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An Infrastructural Event: Making Sense of Panama's Drought

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ABSTRACT: Droughts are often characterised as meteorological events: periodic precipitation deficits associated with atmospheric disruption. However, the droughts that concern our societies are typically socioeconomic events: instances in which water demand approaches or exceeds a supply diminished due to low precipitation. This article analyses a 2015-16 drought in Panama, typically among the world's rainiest countries, to argue that some droughts might be usefully conceptualised as *infrastructural events*. This analytic complements research on climatic and socioeconomic dynamics by opening up lines of inquiry that might reframe drought events. When, for example, does a drought begin and end? Where do droughts come from? Who and what are (in)visible in drought explanations and responses? The article is organised around three key dimensions of the infrastructural event, each responding to one of the questions above. The first, *momentum*, makes the case for a deeper temporal understanding of drought that attends to the inertia of water-intensive sociotechnical systems. The second, *interconnection*, examines how linkages between these systems and regional-to-global infrastructure networks can amplify situated water demands. The third, *visibility*, explores the mechanisms through which infrastructure frames understandings of and responses to drought, including the normalisation of water distribution politics.

KEYWORDS: Drought, infrastructure, water politics, scale, Panama

INTRODUCTION

In 2014, Panama was the fifth rainiest country in the world (World Bank, 2016). In August 2015, with the annual rainy season months overdue, the Panamanian government declared a state of emergency in reaction to an El Niño-related drought that had affected much of the country. Most of the domestic and international attention was focused on the central part of the isthmus: a narrow, urbanized strip of land that is home to some two million Panamanians and is also the site of the Panama Canal.

The Panamanian government's initial response to the drought emphasised conservation. It suspended new water concessions for landscaping and agriculture, created a water security commission to coordinate institutional efforts, and launched a media campaign called "drop by drop, the water runs out" (*Gota a gota, el agua se agota*), asking residents to take responsibility for the drought response by reducing individual and household consumption.

By the time I arrived in Panama in September 2015, the state response was shifting from reducing demand to increasing supply. Speaking to a well-dressed crowd in a posh Panama City hotel, President Juan Carlos Varela attributed water shortages to various factors: El Niño, deforestation, climate change, and individual consumption. He began by referencing Pope Francis's encyclical – water is a human right (2015: 23) – and concluded with a proposal to create a large reservoir that would expand the water supply available for navigation and use in the country's largest cities, Panama City and Colón. The flooding of the reservoir was expected to displace 2000 rural people. Varela's proposal dovetailed with global trends in water management in its emphasis on supply-side principles and infrastructure investment. After a turn to conservation in the 1980s, water managers worldwide were reembracing the infrastructure-led emphasis on supply that dominated the 20th century (Crow-Miller et al., 2017).

Figure 1. Map of Panama.

Source: CIA (1995). This image is in the public domain.

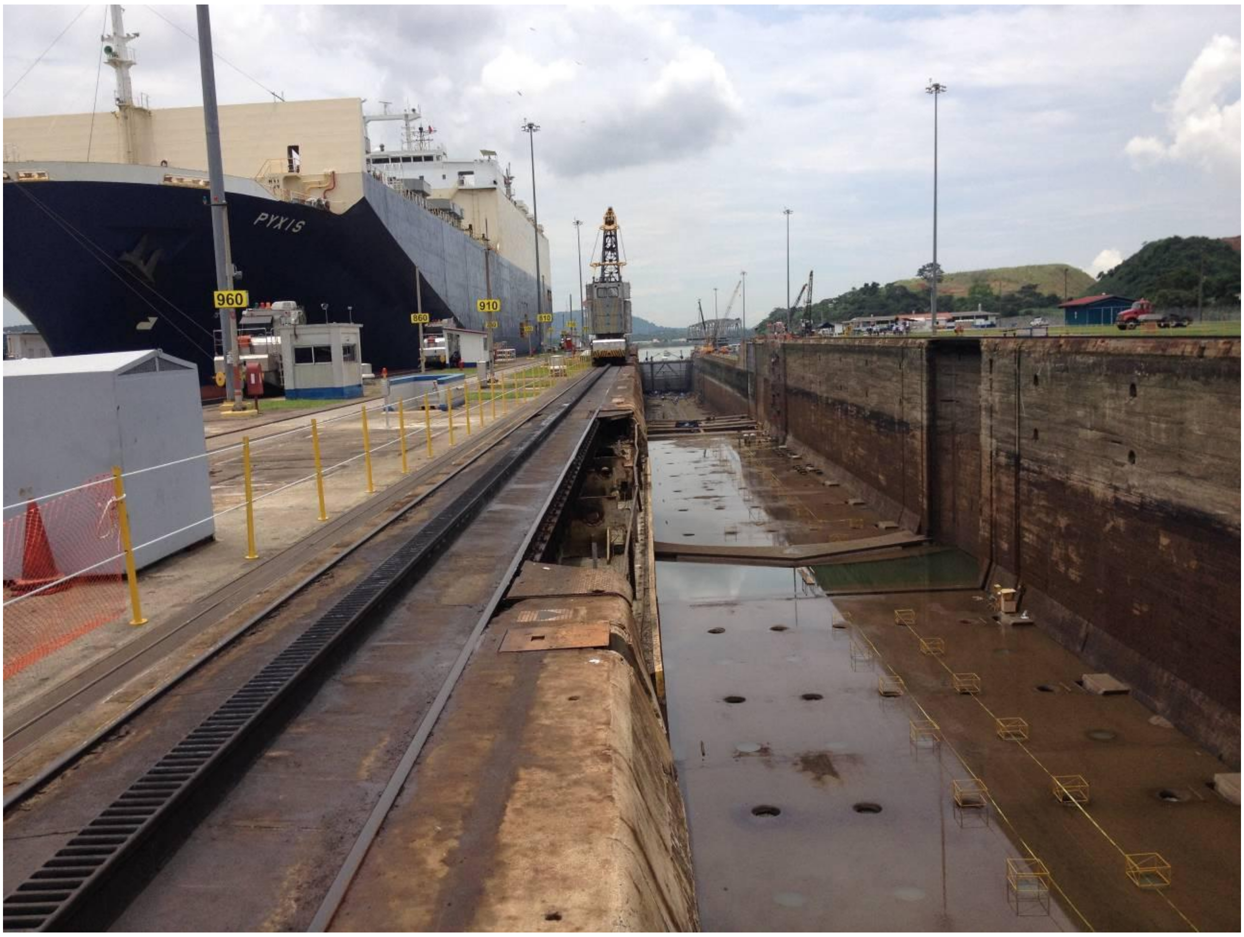
Panama's drought was characterised as a national emergency, but what kind of emergency was it? In media and political accounts, droughts are often presented as *meteorological events*: extended dry periods in which lower-than-expected precipitation levels are associated with atmospheric disruptions like El Niño phenomena. Drought discourse in Panama was no different. In the president's speech, state communications, and domestic media reporting, the drought was typically framed as an abnormal climatic event portending a dryer future. The dominant explanation was, in other words, environmental; the most significant response (creating a new reservoir) was technical. But, as President Varela explained the drought and proposed solutions, there was a hydrological elephant in the room.

Droughts are, by definition, temporary events resulting from atypical climatic conditions (Kallis, 2008). Insomuch as they represent extended departures from the norm with recognisable temporal boundaries (a beginning and an end), droughts are different from normal environmental conditions like aridity. Seen meteorologically, then, a drought *happens to* a place within a time frame. And yet, the droughts that concern human societies are not exclusively climatic phenomena. They are also, crucially, *socioeconomic events*: instances in which water demand approaches or exceeds a reduced supply (Garza, 2003). To this point, scholars have long recognised that drought characteristics are produced through the interplay of precipitation and water demand by certain groups for particular activities – meaning that shortages are relative rather than absolute (Wilhite and Glantz, 1985). When climatological, environmental, and socioeconomic factors are considered together, the duration, intensity, and extent of a given event become difficult to measure. In fact, drought is often called a "creeping phenomenon" due to its temporal fuzziness (Tannehill, 1947; Wilhite and Vanyakho, 2000).

If droughts are meteorological and socioeconomic, they are also sociotechnical (Taylor et al., 2009) because water supply and demand are mediated by the design and operation of the infrastructures that undergird societies and economies. Water shortage concerns are acute – and political – in Panama because the Panama Canal requires, by design, an enormous freshwater supply. It uses a staircase of locks to raise and lower ships transiting between the Pacific Ocean and Caribbean Sea (Atlantic Ocean). During each transit, 197,000 m^3 of water stored in artificial reservoirs is released into the oceans. Half of the volume is used during lockages that raise vessels to the canal's highest point, Gatun Lake – a summit-level reservoir about 26 m above sea level – and the remainder during the descent to sea level.

Panama has had one of the world's fastest growing economies since 2000, when its government assumed control of the canal from the United States. Economic growth has been driven by a vibrant service sector organised around the waterway. Over three-fourths of the national economy measured by GDP is concentrated in industries directly linked with shipping (ports, transshipment, logistics, and ship registry) or adjacent sectors like banking, finance, and insurance (CIA, 2017). Moreover, the Panama Canal Authority (ACP) – a quasi-autonomous state institution – directly contributed one billion Balboas (equivalent to USD$1 billion) in net income from canal operations to the national treasury in fiscal year 2016 (2016: 289). Therefore, it is no exaggeration to say that the canal and, by extension, the national economy assume and depend on a large, readily available freshwater supply. The ACP highlighted this point in its 2016 annual report, which describes how the fiscal side of canal operations was affected by El Niño: the drought lowered water levels in storage reservoirs, which led the authority to reduce the maximum allowable draft (underwater depth) for ships. This prevented some vessels from transiting at full capacity and reduced revenue (2016: 262).

Figure 2. Every ship transit through the Panama Canal's lock system requires approximately 197,000 m^3 of fresh water drawn from artificial reservoirs. The Miraflores Locks complex is the closest to the Pacific Ocean. Here, one of the lock chambers is undergoing scheduled maintenance.



Source: Author (2014)

How much water does the canal really need? How thirsty is it? The Government of Panama's water security plan (2016: 23) estimates that the annual volume of fresh water used for canal navigation is 2.274 billion m^3. Compare this with the *national* human water consumption estimate published in the same report: 390 million m^3. In relative terms, the canal – which draws on a single river basin – uses six times as much water as Panama's entire population of 3.7 million (CIA, 2017). Given the waterway's political-economic significance, staggering fresh water demands, and proximity to two large cities, it is no surprise that actual and potential water scarcity is a powerful rationale for the Panamanian state to pursue projects that will expand regional supply. However, as François Molle (2008) argues, supply-side responses to water shortage that focus on building storage and transfer infrastructure can generate a vicious cycle: overextended facilities lead to shortage crises, which are, in turn, used to justify the construction of more infrastructure to increase supply, thus creating the conditions for the next crisis. Therefore, "enough is never enough" (Molle, 2008) to fix long-term problems when it comes to water supply and infrastructure. This point extends beyond water management. Across sectors, the heedless construction of infrastructure without an analysis of how problems emerge leads to overbuilding.[1]

In this essay, I consider what an analytical focus on infrastructure – "a collective term for the subordinate parts of an undertaking" (Oxford English Dictionary, 2017b) – might allow us to understand about a class of events that includes, but is not limited to, droughts. I argue that Panama's 2015-16 drought can be usefully understood as an *infrastructural event*. This analytic complements research on climatic and socioeconomic dynamics by opening up lines of inquiry that might reframe droughts as events. When does a drought begin and end? Where do droughts come from? Who and what are (in)visible in drought explanations and responses? The article is organised around three key dimensions of infrastructural events – momentum, interconnection, and visibility – that correspond with the three preceding questions. Following a section summarizing the essay's theoretical framework, the section on *momentum* draws on the history of technology to make the case for a deeper temporal understanding of infrastructural events. It shows how early design choices and the development of the Panama Canal as a sociotechnical system with intensive water demands in the early 20th century shaped drought a century later. The next section on *interconnection* draws on science and technology studies to consider the networked geographies of the drought as an infrastructural event. In Panama, the spaces of meteorological drought and socioeconomic drought are not contiguous because infrastructure links the canal-centred service sector to cities, national utilities, and, crucially, global shipping networks. The final section on *visibility* examines the mechanisms through which infrastructure frames understandings of and responses to drought. The article concludes with a reflection on the role of global infrastructure in shaping situated environmental crises and the importance of coordinating action for sustainability.

WHAT IS AN INFRASTRUCTURAL EVENT?

Infrastructure is a complex word with multiple and contested meanings that have changed over time (Carse 2017). Drawing on anthropology, geography, and science and technology studies, I conceptualise infrastructure as a material thing, a bundle of social relationships, and an analytic (Star and Ruhleder, 1996; Edwards, 2003; Carse, 2012; Larkin, 2013; Harvey et al., 2017). To analyse droughts as infrastructural events is not to deny the importance of climatic or socioeconomic dynamics, but to foreground relationships that might otherwise go unnoticed. Panama's drought was a result (in a meteorological sense) of low rainfall and (in a socioeconomic sense) of the relationship between water supply and demand in the region. Analysed as an infrastructural event, the temporality of Panama's drought deepens to include the design and development of water-intensive sociotechnical systems, its spatiality extends to account for interconnections across regional-to-global networks, and the visibility of water users and infrastructures in drought explanation and response is considered a site of politics.

[1] For example, a narrow focus on building roads to reduce traffic congestion can actually increase volume and is thus unlikely to resolve the problem (Duranton and Turner, 2011).

'Event', like infrastructure, is a difficult word to pin down. The Oxford English Dictionary (2017a) defines it as "The (actual or contemplated) fact of anything happening; the occurrence of". In practice, events are often, but not necessarily, deemed significant in some way that distinguishes them among a multiplicity of happenings. Philosophers have sought to understand what events are by contrasting them with other familiar categories like objects, facts, and properties (Casati and Varzi, 2015). Given this article's concern with infrastructure, it is particularly instructive to compare events with objects. Events are generally considered to take up time; objects occupy space. It follows that events (like droughts) are thought to have vague spatial boundaries and clear temporal boundaries. By contrast, objects (like infrastructures) are considered to have vague temporal boundaries and clear spatial boundaries (ibid). The argument developed in this article complicates the event/object distinction by focusing on three dimensions of infrastructural events: momentum, interconnection, and visibility.

Momentum: When does a flood or a drought begin? Historian Scott Knowles (2014) observes that disasters unfold slowly, but we tend to focus on their end points. Disasters draw attention to infrastructure because they are often associated with the malfunction or breakdown of engineered systems. Indeed, modern societies have become so dependent on these systems that 'natural disaster' now refers primarily to the relationship between natural events and infrastructures (Edwards, 2003: 194). The history of technology and, in particular, that field's concept of technological momentum is useful for deepening the temporality of such events. Consider, for example, a destructive flood. One might, in retrospect, construct an account that begins with the first drop of an abnormally large rainfall (a meteorological event). But what makes a flood socially significant – its destructiveness – is not only an outcome of the volume or intensity of rainfall, but the performance of various infrastructures.

Infrastructures begin as centrally managed sociotechnical systems with organisational, financial, scientific, legislative, and resource components (Hughes, 1987). These systems are inscribed with the norms, values, assumptions, and politics of the times and places in which they were designed and developed (Winner, 1986; Bijker et al., 1987). Over time, sociotechnical systems can become entrenched in social and economic life and take on momentum (Hughes, 1969) as groups become dependent upon them. In this way, socially inflected technological choices made in the past continue to reverberate in the present, constituting a "built moral environment" (Bowker and Star, 1999: 326) with inertia. For example, the Euro-American founders of Los Angeles, who were recent settlers, designed systems with flawed assumptions about climate and rainfall, creating the conditions for what Mike Davis (1999) calls "ordinary disaster". Geoffrey Bowker's infrastructural inversion (1994) is a powerful analytical tool for making sense of this type of problem. He observes that analysts often ignore how infrastructures mediate and rework relationships among bodies, knowledge, discourse, and social organization because infrastructures are invisible in terms of social experience. To 'invert' infrastructure is to treat its materiality as an entry point for bringing 'background' relationships to the surface. For example, Bowker (1995) observes that while increased life expectancy in the 19th century has been attributed to scientific advances, improvements in food and sewage systems were the major, if unheralded, causes. Time and space, he argues, are reconfigured socially by infrastructure change.

Interconnection: An event which appears to unfold within boundaries defined by physical geography (e.g. meteorological drought) or political geography (e.g. socioeconomic drought) may actually trace the geography of a long network that links non-contiguous places and systems. Why? Over time, the sociotechnical systems described above – created by system builders, centrally managed, and bounded (Hughes, 1987) – are linked together and become sprawling infrastructure networks. These networks 'grow' through interconnection, often crossing national borders (Jackson et al., 2007). Unlike systems, which are organised and often dominated by identifiable human 'builders', infrastructure networks are ruled by standards: protocols, procedures, practices, and technologies that establish rules for intersystem coordination (Busch, 2011). Why do we need to understand interconnection to make sense of an event like Panama's drought? As discussed below, the canal, which moves an estimated 5% of global seaborne trade (Rodrigue et al., 2013: 33), links Panamanian waterscapes, institutions, and populations to the metabolism of global transportation and the demands of its dispersed clientele.

Through infrastructural interconnections, dispersed publics, technologies, and ecologies come into relation. Consider philosopher Jane Bennett's (2004) account of a North American electrical blackout that unfolded over several days in August 2003, affecting 50 million people across 24,000 km^2. Here, as in Scott Knowles's description of slow disaster above, the blackout "was the end point of a cascade" (Bennett, 2004: 448). The assemblage that begat the cascade – humans, power grids, electrons, trees, wind, and electromagnetic fields – was spatially and temporally distributed. We might extend Bennett's assemblage approach from blackouts to droughts and, in so doing, observe that the rain that falls on one watershed can be transferred to other basins by pipes, tunnels, and electrical cables or even to other nations via transportation infrastructure or virtual water trade networks (Dalin et al., 2012).

Visibility: A happening may become an event – somehow special or abnormal – when it violates shared expectations. For many social scientists, the existence of shared expectations presupposes a social system or structure through which that happening can be interpreted (Sewell, 2005: 197-200). Thus, as anthropologist Marshall Sahlins observes, an event is "a *relation* between a certain happening and a given symbolic system… a happening interpreted – and interpretations vary" (1985: 153). Seen in this way, the phenomena that we call events are not natural, but social constructions that become significant because human beings collectively assign them meaning (Kapferer, 2010: 17). However, social constructionism has been reworked in recent decades by scholars concerned with the complex interplay of social life and the more-than-human world. The work of Gilles Deleuze and Félix Guattari (1987), Donna Haraway (2007), and Bruno Latour (2005) – a few influential voices in an expansive conversation – extends constructionism in new directions. Anthropologist Bruce Kapferer describes the posthumanist orientation toward events in this way: "The significance of events as constructed and defined (usually in multiple ways) by human beings is emergent upon processes – for example, ecological/environmental or biological systems, interspecies relations, socio-political forces not within the direct or immediate awareness of participants – that, in their relative intransigence, force a diversity of human reactive constructions." (2010: 18). Many scholars in the emerging field of infrastructure studies have approach events (particularly moments of breakdown) in this way, focusing on the interwoven meaning and materiality of water, information, transportation, and power networks.

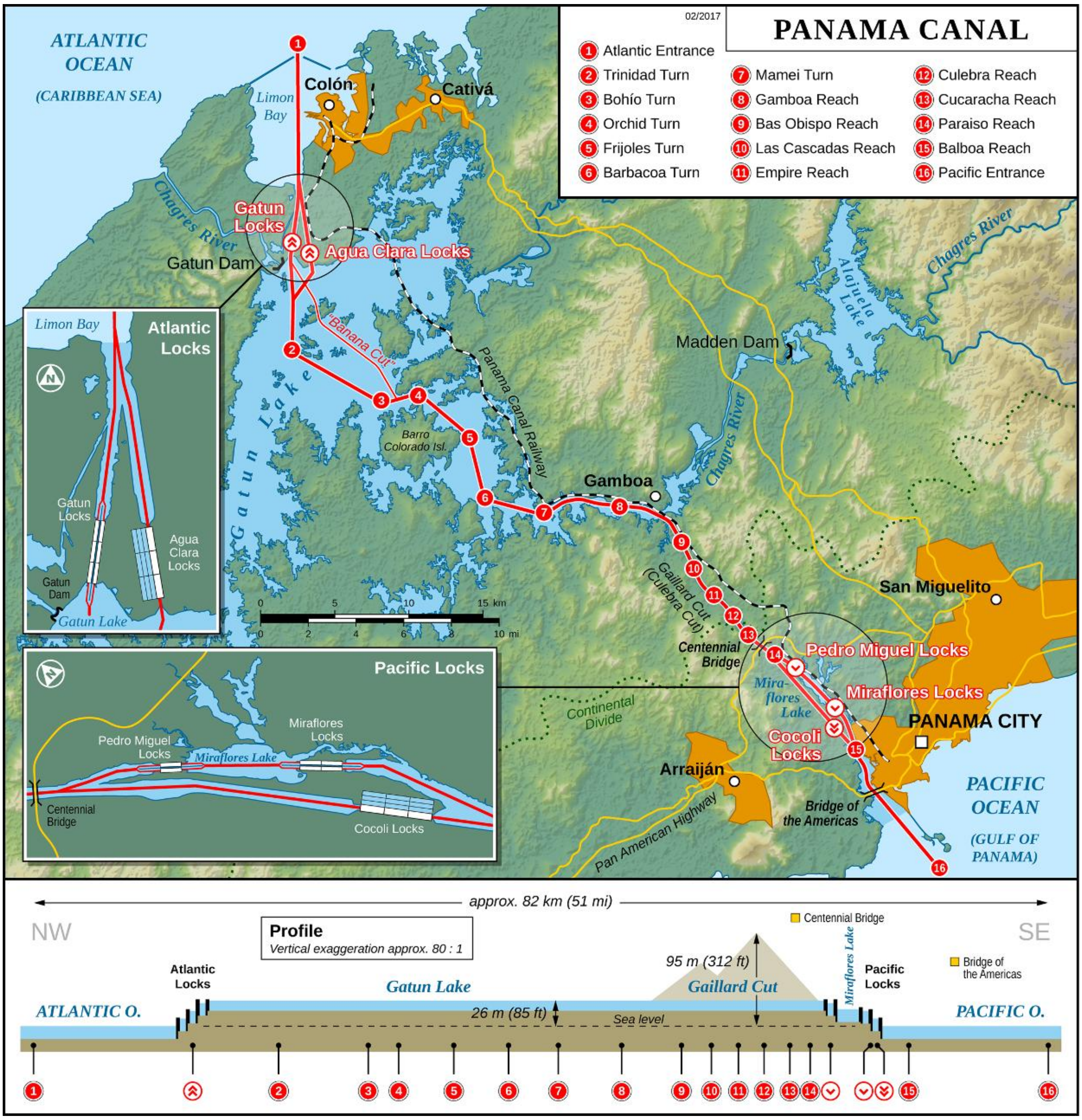
Susan Leigh Star and Karen Ruhleder (1996: 113) write, "The normally invisible quality of working infrastructure becomes visible when it breaks; the server is down, the bridge washes out, there is a power blackout". In this well-known passage, visibility is treated as an outcome of the disruption of relationships between an infrastructure and expectations about how it should operate. In the case of Panama's drought, one could make a case that how the event was seen and understood – its visibility – was shaped by shared these expectations, power/knowledge relations, and the materiality of infrastructure itself. Technological frames (Bijker, 2007) accrete around these relationships, shaping patterns of thought, institutional hierarchies, and organisational routines, thereby rendering some water uses 'normal' and beyond question and others as problematic or subject to change. Finally, when it comes to understanding who benefits from and is burdened by a given event, the relevant publics are not necessarily pre-existing groups (e.g. citizens, classes), but, following philosopher John Dewey, collectives "called into being" by problems attached to infrastructures (Collier et al., 2016).

MOMENTUM: WHEN DO DROUGHTS BEGIN AND END?

President Varela framed Panama's drought as the harbinger of something new in his September 2015 comments, eliding the slow accumulation of sociotechnical – and, by extension, environmental – choices that have created the conditions of possibility for recurrent droughts. The 2015-16 drought was a creeping phenomenon, but not simply in the climatological sense (Tannehill, 1947; Wilhite and

Vanyakho, 2000). Problems of supply and demand were formatted by past design and management choices. As an infrastructural event, the drought unfolded over a century, rather than a couple of years.

Figure 3. Panama Canal and surrounding region. Visible here are Panama's two largest cities (Panama City and Colón) and the storage reservoirs (Gatun Lake and Alajuela Lake) that provide fresh water for canal lockages and potable water for urban populations.



Source: Thomas Römer/OpenStreetMap data (2017). This document is in the Creative Commons.

By analysing the 2015-16 drought as an infrastructural event, its temporality is deepened to account for the momentum of sociotechnical choices made a century earlier. There is no single best way to build a canal – or any technology, for that matter. Before construction began, US politicians, engineers, and administrators debated whether the waterway should be a lock canal or a sea-level canal. Water management questions were pivotal. While a lock canal would depend on stored fresh water, a sea-level canal would be a ditch between the oceans filled with salt water (like the Suez Canal). Superficially, the design debate turned, as one might expect, on engineering issues, construction timetables, and budgetary concerns, but it also involved matters of technological style – the idea that system builders have creative latitude in how they adapt to environments (Hughes, 1987) – and significant symbolic concerns. The value of the waterway for the US imperial project was, after all, not simply a question of military or economic utility, but also of aesthetic and representational power (see Larkin, 2013). For example, early-twentieth-century design debates were inflected with cultural concerns like the colonial dream of a natural isthmian strait (which a sea-level canal would physically resemble) and US pride in scientific and technical capability (McCullough, 1977: 481-489).[2]

Because the US government opted for the water-intensive lock design, the famous story of canal construction as a big excavation project should be augmented with an equally important, if less iconic, story: the assembly of a sprawling regional water management system. From 1903 to 1979, the US government controlled the territory of the Canal Zone (over 1300 km^2). As a political and cultural space, the quasi-colonial enclave occupied a large but relatively narrow (16 km wide) strip of territory centred on the shipping channel (Donoghue, 2014). As a hydrological space, the canal's footprint was larger and grew over time. According to the 1903 treaty between the United States and Panama that established the enclave and laid the legal foundation for canal construction, the United States had authority over the water supply drained by the massive Chagres River Basin, which extended beyond the Canal Zone and deep into Panamanian territory.[3]

The US government's hydrological imperialism was, in part, an outcome of the historically contingent decision to build a lock canal. The design, shaped by social, technical, and environmental concerns, precipitated efforts to reengineer the Chagres River to supply the locks with water year-round. Engineers designed a water management system intended to meet the transportation needs of the time and, in accordance with the requirements laid out by the US Congress in the Spooner Act of 1902: "such as may be reasonably anticipated". In the first half of the 20th century, two major reservoirs, Gatun Lake and Alajuela Lake (then Madden Lake), were created by damming the flow of the Chagres at different points to increase the canal's water supply.

Gatun Lake makes up 32 km of the canal's 77 km-long shipping lane. In addition to its navigation function, the lake was designed to protect the canal and passing ships from floods and also store water for use during dry periods. Regional precipitation is characterised by a May-December rainy season (*invierno*) and a January-April dry season (*verano*). The lake was flooded during the final years of the canal construction era. Gatun Dam, which impounds the Chagres near its historical Caribbean mouth, was completed in 1911 and the lake reached its operating level in 1914, the year the canal opened. At that time, it was the largest artificial lake in the world, but its consequences were far from unique. It transformed regional geography by flooding forests and farms, and displacing the residents of historical river communities (Carse, 2014: 93-119; Lasso, 2016).

In retrospect, it is striking how early water scarcity anxieties emerged in the history of the Panama Canal. Nearly a decade before the waterway opened, Henry Abbot, a well-regarded hydrologist and former Army Corps of Engineers brigadier general who consulted on the canal project, raised concern

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[2] The US Congress's decision to build a lock – as opposed to sea-level – canal was not inevitable. Indeed, there were many passionate advocates for a sea-level waterway. But the decision to build a lock canal was more practical. The sea-level design, due to the amount of earth that would have to be excavated, was projected to cost nearly twice as much (USD$247 million vs. USD$139 million) and to take years longer (an estimated 12-13 years vs. 9 years). After much debate, Congress approved the lock design in 1906.

[3] The United States-Panama Treaty of 1903 gave the US extensive territorial power and environmental control on the isthmus. According to the treaty, the US controlled the water that drained into the canal and could appropriate more territory for water or other uses necessary for the "use, sanitation, and maintenance" of the waterway.

about "whether the Chagres will supply all the needs of the canal in seasons of low water" (1905: 105). Water is plentiful, even excessive, during central Panama's long rainy season. But the dry season can push the stored water supply to its limit, particularly in years when the rainy season arrives late.

During the 1920s, water supply concerns deepened due to several long dry seasons. These drought events played an important role in the subsequent expansion of the canal's hydrological footprint. A second canal storage reservoir, Alajuela Lake (originally Madden Lake), was flooded in the 1930s by damming the Chagres River above Gatun Lake. The stated motivations were: increased water storage for dry season navigation (a buffer against drought), improved flood control, and expanded hydroelectric production.[4] However, the site was located in Panama, not the US Canal Zone. In order to create the new lake, the US President, Calvin Coolidge, signed an executive order in 1922 that annexed 57 km^2 of sovereign Panamanian territory and appended it to the Canal Zone. The order invoked the original 1903 canal treaty, which allowed for the expropriation of Panamanian lands and waters for the "construction, maintenance, operation, and protection of the canal".

For more than a century, water shortage couched in terms of low rainfall, prospective ship traffic, and potable water and hydropower demands has been a concern for the Panama Canal administration (once a US institution, now Panamanian) and a motivation for expanding its territorial jurisdiction. Viewed historically, events like the drought of 2015-16 have become somewhat normal, but they are far from natural. They are shaped – even created – by sociotechnical momentum and institutional frameworks (Taylor et al., 2009). If, for example, the sea-level canal design was chosen over the freshwater-intensive lock design a century ago, the regional supply-and-demand calculus that underpins the drought events of recent decades might look different. And yet, if state responses to the 2015-16 drought echoed those of decades past (more supply!), the infrastructural relationships that format regional water supply and demand have changed. The population has grown and urbanised, increasing the pressure on the two major reservoirs. And, as we will see, the production of drought in 21st century Panama is mediated by interconnections with non-Panamanian publics via long networks.

INTERCONNECTION: WHERE DID THE DROUGHT COME FROM?

The Panamanian intellectual Bonifacio Pereira Jimenez (1964) observed that the history of the Chagres River is the history of Panama. Although the river and the country have changed, his statement still rings true. By paying attention to where, for what, and for whom this engineered river flows, we can make sense of the production of drought on the isthmus. Chagres River water is channelled through locks, turbines, spillways, and pipes. In so doing, it provides Panamanians with potable water and electricity and moves ships, linking the metabolism of global trade to everyday life.[5]

This section extends the previous section's effort to deepen the received temporality of drought events by extending the frame of spatial analysis from region to infrastructure network. Building on scholarship on the water-energy nexus (Gleick, 1994) and water-energy-food nexus (Bazilian et al., 2011), I make the case for analysing Panama's 2015-16 drought in terms of regional-to-global interconnections around what we might call the water-energy-navigation nexus. In central Panama, this

[4] In 1929, as preliminary work for the Alajuela Lake project began, canal administrators framed the looming water problem in networked terms, invoking global shipping and regional electricity: "While the additional water supply to be provided by the construction of the Madden Dam at Alhajuela may not be necessary for lockages until the third set of locks is in service, it is desirable to have it now to increase dry-season water supply…; to control exceptional floods, like that of October, 1923; and to reduce the cost of operating the Diesel electric plant during the dry season" (Governor of the Panama Canal, 1929).

[5] My thinking on water, infrastructure, and everyday life in this essay is inspired by a rich literature that bridges anthropology and geography. See McFarlane, 2008; Birkenholtz, 2013; Furlong, 2013; Meehan, 2013; Barnes, 2014; Chalfin, 2014; Ranganathan, 2014; Radonic and Kelly-Richards, 2015; Anand, 2017; Morita and Jensen, 2017.

nexus turns on Gatun Lake and Alajuela Lake – large reservoirs created to supply a year-round supply of fresh water for navigating the lock canal that also provide water and power for nearby populations.

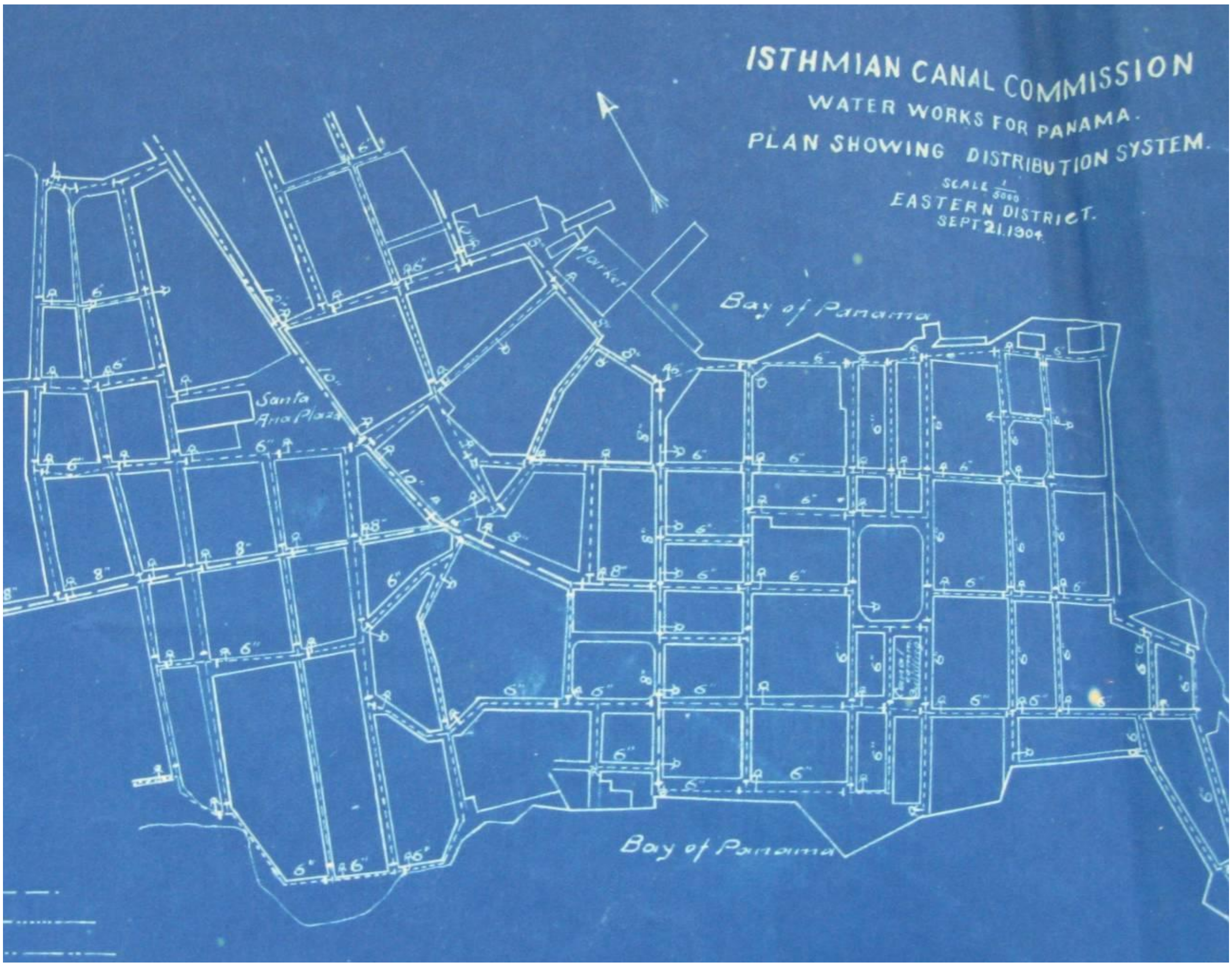
The regional interconnections that shape water distribution and demand today were established during the canal construction era (1904-14). The Panama Canal Company provided all utility services in the Canal Zone, including drinking water. The US government also distributed potable water treated in the Zone to the residents of Panama City and Colón. In the canal treaty of 1903, the US government agreed to finance and build urban public works (potable water, sewer, stormwater, and roads) in return for annual payments equal to interest and amortisation on the investment. The point was not to develop Panama, per se, but control disease – particularly yellow fever. In the early 20th century, American sanitarians worked with Panamanian counterparts to reengineer the cities, building modern water management systems to replace the cisterns, rain barrels, and latrines where yellow fever's vector, the *Aedes aegypti* mosquito, thrived (Sutter, 2016). Pipes linking canal reservoirs to urban Panama were part of a sprawling US campaign to control disease around the canal (Gorgas, 1915).

As Gatun Lake filled and the opening of the canal approached, US administrators opened several water treatment facilities to provide water to the Canal Zone and adjacent Panamanian cities. They drew raw water from canal reservoirs, treated it, and released a portion of the potable water into pipes connected to Panama City and Colón. This was all managed by the Panama Canal Company. Like the water supply, sewerage, and waste management efforts taking place in US cities during the period (Melosi, 2000), these were urban sanitary engineering projects. But the quasi-colonial political context distinguished the reengineering of Panama City and Colón from that of New York and San Francisco. For US sanitary engineers working in domestic cities, the main objective was to improve the health of urban residents themselves. For US sanitarians in Panama, the ultimate goal of the transboundary campaign was to maintain the health of white employees from the United States living in communities adjacent to the cities (Sutter, 2016). Panama City and Colón were like New York and San Francisco in another sense: municipal water came from reservoirs located outside of the cities. But the lakes of the Canal Zone were created primarily for moving ships, not provisioning cities with water.

In the 1950s, the United States transferred control of its pumping stations, valves, and pipe networks in the Republic of Panama to the Panamanian government, but maintained control of infrastructure in the Zone, including the water treatment plants that served the enclave and urban Panama. The first Panamanian national water utility, *Comisión de Acueductos y Alcantarillados de Panamá* (Water and Sewer Commission of Panama), was established in 1956 to manage and improve the urban water and sewage systems set up by the United States. This meant that two institutions – the US Canal Company and the national utility – jointly managed the water supply system. The current utility, IDAAN, or *Instituto de Acueductos y Alcantarillados Nacionales* (National Institute of Aqueducts and Sewers), was established in 1961 with the mandate of implementing projects to improve the national system of water and sewer services and meeting demand in expanding urban areas (Fierro, 1992). In practice, however, municipal water consumed in Panama City and Colón was still collected and treated in the Canal Zone, then released into a pipe network controlled by IDAAN.

Power lines also connected the Zone and Panama. In addition to selling potable water to the Republic of Panama, the Canal Company sold excess hydroelectric power generated at its dam sites. Some of the water used fell over Panama, but was collected and stored in the Zone. Before the 1960s, Panama had no integrated national electrical system. Facilities were concentrated in Panama City and Colón and dominated by a US-based firm – Panama Power and Light Company – owned by General Electric (Wali, 1989: 40). The company, a source of agitation for Panamanian nationalists, controlled electricity, gas, telephone, and streetcar services in both of the terminus cities (Major, 1993: 264).

Figure 4. Since the early 20th century, Panama's urban water systems have been hydrologically linked with the Panama Canal. During the canal construction era, the US government built potable water, sewer, and road systems in Panamanian cities as part of a public health campaign. This 1904 map depicts canal administrators' plan for a water distribution system in Panama City.



Source: US National Archives at College Park, RG 185, Entry 30, File 47.I.53, Box 32. This document is in the public domain.

In the 1960s and 1970s, the infrastructures of empire and sovereignty would take on growing symbolic and geopolitical significance in Panama. Connection was a key issue. From an engineering perspective, the interconnection of previously discrete power grids makes them more resilient and less prone to interruption (Benson, 2015: 115). An article on power outages in the Zone published in a Canal Company newsletter made the technical case: "The Canal Zone and Panama electrical utility systems are interconnected to provide for routine exchanges of energy and for mutual assistance during emergencies. In 1969, the Canal organisation contracted with Panama to purchase up to 30,000 kilowatts of capacity a month for a 25-year period" (Panama Canal Spillway, 1977). In the context of equipment failures or dry weather, the two grids – both heavily dependent on hydropower – could draw upon one another. From a geopolitical perspective, however, infrastructural interconnections between an imperial power and an occupied nation could also be seen as a form of dependency.

If infrastructure was a material and aesthetic conduit for imperial power, it was just as vital in the decolonial project. Panamanians had long been irritated by the prices that the US government charged for potable water and hydroelectric power. In the early 1960s, Panamanian intellectuals encouraged the state to build hydroelectric and water treatment facilities to sever the interconnections that maintained relations of dependency (Bonilla, 2016: 79). The *Guardia Nacional* (National Guard) took control of the Panamanian government in a 1968 coup. Under the leadership of General Omar Torrijos, the leftist military government defined itself in opposition to the Canal Zone and continued US presence on the isthmus, which it characterised as an affront to Panama's sovereignty. Some of the *Guardia*'s nationalist efforts focused on disconnecting the Republic of Panama from the infrastructures of US political and economic domination. In the early 1970s, for example, the *Guardia* took control of the monopolistic US-based Panama Power and Light Company.

Other efforts focused on assembling and extending the reach of national infrastructure. Pursuing a leftist-populist vision of development that merged a belief in modernisation with Third Worldist ideologies of self-reliance, the *Guardia* pursued loans from international development institutions and private banks to build roads, an international airport, port facilities, an interoceanic oil pipeline, and hydroelectric facilities to power a diversifying economy and growing cities (Wali, 1989). In its search for sovereign energy, the government pivoted away from the Canal Zone and created its own multi-use reservoir. The Bayano Hydroelectric Complex, built between 1972 and 1976, was a signature state project that materialised the strategy of diversifying development and reducing reliance on the canal and its utilities (Wali, 1993). It was one of four new hydroelectric facilities constructed during the infrastructure boom of the 1970s. When it came to potable water, however, it was more difficult to escape the hydrological shadow of the canal. Panama City and Colón had never been as dependent on the Zone for electricity as drinking water. Panama had created a water utility (IDAAN) and built distribution networks, but, as cities grew in the 1970s, it remained dependent on storage reservoirs controlled by the United States. IDAAN still purchased drinking water from the Canal Company.[6]

When it came to infrastructure, the *Guardia* was not only inward-looking. It was also forging new global interconnections. As the Panamanian state pursued nationalist infrastructure-led development in the 1970s and sought to build a diverse economy that would provide a buffer from the cyclical booms and busts that had long plagued the transportation service sector – a relationship of dependency that Marxian Panamanian intellectuals call *transportismo* (Castillero Calvo, 1973) – it also leveraged the isthmus's historical role as a trade and finance hub (Wali, 1989). In the 1970s, Panama offered generous tax incentives and lax regulation to make the country a destination for transnational capital and international banks (Johnson, 1976; Warf, 2002). At the same time, negotiations were underway with the United States around the future of the canal. In 1977, General Torrijos and US President Jimmy Carter signed treaties guaranteeing the transfer of the canal and Canal Zone to Panama beginning in 1979 and ending on 31 December 1999. (The treaty also initiated the transfer of authority over regional water sources.) At that point, the imperial infrastructures that Panama's military leaders had previously defined national development in opposition to would become sovereign.

In 1977, several months before the treaty was signed, a drought associated with El Niño foregrounded the potential of regional and global infrastructure interconnections to turn a meteorological drought into a socioeconomic crisis. In an influential paper, the US tropical forester Frank Wadsworth (1978) argued that the critical global shipping channel might become a "worthless ditch" if the infrastructural conditions creating water shortage persisted:

> In May of 1977, the passage of an above average number of ships, an increased use of water for hydroelectric power and the domestic supplies of growing cities, and the production of timber, food, and forage crops within the Canal watershed led to a dramatic demonstration of the limits of the capability of the water system. The surface of Gatun Lake dropped to 3.1 feet below the level required

[6] By the 1970s, the Panama Canal Company's Miraflores Plant was not able to provide enough water for the growing Panama City metropolitan area. In 1975, IDAAN opened a new water treatment facility that drew water from Alajuela Lake and routed it to the city. The raw water treated at the plant was also purchased from the Panama Canal Company.

> for full Canal use. Some ships sent part of their cargo across the Isthmus by land, reloading it at the other coast, and certain bulk cargo shippers even abandoned the Canal, sending very large carriers around the [Cape] Horn. In 1977, this predicament coincided with a serious drought, and this was seen as a harbinger of what could soon take place every year (Wadsworth, 1978: 22).

Because potable water, energy, food, and navigation systems all made demands on the same water sources, the drought was not simply a deficit in precipitation (meteorological event), or even a case of regional demand outpacing supply (socioeconomic event). The Panama Canal's hydrological reliability – the ratio of available water volume to the volume demanded for normal transportation operations and various municipal uses (Vargas, 2006) – is not defined in Panama alone, but in relation to a global transportation infrastructure that undergirds economic globalisation. Canal traffic increased dramatically between the early 20th century and early 21st century, from around 1000 transits in 1915 to nearly 14,000 in 2015. Transits increased sharply in the post-World War II decades, tracking a broader expansion of international seaborne trade. In 1970, 2.6 billion tons of cargo were moved by oceangoing ship. By 2013, that global tonnage shipped had multiplied, reaching nearly 9.6 billion tons (UNCTAD, 2014: 5).

Figure 5. Over a century after the canal opened in 1914, the Panama Canal Authority still sells fresh water from reservoirs under its jurisdiction to Panama's national water utility. The treatment plant shown here draws water from Gatun Lake, which was created as a canal reservoir.

Source: Author (2015).

Rising canal traffic and, thus, water use can be linked to phenomena associated with economic globalisation, including logistics (Cowen, 2014), containerisation (Levinson, 2006), and efforts to reduce trade barriers and facilitate exchange. As traffic through the canal increased in the post-war years, so did draft restrictions like those enacted in 1977. The canal administration enacts draft restrictions – reductions in the maximum draft, or underwater depth, of ships transiting the waterway – when the water supply stored in reservoirs is insufficient for normal operations. In this scenario, large ships may need to reduce or offload cargo for transit. US canal administrators placed restrictions on passing ships in 1957, 1961, 1965, 1977, 1982, and 1998. The last three restrictions occurred during droughts that were associated with El Niño events, like the drought of 2015-16.

In the second decade of the 21st century, Gatun Lake and Alajuela Lake still supply water for most of the two million residents of the urban sprawl that stretches from Panama City (the nation's booming capital and canal's Pacific terminus) to Colón (an impoverished city adjacent to the Caribbean terminus). The Panama Canal Authority (ACP) manages the reservoirs and sells raw and treated lake water to IDAAN, the national water and sewer utility. These transactions are an extension of the historical infrastructural connections that bind global navigation to cities and canal administrators to Panamanian citizens. Between 2012 and 2014, the ACP generated an average of USD$28 million in annual revenue from water sales to IDAAN (Panama Canal Authority, 2014). The ACP still operates hydropower facilities and sells electricity to the national utility (*Empresa de Transmisión Eléctrica*). During the 2012-14 period, the ACP generated an average annual revenue of USD$157 million from selling power to the national grid (ibid). Taken together, the interconnections among the canal, potable water, and electrical systems mean that drought events may pit the water demands of a politically and economically entrenched transportation service sector against those of residents and other industries.

VISIBILITY: WHAT (AND WHO) COUNTS IN DEFINING AND RESPONDING TO DROUGHT?

Scholars in science and technology studies, anthropology, and geography suggest that infrastructure should be analysed as both a material thing (or built network) and a bundle of associated relations (Star and Ruhleder, 1996; Edwards, 2003; Carse, 2012; Larkin, 2013; Harvey et al., 2017). For anthropologist Brian Larkin, the "peculiar ontology" of infrastructures is that they are "things and also the relation between things" (2013: 329). This relational or ecological conception of infrastructure is indebted to the pioneering work of Susan Leigh Star (Star and Ruhleder, 1996; Star, 1999), who calls analysts to move beyond the 'what' of infrastructure (its system components and boundaries) to attend to its 'when' and 'whom'. Star and Ruhleder (1996) list eight key dimensions of relational infrastructures. Two are particularly salient here. First, infrastructure is built on an installed base (ibid: 113). As demonstrated in Section 2 on the design choices that created a water-intensive canal in Panama, infrastructures must 'wrestle' with constraints built into that base as time goes by and problems (like droughts) emerge. Second, infrastructure has a temporal and spatial reach beyond a single event. This point was emphasised in Section 3 on how drought in Panama is shaped by regional-to-global interconnections.

Attention to momentum and interconnection makes it possible to reimagine the temporal and spatial contours of Panama's 2015-16 drought. But infrastructures, as many scholars have observed, exceed their technical functionality. Thus, Brian Larkin directs our attention to the poetics of infrastructures: their capacity to serve as "semiotic and aesthetic vehicles oriented to addressees" (2013: 329). Yes, infrastructures like the Panama Canal move water, power, and bodies, but they also circulate power, desire, fantasy, and aspiration. Communities of geography and practice are socialised to interact with material infrastructures in certain ways and come to embody expectations of functionality. Here, infrastructure – like culture itself – is (ideally) ready to hand, meaning that it does not need to be reassembled each time we use it. Susan Leigh Star and Martha Lampland write, "Good infrastructure is by definition invisible, part of the background for other kinds of work" (2009: 17).

If 'good' infrastructure resides in the background of everyday life, as Star and others suggest, then it becomes visible upon breakdown – when an *event* (like a drought) disrupts the relationship between technical function and social expectations (Star and Ruhleder, 1996: 113). While the 'visible upon breakdown' trope has proven useful in infrastructure studies, it also has limitations. First, the notion that infrastructures work smoothly and are, therefore, experientially invisible, universalises a modern ideal that is geographically specific to the Global North and historically specific to the postwar era (Edwards, 2003: 188; Furlong, 2014). But even if smooth functionality is not a universal reality, it is still a widespread aspiration. Thus, according to anthropologist Kregg Hetherington, it may be more useful to think of infrastructures as "structures that are *supposed to become* invisible, to provide the stability necessary for the emergence of processes of a different order – alternately imagined as development, civilisation, or simply progress…" (2017: 42). Second, as Brian Larkin argues, visible-upon-breakdown represents "the extreme edge of a range of visibilities that move from unseen to grand spectacles and everything in between" (2013: 336). "The point", he writes, "is not to assert one or another status as an inherent condition of infrastructures but to examine how (in)visibility is mobilised and why".

How is (in)visibility mobilized in drought definition and response? Paul Edwards (2017) observes that there are several common mechanisms of infrastructural invisibility. Star and Ruhleder (1996) emphasize what we might call *habituation*; this is when infrastructure hides in plain sight due to the human tendency to ignore stable elements of the environment (e.g. functional infrastructure). Another mechanism is *deliberate hiding*: wires, cables, gas lines, cell transceivers, and, of course, water pipes are buried, hidden in walls, or otherwise concealed to escape attention. But, arguably, the mechanism of invisibility that has most influenced drought definition and response in Panama is *social norms and organisational routines* (Edwards, 2017). Writing about water infrastructure specifically, Wiebe Bijker argues that "technological frames" shape norms and routines. "When things stabilise and grow obdurate", he writes, "stable ways of thinking and fixed patterns of interaction do emerge around them" (2007: 122). While dams, dikes, pipes, and locks are inscribed with values about land use, vulnerability, and managing risk and uncertainty, they come to seem purely technical and objective.

How did technological frames associated with infrastructure shape Panama's drought response? One crucial area was the emphasis on problems of supply relative to those of demand. In media and political accounts, the drought was framed as a meteorological event – a localised manifestation of the El Niño phenomenon, which affects wind, temperature, and rainfall worldwide by altering normal air and ocean currents. Strong El Niño events occur once per decade, on average, with weaker events every three to seven years. The last two phenomena to have major impacts in Panama took place in 1982-83 and 1997-98, the two driest years on record in Central America (STRI, 2015). In 2015, what had appeared to be a weak event was upgraded to strong by June (ibid). The rainy season, which generally begins in May, began later and with less intensity than normal.

Panama's drought may have begun as a meteorological event, but it quickly became a socioeconomic event as water demand threatened to exceed the reduced supply. The government declared a state of emergency in August 2015 and created a national water security commission (*Comisión de Alto Nivel de Seguridad Hídrica)*, which was tasked with coordinating prevention and mitigation efforts across state institutions and began work on a national water security plan. The newly defined drought was discursively framed as a water supply 'deficit' and new concessions for landscaping and agriculture were suspended (*La Prensa de Panama*, 2015). In September 2015, the water security commission launched a media campaign, "drop by drop, the water runs out" (*Gota a gota, el agua se agota)*, that attempted to reduce demand during the drought by asking individuals to conserve water at home (*La Estrella de Panama*, 2015). Rainfall during the final months of 2015 brought some reprieve, but drought-related water supply problems persisted into the next year. By May 2016, the end of another extended dry season, the levels of Lake Gatun and Lake Alajuela – both administered by the Panama Canal Authority (ACP) – were the lowest on record (Government of Panama, 2016).

The ACP was legally established in 1997. In the law that created the authority, the government of Panama gave it the mandate of managing the waterway for "the human and socioeconomic development of the country" (*Asamblea Nacional de Panama*, 1997). The same law assigns the ACP authority over the administration, maintenance, and use of regional water resources for use by the canal and populations in neighbouring Panamanian cities. In its control of regional water resources, the ACP is reminiscent of its predecessor, the Panama Canal Company. Unlike that US state institution, however, the ACP is legally required to take national and regional issues into consideration.

Institutional hierarchies associated with infrastructure shaped the patterns of visibility and invisibility that shaped drought response. The ACP manages the upper half of the regional water infrastructure (the reservoirs, hydroelectric stations, and treatment plants of the former Canal Zone).

The national water and sewer utility, IDAAN, manages the lower half. The ACP still sells water and power to IDAAN. And yet, when the 2015 drought arrived, the entity using the lion's share of regional water – the canal – was hardly mentioned. The public discussion focused on faucets, lawns, golf courses, car washes, and household use. Why was this the case? What does it say about visibility?

Because ships and cities in Panama draw on the same reservoirs – because the canal is interconnected with water and power utilities – this is not simply a point of comparison, but a relationship that raises questions about how environmental burdens and benefits are distributed and what – and, by extension, whose – water demands are subject to revision. The discursive invisibility of the canal's water use is not surprising in light of the dominant technological frame (Bijker, 2007) that renders it normal and value-free. In July 2015, the newspaper *La Prensa de Panama* published an article challenging that frame entitled "Controversy about water use in the metropolitan area". The author suggested that the drought was not a crisis because Panama has "water stress" in the conventional sense but because Panama Canal water managers did not adequately account for human consumption, raising the question of who counts in water management priorities. Although Panama has sovereign control over the territory of the former Canal Zone and the canal, questions of water sovereignty are complicated by the institutional legacies of the US presence. As detailed above, canal administrators still manage the lakes for ship transits and sell water and hydropower to national utilities.

Water scholars have observed that scarcity is not absolute, but the outcome of a constellation factors, including: governance, the social construction of knowledge, climate-related supply, consumer behaviour, the political economy of supply systems, and evolving sociotechnical management choices (Bakker and Bridge, 2006; Alatout, 2008; Giglioli and Swyngedouw, 2008; Taylor et al., 2009). Put simply, droughts can be understood as co-produced (Jasanoff, 2004), in the sense that they are outcomes of the intertwined development of scientific practices, technological artefacts, and discourses – not to mention entrenched power structures and infrastructural interconnections.

In August 2016, the government adopted a national water security plan for 2015-50. The plan, subtitled "water for everyone" (*agua para todos*), was written by the state water security commission established in response to the drought. It lays out five national water security challenges: 1) potable water- and sanitation-service coverage and supply; 2) water supply for economically productive sectors within the context of climate change; 3) watershed health; 4) maintaining water and sanitation infrastructure; and 5) evolving toward a culture of responsible and shared water use. Given its origin in the emergency discourse that crystallised around the drought in 2015, it is not surprising that, while water conservation and demand are discussed, anxiety about future water supply and storage are paramount: "However, it is necessary to increase the availability of the resource through the construction of infrastructure, such as multipurpose reservoirs and supply channels to ensure the supply of water necessary to meet a diversity of current and future demands" (ibid: 75).

As a political response to the drought, Panama's water security plan was in step with a global reembrace of supply-side principles and infrastructure investment among water managers (Crow-Miller et al., 2017). But, as noted in the article's introduction, such a response to water shortage can have the opposite of its intended effect: increasing demand rather than buffering capacity and increasing resilience (Molle, 2008). The plan attends to a diversity of socioeconomic sectors – the 'what' of water supply – but obscures the 'who' of water infrastructure. The national water security plan characterises the goal of supply-side efforts as providing "water for inclusive socioeconomic growth". The emphasis on inclusivity dovetails thematically with the report's subtitle of "water for everyone" (*agua para todos*), but, in this case, inclusive refers to a diversity of economic sectors – human consumption, agriculture, industry, energy, transportation, transportation and biodiversity – rather than publics.

When we conceptualise drought as a meteorological event, the relevant public seems obvious: the people that occupy the affected territory. When we conceptualise it as a socioeconomic event, the publics involved are the citizens of the nation or residents of a municipality. However, when we analyse drought through the lens of infrastructural event, the pertinent publics are more distributed and less apparent. The relative invisibility of infrastructural publics is a feature of their distribution. For these are not necessarily pre-existing groups like populations, citizens, or users, but collectives that gather around infrastructures and their problems (Collier et al., 2016). On the isthmus, for example, flows of water and power have historically linked the Canal Zone to urban Panama, giving shape to a transboundary regional public defined not by political representation, but by pipes and cables. Utilities linked bodies and households to the body politic (Anand, 2017; Bakker, 2012) in ways that did not map onto the political geography of the nation-state, but traced a regional entanglement of hardware with political-economic and aesthetic power. Today, global transportation infrastructure demands enormous volumes of Panamanian water, which means that the publics of the 2015-16 drought included far-flung Chinese producers, Danish shippers, and American consumers (to name only a few key actors).

Figure 6. Pedro Miguel Locks. Panama's contemporary droughts are linked to the hydrological demands of global shipping, which can be overlooked in responses due to the physical and organisational invisibility of infrastructure.

Source: Author (2009).

CONCLUSION

The story of Panama's drought is a story of rainfall, cities, and ships. A straightforward meteorological narrative implies that the drought arrived suddenly and came from above. An analytical focus on infrastructure, by contrast, suggests that the conditions of possibility for drought as a socioeconomic emergency were made slowly on the ground in Panama – or, more precisely, through the water-intensive transportation services that the isthmus provides for the global shipping industry.

In demonstrating how momentum, interconnection, and visibility can format situated experiences of, and responses to, water shortage and scarcity, Panama's drought is not an isolated case. It may even be a harbinger of things to come as the climate changes and fresh water circulates the planet in large volumes via built conduits and bulk commodities. In California, for example, the export of water-intensive crops like almonds, pistachios, cotton, and rice siphons staggering volumes of water from the state's supply. Californian almond and pistachio farmers used 4.7 trillion litres of water in 2010 – second only to alfalfa – and two-thirds of the nut crop was exported (Philpott and Lurie, 2015). There is an interesting, if imprecise, parallel to Panama's drought here. In both cases, drought discourse underemphasised the economic sectors using the most water. But the canal does not produce commodities; it moves them. Its water usage exemplifies the logic through which global transportation infrastructure transforms and makes environmental demands of the places it crosses. In the absence of the shipping industry's hydrological demands in central Panama, the calculus of drought changes.

Engineered infrastructures provide an experience of environmental control, particularly over the short-term and at local and regional scales. They provide warmth in winter, light at night time, fresh fruit out of season, and water in the dry season (see Edwards, 2003). But analysed over longer periods and at larger spatial scales, our infrastructures – precisely because they buffer some of us from environmental processes (most of the time) – create the conditions for what Mike Davis (1999) calls ordinary disaster. Through engineering hubris, false environmental assumptions, and short-sighted development policies, infrastructures facilitate and direct growth that they ultimately cannot sustain.

Infrastructure has become a vibrant site of interest for overlapping communities of scholars, designers, and activists in recent years. It has also become a locus of activity related to sustainability. Has the momentum of infrastructure at a planetary scale locked us into a catastrophic future? "Temporality and scale seem to be against us", writes anthropologist Dominic Boyer. "How can we coordinate action to generate 'sustainable' modern infrastructure at a planetary level in the dwindling time horizon within which earth and climate scientists are urging us to act?" (Boyer, 2017: 174). The pragmatic answer, Boyer suggests, is probably less a revolutionary seizure or disconnection of global infrastructure and more a "creative squatting in, and repurposing of, a gridworld that will find itself incrementally disabled by a redistribution of its materials and energies" (Boyer, 2017: 185). The analysis of infrastructural events like the one that unfolded in Panama in 2015 and 2016 can make the gridworlds that we inhabit more visible and, in so doing, facilitate projects for sustainability and justice.

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