



## Worlding via water

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## Worlding via water: desalination, cluster development and the 'stickiness' of commodities

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Whilst it may no longer be particularly controversial to highlight water as a matter of politics, to describe water's *matter* as political still challenges mainstream understandings of natural resource management. Indeed, water provides a sticky medium for the formation and consolidation of broader social, economic and discursive relations, which are enabled or constrained by the production history or 'cultural biography' of the commodity. This has been widely demonstrated in relation to capitalist urbanization and neoliberal accumulation in the field of political ecology, with both processes shown to be dependent on the prior commodification of water. This chapter will provide an original perspective on water commodification by demonstrating how desalination technology has allowed for the commercialization and 'worlding' of the water sector in Singapore, elucidating the close linkage between economic clustering and resource management. Before the 2000s, when desalination and recycled water were introduced, Singapore was dependent on imported water from Malaysia, requiring ongoing and contentious diplomatic negotiations. The politicized character of the supply network prevented the restructuring and commercialization of the sector, but with the fourfold increase in privately manufactured desalinated water, the Singapore Government could apply its cluster development policy to the embryonic industry. The sector, now home to 180 water companies and 26 research centres, has been designated a key growth frontier, with water acting as an agent of worlding in the global knowledge economy.

Water is borderless.

(PUB, 2011, p. 33)

### Introduction

In February 2014, Singapore experienced its driest month in 145 years but was able to avoid water rationing by operating its desalination and water recycling facilities at full capacity, producing 55 percent of the required supply (Hansard 2014). By 2020, the amount of desalinated water being manufactured on the island will have increased more than four-fold since the construction of the first desalination plant in 2005, rising to a total production capacity of 863,757 m<sup>3</sup>/d. There are currently five desalination plants in operation or under construction along the south and west coasts of Singapore, with one proposed for the smaller, adjacent industrialized island of Jurong. This is a significant amount of capacity for an island that is just 720 km<sup>2</sup> in size, making desalination an integral component of the water supply network, alongside imported water from Malaysia, domestic reservoirs and recycled water. As the 'Design, Build, Operate and Own' (DBOO) model of infrastructure development is the preferred policy for desalination in Singapore, with a public-private partnership (PPP) being used for the first time on the island to finance the government's initial foray into this technology, water is being privately manufactured on an ever-increasing scale. Combined with NEWater, its recycled water programme introduced in 2003, and its

seventeen local reservoirs, Singapore was in the position to allow one of two water agreements with Malaysia to expire on the 31 August 2011, reducing its reliance on imported sources, depoliticizing supply.

For decades, since Singapore became a fully independent country in 1965, water had proved to be a conspicuous point of contention and a lightning rod for dispute, associated with crippling droughts, stringent rationing and geopolitical wrangles with confrontational neighbours. Where water supply appeared in government reports or the national media, it would be framed as the 'Achilles heel' (Low, 2002, p. 12) of Singapore's political sovereignty and economic prospects, and was therefore the subject of sensitive, politically charged negotiations with Malaysia. In the year that Singapore gained Independence, ejected from Federation of Malaysia after a breakdown in diplomatic relations, imported water from that country accounted for 80 percent of overall supply. This source of water, constituting the overwhelming bulk of supply, was a 'material emblem' (Bakker, 2010b, p. 52) of geopolitical dependency and asymmetric bilateral relations, discussed behind closed doors in the language of strategy, diplomacy and compromise. Britain's extraordinary capitulation to the Japanese during World War II, precipitated by the blocking of imported water, also served as a constant reminder of Singapore's inherent vulnerability and 'extraterritorial leveraging' on foreign countries (Phelps, 2007, p. 372). This prompted Lee Kuan Yew, the 'Founding Father' and Prime Minister of Singapore from 1959 to 1990, to venture that 'every other policy has to bend at the knees for our water survival' (Tan et al., 2009), including economic development.

However, with the advent of desalination at the turn of the millennium, water supply has not only been dramatically augmented but stripped of its negative connotations and rebranded as a marketable commodity by the state water authority, the Public Utilities Board (PUB), as part of broader shift in communications and engagement strategy (PUB, 2004). By leveraging on the involvement of private companies rather than diplomatic representatives, desalination technology has enabled PUB to circumvent fractious bilateral arrangements, allowing for the subsequent commercialization and internationalization of the water sector. With the production costs of water membranes decreasing by 50 percent in the 1990s, alongside improved energy efficiency and extraction rate, the ocean now offers the Singapore Government an ancillary, unbounded hinterland to source water, extracted by means of technology rather than diplomacy (Usher 2018a). Consequently, the water industry has been designated a primary growth frontier for Singapore, which had not been possible before the introduction of desalination and recycled water, given its politicized status. The number of water companies located on the island has tripled since 2006 when water technology was identified by the National Research Foundation as a strategic research priority, with 180 companies and 26 research centres providing the institutional basis for Singapore's transformation into a 'global hydrohub' (PUB, 2005). Rather than bending at the knee of water policy, economic development is increasingly facilitated *through* the supply network, allowing for the 'strategic coupling' (Coe et al., 2004) of the domestic economy and global water industry networks. Desalination in particular has provided an expedient springboard for water companies seeking to penetrate regional and international markets.

This chapter will demonstrate how desalination technology has been instrumental in depoliticizing water supply in Singapore and making it amenable to commercialization, recalibrating the 'cultural biography' (Kopytoff, 1986) of water in the process. The motive behind the rapid expansion of desalination has not only been to diversify and augment supply but to allow for the internationalization or 'worlding' (Roy and Ong, 2011) of the

domestic water industry, which had not been possible with imported surface water. PUB has sought to rebrand water as a commercial, privately manufactured object to enable broader government policy on cluster development, with the water sector identified as a key growth frontier. It will be argued that, as a result, the cultural status of water has escalated, providing a commercialized medium for the arrangement of an alternative set of social, economic and political relations. The chapter will explore the ambiguous mandate of the state water authority that seeks to synchronize the dual exigencies of water security and economic integration, an increasingly strategic and lucrative dovetailing.

First, the chapter will consider the growing importance of cluster development to Singapore's knowledge economy, which has provided the basis for its regionalization policy and ongoing hinterlandization programme. Subsequently, drawing on resource geographies literature and the concept of worlding, the chapter will elucidate the complex relationship between the commodification process and water management, emphasizing the social life of natural resources. The chapter will then turn to the empirical case study of desalination, focusing initially on the politicization of water supply during the years immediately following sovereign independence. Next, the chapter will examine the corporatization of PUB and the water sector in the early 2000s, which was a necessary measure for the clustering and regionalization of the industry. This will lead into a discussion of Singapore's ambitions for the worlding of the water sector, focusing on strategic state funding and the regionalization of firm activities through desalination R&D. This research is based on documentary analysis of government reports, parliamentary debates and media sources, and data from 25 interviews, with civil servants, CEOs, industry figures, entrepreneurs and research centre founders, addressing the lack of bottom-up insight into state-firm relations in clustering and economic strategy (Yeung, 2016).

## **Hinterlandization and clustering strategy**

Since August 1965, when Singapore attained political independence and became a sovereign nation-state, the People's Action Party (PAP), the still incumbent party, has sought to integrate the country into the wider global economy in a process known as 'hubbing' (Chang, 1998) or 'hinterlandization' (Sparke et al., 2004). Given Singapore's small land area of approximately 720 km<sup>2</sup> and isolated island geography<sup>1</sup>, separated from Malaysia by the Straits of Johor, a fundamental component of state policy has been the establishment of cross-border connections with regional and international networks. This has necessitated the formation of political, economic and ecological links, which have been vital for the transformation of Singapore into a viable sovereign nation. As Chua (2011, p. 29) asserts, '[c]ompletely devoid of all natural resources, including land and population, [Singapore] is dependent on the global market for everything – capital, labor, materials, and food – to develop its domestic economy...the world has always been the horizon of relevance for Singapore'. Therefore, to overcome geographical isolation and competitively position Singapore as a major global node in the region, a range of sectors have been actively and aggressively internationalized under the direction of an interventionist developmental state (Huff, 1995). As low-cost manufacturing gravitated to developing Asian countries offering cheaper production rates in the 1980s, Singapore was impelled to upgrade and compete for investment and high-end professionals. The PAP assumed greater responsibility for actively

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<sup>1</sup> The land cover of Singapore was approximately 580km<sup>2</sup> in 1965 before large-scale land reclamation.

globalizing its industries, switching to high-end manufacturing and the production of advanced technology (Yeung, 2000). On the back of this specialization in technology, the 1990s witnessed a drive towards a knowledge-based economy, supported by policy that saw wages increase by over 40 percent to encourage expansion of the financial, biosciences and pharmaceutical sectors (Chua, 2011).

The compulsion to integrate into global networks has only increased as the domestic economy became more closely oriented towards services and knowledge production, occurring in an era of intensified competition between cities. In 1991, the Strategic Economic Plan incorporated the 'clustering' model into government policy, which, as Wang and Yeung (2000) reveal in respect to the chemical sector, marked a radical departure from previous industrial strategy. Clustering aims to provide overseas firms with unique locational advantages and associated benefits of proximity, embedding companies within a closely integrated business and research environment whilst facilitating regional expansion into Southeast Asia. Within the chemical industry and other sectors, Singapore has been publicized as a 'launching pad' (Wang and Yeung, 2000, p. 849) to prospective companies, offering networking and joint R&D opportunities, and entry into the significantly larger markets of Malaysia, Indonesia, China, Vietnam and the Philippines. The Government has sought to entice foreign investors and international private business to the island by maintaining an optimum level of 'stickiness' (Markusen, 1996) that keeps companies anchored in Singapore, locking firms into domestic industry networks. Drawing on the example of 'one-north', a large science, technology and media park that was constructed in Singapore during the early 2000s, Wong and Bunnell (2006) demonstrate that clustering has necessitated widespread, sophisticated interventions from the state. In particular, the state has provided the 'institutional thickness' to adapt to new market trends and anchor the knowledge economy in place, through the 'fostering and leveraging of linkages among the cultural, technological and economic domains' (p.72).

The PAP has installed a 'whole-of-government' (interview, 26 March 2013) approach to its clustering programme, whereby umbrella organisations such as the Economic Development Board (EDB) and International Enterprise (IE) Singapore have cooperated with sectoral departments to provide institutional capacity and public investment to encourage the bundling of manufacturing firms, suppliers, service providers and government bodies within its designated growth frontiers (Grunsvan and Egeraat, 1999). Since the 2000s, cluster development has become a primary facet of industrial strategy in many countries across the world to enhance national competitiveness, based on close partnerships between private and public organizations in the interests of spatial agglomeration (World Bank 2009). The role of public bodies is essential in the early stages of cluster development as 'catalyst' (World Bank, 2009, p.8) and coordinator, to encourage innovation, streamline supply chains, set standards, optimize externalities and overcome bottlenecks, which is particularly crucial in highly specialized areas of technological development (Hess and Coe, 2006). As a cluster becomes more specialized in relation to the wider economy, the greater the likelihood it will attract firms from other regions intending to secure a foothold in an emerging market, leading also to stronger, more predictable spillover and multiplier effects.

To catalyze and reinforce synergistic linkages between competing firms and the Government, the EDB established a S\$1 billion Cluster Development Fund in 2000, not only to anchor international firms in Singapore but to promote the regionalization of local industries through the formation of sectoral connections in specialist areas of technological development. Clustering has provided an effective mechanism to bolster the Government's

more longstanding regionalization policy, officially launched in 1993, which was introduced to address the country's erstwhile reliance on foreign capital and to overcome the limits of an increasingly saturated domestic economy through the state-driven penetration of other Asian markets (Yeung, 1998). Technology specialization has been Singapore's preferred cluster development strategy, particularly 'environment-related technologies', which have provided a linchpin for the consolidation and expansion of supply chains (OECD, 2012, p.187). Consequently, R&D takes on an added urgency in Singapore given the country's economic and indeed sovereign dependence on technology, which receives a significant proportion of the national annual budget (Anwar and Zheng, 2004). The Research, Innovation and Enterprise Plan is the key national framework for promoting R&D, with S\$35 billion of public investment committed to funding knowledge-based innovation for the period 2011 to 2020, to establish Singapore as a global research and development hub. A funding stream dedicated to the development of clusters is central to the framework, which offers financial support for the nurturing of partnerships around priority technologies. A range of government-linked companies (GLCs) and statutory boards have been leant upon to facilitate cluster development and regionalization, enabling what Yeung (1998, p.405) terms 'political entrepreneurship', to open up and exploit specialist niches in international markets and piggyback on the commercialization of products and services.

### **The political matter of water**

The PUB was formed in 1963 with the difficult mandate of ensuring the secure supply of water, electricity and gas on an island with very limited natural resources. Whereas electricity and gas provision were corporatized in 1995 and taken over by Singapore Power, water has remained under the authority of PUB as it is deemed too sensitive and critical to make the responsibility of a commercial organization. During the 1990s, privatization and corporatization were advocated for GLCs involved in non-essential services, where they should instead act as 'big brother' and link up with companies to 'establish linkages' and 'open up doors' with contacts in the region (Hansard 1993). However, the general public were concerned about proposals to corporatize PUB as it may lead to increased prices, whilst many politicians and civil servants were hesitant on security grounds, vocalizing their concerns in Parliament. Water, for the time being, remained an object of state administration. On this basis, it is not particularly controversial or original to highlight water as a matter of politics, but to describe water's *matter* as political still challenges mainstream understandings of natural resource management.

As Braun and Whatmore (2010) contend, there is a politics to matter that is immanently bound up with the material properties of natural resources, emerging in the moments that things interfere physically in social and economic life, altering opportunity structures of different actors and changing the course of future events. In colonial Egypt for instance, Mitchell (2002) reveals how the unpredictable coming together of mosquitoes and water, facilitated by the national system of canals, produced a material agency that precipitated the sovereign independence of that country, evincing the complex intertwining of ecology, politics and technology (see also Carroll, 2012; Mukerji, 2009; Pritchard, 2011; Sneddon, 2015; Usher, 2014). Natural resources such as energy, water and food, which are hybrid or 'cyborg' objects in their own right being co-produced through both social and ecological processes (Swyngedouw, 2006), regularly resist being enrolled into systems of human practice; they have a tendency to 'strike back' as Latour (2000) memorably puts it, evading

straightforward categorization, accommodation and socialization. When resources are enrolled into human systems they do so disruptively, unsettling existing institutional and technological arrangements whilst enabling the formation of new relations between economic, political, cultural and technical components, shaping new geographies.

The disruptive materiality and active capacities of natural resources have been taken more seriously within geography and other social sciences, transforming the way that environmental management is understood (Bakker and Bridge, 2006). The material properties of water in particular- heavy, changeable and fluid- have been shown to occasion centralized, bureaucratic forms of management, whilst its transitory, life-giving nature has also attracted a profound cultural symbolism (Bear and Bull, 2011; Orlove and Caton, 2010). This makes water socially sticky or 'promiscuous' (Linton, 2010, p. 4), tending to connect different spheres of human organization. In the fields of resource geography, political ecology and environmental governance, the focus is increasingly on the co-production of social forms and ecological matter during the process of resource acquisition, encompassing the stages of extraction, distribution, treatment and consumption. Focusing on the 'strikingly generative cultural object' of carbon, Bridge (2010, p. 829) insists that natural resources are so in name only, arguing on the contrary that resources are produced and assigned value through political, economic and discursive processes. Human systems are transformed as much as ecology in processes of resource management, from the everyday routines of personal hygiene to the administrative capacities of the nation-state (Bridge, 2013; Kaika, 2005; Usher, 2018b).

The central importance of commodification, or the entry of ecological matter into capitalist production processes and market-based transactions, has been emphasized for its impacts on capital accumulation and social organization (Jackson, 2000). Indeed, capitalism itself has been recast as an ecological project, which has been consolidated historically through its ongoing subsumption of material flows, particularly fossil fuels and water, intertwining humans and nonhumans in ever tighter, more profitable configurations (Malm, 2016; Mitchell, 2011; Moore, 2015; Swyngedouw, 2015). As Moore (2015, p.2) posits, '[c]apitalism is not an economic system; it is not a social system; it is *a way of organizing nature*'. And indeed, the organization and commodification of nature through desalination technology is attracting growing levels of critical scholarly attention, due to the novel socio-ecological imbroglios that are produced (Feitelson and Rosenthal, 2012; Loftus and March, 2016; March, 2015; McDonnell, 2014; McEvoy and Wilder, 2012; Swyngedouw, 2013; Swyngedouw and Williams, 2016).

The surprising and elaborate ways in which nature-matter enters human systems of collective social life has become the subject of what Bakker and Bridge (2006, p.11) term 'commodity stories', which serve to illustrate the eclectic nature of the capitalism and ecology linkage (Tsing, 2009). Commodities have a cultural biography that exceeds their purely economic value, providing a medium for the convergence and consolidation of wider social relations through market transactions, leading to new spatial arrangements and symbolic identities on the back of processed natures, from sugar, seafood and mushrooms, to beef, gas and oil (Bridge and Le Billon, 2017; MacLachlan, 2001; Mansfield, 2003; Mintz, 1985; Tsing, 2015). Given its essential life-giving properties and rich cultural value, water has perhaps been the most 'uncooperative' resource to commodify, being fluid in both physical and symbolic terms (Bakker, 2003). The process of turning water into a commodity is therefore arduous and requires much social work, but this transition allows water to be exploited in many different ways (Swyngedouw, 2004).

To enable this level of economic flexibility and profitability, water has to first be abstracted from its social context, stripped of its geographical and historical origins, and turned into the clear, neutral and standardized object, H<sub>2</sub>O (Linton, 2010). Water enters the supply system as an unrefined natural element and appears the other side of treatment as a 'fetishized' commodity, with urban infrastructural networks serving to obscure the social relations that have produced it (Kaika and Swyngedouw, 2000). Once purified, physically and culturally, water can be ascribed new social meanings, economic uses and 'wish images', providing a neutralized metabolic vehicle for the conveyance of society's various 'delights and desires' (Kaika, 2005, p. 31). The more opaque this production process becomes, through sophisticated branding techniques or advanced technology, the more readily the commodity can be re-scripted, branded and commercialized. This will only accelerate the already rapid financialization and internationalization of the water industry, which has ensued in an environment of opacity and complexity (Loftus and March, 2016; March and Purcell, 2014).

Whilst the commodification of water has been extensively examined in relation to capitalist urbanization (Gandy, 2004; Kaika, 2005; Loftus, 2007; Swyngedouw, 2004) and neoliberalization (Bakker, 2002; Budds, 2013; Harris, 2009; Ioris, 2012; Nash, 2013; Roberts, 2008), there is a need for further research on the 'conjunctural effects' of water resources in the formation of global socio-ecological networks (Braun, 2006, p. 645). As Braun (2005, p. 642) emphasizes, '[i]t bears repeating that what is unique about urban natures is not that they are 'metabolized'...it is that the networks that comprise urban natures are at once more dense, and more extended, than nonurban networks'. Roy and Ong (2011) define 'worlding' as the everyday, situated practices that serve to connect localities to broader global assemblages, physically and discursively<sup>2</sup>. Rather than conceptualizing globalization as a logic or force, worlding denotes the ongoing, bottom-up and contingent process of connection-making between disparate, geographically dispersed sites (Blok, 2014; Jayne et al., 2011; McCann et al., 2013). The commodity story this chapter relates traces how the transformed cultural biography of water, from geopolitically sensitive imported surface water to privately commercialized, manufactured desalinated water, has enabled PUB to world the water sector in line with the government's broader clustering strategy.

## **The geopolitics of 'touchy' water**

Until the turn of the twentieth century, the commodity story of water was dominated by diplomatic agreements, and more damagingly, recurrent geopolitical fallout, toxifying the issue of supply. Singapore has been reliant on Malaysia for its water supply since the late 1920s, when the British colonial administration first agreed transferal terms with the Sultan of Johor. Whilst Singapore receives a high average rainfall of 2400 millimetres a year and is completely surrounded by water, its already limited land surface has become increasingly urbanized, compounding its lack of natural aquifers and lakes. The UN has ranked Singapore 170th out of 193 countries in terms of water availability, positioning it amongst the most water scarce in the world. Imported water from Malaysia has therefore been essential to Singapore's overall supply, upheld by diplomatic accords that have been regularly subject to geopolitical bargaining and media attention (Ganesan, 1998; Nathan, 2002). And indeed, Singapore's existential dependence on Malaysia for its water supply has coloured bilateral

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<sup>2</sup> 'Worlding' has recently been explored in relation to water supply by Furlong and Kooy (2017) but in a different analytical register, as a methodological imperative rather than empirical process of globalizing.



relations *in toto*, exemplifying the countries' commitment to cooperation during warmer periods, typifying their irreconcilable differences in less cordial years. Irrespective of the changing geopolitical situation, water stood in as a material emblem of sensitive border relations, accentuating localized tension rather than global integration.

When transfer agreements were originally negotiated for water extraction from the Malaysian mainland, in 1927 and 1932, Singapore was part of the broader administrative district of British Malaya, which was presided over as a loosely integrated unit. As Frost and Balasingamchow (2009) reveal, Malaya was held together as a distinctive political entity by tin can and rubber production. To support the development of these highly profitable industries, the British established pan-Malayan governmental departments to administer the supply chain. Completed in 1923, the railway bridge that connects Malaysia and Singapore across the Straits of Johor, historically serving to transport rubber and tin, also provides the necessary supporting infrastructure for the cross-border pipeline for imported water. This level of integration, supported by highly positive diplomatic relations with the Sultan of Johor, then an ardent Anglophile, served to embed and downplay the water connection between the two countries. This connection would be further consolidated with two major longstanding agreements with Malaysia in the early 1960s, legally guaranteeing approximately 2 million m<sup>3</sup>/day of water across the bridge until 2061. However, this metabolic relationship, muted and largely concealed, would soon become a conspicuous focal point of geopolitical leveraging. Under the new agreements the pipeline had been providing 80 percent of the island's needs, but Singapore was dramatically ejected from the Federation of Malaysia in 1965, forcing sovereign independence. Lee Kuan Yew, Prime Minister of Singapore for over thirty years, was unable to hold back his tears on live television when faced with questions on the future prospects of his country.

Domestically, water rationing, which was imposed across the island in 1961 and 1963 for a period of ten months, had already undermined the reputation of Singapore's nascent industrialization programme (PWD 1963). Daily average consumption more than doubled in ten years to 65 million gallons per day in 1965, an 'extraordinary' increase resulting from industrialization, population growth and expansion of supply networks to rural areas (PUB, 1965, p. 41). The resulting rationing episode, triggered by a period of drought, would continue to linger in the public imagination for decades, serving as a reminder of Singapore's precarious water position (Tan et al., 2009). The Singapore Government resorted to a negative public education campaign that vilified the 'water waster' (*The Straits Times* 29 May 1971), directed towards domestic and industry users, which branded water as a limited strategic resource that necessitated strict governmental control (PUB, 1981). Water was not something to freely consume and enjoy but to conserve, fret over and fear, which in 1975 became legally designated as the exclusive property of the state water authority, centralizing and indeed politicizing its distribution (Hansard 1975). This negative, repressive scripting of water would later prove detrimental to PUB's clustering programme, restricting the branding possibilities and economic upgrading of the sector (PUB, 2004).

Most significantly, whilst the water agreements with Malaysia were written into Singapore's Declaration of Independence in 1965, officiated by representatives of the United Nations, imported water quickly became serviceable as a 'lever' through which to negotiate and contest wider bilateral arrangements (Lee, 2000, p. 254). According to Lee Kuan Yew, Tunku Abdul Rahman, Malaysia's first Prime Minister, declared a willingness to halt imports if

Singapore went against his own country's interests; a hardly veiled threat that continues to enjoy purchase in contemporary rounds of geopolitical posturing (Hansard 2002). As Tortajada et al. (2013, p. 152) emphasize, the media has been a central arbitrator of Singapore and Malaysia's 'water relationship' through the shaping of public opinion, assuming provocative editorial stances, polarizing debate and heightening the emotional register of discussions. As the main source of communication and information on water relations, the media politicized water supply more acutely than it had been previously, which reached a breaking point in the early 2000s. In the wake of the Asian financial crisis of 1997, Singapore and Malaysia sought a 'framework of wider cooperation' on a number of bilateral issues, including financial loans, pension schemes, joint land development, airspace restrictions, military exercises and water supply (MICA, 2003, p.3). For the next three years, negotiations around water pricing, and how this brought into question the very basis of the water agreements, would become increasingly protracted and linked to the broader set of sensitive topics.

In addition to the growing concern being expressed by politicians about Malaysia's ability to 'blackmail' (*The Straits Times* 7 February 2002) Singapore, private companies were also growing increasingly concerned that the water pipeline had become a lightning rod for controversy and dispute. This became particularly apparent in 2002 when bilateral relations reached their lowest point, leading Prime Minister Goh Chok Tong to suggest that continued contestation of the water agreements would 'undermine [Singapore's] very existence' (MICA, 2003, p.1). With the cultural biography of water characterized more and more by the high politics of sovereignty and geopolitical fallout, played out in an increasingly negative press, the potential for commercialization of the sector was much diminished. In response, as a senior adviser for the water technology company Hyflux suggested, PUB leaned on the private sector to introduce desalinated and recycled water to the network, to depoliticize and subsequently commercialize water:

In the area of surface water treatment, why they have not done it [commercialization] is because the main source of that water is politically... [pause] you know? It's difficult, right? The Malaysians say, I'm not going to supply you with the water, or my price will increase, because you are selling it at a profit, etc. So you just can't. You can't get commercial. Some people say maybe that's better to do commercially, but you can't... water is a very touchy thing. You can't be making a lot of money out of it, you just can't (interview, 8 April 2013).

Aside from the geopolitical scripting of water, the process of ascribing value and apportioning profit is also extremely complex with imported water due to the entangled, transboundary extraction process and shared responsibility for its production. The water agreements legally transfer land on the Malaysian mainland to Singapore for reservoir construction, whilst PUB are required to provide Johore with a fixed amount of 77,284 m<sup>3</sup>/d treated water at a reduced rate, locking the countries together metabolically, technologically and contractually. As the Hyflux advisor reflected, 'who owns the right of the water? Singapore is taking from Malaysia's side...all the infrastructure is built by Singapore...[for] the whole development I think we pay rent...so it's difficult to talk about commercially, because who owns that?' (Ibid.).

## **Commercializing water through desalination**

Water has a cultural biography in that it changes not only biophysically during the extraction, treatment and consumption process but also socially, accruing different symbolic meanings and political resonances depending on its historical and geographical journey. Given its intricate geopolitical and infrastructural interconnections with Malaysia, the sensitive socio-ecological imbroglio created by imported surface water exposed Singapore's inherent vulnerability, and furthermore, prevented the commercialization of the water sector. This is recognized by politicians and industry figures alike, as illustrated by a Director of a leading water technology institute who proffered 'because of history, they [Singapore Government] don't want to get too tied into foreign water' (interview, 21 March 2013). By comparison, advanced treatment solutions such as desalination and recycling short-circuit the need for geopolitical arrangements, allowing producers and consumers to 'judge water by its quality, not by its history' (Ibid.). This also opens up commercial possibilities for water companies, which can privately manufacture water and create investment potential whilst avoiding overtly political issues of water distribution and transboundary transfers. The Hyflux senior advisor emphasized this strategic dovetailing, affirming that 'the industry can't control that [surface water transfers]...the private sector can't get the access. So in that sense I think water can't be totally privatized...but on the treatment side, you can privatize it' (interview, 8 April 2013).

It is in this context of geopolitical and commercial pressures that desalination was strongly advocated as an alternative source of water supply. Certainly, desalination had been proposed previously, most notably after Singapore gained independence as a way to reduce its reliance on Malaysia. Desalination was considered to offer a potentially unlimited supply of water in the Water Master Plan of 1972, the first comprehensive survey of its kind in Singapore, but the technology was in its infancy. Membranes were not only very costly to manufacture but they were also liable to fouling (Tan et al., 2009). Desalination at this early stage in its development largely utilized flash distillation and the managed evaporation of seawater into condensed freshwater. In 1971, it was announced during a parliamentary debate on water supply that 'desalination has a great future. It could solve our water problem radically' (Hansard, 1971), but membrane demonstration plants were terminated in 1976 after just one year of trials. Consequently, reliance on imported water continued into the late twentieth century due to the lack of available land for local catchment development and rapid growth of Singapore's economy. In fact, the water agreements were updated in November 1990 to facilitate construction of the Linggiu Dam, which is now Singapore's main source of imported water, able to meet 60% of demand.

Prompted by worsening bilateral relations, Prime Minister Goh Chok Tong suggested to Parliament that Singapore 'move a little away from our reliance on Malaysia for water' (Hansard 2002). The Prime Minister reiterated this in official correspondence with Malaysia: 'I do not want our bilateral relations to be always strained by the issue of water...We have just called a tender for a 136,383 m<sup>3</sup>/d desalination plant, which will be ready in 2005' (MICA, 2003, p.55). The possibility of constructing underwater supply pipes from Indonesia was also explored but deemed unrealistic. However, with the production cost of water membrane technology decreasing by approximately 50 percent during the 1990s, desalination and water recycling were prioritized as future avenues of diversification. Membranes had become thinner and more durable, lasting five rather than three years, and requiring less water pressure and therefore reduced energy to treat water (Hansard 2001).

To depoliticize the water supply network, what were then deemed 'unconventional' sources, recycled and desalinated water, were gradually brought on line through targeted R&D and government incentives. Desalination, alongside recycled water, is now expected to provide 85 percent of national supply by 2060, marking an extraordinary transformation of the water management regime (PUB, 2016).

Recycled 'NEWater' was launched in 2002 primarily for non-potable use, mainly for the wafer manufacturing industry, but the longer term objective was to augment the domestic water supply by piping it directly into reservoirs in increasing amounts (PUB, 2002). Four years earlier a demonstration plant had successfully shown that membrane technology could be relied upon on a commercial scale, producing 10,000 cubic metres of water per day (PUB, 1999). With the last factory completed in 2010, there are now five NEWater facilities altogether that can meet 40 percent of water demand, predicted to increase to 55 percent by 2060 (PUB, 2016). In addition, two desalination plants were introduced in 2005 and 2013, capable of meeting 25 percent of Singapore's water demand. In 1998, a review of the Water Master Plan departed from previous strategy by highlighting the need for increased private sector involvement in the roll-out of desalination and recycled water (PUB, 1999). Two further desalination plants will be in operation by 2020, at Tuas and Marina East, with a fifth tender announced for Jurong Island. With the introduction of NEWater and desalination, one of the water agreements with Malaysia was allowed to expire on the 31 August 2011, marking a symbolic moment in the history of Singapore and significantly depoliticizing the issue of water supply. The second will not expire until 2061, granting the state sufficient leeway to plan and deploy further sources of supply.

According to a PUB Technology Officer, 'to overcome land, we're moving the water system. It's no different, it's manufacturing!' (interview, 11 April 2013). The shift from surface water to treated water through desalination and recycling facilities has allowed PUB to delink the supply network from Malaysia, effectively producing a commodified form of water without a historical or geographical profile. Moreover, PUB has actively disassociated water from the operations of the state, de-monopolizing the government's exclusive license to produce, own and brand water, opening up and multiplying the social identity of water. Whilst the amount and quality of water will not necessarily change, as an environmental technology entrepreneur observes, the wider social, economic and political arrangements have, altering and simplifying the ownership rights of water, facilitating its commercialization:

Last time, PUB owns all the water production plants. Now, no...even the so-called private sector is part of the water story, it has changed. PUB sets the guidelines of how much water it wants to produce; water quality, the PH, the operational standards, all these requirements are there in the tender document. So the private sector just have to meet the tender, to get it built...a bit political, we are surrounded by Muslim countries, so we are in the middle of nowhere. So self-reliance is very important to us. It's an opportunity for the corporates, because they actually can tender for it...it's no longer the Government's baby, it's everybody's baby. It's a drastic change, it's really a drastic change (interview, 9 April 2013).

Singapore's first desalination plant at Tuas was announced in 2000, where desalinated water would be purchased from the private sector through a DBOO tendered contract won by SingSpring, a wholly-owned subsidiary of Hyflux (PUB, 2000). This was the first time a PPP model had been used by PUB and in Singapore more generally, which the Ministry of

Finance introduced in 2004 to encourage private sector involvement in erstwhile public services, in the interests of efficiency and risk distribution. In the case of water, however, DBOO has also been leaned upon to take the geopolitical heat out of water supply and to prime the sector for cluster development. All of Singapore's subsequent tenders for desalination plants have been delivered under DBOO agreements except one, progressively increasing the amount of water that is privately manufactured. Water transactions under the tendering process for desalination are negotiated between PUB and private companies not sovereign countries, allowing for a more transparent, commercially driven process based on value creation and profit maximization rather than diplomacy.

Once a company agrees to produce a certain amount of water at a predetermined quality and price, the cost of manufacturing desalinated water is driven down by the company's desire to increase profit and share price: 'This is their only interest, their only interest' (interview, 9 April 2013). The cultural biography of water produced through desalination is consequently marked by advanced technology and market exchange, produced in a neutralized corporate environment. Hyflux won four of the five initial tenders for membrane-based water production through desalination and recycling facilities, which, according to their senior advisor, were announced during 'industry nights' held every three months, where business sponsors that are signed up to the [Singapore] Water Association [SWA] meet each other and network, and PUB 'tell everybody about some of the projects they will be procuring' (interview, 8 April 2013). Tendering is therefore reliant on the clustering of water companies in Singapore that compete for contracts to privately produce water, within a 'free-for-all ecosystems' (interview, 11 April 2013) coordinated by PUB. Cluster development of the water sector has been achieved through the corporate restructuring of PUB, the geographical anchoring of private companies in Singapore and the subsequent opening of regional markets, all of which have rested on the prior rebranding of water as stylish, luxurious and marketable, even 'sexy' (PUB, 2012, p. 46).

In 2004, the '3P' programme was introduced to de-monopolize the state's administrative hold over water management and open the sector to the concerns, expertise and interests of private actors. To facilitate this shift, PUB comprehensively reformed their communications strategy through a large-scale rebranding exercise. Whereas official communications had previously been oriented around national security and geopolitical restrictions, water would henceforth be framed in the language and imagery of consumerism, epitomized by the decision to remodel the state annual report as a lifestyle magazine. This was 'not merely for cosmetic purposes' (PUB, 2004, p. 3), but to create a foundation for the growth of the water industry through advanced treatment technology. This followed legislative reforms the previous year, which liberalized ownership rights over water, allowing domestic collection of rainwater and public access to reservoirs and waterway space (PUB, 2003). PUB as an organization was also restructured in 2004 in order to facilitate greater private sector involvement, becoming more streamlined, commercially-minded and oriented towards its 'business processes' (PUB, 2004). Engineers were even encouraged to undertake free training programmes in 'softer skills' such as public communications, marketing and commercial development. More broadly, PUB adopted a financial model based on 'best sourcing', or the competitive involvement of the private sector in service delivery, particularly through the roll-out of desalination that would commence the following year.

## **Plugging in the global hydrohub**

Whilst the social identity of water had been radically and lucratively transformed through meticulous branding exercises, priming the sector for rapid growth, companies would also have to be physically anchored in Singapore through flexible and attractive test-bedding sites. PUB encourages water companies to test new technologies in dedicated sites, particularly treatment-based innovations such as water membranes, which serve to cluster companies and technologically lock them into the domestic economy, using Singapore as a 'living laboratory' (interview, 26 March 2013). To compete for tenders, foreign firms must incorporate as a Singapore-based company, encouraging long-term commitment to the country (interview, 8 April 2013). As the PUB Technology Officer exclaims, 'our door is always open...we go on a journey with them, we create opportunity, we test it in our facilities side-by-side. Basically, if you've got ideas, there's nothing better than this. Just bring the money in, test it side-by-side' (interview, 11 April 2013). The water technology entrepreneur claims the number of test bed sites may have increased from hundreds to thousands: 'I know they have a lot of test beds. The figures keep changing, and usually up [laughs]. So I was talking to PUB, "so, how many test beds now?" The staff were, the staff [replied], "also lost count now, I need to get an update myself"' (interview, 9 April 2013).

And indeed, the wide availability of test-bedding exerts a global pull on water companies, as the CEO of a foreign enterprise attested: 'There is one element of luring companies to Singapore, is by promising all kinds of test-bedding opportunities...basically they do it for free, and PUB facilitates with space' (interview, 20 March 2013). Another foreign Director of a water company highlighted the streamlined, corporatized organizational structure of PUB as a corresponding pull factor:

Most of the time, when industry develops something new they don't think of partnering with the Government to test it, because of all the bureaucratic hassles and all the other stuff. But Singapore, as you have probably seen, is a very different kind of government, and is very proactive...this is a compliment to Singapore, I don't think you could really call them a public enterprise with all the negative connotations. It's run like a corporation, and in the good sense of a corporation (interview, 21 March 2013).

Waterhub, an R&D centre established in 2004, has provided a 'unique' (Ibid.) opportunity for water companies as it co-locates both private enterprises and PUB in a single facility to encourage the establishment of public-private partnerships through joint test-bedding activities. This was coupled with the creation of the SWA to provide a forum for professional networking and industry nights, located in the centre. An EDB representative identified a 'strong link' between PUB and the SWA, allowing for the state authority to exert its influence on industry activity (interview, 26 March 2013). If test beds provide the connection point, the binding agent that reinforces the link is R&D funds. Advanced membrane technology, allowing for the treatment of used and high-salinity water, has been prioritized in line with the roll-out of desalination. The S\$20 million Innovation for Environmental Sustainability Fund, established in 2001, initiated a sustained R&D stream, in the same year that PUB hosted the region's first desalination conference (PUB, 2001). The following year PUB acquired the Centre for Advanced Water Technology (CAWT) to support the embryonic water industry, whilst Technology Groups were formed for staff to specialize in desalting and membrane treatment (PUB, 2002).

From 2003 onwards, PUB assumed a more proactive role in promoting R&D in membrane technology by linking with the government funding agencies EDB and International

Enterprise Singapore, which accelerated the expansion of the water industry. It was announced that Singapore would be positioned as a 'global hydrohub', a key node in the global water industry, piggy-backing on water technology development as one of the fastest growing sectors worldwide (PUB, 2005). The water sector was designated a 'major economic growth frontier' in 2006 as EDB sought to capitalize on the escalating cultural status of water and the growing number of private companies locked into Singapore through test-bedding (interview, 26 March 2013). According to the Director of a major foreign company, 'a lot of companies at that time decided to have a presence in Singapore...so our agreement with the Government is essentially a ten-year agreement, which has now been extended to eleven years...it'll go through to 2017' (interview, 21 March 2013). The EDB organizes three to four meetings a year with water companies to identify relevant funding and test-bedding opportunities, 'and it's a very mutual relationship. To bring it from a research standpoint to a market product, that's the gap that you have to overcome. And Singapore understands how to do it' (interview, 8 April 2013).

To consolidate partnerships with the private sector, a range of funding schemes have been established that are oriented towards joint projects between PUB and foreign firms, administered by the test-bed (EWI). The EWI is a one-stop interagency body led by and integrating the operations of PUB and EDB, set up to coordinate R&D efforts and spearhead the worlding of the water industry. An initial fund of S\$330 million was provided to the EWI by the National Research Foundation, which by 2011 had received a further S\$140 million leading to technological breakthroughs in the development of ceramic and biomimetic membranes. In addition to enhancing domestic capability, cluster development and internationalization are its core strategies. In much the same way that water had to first be commodified and rebranded through desalination in particular, EWI has provided funds to assist foreign, previously public utilities to commercialize aspects of their operations in order to enter the global water technology economy. As the Manager of a Dutch water company revealed:

You have the hurdle that you are a utility and you're not allowed to sell, on a commercial basis, your technology to another utility around the world. Therefore you need a commercial entity...so now it comes from the public domain where everything is tested and almost ready to go to the market, you bring it to a commercial entity, private sector, and then you connect to another utility...as soon as you're a private company, you're entitled to all kinds of financial incentive packages which you were not entitled to as a public company (interview, 8 April 2013).

The commercialization of both water and utility companies has been central to the broader strategy of internationalizing the industry in Singapore, which has been achieved by bringing on line desalination as well as recycling facilities, to provide a technological docking point. The next phase is one of integrating and anchoring companies through test-bedding and funding schemes, bringing multiple companies together through shared facilities. This confers the advantage of proximity for companies and PUB, as the EDB representative emphasized, 'the membrane suppliers want to work with system integrators, for example. The system integrators are very trusted to work with the project developers, people who are actually the utility companies operating water plants around the world, etcetera... we see Singapore as the melting pot, the meeting place for water companies' (interview, 26 March 2013). And indeed, water companies and public utilities are using desalination in particular as a springboard for regional expansion, having gained funding, support and a 'reference' from PUB to win tenders in other markets in Asia and beyond (Ibid.). The EWI, PUB and

EDB have facilitated, harnessed and exploited the scaling-up and commercialization of water technologies in a close relationship with private companies, actively identifying partners from across the world and providing 'market access' in Southeast Asia, Middle East and China (Ibid.).

Before Hyflux became publically listed in 2001, its operations were small-scale, driven by modest contracts with industrial customers. With its specialist focus on membrane technology, however, it benefited from PUB tenders, winning four of five that were initially publicized, transforming the company into an internationally recognized brand and extending the global reach of both associated parties. Hyflux's overseas revenues increased by nearly 50 percent from 2004 to 2006, securing contracts in China and the Middle East, including the world's largest reverse osmosis desalination plant in Algeria worth S\$632 million (*The Straits Times* 13 June 2008). Key to Hyflux's success abroad has been 'bragging rights' of having first established itself in Singapore as operating a DBOO desalination plant, and being geographically situated within neighbouring larger markets: 'From Singapore, in 6 hours can you go to Beijing, all the way to India. Just China and India alone! So yeah, if we can be the knowledge centre that international companies can also use as a springboard, it certainly would help' (interview, 8 April 2013). Hyflux's business model is to develop purification technology in Singapore but apply the commercialized end product globally given the relatively small size of the domestic market, scaling-up 'from Singapore to the world...everything we do here is for global markets' (interview, 21 March 2013.).

Therefore, whilst test-bedding and R&D is inevitably localized, the longer-term expectation is that companies eventually export water technology that has been developed and licensed in Singapore to accrue profits for PUB downstream. More importantly, this process links Singapore with other countries via private companies and research institutes rather than through diplomatic negotiations, in the commercial as opposed to geopolitical sphere. The Director of a prestigious research institute, established in 2007 with S\$24 million of EWI funding, revealed that his centre had acted as a looped conduit for inward investment from the Netherlands and outward investment in surrounding regional markets, situating Singapore in wider global networks:

What I am encouraged to pursue is export actually, to work outside of Singapore...for every ten dollars of the project value I generate outside Singapore, then I will earn an additional five in the form of subsidy...So, they really want us to go out. But it's not pressure, it's a carrot...so, it's a gateway that you pass through [but] a hub is something else. Hub is, you sit there, and you have these networks that take you somewhere but they also bring you back...then you realize that you can reach to Hong Kong and you can reach to Sri Lanka. Four hours is really a short flight. Then you sit, and you say, 'I have a meeting this evening in Chennai'. Right, so that's four hours away from here, so we just drive to the airport and I'll be in Chennai by five o'clock this afternoon (interview, 4 April 2013).

The water sector now offers the Singapore Government a strategic entry point into wider global networks and national territories, circumventing fractious diplomatic negotiations with Malaysia whilst providing a clustering point for economic development. As part of the Research, Innovation and Enterprise Plan, the key national framework for promoting R&D, the water sector is identified as a priority area for the further expansion of the knowledge-based economy, leveraging in particular on the competitive strengths of membrane technology. In 2016, the total value of deals made during the biannual Singapore International Water Week (SIWW) was S\$15.2 billion, an event that was launched in 2008



to profile 'Singapore as a global water hub to the world' (Hansard 2009), which attracted over 21,000 participants from 120 countries (PUB, 2017). And indeed, none of this would have been possible without prior diversification into desalination and recycled water, which have not only augmented domestic supply but rewoven the social, technical and ecological, the public and the private, into more commercialized and lucrative imbroglios.

### **Conclusion: a sticky commodity**

This chapter has revealed how the Singapore Government has increasingly leveraged on desalination technology, through targeted R&D, water rebranding and the corporate restructuring of PUB, to strip water of its geopolitical links and integrate the domestic economy into global industry networks, worlding Singapore via the water sector. Desalination 'de-spatializes' water, certainly, but it also re-spatializes its metabolic trajectory, producing a 'new geography' that is more flexible and unfixed (Feitelson and Rosenthal, 2012, p. 273). Rebranded and sourced from an alternative hinterland to that of Malaysia, water has become a medium for corporate globalization rather than bilateral leveraging, with profound implications for Singapore's geoeconomic position in the world. The cultural biography of water has consequently been depoliticized and commercialized; its historical and geographical profile has become actively untethered from territorial space, allowing for the crystallization of an alternative set of relations around which industrial clustering can be realized in the knowledge economy. Whereas previously water had been negatively scripted as a sensitive and contentious topic of diplomatic negotiations, particularly by the national and international media, the commodity story is increasingly marked by corporate branding, consumer products and lifestyle choice. This re-scripting will only become more acute and sophisticated as the private manufacturing of water through desalination and recycling is set to dramatically increase over the next fifty years, expected to provide 85 percent of overall supply by 2060. By decoupling water from territorial space, and the associated geopolitical and geographical encumbrances, desalination may 'pave the way for its full commodification' (March, 2015, p. 238).

Whilst there has been a significant amount of critical scholarship on the commodification of water, particularly within urban political ecology and the literature on 'neoliberal natures' (Bakker, 2010a; Castree, 2008; Himley, 2008), this chapter has sought to provide an original perspective on this process by emphasizing its relationship to worlding practices. First, it has been demonstrated that water has a malleable social identity or cultural biography that changes in accordance with its production history. This does not only have symbolic or discursive repercussions but impacts materially on social and economic life, enabling or constraining the formation of wider relations, altering the social 'stickiness' of water. Whether water can be described as either 'touchy' or 'sexy' depends not only on discursive factors but the physical infrastructural arrangements of its extraction, distribution and consumption. Similarly, the ability to ascribe an economic value to water and accrue profit is also dependent on the technical configuration of water infrastructure, which becomes more complex with transboundary pipelines, encouraging the uptake of advanced treatment such as desalination. As it has previously been argued (Mitchell, 2011; Usher, 2018b), resource use practices do not only process and transform ecological matter; they also shape human systems of organization, politically, economically and culturally. In this case, the co-production of resources and society is revealed to have a specific scalar signature, facilitating the worlding of the domestic water sector: 'Whatever innovations occur in

Singapore as a result of how thriving and vibrant the water sector is here, this can then be used as a platform to get on into other countries as well. Not just developing countries, the whole world because this is an international brand' (interview, 9 April 2013).

Second, the chapter has highlighted the ambiguous relationship between the public and private sectors, particularly in the form of PPPs and DBOO, which desalination and other advanced, integrated systems of water treatment have reconfigured, complicated and blurred. It is clear from this case of Singapore and from others across the world that the private sector has become more prominent in the delivery of formerly public utilities, which has contributed to the general shift towards the commercialization, marketization, financialization and, in many instances, privatization of water supply (March and Purcell, 2014). However, this chapter has sought to offer an alternative but complementary perspective to political ecological research that approaches water commodification as accumulation strategy or neoliberal ideology (Swyngedouw, 2005), focusing instead on the role of private water companies as 'intermediaries' (Guy et al., 2011). Intermediaries are actors, institutions or objects that have the capacity to transform the wider system as a whole through their integration into existing socio-technical arrangements, challenging path dependencies and reconfiguring existing infrastructural and institutional arrangements. Here, the integration of private water companies specializing in technology necessary for desalination and recycling, through test-bedding and targeted R&D, have facilitated a general shift in the water management regime from diplomatic to commercial transactions, depoliticizing supply. As a CEO of a foreign water company proposed, 'if Singapore is able to make themselves independent from the water supply in Malaysia through desalination and water recycling...[it] is by spending a lot of money on research and getting private companies involved...without private sector involvement it would be impossible' (interview, 20 March 2013).

Finally, whilst it is popularly thought that globalization contributes to the hollowing out of political sovereignty, this chapter has demonstrated that worlding as an 'art' (Roy and Ong, 2011) can in fact stretch, convert and augment state influence in quite intricate and unexpected ways, and not simply 'undermine' public authorities (Feitelson and Rosenthal, 2012, p. 282). Indeed, globalization is not a structural outcome of free markets but is a contingent and highly contextualized process that occurs through practices, technologies, infrastructure, standards and natural resources (Braun, 2006). Moreover, the relationship between state authorities and foreign companies could be regarded as 'symbiotic' (interview, 8 April 2013) in many ways. The Singapore Government has reduced its water dependency on Malaysia, depoliticized supply and implemented cluster development policy through roll-out of desalination and NEWater, whilst foreign companies have benefited from funding, test-bedding and infrastructural capacity. As revealed by the research institute Director, 'the Government doesn't see us as consultants. They see us as part of their own network...we are very much their own colleagues, if you will...this is the relation with Government' (interview, 4 April 2013). While it is not unexpected that there is 'interactive complementarity' (Coe et al., 2004, p.469) between state authorities and foreign companies in internationalization processes, this chapter has highlighted how desalination provides a particularly conducive technological platform through which worlding can take place, being already embedded in wider corporate networks that are global in ambition and scope. There is an urgent need for further research focused on the social cost of this complementarity, however, in terms of the imperceptible commercialization of public services, the expanded

but opaque role of private water companies in research and delivery, and the contracting cultural biography of water under its relentless commodification.

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