Antipode*, 49(1), 125-148.
- Meehan, K. M. (2014). Tool-power: Water infrastructure as wellsprings of state power. *Geoforum*, 57, 215-224.

- Mehta, L. (2013). *The limits to scarcity: Contesting the politics of allocation*. Routledge. Milanez, 2014.
- Mitchell, T. (2002). *Rule of experts: Egypt, techno-politics, modernity*. University of California Press, Berkeley.
- Nobre, C.A., A.F Young, P. Saldiva, J.A Marengo, A.D. Nobre, S. Alves Jr., G.C Silva, and M. Lombardo (2010) Vulnerabilidades das Megacidades Brasileiras às Mudanças Climáticas: Região Metropolitano de São Paulo [WWW document]. URL http://mudancasclimaticas.cptec.inpe.br/~rmclima/pdfs/publicacoes/2010/SumarioExecutivo_megacidades.pdf
- Nunes T (2015) Reclamações por falta de água crescem 62,5% no primeiro semestre em SP. Folha de São Paulo, July 29. [WWW document]. URL: <http://www1.folha.uol.com.br/cotidiano/2015/07/1661664-reclamacoes-por-falta-de-agua-crescem-625-no-primeiro-semester-em-sp.shtml>
- Nye, D. E. (2010). *When the lights went out: a history of blackouts in America*. Mit Press, Cambridge.
- Oliveira, L. (2016) Bairros da periferia da capital ficam sem água mais cedo. *Agora*. [WWW document]. URL: <http://www.agora.uol.com.br/saopaulo/2016/09/1818280-bairros-da-periferia-da-capital-ficam-sem-agua-mais-cedo.shtml>
- Pasti et al (2014) Crise hídrica, uma crise política. Medium, October 23. Available at: <https://medium.com/cidades-e-planejamento/crise-hidrica-uma-crise-politica-225e6ed84260>
- Porto M (2012). Gestão de Recursos Hídricos em São Paulo. In Padovano B and Numar M (Eds.) São Paulo: *Em Busca da Sustentabilidade*. Editora Pini Ltda: São Paulo.
- Ramutsindela, M. (2017). Greening Africa's borderlands: The symbiotic politics of land and borders in peace parks. *Political Geography* 56, 106-113.
- Rademacher, A. (2011) *Reigning the River: Urban Ecologies and Political Transformation in Kathmandu*. Duke University Press, Durham, NC.
- Ranganathan, M. (2014) “Paying for Water, Claiming Citizenship: Political Agency and Water Reforms at the Urban Periphery”. *International Journal of Urban and Regional Research* 38.2, 590-608.
- Ranganathan, M. (2015). Storm Drains as Assemblages: The Political Ecology of Flood Risk in Post-Colonial Bangalore. *Antipode*, 47(5), 1300-1320.
- Ranganathan, M. (2016). Thinking with Flint: Racial Liberalism and the Roots of an American Water Tragedy. *Capitalism Nature Socialism*, 27(3), 17-33.

Ribeiro, WC (2011). Water supply and water stress in the Metropolitan Region of São Paulo. *Estud. av.* 25(71), 119-133..

Rigby C (2015a) São Paulo – anatomy of a failing megacity: residents struggle as water taps run dry. The Guardian, February 25. [WWW document]. URL: <http://www.theguardian.com/cities/2015/feb/25/sao-paulo-brazil-failing-megacity-water-crisis-rationing>

Rigby C (2015b) São Paulo's water crisis: in the Favela do Moinho, 2,500 residents rely on one impossibly thin blue pipe. The Guardian, April 15. [WWW document]. URL: <http://www.theguardian.com/cities/2015/apr/15/sao-paulo-water-crisis-favela-shortages-poorest>

Robbins, P. (2003). Political ecology in political geography. *Political Geography* 22, 641-645.

Rodina, L (2016) Human right to water in Khayelitsha, South Africa—Lessons from a ‘lived experiences’ perspective. *Geoforum*, 72, 58-66.

Rolnik, R. (1997) *A cidade e a lei: legislação, política urbana e territórios na cidade de São Paulo*. Studio Nobel, São Paulo.

Romero, S (2015) Taps Start to Run Dry in Brazil’s Largest City. *New York Times*, February 16.

SABESP (2015) Crise Hídrica, Estratégia e Soluções da SABESP para a região metropolitana de São Paulo. [WWW document]. URL: http://site.sabesp.com.br/site/uploads/file/crischidrica/chess_crise_hidrica.pdf

SABESP. Redução de pressão nas Tubulações. [WWW document]. URL: <http://www.sabesp.com.br/reducaopressao/>

Seabra, O (1987). *Os meandros dos rios nos meandros do poder: Tietê e Pinheiros—valorização dos rios e das várzeas na cidade de São Paulo*. São Paulo: USP/FFLCH.

Serapião F (2014) Amigos abastecidos. Blog do Serapião, February 21. [WWW document]. URL: <http://www.cartacapital.com.br/blogs/blog-do-serapiao/amigos-abastecidos-1751.html>

Silva R (2012) Águas e Saneamento: Desafios para a Metrópole. In Padovano B and M Numar (Eds.) *São Paulo: Em Busca da Sustentabilidade*. Editora Pini Ltda: São Paulo.

Silver, J. (2014). Incremental infrastructures: material improvisation and social collaboration across post-colonial Accra. *Urban Geography*, 35(6), 788-804.

Souza F (2015) Possível rodízio em SP vira 'piada' em condomínio sem água há 11 dias. Folha de São Paulo, January 29. [WWW document]. URL: <http://www1.folha.uol.com.br/cotidiano/2015/01/1582054-possivel-rodizio-em-sp-vira-piada-em-condominio-sem-agua-ha-11-dias.shtml>

Sugahara S, R.P. Rocha, R. Silveira (2009) Non-stationary frequency analysis of extreme daily rainfall in Sao Paulo, Brazil. *International Journal of Climatology* 29: 1339–1349.

Swyngedouw, E (2004). *Social power and the urbanization of water: flows of power*. Oxford: Oxford University Press.

Swyngedouw, E. (2010). Apocalypse forever?. *Theory, Culture & Society*, 27(2-3), 213-232.

Swyngedouw, E. and N. Heynen (2003). Urban political ecology, justice and the politics of scale. *Antipode* 35.5, 898–918.

von Schnitzler, A. (2016) *Democracy's Infrastructure: Techno-Politics and Protest after Apartheid*. Princeton University Press, Princeton, NJ.

Whately M, Lerer R, (2015) Brazil drought: water rationing alone won't save Sao Paulo. *The Guardian*, February 11.

Whately M (2014) A crise da água em São Paulo. Blog da Raquel Rolnik, April 14. [WWW document]. URL: <http://raquelrolnik.wordpress.com/2014/04/14/a-crise-da-agua-em-sao-paulo/>

Winner, L. (1980). Do artifacts have politics?. *Daedalus*, 121-136.

Xavier TMS, Xavier AFS, Silva Dias MAF (1994) Evolução da precipitação diária num ambiente urbano: o caso da cidade de São Paulo. *Rev Bras Meteorol* 9: 44–53.

Zeiderman, A. (2016) *Endangered City: The Politics of Risk and Security in Bogotá*. Duke University Press, Durham.