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Tankers, Wells, Pipes and Pumps: Agents and Mediators of Water Geographies in Amman, Jordan

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ABSTRACT: Water tankers and private wells along with the municipal piped water system have become an important feature of the techno-social assemblage of water supply in Amman, Jordan. The article takes a theoretically hybrid approach aimed at generating a conversation between actor-network theory (ANT) and the critical-realist and political-economic approaches. We undertake both ANT-inspired and then social-structural analysis of the geography of access to water in Amman. The ANT-based analysis of 'things' like tankers, wells, pipes and pumps draws attention to their relational agency in enabling or constraining access to water. The structural analyses remind us of the enduring class-, gender- and geopolitically based power relations that provide the context for the technologies, or things, to work. The key argument is that ANT is useful as a meso-level framework, which may enrich structuralist narratives on geographies of access to water. Specifically, in the case of Amman, Jordan, the inequitable access to water is linked to the history of the Jordanian state, its security imperatives and the technologies that are pressed into service to manage water.

KEYWORDS: Actor-Network Theory (ANT), Critical Realism, water tankers, private wells, Amman, Jordan

INTRODUCTION

Water tankers have become a ubiquitous feature of domestic water supply systems across the Global South. Much attention has been paid to the neo-liberal-inspired privatisation of water utilities (see Bakker, 2005; Swyngedouw, 1997; Loftus, 2005), as well as to hybrid formal/informal water access strategies of the urban poor (for example, see Ahlers et al., 2014); yet, there is little scholarly work on the power-laden political-economic imperatives fashioning assemblages of water supply systems, combining piped with tanker water, to create geographies of unequal access. As the capital of a middle-income country, Amman is a particularly interesting city when it comes to investigating the interactions between the state, notions of citizenship, public water supply and commercialisation – not least because Jordan is considered one of the most water-scarce countries in the world (with water availability of 146 m³, where less than 1000 m³ is considered scarce by international standards [Ministry of Water and Irrigation, 2015]). It is also interesting because of its unique demographic profile and the tensions around who qualifies as a citizen of the Jordanian state and on what terms. In this paper we reflect on the results of field work in metropolitan Amman, combining our mainly political-economic, critical-realist perspective with insights from actor-network theory (ANT). The ANT-based exploration of the materiality of tankers, pumps, wells and the piped water system in explaining unequal access to water is imbued with a deeper concern for the question of social power. We follow Latour's (2005: 50) critique that in structuralist or 'sociology of the social' accounts "the hidden variables have become

packaged in such a way that there is no control window to check what's inside". We agree that controversies and uncertainties about, say, the social distribution of water in Amman, necessitate attention to multiple human and non-human actors. By focusing on the relationality of the material, and localising the global, ANT can enrich those meso-level, critical-realist, 'actual' accounts of events, and perceptions thereof, that fashion lived experience of access to, or denial of, water (Holifield, 2009).

The exploration of the techno-social assemblage in Amman pivots around four main technological artefacts, split between the private and public water conveyance systems: the privately owned deep water wells and the water tankers for conveyance of water from the wells on the one hand and the public piped water distribution network and the ubiquitous pumps, including suction pumps in the system, on the other. The suction pumps are mostly electric devices used to draw water from (generally public) pipes into a chamber emptied by a piston and then using the same piston action to pump water into the household internal piping system. We focus on these technologies because we found them to significantly affect water access outcomes in Amman in ways that a simple realist-structuralist approach could not fully describe. Since technology is integral to water supply networks, as are the power relations that provide the social context for it to function, it is our view that there is an urgent need to destabilise the theoretical silos that constrain researchers either to the agency of technology or to social-structural narratives on power. The possibility of incorporating both conceptually when explaining water geographies is an issue at the heart of our narrative.

Jordan probably has one of the most researched and scrutinised water sectors, in terms of international policy and donor-funded research (see, for example, Hagan, 2008; van Aken et al., 2009; IRG, 2011), but the quantum of academic research on the social geography of water access in the country is not comparable (for some examples, see Rosenberg et al., 2008; Hussein, 2018; Yorke, 2013). The strong international attention to the Jordanian water sector is driven more by its geopolitical significance in a turbulent region of the world than necessarily its water scarcity profile. Jordan is one of the two Arab states that has a peace treaty with Israel and is the only country in the Levant not facing an active insurgency, foreign military engagement or even terrorist activity comparable to its neighbours. Jordan is also home to more than 1.27 million Syrian and 0.13 million Iraqi refugees, who, combined, constitute about 14% of the total population of 9.5 million (Ghazal, 2016). Around 42% of Jordan's population lives in the capital city of Amman, and the geopolitically induced demographic shifts in the city, as well as the wider trends discussed here and later in this article, are critical to understanding the political valence of the techno-social water assemblages in Amman.

In the section below we will review the literature on techno-social water assemblages, urban water privatisation, power relations and the specific case of the Jordanian water sector to elucidate the ontological possibilities offered by ANT and its potential synergies and dissonances with the more critical-realist-inspired political economy approach to water resource geographies. The articulation of the theoretical framework and the Jordanian water context will be followed by a brief profile of the social geography of access to water based on 25 detailed household-level interviews across Amman and one household-level focus group, as well as interviews with tanker owners and focus groups with tanker drivers at 11 locations, including 7 of the 18 private wells supplying drinking water to metropolitan Amman. It is clear that technologies such as the turbine water pumps, tankers, piped water systems and suction pumps are instrumental as physical purveyors of water and thence social relations 'crystallised' through water. But do techno-social assemblages cause, reflect or coincide with the socio-spatial relations of access to water? The literature seems to point in various directions and we begin the search for a clearer answer as we delve into the literature below.

TECHNO-SOCIAL ASSEMBLAGES AND LOCAL HYBRID PRIVATISATION

From the early 1990s urban water supply became an increasingly central concern for geographers within the context of the neo-liberal-driven privatisation of water in the Global South (see, for example,

Swyngedouw, 1997; Loftus and McDonald, 2001). The literature characterises the uneven water service delivery across the urban landscape as an interplay of state power and the socioeconomic power of the citizens (Bakker, 2003a), or privatisation as illustrative of 'accumulation by dispossession' (Swyngedouw, 2005). At the same time it focuses on the subjectivities and strategies of resistance of the poor and dispossessed to the forces of national and global capital (see Loftus, 2007; Deedat, 2002; McDonald and Ruiters, 2005; Mustafa and Reeder, 2009; Loftus and Lumsden, 2008 among others).

Despite international calls to take a human rights approach to the provision of water and sanitation the reality of access to such services remains uneven globally (Albuquerque, 2013). Cleaver (2002) and Ahlers et al. (2014) use the formal/informal dichotomy in water supply systems to argue that access to water is, in fact, co-produced by multiple actors traversing the boundaries between formality and informality. Informal means of accessing water are not temporary phases but integral to the modes of neo-liberal-inspired urban development (Kooy, 2014; Bakker, 2013; Birkenholtz, 2010), and capitalist state formation (Gandy, 2008; Meehan, 2013a), and are therefore likely to become dominant. The endurance of informal water regimes is partially explained by the scalar strategies employed by the actors in the informal sectors in building alliances locally and nationally, and the appropriation of the international discourse on efficiency, cost recovery and the free market (Marston, 2014). We will touch on this theme as we elaborate on the Amman case study below, particularly with reference to the role of private tankers in the delivery of domestic water.

Starting with the seminal work of Swyngedouw (1999) on the techno-social waterscapes of Spain, there is now an increased focus on water delivery technology and the social nature it spawns. Focusing on tubewell technology for the pumping of groundwater, Birkenholtz (2013 and 2009) points to the difference in outcomes depending on gender and age, and how its use empowered farming cooperatives in Rajasthan, India. Sultana (2013) highlights contradictory development outcomes with regard to the role of tubewells in conveying arsenic-free water. De Laet and Mol (2000) similarly point to the varying health outcomes with the bush pump in Zimbabwe, based on the 'fluidity' of the pump and its relationships with the physical and social landscapes. The qualities of things, and how they relate to various political-economic forces, have thus become a subject of interest for water resource geographers (see also Linton, 2010). We explore the question of the materiality and agency of things in the ANT tradition in our case study of Amman, Jordan. Before doing so, however, we will outline the basic argument of ANT below.

ANT asks us to consider how non-human things and organisms matter in structuring social relations. It argues that humans and non-humans are in relational networks where agency is not just the preserve of the humans. The materiality of things like water, conveyance systems and collection technologies, e.g. cisterns, pipes, pumps and tankers, and how they interrelate, lends agency to them, producing patterns of social relations and access outcomes (Bakker and Bridge, 2006; Meehan, 2013b). The agency of things is not intrinsic to them but rather emerges from their relationships with other things, and humans. Bakker (2003b) asks how water can be an uncooperative commodity for neo-liberal privatisation. It is partially to do with its fluid materiality and the dominant technologies, e.g. the piped systems used for its conveyance, thereby making it a natural monopoly. Similarly, as discussed above, tubewells modify development and organisational outcomes, almost mimicking human agency. Things and humans therefore become *actants* in networks, which must be analysed symmetrically, dispensing with any a priori assumptions about the relative power of one actant over another (Latour, 2005; Lave, 2015). In other words, ANT leads us to a flat ontology where the concern is with the emergent relations, uncertainties and controversies that fabricate the social, rather than presuming the existence of abstractions and hidden forces to provide its context (Holifield, 2009; Latour, 2005).

The term 'assemblage' (used earlier) refers to a collection of relations between heterogeneous human and non-human entities (Muller and Schurr, 2016). While the original formulation of the term by Deleuze may have been more affective than materially actual, as in ANT, there is potential nonetheless for ANT to have a conversation with Deleuzian thinking to incorporate more of the latter's

concern for the unexpected, the episodic and human corporeal capacities (Muller and Schurr, 2016). It is precisely the apparent equality of the material capacity of things and humans (actants) in a network that draws criticism of ANT from different traditions. From a Marxist perspective, for example, Kirsch and Mitchell (2004) insist that, rather than things making us work, the social relations of work between humans create the 'dead labour' of things, such as computers, with which we interact. This means that questions such as why things are in relational networks and where and how they are produced and for whose benefit continue to be of fundamental political significance. Lave (2015) goes even further by arguing that "there is no necessary correlation between ontologically radical and politically radical" (218). She argues that ANT's theoretical positions are more consonant with a rational choice *homo economicus* of the neo-liberal imaginary than a historically situated and gender-, class- and power-differentiated subject at the heart of the political ecology project. Therefore, Lave argues, attempts by political ecologists to "engage" ANT "in the matrimonial and military sense of the word" (213) are futile at best and counterproductive in essence.

ANT's concern with the actual echoes the 'actual' in the critical-realist thinking that underpins a considerable proportion of political-ecological research. All forms of realism, including critical realism, are committed to the ontological position that there is a reality independent of our perceptions that is knowable (Proctor, 1998). Critical realism within social science is largely based upon the work of the philosopher Roy Bhaskar and posits three levels of reality: the real, the actual and the empirical. The empirical is where experiences exist as they are perceived; the actual is where experiences and events exist, accepting that events exist independently of perception and may be emergent instead of structurally preordained; the real consists of abstract structures containing the mechanisms that lead to events and their perception (Sayer, 1992; Mustafa, 2002; Lawson and Staeheli 1990). We are mindful of the fundamental disagreements over, *inter alia*, the nature of reality, the causation of events and the questions of agency of things and humans between realism and ANT. Nevertheless, following Elder-Vass (2008), we suspect that ANT is a meso-level framework. Actor-network theory may grasp actual-level events, in realist parlance, since it concerns the interactions between humans and technology. Although problematic, we maintain that the 'flat ontology' of ANT could enhance realist accounts of how human agency emerges from interactions with things in the realm of the actual. However, real, macro-level, structural mechanisms must provide the normative framework for an understanding of how some humans come to have more agency than others (Elder-Vass 2008).

Our concern with exploring the emancipatory potential of coupling ANT with critical realism, without attempting to collapse the distance between them, may open up newer sites for alternative political action (Muller, 2015 Holifield, 2009). In fact, many have leveraged assemblage thinking and ANT-type analyses in a distinctly political-ecological/realist register to explore, for example, energy poverty in the US (Harrison and Popke, 2011), China's water machine (Webber and Han, 2017) and natural resources (Richardson and Weszkalnys, 2014), to name a few. We undertake a comparable tracing of the relational materiality of water infrastructure and its mediations to explain how structural forces translate into the empirical experience of variable water access in Amman.

THE SOCIAL GEOGRAPHY OF WATER SCARCITY IN AMMAN

Since its inception following the collapse of the Ottoman empire, and its formal independence in 1946, Jordan, like most other post-colonial states, has been busy with the projects of nation-building and state-formation. Its task was further complicated by influxes of Palestinian refugees – in the aftermath of the formation of the state of Israel in 1948 and then Jordan's defeat in the Six Day War of 1967. Those refugees and assorted Palestinian factions fighting against Israel, chief amongst them being the Palestine Liberation Organization (PLO), came to dominate the Jordanian body politic until the bloody war between the PLO and the Jordanian armed forces known as Black September in 1970. Even after the Jordanian state, under the Hashemite monarchy, had established its writ (by expelling the

leadership and fighters of the PLO) it had to continue to manage a balancing act between more than half of its population that was of Palestinian origin and the local populations from the East Bank of the Jordan River. By 2018 the East Bank Jordanians dominate the civil service and armed forces while the West Bank Palestinians are prevalent in the business sector. As the seat of government and the largest population concentration in the country, Amman is at the epicentre of those tensions and fissures that underlie the Jordanian polity (Yorke, 2013). In the aftermath of the Arab Spring, the state has been even keener not to disturb the delicate peace that prevails in Jordan – to the point of letting people get away with not paying their water bills (Mustafa et al., 2016).

Water management is not merely politicised in Jordan; it *is* politics. As van Aken et al. (2009) observe, in an exceptionally artificial post-colonial state such as Jordan centralised planning and management, particularly in the water sector, represented a conduit for state- and nation-building. In the 1990s, however, Jordan boarded the neo-liberal bandwagon to accelerate the modernisation of the country. This neoliberal turn was particularly pronounced in the greater metropolitan region of Amman (Parker, 2009; Potter et al., 2009). As all the other sectors in the city, water supply was privatised in Amman in 1999 and placed into the hands of a company, LEMA, backed by international investors. The privatisation experiment lasted about eight years until 2007, when the water supply network was transferred to a new company, Miyahuna, which to this day is owned by the state-run Water Authority of Jordan (WAJ) (Rosenberg et al., 2008). Miyahuna's remit, however, remains distinctly commercial, consonant with the schema of water commodification proposed by Bakker (2005).

The hybrid, commercialised, public and private supply of water – primarily by tankers and water vendors – must be viewed in the context of the somewhat unique development trajectory of metropolitan Amman in particular and the Jordanian state more broadly. From its origin as a small town of 2-3000 people dominated by Circassian migrants in the early 20th century, Amman today is a major regional metropolitan hub with a population of about 4 million, of a total national population of 9.5 million (Ghazal, 2016). Much of the phenomenal growth of Amman was driven by migration borne of geopolitical turmoil in its neighbourhood. The US invasion of Iraq in 2003 and the outbreak of the Syrian civil war in 2011, along with the Arab Spring, led to newer waves of refugees. Palestinians aside, the refugee populations, along with guest workers, constitute around 30.6% of the population of the country, about 49.7% of whom live in metropolitan Amman, according to the 2016 census (Ghazal, 2016).

Despite its unique demography, 98% of metropolitan Amman's residents are connected to the water supply system – a remarkable accomplishment for a low-middle-income country (Gerlach and Franceys, 2009). Nevertheless, the water supply network has been subject to rationing since 1987, which was somewhat eased from 2013 by 100 Mm³ of water pumped from Disi wells about 326 km away (MWI, 2014) (Figure 1). Amman had been supplied with water for only 24 hours once a week. Since Disi, however, water is supplied in many neighbourhoods for about four days every week, although our interviewees from poorer neighbourhoods on the outskirts reported having water for just one day, and sometimes not even that because of the poor state of the pipes in the neighbourhood. Due to the Mediterranean upland climate of the western Jordan escarpment, where Amman is located, water is an issue mostly in the dry summer months and not during the wetter winters. In summer water tankers become the main conduit in making up the shortfall of water for the poor and to provide larger quantities to the more affluent consumers and commercial facilities. The main consumers of water at the higher end are: lawns, swimming pools, restaurants, shopping malls and hotels. The key distinguishing feature between the affluent western and northern Amman neighbourhoods and low-income central, southern and eastern parts is the storage capacity (Rosenberg et al., 2008). As per Potter and Darmame (2010), low-income households have an average of around 3 m³ of storage capacity, with 60% having 2 m³ or less. Meanwhile, high-income households typically have five to six times more capacity, as confirmed by our survey. However, poorer water users with lower consumption are subsidised by the state, through below-cost water charges (Gerlach and Franceys, 2009).

The peak water supply in Amman for the month of August was about 10 Mm³, based on a 36-hour supply per week. The private tanker trucks that make up the shortfall buy water from 18 privately owned wells around metropolitan Amman. Even during the hours of municipal piped water delivery big Miyahuna pumps are needed to get water to the high storage points before it is distributed by gravity to the settlements along the seven main and many other minor hills of Amman. As the water travels downhill from water mains to secondary and tertiary pipes, many consumers use suction pumps installed on their properties to draw extra water from the system during its hours of operation. Again, high-income households are at an advantage: not only do 40% of them have suction pumps installed on the system; 88% have dedicated water meters as opposed to 28% and 44% respectively for low-income households (Potter and Darmame, 2010).

Amman's businesses receive around 13.25% of the water supply (MWI, 2015), but demand is underestimated, since, according to Sigel et al. (2017), 56% of businesses have no piped connection and are exclusively reliant upon tanker water. An additional 21% supplement their piped supply with tanker water.

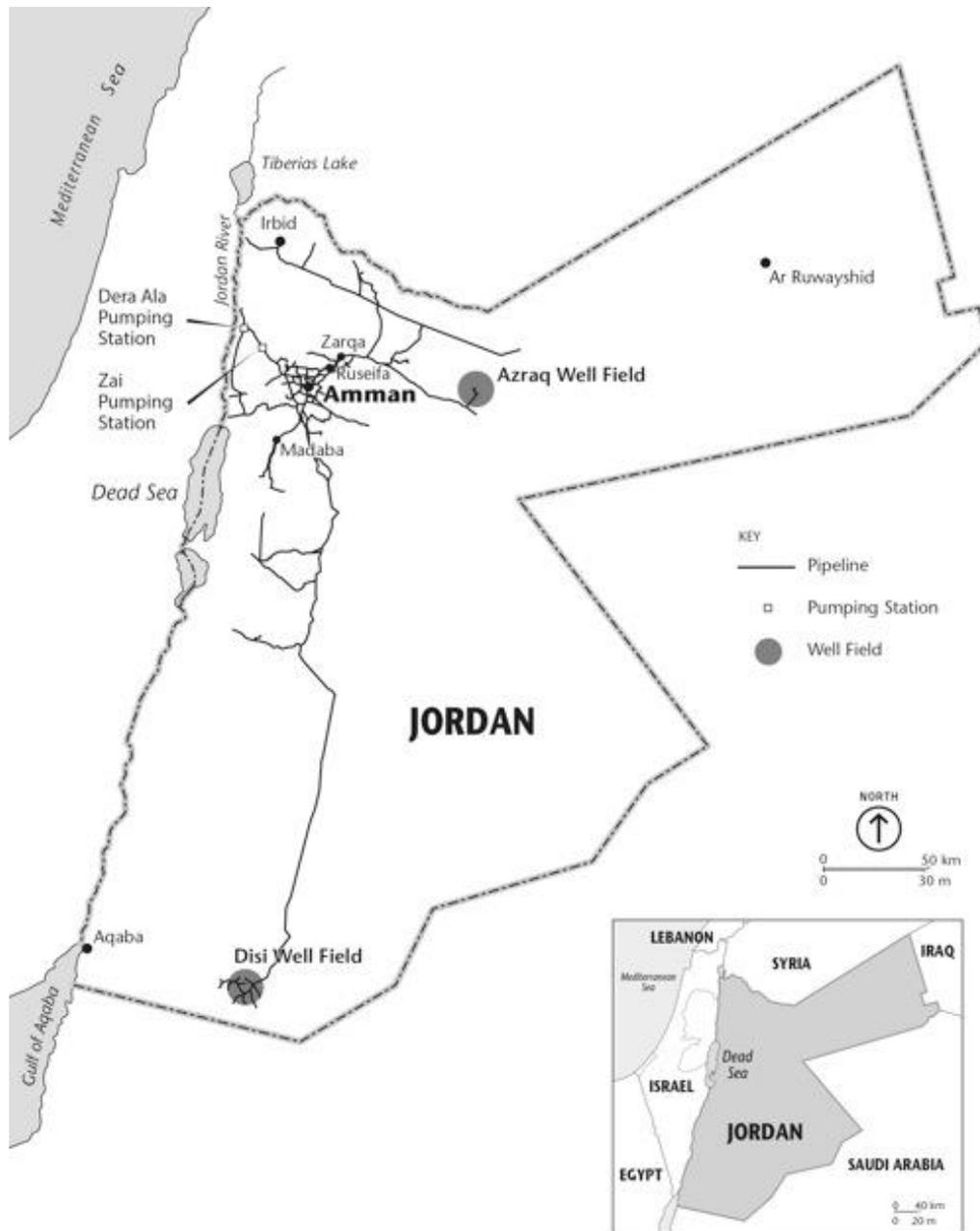
The main reason given by most commercial operators during our interviews (including hotels, hammams and water vendors) was that it made more economic sense to use tanker water as it was cheaper than the block rates of piped water. The same was true for high-volume domestic water use, such as swimming pools and lawns. This defeats the principle underlying Miyahuna's block tariff structure, where high-end users cross-subsidise the smaller domestic users, in that the supplier has ended up subsidising the smaller users while the larger users transfer their revenues to private well owners and tanker drivers – a stark case of the socialisation of subsidy and privatisation of profit in water.

In the urban water supply sector private wells, tanker trucks and water pumps have become important conduits for the realisation of capitalist logic. We turn now to a broad overview of the role of these technologies in fashioning the techno-social assemblage that is Amman's water supply system.

EMERGENT GEOGRAPHIES OF AMMAN'S TECHNO-SOCIAL ASSEMBLAGE

Water pumps have been the lynchpin of Amman's expanding water infrastructure, as they inevitably are in most contemporary water networks. With international funding (primarily from USAID), gigantic pumps take 60 Mm³ of water per year from the King Abdullah Canal in the Jordan Valley, about 400 m below sea level, to Amman, a city about 800 m above sea level. They also convey 100 Mm³ of water uphill over 326 km to Amman from the Disi well field along the Saudi Arabian border (MWI, 2015). The pumps are further integrated into every aspect of Amman's water supply network. The spatial reach of these pumps and pipes, vertically and horizontally, from the Jordan Valley to the Saudi Arabian border, to well fields across the Jordanian highlands and deserts, is impressive (Figure 1). The ubiquity and efficacy of these technological artefacts makes them integral to the hydro-metabolism of Jordanian society, especially in Amman (Linton, 2010). Without rehearsing the well-known argument on hydro-metabolism and how technology links spatially dispersed actors we suggest that these pumps also link Jordanian society with the designers and financiers of these pumps in the Global North, primarily Germany and the United States. The pumps on the water mains, especially those doing the heavy lifting, demand and receive the energy and attention of their human attendants. The failure of a pump on the mains is simply not an option, especially as they undertake their Atlas-scale task of pumping water up the mountains and plateaus of Jordan. More than 14% of Jordan's electric capacity is dedicated to these pumps (Busche and Hayek, 2015). As the water reaches Amman it branches out into 44 major arteries that convey the water to high reservoirs, whereupon the job of the pumps is complete.

Figure 1. Map of Jordan with major well fields and pipelines supplying water to the Amman metropolitan area.



The pumps are judicious in their job of conveying water across the 44 main water districts of Amman – or so say the system managers. From there on water is meant to be conveyed by gravity to 325 sub-districts. As a Miyahuna operative insisted, the pumps do not discriminate between the sub-districts, but rather the uneven topography of the city leads to an unequal distribution of water to users.

Equity is something we want to achieve, but geographical constraints mean we cannot. Ideally, rationing would be equal. We face problems in certain areas where the water conveyor is inadequate, so that the secondary system is not completely pressurised and cannot carry enough water to customers. This happens in more than one area. The primary and secondary [piping systems] have enough capacity, but the tertiary does not (A Miyahuna operative 14/07/2016).

As water flows into the pipes by gravity the pressure starts to build from the tail of the distribution system. Often by the time it builds all the way to the head of the system the supply cuts off. Households located across the street from one other can have very different supply patterns. One might be at the tail of one sub-district, while the other is at the head of a different one. This creates the impression that human agency, rather than the system, is discriminating in water supply. For Miyahuna it is the agency of the piping and the pumps that defeats the human intent of equitable supply. There is no human or social driver, just an emergent property of the system and a function of the fluid materiality of water (Bakker, 2005; Bakker and Bridge, 2006).

To complicate the picture further and obscure the avowed human attempt to achieve equitable supply, the water that descends downhill from the mains to the secondary and tertiary systems, which is supposed to obey the laws of gravity and reach everyone in its path equally, does not. Suction pumps on some private properties help the pressure along by defying the laws of gravity just as their bigger siblings do in the main system. The authorities say they are illegal, but these pumps selectively bestow water on some and deny others, who innocently have faith in gravity for their share, although the physical geography in which the system operates will not even allow for that. Thus, the emergent pattern of water access obeys the geography and power of suction pumps over the physical geography of the households, just as in the larger scale, hydro-social systems (Linton, 2010). The suction pumps can also be helped by bigger pumps, which, on some main lines, are not limited to the conveyance of water to the elevated towers or storage areas but supply secondary and tertiary lines and high-rise or multi-unit apartment blocks directly. There again the water pushed to the tertiary lines is gratefully pulled in by the suction pumps. To keep the peace between generally well-heeled water users along such lines in West Amman, the pumps also seem to operate 4-5 days a week instead of the 36-hour rationing that is supposed to apply equally to all.

In the poorer neighbourhoods of central and east Amman suction pumps run a protection racket for water users who can afford their services (Figure 2). They act as a mediating technology in this instance, as per Furlong (2010), that renders the supposedly stable, invisible water infrastructure visible and unstable for the users, who become active agents in the functioning of the system. Suction pumps promise humans water in return for capital and running expenses, and at the cost of the opprobrium of neighbours, whose rightful water they redirect. Their appendages of piping and storage tanks are strong and spacious in west and north Amman, while in south and east Amman, tertiary pipes break more frequently and storage capacity is generally the bare minimum of 2 m³, further exacerbating the unequal access. Enter the other actants, the tanker truck and private well, to make up the shortfall in the poorer neighbourhoods and provide water for commercial and luxury use in the more affluent west and north Amman.

As at 2018 the discrepancy in supply and demand in Amman stands at 45 Mm³ per year (MWI personal communication). The shortfall is mostly covered by 18 privately owned, deep-water wells producing 40-100 m³ of water per hour, officially operating 6-12 hours per day but unofficially much longer, according to our field observations and conversations with tanker drivers. All the wells have overhead pipes to fill tanker trucks (Figure 3) and business is brisk during the summer months. The wells' water quality is strictly regulated by the government. As reported by many water managers, water quality incidents are taken very seriously, as the state will not yield on this part of the social contract. The wells have storage tanks attached where the water is treated with chemicals, primarily chlorine, to prevent contamination, and from there the water is dispensed. The regulation wholesale price of water from these wells to tankers is 0.55 JD/m³,¹ however, in our interviews we found the price to vary from 0.75-1 JD/m³.

¹ 1 JD = US\$1.41 (2017).

Figure 2. A suction pump assembly in Russeifa, near Amman.



Figure 3. A tanker filling up at a private water well near Amman, Jordan.



Water tankers are the arms of these wells through which the water is conveyed to its final users. They have capacities of 3, 6, 8, 12, 16, 18 and 20 m³. The larger tankers tend to serve businesses, the construction industry and large domestic clients with swimming pools and gardens. The smaller

capacity tankers primarily serve domestic clients, most commonly in the densely populated neighbourhoods of central and east Amman. During periods of high demand the legal wells face competition from illegal wells and springs, where the price of water is a fraction of what it might be from the legal wells and the waiting period is much shorter. The water from illegal wells and springs primarily serves the construction industry, businesses, for non-drinking purposes, and quite often the poorer households, again for non-drinking purposes. This water is conveyed in green tankers, which are only supposed to contain potable water. Blue tankers are for agriculture and landscaping. However, customers prefer water dispensed from green trucks, not least because no business or household would like to have a blue tanker parked outside. The mechanics of the process were explained by a well-owner thus:

Illegal wells hurt our business. This summer I am happy that there is an illegal spring in the neighbourhood. There was a fight between drivers over the long wait at my well. In the winter? There I have a problem with illegal wells, because business is slow and I need customers.

It is easy enough for tanker drivers to obtain a certificate saying their water is from Al Awamle well, whereas it may actually be from Wadi Seer [where there is a well-known illegal spring]. There is no way to prove that the certificate is not from this site. Drivers like to fill from illegal wells because of the shorter distances and waiting times: they can fill their tank five times from the illegal well while they may be able to fill up only twice here. The drivers use mobile phones to warn each other about the police. They don't worry about the environmental police because if they catch him, he can call the governor [or another important person] and get bailed out quickly from prison; meanwhile his sons can drive the tanker. The fine is quite low as well. But also, in the summer, the environmental police turn a blind eye [because they understand that the use of illegal water helps keep the peace] (Manager of a legal well, Amman, 15/08/2015).

Again, the materiality of the tanker, including its demand for fuel to convey water, forces the human operators to engage in illegal activity to satisfy the demand for water, particularly since, in the hilly topography of Amman, elevation and distance are key to the cost of doing business. Secondly, the material fact that tankers can be stable only when completely full or empty has important consequences for who gets served by them and on what terms. Tanker drivers will sell the full volume of water and never a part of it. A 20 m³ tanker can cost up to JD45 in west Amman. The smaller customers in east Amman, however, cannot always afford the smallest 3 m³ tankers for JD14, and do not usually have the necessary storage space even if they could. In the poorer Russeifa in east Amman, for example, local gangs often claim a cut of the water from the tankers delivering in the neighbourhood. Other times people either pool a tanker and have it delivered to several adjacent households or simply bargain with the drivers to do them a favour. For example,

A rich customer will pay for 20 m³ even if he doesn't need it. The poorer one needs 2 m³ and can't even pay for that. Rich people take 20 m³ three times a week for swimming pools or to irrigate. A poor person walks the streets finds a tanker and asks for 1 m³. Or he might eventually get hold of a tanker driver in his neighbourhood to get water (Tanker driver, Amman, 11/07/2015).

The emergent trend of water access through tankers points to the material limitation of having to deliver their full loads and how this intersects with the class and buying power of the users to create geographies of varied access. Simultaneously, the production levels of individual wells and their technological and supply limitations make the drivers wait for hours upon end to fill up their tankers. These same limitations provoke illegal behaviour by the drivers, who are trying to earn a living. The materiality of things such as pumps, pipes, wells and tankers seems to have a perpetually emergent affect on the geography of access to water across Amman. Yet a more structural lens adds a deeper layer of meaning to this agent-centred account of the geography of domestic water access.

SOCIAL-STRUCTURAL UNDERPINNINGS OF AMMAN'S WATER GEOGRAPHIES

As ANT invites one to attend to how events actualise as a result of emergent relations between humans and technology, without any a priori assumptions about the causative power of one over the other, the realist/structural framework pushes us to add relief to that flat ontology. The geography of unequal access to water has certain social-structural underpinnings that are deeply intertwined with the nature of the Jordanian state and its political imperatives. A Western-supported monarchy, it draws its legitimacy from managing a pyramid of tribal loyalties with regard to the indigenous Jordanians and commercial interests with regard to the Palestinian-Jordanians, especially the latter's concentrations in Amman. Viewed from this perspective, one would expect the distribution of the quality of the pipe network and operation and maintenance of the pumps to follow the geography of class more closely than the agency of things. As described above, however, human agency is in turn exercised through things, such as suction pumps, or the state of disrepair of the piping network in poorer neighbourhoods, for example, the industrial and mining town of Russeifa outside eastern Amman (Scott 2015):

We get water only once a week, but we must have coffee every day. The water pipeline is not underground; it gets broken by cars and has to be fixed every 7-10 days. We wait to clean the houses and clothes on Tuesday – the water day. They supply it in the winter about 3-4 days a week, but the pipes break all the time and sometimes Miyahuna comes after 2 weeks to fix the line. The local people meanwhile have to fix the line (Female 1, Russeifa, 30/08/2015).

In places like Russeifa the water supply situation is exacerbated not only by shorter supply hours but also by differences in the timings of delivery within the neighbourhood for reasons that are integral to the structure of the Jordanian state, as discussed above:

Every Tuesday we stay up all night to fill up the tanks. Sometimes we use gallon containers to transfer water from house to house. This year things are better than they have been in the past. There is a *mukhabarat* [state intelligence] centre close by here, so those people are particularly well off. There is a water line to the intelligence centre, and there is perpetual water pumped on that line all 7 days, but we are not on that line. Also, the people down the street [are well off with water] as the lower area gets better water than the higher area. We drink water from the WAJ supply. There are some people who drink WAJ water. We don't use filtered water, and we don't have money to pay for bottled water. Piped water is good enough. (Male 1, Russeifa, 30/08/2015).

In the more affluent neighbourhoods, however, which are mostly in west Amman, the residents almost universally reported never having problems with broken pipes, and at times having water for the whole week:

In my area the situation is very good. We have water from Tuesday to Friday, and then the rest of the week we use the stored water. But often we have water all week. In fact, most of the time we have a water supply all week. My parents have water only 3 days. They are elderly and they live in Marsh-al Hamman close to me (Female 1, Mugablin, south-west Amman, 19/08/2015).

The highly localised unevenness of the water supply even within neighbourhoods could not be explained by the physical limitations of the system:

We access water 4 days a week, Tuesday to Friday; the water comes for 24 hours on all those days. Water pressure is excellent here; we don't need a pump to get the water into the tank. I've been living in this house for 1 year; before that I was living in a different neighbourhood here in Al Nasr. In my old house water came only twice a week (Female HH2, Al Nasr, 6/09/2015).

The consequences of the state allowing unequal access to water through acts of omission and commission vary according to gender and class. Women are often subjected to abuse by their family members and end up sacrificing their own hygiene for fear of the men:

I have one son, who has to take two showers per day. He works in the sun in the phosphate mines, so he has to change his clothes daily and take a shower. And if he can't find water, he becomes angry and abusive. So, for him I have to borrow water from the neighbours (Female 3, Russeifa, 30/08/2015).

My neighbours and I are very close. They often ask me to turn off the suction pump so the water can go to their tanks as well. I never say no because I understand their needs, because we all suffer together. Sometimes I get into arguments with my sons when it comes to taking baths. They want to have a bath every day (we women don't), so I end up buying drinking water just to keep them happy (Female HH2, Russeifa, 31/08/2015).

Sometimes poorer people, too, use technology, such as the suction pump, to engage in behaviour that is perceived to be immoral or anti-social. Suction pumps are simultaneously a necessity and a main cause of conflict. The actual events may suggest the suction pumps to be complicit in the conflict, and actually disruptive to community cohesion, but those communities themselves are embedded in deeper geographies based on class and gender:

There are a lot of problems because we have installed the [suction] pump, but other neighbours steal our water, so we will do what we need to get our water. Sometimes WAJ employees see that there are these pumps and they look the other way. They don't want to fight people. Everyone has a suction pump, but those pumps are not installed on the water mains but in the houses (Male 1, Russeifa, 30/08/2015).

The story of having sufficient water and then storage as well was happily repeated across all the household interviewees in the more affluent neighbourhoods, while the inverse was lamented with equal resentment in the poorer neighbourhoods. It is true that the agency of things was somewhat in evidence in local patterns of access in terms of the position along a water line, the strength of a suction pump or the operations of the bigger pumps along the main lines; yet, beyond the actual events, as documented in other urban water supply situations in a more structural, political-economic or dialectical mode of explanation, the persistence of these patterns showed them to be more structurally repetitive than contingently emergent (Loftus and McDonald, 2001; Bakker, 2007; Swyngedouw, 1997).

The spatial patterns of tanker water delivery are not just a function of distance decay or the material limitations of pumping and/or the tanker trucks. The trucks are almost always owned by individual operators or small businessmen renting out fleets of two to three tankers. There is a large Saudi enterprise that has recently entered the market, but most truckers view it as a front for money laundering than a genuine business enterprise. The wells, on the other hand, have very powerful and influential owners with a designated clientele, who can only receive water from specific wells. Indeed, they are powerful enough to violate the water pumping and pricing regulations by multiples of the amount they report with the authorities lacking the temerity to do anything about it (MWI official, personal communication). In the words of a smaller well owner, the well business "is all mafia-ised, especially in west Amman" (13/08/2015). Tanker drivers confirmed that large businesses in west Amman have exclusive deals to receive the water from specific wells. Rather than supplementing the municipal supply, these companies are using tanker water as a substitute. The block tariff structure means that after a certain volume it becomes cost effective for large-scale users to disconnect their supply altogether and rely on tankers. It was repeatedly confirmed that wells have a captive clientele who will not risk tapping alternative sources for their water supply or shopping around for cheaper tankers.

There is high demand on this well [possibly] because it is far away from the waste-water network. People in Amman specifically ask for this well. I can ask 5 JD/m³ extra for water from this well. West Amman is mainly where I sell the water. This is all water for swimming pools. The WAJ rate for pools is too high, so after a certain point they stop using water at that level. We do very well in the winter because we still sell to hotels, restaurants and construction sites (Tanker driver, south Amman, 11/07/2015).

Some wells in east Amman also specify areas where tankers with water from other wells may not operate. Protection rackets are particularly rampant in poorer neighbourhoods, where only tankers from certain wells are welcome:

There are people who actually look into the tankers to get the residual water in Russeifa as extortion. All the markets are divided up by people who allow tankers to do business in some places and not others (Well owner, Zarqa, 13/08/2015)

There is competition between the Zarqa and Amman wells. If you want the water from here, you can get 6 m³ for JD5. You would have to pay JD8 for the same water in Zarqa. Zarqa people don't want Amman people to come to their wells [and hence we don't go there] (Tanker driver, Amman, 13/08/2015).

Overall, the picture that emerges through a structural lens is a water supply regime driven by class and national security imperatives. The Jordanian government has to hold together a state where 50% of the population – those of Palestinian descent – have unclear citizenship status, for example, in terms of their ability to gain employment in the state and security establishments. Its intimate relationship with the West, and its ally Israel, is viewed with jaundiced eyes by most of the population. Its system of government is dependent upon the politics of patronage, meaning rationality in water use must be sacrificed at the altar of national security, and the distribution of benefits must be stratified by class, whereby the equity of patronage to power-brokers ensures that they maintain a hold over their client populations (Yorke, 2013; Hussein, 2018). The water supply picture painted above is hardly surprising. As a Ministry of Water and Irrigation official bluntly stated:

We have many hydro-economic models, but we cannot apply them because they are too scientific and rational. We want to maintain national security and that's not always rational (MWI official, 12/08/2015).

CONCLUSION: THE STRUCTURAL AND THE EMERGENT IN AMMAN'S WATER GEOGRAPHY

We followed tanker trucks from wells to their tanker stations to households. We also traced the flow of water from its source in the King Abdullah Canal to Zai water treatment plant to the municipality of Amman. Although not aiming to undertake anything like an ethnography of the infrastructure (Star, 1999), we supplemented the following of things with interviews and focus groups. The relations between things and humans gave us insights into how the fluid materiality of water intersected with the networked nature of pipes, the discontinuities in the network, the topography and the varying power of the pumps across the network to assemble a techno-social geography of water access. Yet in tracing these networks we failed to remain 'myopic as an ant', as Latour (2005) demands of ANT scholars. This was mainly for lack of trying but also, in moments of (in)'voluntary blindness' (p. 190), the voices of the water users, tanker drivers, water managers and academic colleagues reminded us of the significance of power relations – and the structural mechanisms through which they actuate. The techno-social assemblage of things can indeed be seen to fabricate the lived experience of water access in Amman, but it is the political, economic and statist imperatives that define the conditions under which pumps bestow their favours – as if they could – repeatedly upon the powerful and rich rather than the weak and poor of Amman. ANT-driven analyses illuminate the everyday, extant reality of access to water as it is mediated by technology. But what makes that reality persistently extant are the multilevel processes of state formation, geopolitics and local elite politics.

Jordan has been able to pursue enormously expensive and technologically sophisticated solutions to its water scarcity problem, thanks in no small part to its significance in one of the world's most geopolitically active zones. As a senior water manager noted, many of Jordan's water problems are a function of the demographic changes the country went through because of Western policies. Her view, like those of many Jordanian officials, was that the West owed Jordan the resources to help it negotiate its water problems. There is some truth to that argument. Even the most sensible, low-cost solutions,

such as more strictly regulating the wasteful, upland agriculture to save groundwater to supply Amman, is hostage to the state's imperative of not antagonising the politically powerful highland farmers. Meanwhile, the West, recognising the fragility of the state, keeps its chequebooks open for expensive infrastructure projects without pushing too hard for sensible, low-cost solutions (Bonn, 2013; Hussein, 2018; Yorke, 2013).

Our conclusion may be unsatisfactory to purist votaries of both ANT and structural political ecology. The argument and evidence in this paper are a provocation and reminder that theory must help in explanation. There is little critical-realist attention to the *actual*. The structuralist mode of explanation, essential as it is, could benefit from that nuance, just as it sometimes does from extensive, positivist research methods (see Mustafa, 2002 and Neumayer and Plümper, 2007 among others). This is not a call for sociologists of the social or of associations – to use Latour's (2005) terms – to engage in a political or matrimonial sense (Lave, 2015). The myopia or blindness that ANT demands in order to trace the associations has been asked for before in the form of scientific objectivity. Just as the positivist scientific method and its artefacts have developed political valence so too can a focus on the fabrication of the social through associations between humans and technology (Holifield, 2009). It has clearly not been enough to discover the structural imperatives and power relations that lead to uneven access in domestic water supply. Perhaps what is also needed is a richer, multi-actor account of how that unequal access is actuated in locales from Amman to the rest of the urban realm.

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