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Diversification or Loading Order? Divergent Water-Energy Politics and the Contradictions of Desalination in Southern California

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ABSTRACT: This paper explores the contradictory and sometimes incompatible imperatives towards enhancing water supply reliability and addressing the water-energy nexus. Using the highly contested development of seawater desalination for municipal water supply in the San Diego metropolitan region as an analytical entry point, the paper excavates divergent water-energy politics emerging in California. Two underlying paradigm shifts of water governance are identified. First, supply diversification represents an attempt to increase reliability through the development of multiple decentralised water sources. Second, the notion of a loading order is being promoted by certain groups as a way of prioritising different water source options according to sustainability criteria, including energy footprint. Drawing on the concept of the socio-ecological fix, the paper argues that seawater desalination – as a technological adaptation to water stress – occupies a paradoxical position, being consistent with diversification, but representing a water-energy trade-off inconsistent with the loading order. This has resulted, the paper suggests, in a polarised debate between desalination and wastewater recycling as alternative climate-independent sources of freshwater. As such, the disputes over desalination in San Diego are understood to be a crucible for broader politics of resource governance transitions.

KEYWORDS: Water-energy nexus, desalination, political ecology, diversification, loading order, California

INTRODUCTION

SAN DIEGO, CA, 1991. The State of California is entering its fifth year of severe drought. In the urbanised coastal south, water agencies are beginning to exhaust local supplies and demand for imported water ramps up. In San Diego, which unlike its neighbours Orange County and Los Angeles does not sit on top of groundwater aquifers, the County Water Authority (SDCWA) imports 95% of its supply from the Metropolitan Water District of Southern California (hereafter 'MWD' or 'Metropolitan'), which serves a population of roughly 19 million with water transferred from the Colorado River and Northern California. In November of 1990, Metropolitan's Board of Directors had adopted a five-stage shortage allocation plan called the Interim Interruptible Conservation Plan, in response to the drought conditions. Stage 1, which called for a 5% voluntary reduction by member agencies, was implemented at once. Less than three months later, with crisis looming, MWD enforced Stage 5: mandatory reductions of 20% for municipal and industrial users and a 50% cut for agriculture. For San Diego, this meant an overall cut of 30%. At the beginning of March 1991 the Board moved to introduce and implement a further level to the plan, Stage 6, which would have resulted in an overall loss of 50% of San Diego's supply, a decision that the SDCWA was virtually powerless to challenge. Only unexpectedly high rainfall that month, which would become known as Miracle March, prevented the 50% cut.

This period is now considered a significant turning point in the governance of San Diego's water supply. Following a backlash (in particular) from the San Diegan business community, the SDCWA embarked on an aggressive and, in many respects, a highly effective diversification strategy aimed at reducing reliance on water imports from MWD. The flagship project of this effort is the *Claude 'Bud'*

Lewis Carlsbad Desalination Plant, which was inaugurated in December 2015, just a year before the end of California's latest drought. The plant produces 190 mega litres (ML) per day and can meet 10% of the region's demand (SDCWA, 2017). San Diego has, in effect, turned to the Pacific Ocean to solve the deep structural challenges that have dogged its hydro-social cycle since the 1940s. The project, which is the result of a major public-private partnership between a company called Poseidon (the developer) and the SDCWA (the off-taker), despite taking 18 years to complete has been celebrated by the water industry – receiving, for example, the Global Water Intelligence *Desalination Plant of the Year* award for 2016. Its development, however, was beleaguered by sustained and severe criticism from various civil society organisations, in particular from a coalition of environmental groups called the Bay Council. Indeed, with no fewer than 14 separate lawsuits having been brought against the project (Garrett, 2014), the Carlsbad plant is possibly the most politically contested single desalination facility in the history of the industry. One of the major points of contestation has been the high energy intensity – and therefore greenhouse gas emissions – associated with the desalting process (Cooley and Heberger, 2013). Given that the oceans are, in all practical respects, inexhaustible, through the application of desalting technologies the problem of water scarcity effectively becomes one of energy availability. Desalination agitates, therefore, both the assumed separation between the governance challenges of energy and water, and relative scarcities between them.

This paper considers the contradictions and inconsistencies of two emerging parallel and overlapping water governance paradigms. The first concerns the ongoing shift – which has been particularly strong in Southern California – towards supply diversification in response to the decline of centralised infrastructure management characteristic of the state-hydraulic paradigm. The second concerns increasing attempts to address connections and tensions between water and energy, often referred to as the 'water-energy nexus' (Hussey and Pittock, 2012; Olsson, 2015; Scott and Pasqualetti, 2010). Nexus thinking has developed over the last decade as a techno-managerial framework and methodology for managing tensions between resource sectors that have traditionally been governed as separate entities, and for taking advantage of potential efficiencies and synergies between them (Allouche et al., 2015; Cairns and Krzywoszynska, 2016; Williams et al., 2014). Together, this paper posits, these broad trends underpin a crucial socioecological fix (Ekers and Prudham, 2017a) for a region facing complex and severe resource challenges. In this context, desalination occupies a paradoxical position. On the one hand, it is strongly consistent with the imperative towards supply diversification, because it offers a decentralised and local source of water, independent from river-basin politics (March, 2015). But on the other hand, because the purification process is highly energy intense, it represents a water-energy trade-off, inconsistent with multi-benefit forms of governance prescribed by nexus thinking. This contradiction sits at the heart of the intensely politicised debate about desalination in California.

More importantly, the paper argues, the desalination paradox reflects a deeper set of tensions in the governance of water, between managing supply options as a varied portfolio (which each contributes to overall security) or as a priority list to be developed incrementally. In California, this has resulted in a polarising debate between a set of interest groups pursuing diversification strategies, and those arguing for a loading order approach. The concept of a loading order, which was initially borrowed from the electricity sector, is based on the idea that the most socially and ecologically responsible water sources should be fully developed before decision-makers turn to expensive and energy-intense options like desalination (Coastkeeper California, 2016). In San Diego, the Bay Council environmental groups have been particularly vocal in promoting a loading order over diversification. Their contention is that water managers should first pursue conservation efforts before developing wastewater recycling, with seawater desalination as a last resort. This debate between diversification and loading order approaches has resulted in fierce disagreements around the development of different technologies. The paper discusses, therefore, the emergence of a perceived antithesis between wastewater recycling and desalination as alternative water supply options.

The paper uses the contested development of the Carlsbad Desalination Plant as an analytical entry point to excavate the wider politics of water and energy in California. The empirical research presented in this paper was conducted in Southern California between 2014 and 2015. Data collection involved 36 expert interviews with a range of stakeholders, extensive documentary analysis and site visits. Archival research was also conducted at San Diego State University, the San Diego History Centre, the San Diego Public Library and the National Archives in Washington, DC. In what follows, I first critically examine the paradigmatic policy shifts towards, governing the water-energy nexus, and water-supply diversification. Second, the paper provides an analysis of the political contestation around the development of desalination for San Diego, discussing the debates between proponents of diversification and loading order, and desalination and wastewater recycling. Finally, the paper suggests that desalination occupies a contradictory position between two forms of socioecological fix for water-energy governance in California.

DESALINATION AND THE CONTRADICTIONS OF WATER IN CALIFORNIA

The desalination of seawater for municipal water supply is now a major focus of research and scholarship on water challenges across academic disciplines. From a fringe water source two decades ago, largely limited to the Arabian Peninsula, desalting plants now operate in 150 countries, supplying more than 300 million people with potable water (IDA, 2015). Yet, there is an overwhelming preponderance in water governance circles to understand the extraordinary development of global desalting capacity and the emergence of seawater as a 'solution' to water scarcity and stress, as an *ageographical* and *apolitical* phenomenon. A review of the most cited academic papers on desalination from the last decade – published in journals like *Science, Nature, Desalination* and *Water Research* – reveals an extraordinary and distinctly Malthusian consensus on the key drivers and imperatives of this technological adaptation. Fritzmann et al. (2007: 1), for example, argue that desalination offers a "means to reduce current or future water scarcity", which they define as arising from a "mismatch between water supply and demand". This mismatch is predominantly understood as a technical problem, rather than a social or political one, and is generally agreed to be driven by a combination of population growth, urbanisation and industrial expansion (e.g. Ghaffour et al., 2013; Khawaji et al., 2008; Shannon et al., 2008). In this context of growing water scarcity, understood in a narrow technical sense, desalination is presented as a "seemingly unlimited, steady supply of high quality water" (Elimelech and Phillip, 2011: 713) that has "emerged as a key to sustaining future generations across the globe" (Greenlee et al., 2009: 2318).

This paper, conversely, presents an altogether different interpretation of the desalination phenomenon. Drawing on an emerging body of scholarship presenting critical interpretations of desalination (Feitelson and Rosenthal, 2012; Fragkou and McEvoy, 2016; Loftus and March, 2016; March, 2015; March et al., 2014; McEvoy, 2014; Swyngedouw, 2013; Swyngedouw and Williams, 2016; Williams, 2018a), I argue for a more politically astute understanding of this technological adaptation that recognises its social and ecological contradictions. In Southern California, the contradictory nature of desalination is highlighted in the competing imperatives to address ecological sustainability concerns by managing the water-energy nexus and to enhance water security and reliability through diversification.

The water-energy nexus

There is increasing recognition in policy, business and environmental management circles of the importance of governing the connections between resource sectors that have previously been managed in 'mutual isolation' (Scott and Pasqualetti, 2010). Put simply, the water-energy nexus considers the embedded energy in water systems and the embedded water in energy systems, or succinctly "energy for water and water for energy" (Perrone et al., 2011: 4229). Tensions between the water and energy sectors can arise when allocation squeezes or price fluctuations in one result in challenges for the other; when insecurity in one translates as insecurity for the other; or when unsustainable or contradictory management decisions in one sector carries implications for the other. These tensions can, as Hussey and Pittock (2012) point out, lead to 'questionable trade-offs' between water and energy. Given the amount of energy required to treat, transport, consume and dispose of water, and the amount of water required to extract, produce and consume energy, any growth in demand for water entails growth in demand for energy, and vice versa. These relationships are, moreover, further confounded by the development of alternative technologies, such as seawater desalination and wastewater recycling, which are often more energy-intense than traditional supplies, creating a growth cycle of mutually reinforcing resource use (King et al., 2013).

Attention to the water-energy nexus, then, offers political, institutional and technological means by which the use of energy by the water sector and water by the energy sector might be optimised according to sustainability criteria (Andrews-Speed et al., 2015; Olsson, 2015). At its core, nexus thinking is about reducing tensions, trade-offs and maladaptations between resources, and enhancing synergies and shared goals between them (Williams et al., 2014). The fundamental argument of nexus thinking is that tensions and trade-offs should be addressed through the application of technologies that embody benefits for more than one sector, institutional restructuring to foster cooperation and collaboration, and information-sharing between sectors. The nexus offers, in effect, a way of managing the connections *between* water and energy, rather than seeking compartmentalised sustainable transitions independently. As such, this emerging paradigm of integrated resource governance is rapidly being assimilated into sustainable development discourses, and is argued to be key to the achievement of the United Nations Sustainable Development Goals (Yillia, 2016). Much of the emphasis of the nexus literature, in terms of recommendations, is directed towards finding opportunities for multi-benefit management strategies and adaptations (Kurian and Ardakanian, 2015; Pittock et al., 2015).

With the growing traction of nexus thinking in mainstream environmental management circles, there has been a concomitant emergence of voices critical of the notion. Indeed, some have expressed doubts about the novelty of nexus thinking, given that, as Rees (2013: 280) points out "there is, of course, nothing new in the identification of linkages between water, food, energy and ecosystems". So, on the one hand, we have a concept that is gaining huge traction at all levels of governance and that is starting to shape debates and policy formation on issues of environmental sustainability. Yet, on the other hand, this is a term that is, as Cairns and Krzywoszynska (2016: 166) suggest, characterised by "obviousness and ambiguity" in its use. The real question, then, is what is the political *work* that this concept is doing? And why, given its fuzziness, has 'the nexus' risen in such profile across such a wide range of actors and institutions?

On this question, Allouche et al. (2015) have pointed out that although the core recommendation of nexus thinking for integrated governance, in many respects has universal appeal, the discourse has so far overlooked questions of power and inequality in resource access. Moreover, they contend that because the nexus has been framed in very technical terms, the debate has been structured precisely to overlook such issues. Similarly, Williams et al. (2014) argue that the dominant framing of the water-energy nexus as *apolitical*, nevertheless has deeply *political* implications. By conceptualising the 'problem' of resource availability and sustainability as rooted in inefficiencies between sectors, understood in the technical – rather than political – language of tensions and trade-offs, the 'solution' becomes a technical one of minimising inefficiencies and amplifying synergies. In effect, this paper argues, the water-energy nexus provides the language, impetus and methodology for a contemporary socioecological fix that internalises resource interconnections to address availability challenges without challenging the logic of growth-oriented consumption.

California is one of the few places where the concept of a water-energy nexus is being explicitly mobilised in policy. The urgency of nexus challenges is, for several reasons, particularly evident in California. The vast storage and conveyance systems that transport vast quantities of water from the Colorado River and Northern California to the populous Southern and agriculturally productive Central regions make the connections and tensions between water and energy security very visible. For example, embedded energy in water delivered through the north-south State Water Project transfer is nearly ten times greater in the South than in the North (DWR, 2016). Moreover, the complexities of addressing these tensions has been made more acute in the context of recurrent drought and climate change (Lofman et al., 2002). The need for greater policy integration between California's water and energy sectors was first highlighted by government in 2005 in an influential report by the California Energy Commission. The purpose of the study was to quantify the demand for water in California's energy sector and the demand for energy in its water sector, and to identify the "points of highest stress" between the two systems (Klein et al., 2005: 1). The main recommendation made by the report, which is still widely cited, was for better coordination between the water and energy sectors, and for joint management of infrastructure.

Since 2005, the language and imperatives of the water-energy nexus has become commonplace at both state and local levels. Sustained attention has been paid to both the energy footprint of the water system and the water footprint of the energy system (Fulton and Cooley, 2015; Fang et al., 2015). For over a decade, civil society groups have been calling for government to investigate seriously the connections between water and energy in California, and to address the implications of the water-energy nexus for sustainability and development (Cohen et al., 2004). These groups, broadly, argue that the relative abundance of cheap, state-subsidised water in the desert Southwest has encouraged wasteful use practices, and moreover, does not reflect the negative energy and GHG emission externalities of the water transfer system. Although regulation is being introduced piecemeal, a number of agencies are now actively trying to govern the water-energy nexus. At state-level this includes: the California Public Utilities Commission, which regulates privately owned utility companies and has a special nexus proceeding (CPUC, 2016); the California Energy Commission, which has a nexus technologies research programme (CEC, 2016); the Department of Water Resources (DWR 2016); and the Climate Action Team (WET-CAT, 2016) are making the most significant efforts in this area. The focus of these programmes is very much on building institutional cooperation and promoting technological strategies, rather than addressing deeper systemic issues. As one California government official stated:

> We don't seek to change the system of water or energy government, we're just trying to make sure we address the water-energy nexus (Interview, 30/07/2015).

Despite an overall lack of coordinated vision, the water-energy nexus is now a key policy area for a number of state-level government departments in Sacramento, as well as for regional government. One of the core strategies outlined in the 2016 update of the California Water Action Plan 'roadmap' is to "increase water sector energy efficiency and greenhouse gas reduction capacity" (NRA, 2016: 6).

In San Diego, where utilities have historically relied on long distance imports, the connections between water and energy are stark. The connected challenges posed for the region's development have, of course, long been recognised. For instance, a planning report from 1980 observed that "both water and energy are critical resources to the San Diego region, neither of which is locally abundant", and that "clear-cut acceptable solutions to meet increasing demands are not at hand" (SDWUD, 1980: iii). With little local supply of surface water or groundwater, and sitting at the end of all the distribution pipelines, San Diego has the highest levels of embedded energy in its water supply in the state (Powers, 2007). Nexus challenges are starting to rise in the priorities of local government and utilities. The San Diego County Water Authority and the San Diego Gas and Electric Company are, for instance, piloting collaborative approaches to fostering water-energy efficiencies (CPUC, 2016). In the water sector, specifically, there is increased pressure for suppliers to quantify the energy footprint of various sources and to include such considerations in decision-making. This has prompted, for example, the SDCWA to publish its Climate Action Plan, a voluntary strategy to bring the Water Authority in line with the state's emission targets by 2020 (SDCWA, 2015). Nevertheless, the concept of a water-energy nexus, as it is being mobilised to address challenges in California, offers a path to 'sustainability' by seeking efficiencies at the margins of resource sectors, rather than forming the basis of a radical transformation of resource governance.

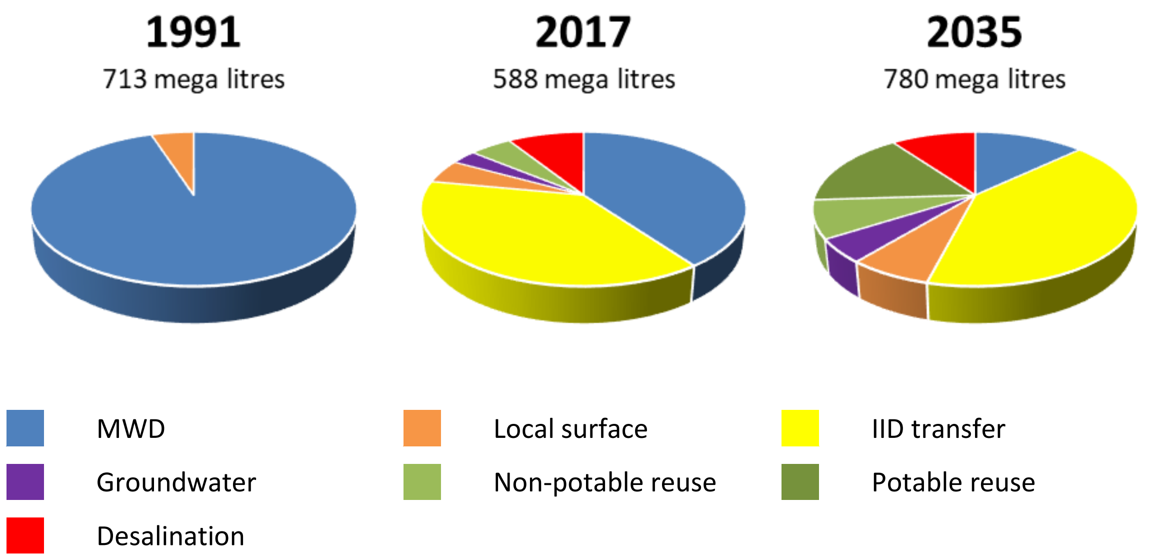
Diversification

The movement towards diversification has been especially strong in the urbanised coastal belt of Southern California. This paradigmatic shift is being driven by two interrelated processes that are together undermining the logic of water management that dominated the American West throughout the 20th century, and therefore threatening the material preconditions of urbanisation in the coastal belt. Firstly, climate change is altering precipitation patterns, contributing to increased severity and length of drought periods, unpredictable and dramatic El Niño/La Niña cycles, and a broad trend towards reduced snowpack in the Sierra Nevada Mountains (Mann and Gleick, 2015). This is compelling water managers and municipalities to look beyond traditional riparian water sources and invest in technologies that provide a buffer between water users and an increasingly unpredictable climate. Secondly, the collapse – or at least deterioration – of the state-hydraulic paradigm is prompting a trend towards localised and decentralised supply 'alternatives'. Since the mid-20th century, Southern California has relied on an extraordinary transfer of water from the Colorado River Basin and Northern California through federal and state-funded mega-infrastructures. Now, in response to increasing competition for transfer water under conditions of reduced reliability, a dysfunctional and entrenched system of water rights, and growing appreciation of the ecological implications of moving large amounts of water between basins, are pursuing alternative and 'diverse' supplies.

While diversification strategies incorporate a multitude of water source options, seawater desalination and wastewater recycling, which both utilise almost identical reverse osmosis technology, receive particular attention for being rainfall-independent supplies (Badiuzzamen et al., 2017). Desalination is perhaps the most high-profile, and has been considered by many of the water agencies in California and indeed other Colorado Rover states (Mumme et al., 2017; Williams, 2018b). Nevertheless, despite receiving a great deal of attention, large-scale desalination has not been widely adopted as a diversification strategy in California, except for in San Diego County. The development of wastewater recycling facilities has, by contrast, burgeoned in the last decade, a trajectory that is predicted by many to continue, both in California and globally (Kjellén, 2018; Pacific Institute and NRDC, 2014). Although public perception of wastewater recycling has been a significant impediment, there is growing evidence that well-designed and properly-communicated projects can receive support (Dolnicar and Schäfer, 2009; Ormerod and Scott, 2012). For instance, several agencies in Southern California have developed indirect potable reuse – i.e. where recycled water is fed into an environmental buffer, such as a reservoir or aquifer, before rejoining supply – in part because this method is seen as more palatable than direct potable reuse (Meehan et al., 2013).

In Southern California, almost all water agencies are pursuing diversification strategies. Los Angeles, for example, is investing in a variety of alternative supplies, including stormwater capture, wastewater recycling and groundwater recharge. Long Beach, by comparison, has for a number of years been advancing a highly effective efficiency and conservation agenda through the use of smart meters. And Orange County has continued to expand its Indirect Potable Reuse wastewater capabilities. San Diego has been particularly proactive in this regard. Over the past 25 years this has involved a USD3.1 billion capital improvement plan aimed at enhancing local and alternative water supplies. The county is aiming to reduce its use of water imported from MWD from its peak in 1991 of 95% to below 20% by 2035 in order to dampen the effects of future cuts to its USD200 billion regional economy (Figure 1). The county-level investments include securing additional supply though an unprecedented transfer deal with the Imperial Irrigation District; developing the county's limited groundwater resources; promoting wastewater recycling; a reasonably successful (albeit still insufficient, some have argued) conservation programme; and of course, seawater desalination (SDCWA, 2011). The SDCWA has also encouraged its 24 member agencies to develop their own diversification projects – most notable of which is the City of San Diego's USD2.3 billion *Pure Water* Indirect Potable Reuse recycling scheme (City of San Diego, 2016).

Figure 1. San Diego County Water Authority's diversification strategy (adapted from SDCWA, 2017).

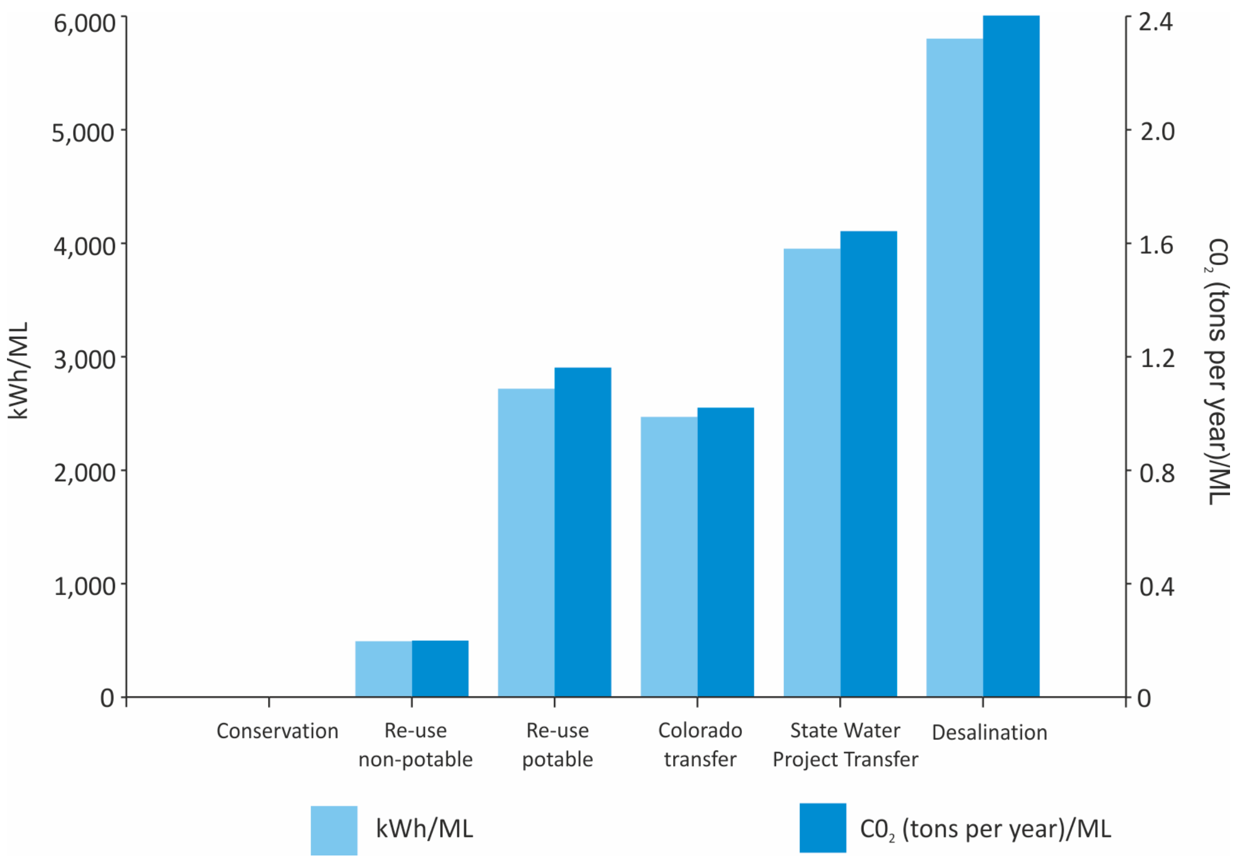


POLITICISING SEAWATER

Turning to the abundant oceans to meet expanding water needs certainly seems like an attractive proposition to water managers under pressure to safeguard regional prosperity. Yet, the development of desalination is never uncontested, and a number of formidable barriers, both technical and social, have prevented the realisation of the ocean panacea (Cooley et al., 2006; March, 2015). This is reflected in California where the development of desalination has been challenged and contested fiercely by an organised coalition of environmental organisations. In San Diego, opposition to the Carlsbad project has been coordinated by a group of six environmental organisations called the Bay Council. The Bay Council – which includes the local chapters of some nationally and internationally known groups like Sierra Club, Surfrider and Coastkeeper – meet regularly and direct their individual resources and efforts in coordination with each other (San Diego Bay Council, 2018). The efforts to scupper the Carlsbad project were led by Surfrider, Coastkeeper and the Coastal Environmental Rights Foundation. These groups have been supported by their state and national counterparts, and by organisations like the Desalination Response Group (2016) and Residents for Responsible Desalination (R4RD, 2018), that have formed specifically around the desalination issue. The Carlsbad project was beleaguered by lawsuits and backlash from environmental groups, disputes between the project developer and permitting agencies, and struggles to secure municipal buyers to sign long-term purchase contracts. The Bay Council's strategy, which was primarily litigious, involved bringing legal challenges against Poseidon and the County Water Authority in an attempt to stop the project at various permitting hurdles (Garrett, 2014).

Whereas desalination developments in other states and countries have largely been contested on the narrow issue of saline brine discharge (Malaeb and Ayoub, 2011), in California concern over the social and ecological costs of desalination has revolved around three interrelated issues: the energy and GHG problem; the seawater intake marine life impingement and entrainment issue; and the cost and financing issue (Cooley and Heberger, 2013; Cooley et al., 2013; Cooley and Ajami, 2012, respectively). Although the organisations critical of desalination are by no means uniform in their views on water, these recurring concerns are consistently put forward. For instance, a joint policy brief entitled 'Proceed with Caution', warns that seawater desalination is "typically the most energy-intensive water supply option" and is therefore associated with "significant greenhouse gas emissions"; that the technology is "very expensive" and could pose "financial risk for ratepayers and taxpayers"; and that the process can have "significant impacts on the marine environment" (NRDC et al., 2014: 2-3). Chief amongst these points of dispute is that of energy consumption. Indeed, because of the mechanical challenges involved in separating dissolved salt from water, "energy will always remain the crucial constraint" (Schiermeier, 2008). Given that the oceans are, in all practical respects, inexhaustible, the main limiting factor on water production becomes one of energy availability. In San Diego, desalination represents the most energy-intensive source of water available by a notable margin (Figure 2).

Figure 2. Embedded energy and CO_2 emissions per mega litre associated with San Diego's water supply options.



Note: The IID transfer is delivered through the Colorado River Aqueduct. Source: Adapted from Powers (2007).

Indeed, transporting water 500 km from the Colorado River uses less than 45% of the energy required to desalt the Pacific Ocean, and 800 km through the State Water Project less than 70%. Significant efficiency gains have been achieved over the last 50 years – for instance the energy requirements to operate seawater reverse osmosis membranes has dropped from 20 kWh/m^3 in the 1970s to 2 kWh/m^3 (Peñate and García-Rodríguez, 2012). Notwithstanding, the embedded energy within the desalting process and the consequences of this for greenhouse gas emissions and water price, has become the Achilles Heel for the desalination industry.

Divergent water-energy paradigms: 'diversification' vs. 'loading order'

The discussions on desalination have formed around a set of discursive antitheses that represent divergent notions of resource governance. Desalination, and the disputes that have emerged around the development of the Carlsbad plant and other projects, sit at the apex of deeper debates about the future of water supply reliability in Southern California, and the ways in which the trade-offs and shared goals between water and energy should be managed. These debates have coalesced into a polarised dispute between two opposing visions on water security, sustainability and relative water and energy scarcities: as 'diversified supply portfolio' on the one hand; and as 'loading order', or priority list on the other. Proponents of the first position argue that water security should be achieved by spreading the risk of shocks or supply reduction over many water sources. In other words, having a diverse portfolio means that the effects of reductions to one supply are cushioned by the reliability of others. This is exemplified by the San Diego County Water Authority's aggressive supply diversification strategy following the shock of the 1991/92 cuts by the Metropolitan Water District. In contrast, other groups (led by the Bay Council) have argued that the diversification paradigm encourages water managers, firstly, to focus on supply solutions rather than demand management and behavioural change, and secondly, to invest in expensive and ecologically unsound supplies before fully exhausting more viable options (California Coastkeeper, 2016). Instead, these groups advocate the institution of a water 'loading order'.

The concept of a loading order was developed in the energy sector in the early 2000s. Its implementation was a response to the dual pressures of, on the one hand, structural mismanagement of electricity that led to severe price increases and widespread power outages in 2001 (now known as the Californian energy crisis), and on the other hand, climate change and the imperative for increased renewable generation. Adopted in the California Energy Action Plant (CEC and CPUC, 2005) the loading order became the foundation of a significant restructuring of the state's energy sector. The premise is quite simple. All potential energy sources available to Californian companies and utilities are placed on a priority list, based on their comparative merits and drawbacks. Solar power is, for example, higher on the list than large-scale coal generation because it is consistent with the state's aim to enhance its renewable energy capacity. These various energy sources are then invested in and brought onto the grid in accordance with this 'loading order'. Particular priorities include: first, energy efficiency through the implementation of building and appliance standards; second, demand response, which includes new rate structures that encourage consumers to lower high peak demand; third, renewable energy, in particular from wind, solar and hydroelectric pump storage; and fourth, distributed generation by consumers, for example through home-installed solar panels (CEC, 2005).

In an intriguing development of nexus thinking, California's environmental communities, including the Bay Council, are almost unanimous in their call for a loading order in the water sector. The concept was originally put forward by the Coastkeeper Alliance, as a framework for the "prioritisation of sustainable water supplies to ensure water infrastructure planning provides the most social and environmental benefits, while minimising negative impacts to California's waterways" (Coastkeeper California, 2016). This would involve, more or less, a direct transfer of policy from the energy sector to the water sector. Water source options would be ranked based on their ecological and socioeconomic credentials, with investment being directed towards, and priority given, to the most cost-effective and environmentally sound. Southern Californians should, according to this vision, fully exhaust conservation potential before moving to more expensive and energy-intense options. Seawater desalination, because of the social and ecological trade-offs it embodies, would be a last resort option in the loading order. So, for proponents of a loading order, seawater desalination represents the most drastic and lowest priority water source option available to Southern California. In contrast, for those who argue for portfolio diversification, the capacity of desalting technologies to produce climate and rainfall-independent decentralised water makes it an invaluable component of a prudent approach to water management.

These two concepts, which have been brought into direct conflict in the development of desalination, represent divergent visions of water governance, and contradictory notions of relative water and energy scarcities. Proponents of each have been equally ardent in their criticism of the other. For example, as one participant argued:

> Certainly, we want a diverse portfolio and to balance all of these reliability issues, but the notion that we're going to do everything now does not lend itself… We need to be looking at the notion the energy sector has used, the notion of least-cost-planning, and building new supplies and reducing demand as needed (Interview, 29/12/2014).

The large water utilities have, in return, been highly critical of the loading order concept, arguing that the material characteristics of water would make such a policy transfer inappropriate. The Metropolitan Water District of Southern California, for instance, retort that the "water industry, unlike the energy industry, is wholly dependent upon the availability of its water sources and cannot 'generate' water supplies upon demand", and that therefore "resource 'loading orders' will not work" (MWD, 2014, 1-2). The SDCWA responds along similar lines:

> You've got these two policies coming to a head. We've been trying to explain that first and foremost comes water reliability. Is energy a consideration in supply development? It is, but it is not the primary factor (Interview, 24/06/2015).

At its heart this dispute, which has crystallised around seawater desalination as being emblematic of divergent water politics, lie very different understandings of scarcity, and contradictory visions for future resource governance. It is important to note, however, that both approaches are, in essence, technocratic, managerial and solutions-oriented. The categorisation of savings through conservation as 'new supply', and the focus of conservation programmes on demand-side technologies like water meters and smart appliances illustrate this. The call from environmental groups for a loading order in the water sector does not, of course, represent a radical re-imagining of California's water-energy future. The driving imperatives that underpin the concept of a loading order for the water sector – just as in the energy sector – are towards greater use efficiencies, minimisation of resource trade-offs, and maximisation of synergies and multi-benefit management strategies. Indeed, the loading order suggests – as does the very concept of the water-energy nexus – a shift towards integrated environmental governance whereby externalities are increasingly internalised to the processes of capital accumulation.

It's all in the name: Desalination and recycling

Over the past 20 years, wastewater recycling has also emerged as an increasingly important element of supply diversification in California, but under very different political conditions to desalination (Pacific Institute and NRDC, 2014). While the large water wholesalers in Southern California – the Metropolitan Water District and the San Diego County Water Authority – cannot directly develop recycling capacity because they provide only water services, not sewerage or drainage services, they are nevertheless supportive of reuse as an alternative supply that contributes to a diversified portfolio. Over the last decade, through multiple small and medium-sized projects its member agencies have increased the non-potable recycled supply in the SDCWA service area to 37,000 ML a year, roughly 6% of total supply (SDCWA, 2017). This is a little over half the amount produced at the Carlsbad Desalination Plant. With most of the large golf courses, parks and playing fields in San Diego County served by non-potable (purple pipe) supply, and given the high cost of expanding a dual potable/non-potable distribution system, focus is now shifting to recycling for potable use.

Partly as a result of the debate between diversification and loading order, wastewater is often framed in zero-sum opposition to desalination. The Bay Council groups give wastewater recycling high priority on the loading order and argue that its potential should be fully developed before suppliers turn to desalination. As one participant explains:

> You're right at ground zero; the push between greater recycling and greater desal. The County Water Authority says those things aren't in opposition, but in reality they are opposing because there's only limited funding, only so much water we truly need once we start conserving … They're not necessarily mutually exclusive, but they are in opposition (Interview, 11/09/2014).

Orange County, which borders San Diego County to the north, has led the water treatment industry in indirect potable reuse since the 1970s. The OC Water District's Groundwater Replenishment System (GWRS), which works by pumping treated wastewater underground to recharge aquifers, is now the largest potable recycling operation in the world, producing 380 ML/day (OCWD, 2016). The OCGWRS has been hugely successful, in large part, because it addresses two problems: those of saline intrusion into coastal aquifers, and of water supply reliability (Anderson, 2003). San Diego is also stepping up efforts in potable reuse. A USD2.85 billion new recycling development by the City of San Diego, called Pure Water San Diego, is being delivered independently from the County Water Authority to service the City's 1.3 million water customers and 2.5 million wastewater customers (City of San Diego, 2016). Again, this project will tackle two key water challenges. First, on the waste management side, the City has been in breach of its outfall permit for the last 20 years and has been under pressure from the Bay Council groups to reduce discharge flows. To upgrade current facilities simply to bring them in line with permitting standards would cost an estimated USD1.8 billion, without producing any additional water. The full implementation of the Pure Water Programme, by contrast, will reduce ocean discharge by half and create a potable water source. Second, on the supply side, Pure Water will, when complete, provide 315 ML/day of rainfall-independent and import-independent water. This is 125 ML more than the Carlsbad plant and constitutes around a third of the City's current demand. The water produced will be around 40% less energy-intense than desalted seawater and will cost an estimated USD2,350/ML (around USD600/ML less than Carlsbad).

Despite utilising virtually the same reverse osmosis technology and representing the only two 'alternative' water sources that are independent of precipitation, and despite both being associated with (relatively speaking) very high levels of embedded energy, the political formations around desalination and potable reuse could hardly be different. Although Poseidon was able to garner significant political support for the Carlsbad project, desalination has faced sustained and heavy criticism from civil society groups. In response to these criticisms, regulating agencies have begun to tighten standards for future desalting facilities. Carlsbad's sister project – Huntington Beach, Orange County – was, for instance, delayed after the Coastal Commission (which oversees the use of land and water in the coastal zone) refused to compromise over intake requirements (Hiltzik, 2017). Conversely, wastewater recycling is gaining momentum, both in terms of regulation and political support. Indeed, San Diego's Pure Water project is now at the centre of an extraordinary political alignment between utilities and water managers, environmental groups and the San Diego business community:

> It really solves two big issues: our wastewater issue and the permits for discharge, and our water issues. It gives us the reliability we need… Everything is meshing together. We've got a coalition of environmental

> groups, the business community, and the tax payers association supporting this programme (Interview, 30/10/2014).

The Bay Council groups are unanimous in endorsing recycled wastewater, and have signed letters of support for Pure Water. These groups are broadly supportive of the techno-managerial adaptations that underpin the diversification of San Diego's water supply, but favour wastewater recycling because it solves the pollution issue and, although being both energy-intense and expensive, is less so than desalination (Coastkeeper San Diego, 2012). Put simply, while both applications of reverse osmosis technology are consistent with diversification strategies, recycling is consistent with a multi-benefit form of integrated environmental governance; seawater desalination is not.

Emerging politics of water-energy

The divergent visions for Southern California's water-energy future and contradictory notions of relative scarcities revealed in the desalination debate have been played out in the state's court system. The various energy-related disputes over the Carlsbad project have revolved around the issue of greenhouse gas emissions associated with desalination, and disagreement over the responsibilities of water companies and utilities to pursue mitigation strategies. This has been complicated by a context of regulatory confusion. There are currently no laws in California requiring water companies or utilities to fulfil particular energy efficiency, source or use criteria. In other words, a desalination plant may be built without the developer having to meet any requirements in terms of energy performance. The water sector is, moreover, exempt from the state's reduction targets in greenhouse gas emissions. The 2006 Global Warming Solutions Act, which sets emissions reductions targets to 1990s levels by 2020, focuses on the energy and transport sectors, and has no specific requirements for embedded energy. As such, the lack of a clear regulatory pathway for desalination projects has contributed to a fuzzy and complicated permitting process.

Without a state-wide framework, the energy issue is currently regulated by the California Coastal Commission using the proxy of greenhouse gas emissions. Under the Coastal Commission's mandate it may stipulate certain energy requirements for desalination plant developments by asserting the link between GHG emissions, global climate change and sea-level rise, which carries implications for its regulatory zone. The Commission therefore requires developers to submit an Energy Minimisation and Greenhouse Gas Reduction Plan as part of the permitting process. Notwithstanding the obvious oversights of such a framework for comprehensively addressing the water-energy nexus – for instance concerning exposure to energy price fluctuations and other cost-related vulnerabilities – the greenhouse gas issue became a key point of contestation of the Carlsbad project.

The debate so far has really condensed around the issue of growth. "The overall energy implications of a seawater-desalination project", argue Cooley and Heberger (2013, 1) "will depend on whether the water produced replaces an existing water supply or provides a new source of water for growth and development". The project developer, Poseidon, has placed a lot of emphasis on the plant's green credentials. Calrsbad is, they stress, the most energy-efficient desalting plant ever built because of the Pelton Wheel energy recovery devices and the patented pump configuration developed by the plant's designers and operators, IDE. Poseidon claims, moreover, that the plant is carbon neutral. At face value, this is an extraordinary claim to make, given the energy intensity of seawater desalination compared to other water source options. Indeed, the project's website asserts that it is the "first water infrastructure project in California to have a net carbon of zero" (Carlsbad Desalination Project, 2016).

The claim, outlined in the Energy Minimisation and Greenhouse Gas Reduction Plan (Poseidon Resources, 2008), which was approved by the Coastal Commission in August 2008, rests on the assumption that the water produced by the desalting plant will displace water that would otherwise have been imported through the State Water Project. The plan measures the overall indirect GHG emissions of the plant as the difference between emissions associated with the total electricity consumption of the plant and emissions associated with imported supply. The 6,000 kWh required to desalt a mega litre of ocean water at Carlsbad is effectively mitigated by removing the need to import a mega litre of water from Northern California at 4,200 kWh/ML. Poseidon therefore calculates that the total energy footprint of water manufactured in Carlsbad is only 1,800 kWh/ML. This one-for-one replacement of supply accounts for around two thirds of the CO_2 emissions mitigation for the plant. The remaining emissions are then offset by a variety of mitigation strategies, including on-site solar energy production, reforestation programmes, and sequestration through wetlands conservation and restoration projects near the desalination plant site on the Agua Hedionda Lagoon. Any outstanding emissions identified in the annual emissions report submitted to the Coastal Commission will then be offset through carbon credits. This, according to Poseidon, "represents an unprecedented voluntary commitment to account for and bring to zero indirect GHG emissions" (MacLaggan, 2008 cited in California Coastal Commission, 2008: 2).

The projected climate impact and energy footprint of the desalination plant is premised on two assumptions. First, that the plant is producing replacement water for San Diego, rather than additional water. Second, that it replaces water imported through the State Water Project, rather than the less energy-intense Colorado River transfer, both of which are delivered to San Diego by Metropolitan. Opponents of the project contended that there could be no clear link drawn between the addition of desalted water and removal of imported water from San Diego's supply. It is more likely, the Bay Council argues, that desalination will increase overall supply, that the supply security it guarantees will foster further development of the region, and that its viability as an alternative supply should therefore be assessed on the grounds of its true energy intensity. In December, 2009, the Bay Council groups made a legal appeal against the Coastal Development Permit issued by the Coastal Commission. The contention of the environmental groups was that Poseidon intentionally misled the Coastal Commission in its commitment to developing a carbon neutral facility. The claim was based on an earlier agreement Poseidon had made with MWD that the water produced at the Carlsbad plant would not displace imported supply – an agreement that had not been disclosed to the Coastal Commission. On investigating the claim, the Coastal Commission found that Poseidon had deliberately withheld information and intentionally misled the Commission in order to claim that the Carlsbad facility would be net carbon neutral. It concluded, however, that due to overwhelming political support for the project at both the state level and from local municipalities "the Commission's decision would not have changed based on Poseidon providing complete or accurate information about the project's effects on SWP-related emissions" (California Coastal Commission, 2010: 121).

In charting this dispute over water and carbon accounting, my aim is not simply to outline the choreographies of contestation over the development of one desalting plant, but to point to a deeper dispute. The extraordinary material and political factors that are brought into play in the desalination assemblage are such that the Carlsbad project became the focus of broader debates on environmental governance and water-energy futures. Indeed, the desalination debate has raised the water-energy nexus in the priorities of California's environmental groups, as well as for government and industry. NGOs and civil society organisations are beginning to put pressure on governments to address the tensions and trade-offs between water and energy. The conflicts that have surrounded the development of desalination in San Diego – particularly in the contradictory imperatives towards increased water supply reliability through alternative sources and climate change mitigation – may well be a bellwether of things to come.

CALIFORNIA'S TWOFOLD WATER FIX

The emerging water-energy politics in California are messy, contradictory, fiercely contested, and of course, open to a variety of interpretations. Drawing on recent work by Michael Ekers and Scott

Pudham (2015: 2017a: 2017b), this paper argues that the disputes over desalination in San Diego reveal the tensions between two forms of socioecological fix. The notion of a spatial fix was initially developed by David Harvey (1981, 1982; 2014) to describe the geographical and historical strategies that sustain or rejuvenate capital accumulation in response to recurrent crises of overproduction and cyclical downturns. The spatial fix, Harvey argues, has been central to historic patterns of economic development because it allows capital to overcome barriers to accumulation without fully addressing or solving its internal contradictions, thereby "partially mask[ing] the irrationality of capitalism" (Harvey, 1981: 11).

The ecological dimension to the spatial fix is, of course, critical for understanding mechanisms to overcome what O'Connor (1998) calls the 'second contradiction of capitalism'. This describes capital's tendency to undermine or deteriorate the material conditions for its own reproduction, resulting in a *crisis of underproduction*. In this regard, water scarcity resulting from over-extraction, depletion, pollution, and modernist supply-driven modes of governance, represents a threat to continued economic growth under the productivist logic of water management. The spatial fix, in this regard, does not resolve the contradictions of capital, but rather displaces geographically or postpones the full effects of a crisis and its implications for prevailing economic growth (Smith, 1984). Ekers and Prudham (2017a, 2017b) have pointed out the importance of infrastructure in this process, by elucidating the connections between capitalist development, environmental transformation and investment in fixed capital. Fixed capital (like a desalination plant), they argue, is an essential mechanism by which the metabolic interactions between humans and nature are shaped, and therefore mediates the social and ecological for relations that underpin accumulation. Understanding the ways in which infrastructures are enrolled as socioecological fixes, and thereby shaping the material conditions of accumulation, in other words, allows us to "interrogate the political ecology of capitalist accumulation and crises thereof as they articulate with the broader politics of environmental change and everyday life" (Ekers and Prudham, 2017b, 15).

In this regard, seawater desalination is understood to be part of a diversification fix for water stress, an infrastructural development capable of producing freshwater regardless of climatic or hydro-political context. In the face of concerns over growing water scarcity for many cities, March et al. (2014, 2642) observe, "desalination appears as a sort of 'cornucopia' able in principle to solve future water needs of urban expansion". Similarly, Swyngedouw (2013: 262) has argued that "whereas terrestrial waters are marred by complex property rights, inserted in dense regulatory and institutional arrangements, infused with all manner of social, cultural, and ecological conflict", the incorporation of seawater desalination as an element of water supply, by contrast, "appears to be free of these highly charged meanings, claims, and practices". Desalination, then, represents a socioecological fix for thirsty urban societies by applying a high-technology 'solution' to the problem of water scarcity – and one that is promoted as ecologically sensitive by many of its proponents – thereby maintaining a supply-driven, growth-oriented model of water management (Swyngedouw and Williams, 2016). Yet, as such a water fix, desalination does not resolve the contradictions it sets out to overcome, but rather displaces or postpones their effects (McEvoy, 2014). At the same time, increasing attempts to manage the water-energy nexus through concepts like the loading order, can also be understood as a socioecological fix that seeks efficiencies between resource sectors in order to secure the material conditions of accumulation. According to the nexus rubric, it is not sufficient for a water supply project, for example, to *merely* supply water, but must also fulfil other sustainability criteria relating to nexus interactions. The burgeoning policy focus on managing the resource nexus represents an attempt to quantify and shape certain aspects of resource governance that were previously externalised. As Scott et al. (2015: 16) puts it, nexus thinking pursues "integrated approaches to resource use that emphasise longer-term social and ecological sustainability while offering operational means to internalise externalities". In other words, the connections between resources become the new focus of innovation, transformation and investment.

CONCLUSION: BREAKING THE 'CYCLE OF INSANITY'

> You look at urban environments and everything is sloped to make sure that whenever there's a drop of water, we capture it and force it off the land. And everything that goes down your toilet goes to one centralised plant, cleaned up and dumped in the ocean. And to complete the cycle of insanity, rather than not doing that anymore, we pump it right back out of the ocean and take the salt out of it. Now we're realising it's a really broken system… The only water proposal that doesn't fit into a multi-benefit future management plan is seawater desal. It's a supply development for sure, but it doesn't do anything else; it's just really expensive supply (Interview, 05/11/2014).

This paper argues that the presentation of seawater desalination as a viable alternative water supply for Southern California, and the heated debates that surround this issue, offer valuable insights on the changing geographies and political economy of resource governance more generally. The disputes around the Carlsbad desalting facility, which have largely been litigious – California's courts being the battleground favoured by the Bay Council and the convoluted permitting process the subject – go beyond those of a reactionary, project-specific fracas. Indeed, the crucible of desalination has brought divergent notions of sustainability, relative scarcity and resource governance into direct confrontation. The various groups and interests that have marshalled themselves on either side of the desalination debate (for the debate has become somewhat reductionist and polarised), represent very different visions of Southern California's water and energy futures. Desalination has emerged at the centre of these debates. Indeed, desalination, because it is so contentious, illustrates well the broader paradigmatic shifts around diversification and water loading order in California. By pursuing desalination, water and energy are brought together in new and extraordinary ways, reconfiguring nexus interactions and interdependencies. Relative scarcities and abundances become muddied. The politics of energy become the politics of water, and water that of energy.

Desalination, as the interview excerpt above illustrates well, occupies a deeply contradictory position in the context of resource governance transitions. Although desalination is being enrolled in a process of reassembling the technical and social relations of water in San Diego through diversification, aimed at reducing reliance on contested transfer networks, the arguments for integrating desalination as a component of a diversified portfolio are exclusively water supply-oriented. In other words, that which is gained in terms of water supply represents a direct trade-off for energy and other areas of resource governance. Desalination, because it addresses only water challenges regardless of interconnected implications for other sectors, is consistent with compartmentalised modes of resource governance. Indeed, led by the Bay Council and California's vocal environmental groups, those who oppose desalination developments are arguing for water governance practices and technologies that reflect the resource nexus, manifested in the notion of a loading order. Desalination, then, represents a solution under a very particular resource rubric, but is inconsistent with growing calls for integrated environmental governance. The novelty of large-scale desalination, and the political and ecological complexity of a large infrastructure like Carlsbad, elucidate relationships and processes that would perhaps otherwise remain unseen or un-problematised. The disputes over the intricacies of carbon accounting that have structured the desalination debate in San Diego, this paper argues, stand as proxies for deeper divisions between concepts of nature and the future of resource governance. While desalination is consistent with the diversification fix, it undermines the nexus fix. This paradox, I argue, lies at the heart of debates over desalination in Southern California. By opposing desalination and supporting wastewater recycling, California's environmental groups have aligned themselves very closely with the techno-managerial concepts of mainstream nexus thinking. Given that the recent popularity of nexus thinking, I have argued, must be read as part of a broader shift in the logics of capital towards integrated environmental governance, a tentative conclusion – or at least suggestion – of this paper is, therefore, that the 'progressive' environmental community in California are becoming increasingly vocal actors in the advancement of this emerging mode of accumulation.

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