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Questioning the Constructed Intangibilities of Water Resources within the Modern Household

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Abstract

The built environment defines how societies shape relationships within hydrological systems to ensure water security within natural and constructed limitations. Globally, due to geographic, climatic, and anthropogenic reasons, the experience of water scarcity is highly unequal. Within water-secure households, water is often taken for granted as a resource; this is in stark contrast to over a quarter of the world, including at least two million American citizens, for whom water insecurity intersects with the risk of losing residential tenure and heightened disease burden (Urban Waters Learning Network, n.d.; Fedinick et al. 2019).[1]

In this paper, I show how centralized water governance models typically result in highly varied levels of household water security. Globally, public and private water authorities have adopted an economic model of scarcity in water management. Governments and service providers attempt to forestall unsustainable environmental degradation, costly energy intensity, and the mismanagement crippling large-scale infrastructural systems with the revenue they derive from treating water as an economic good. However, these models do not guarantee water access, safety, or affordability and have resulted in the unequal distribution of water scarcity between households.

The issues with centralized water management and the burden on communities are discussed through a case study of the 'Day Zero' drought in Cape Town, South Africa, which took place from 2015-2018. I discuss water access in two households before and during this three-year drought and emphasize how the built environment factors into consumption patterns, water tariffing, and the regulation of water access.

In contrast, I argue that decentralized and on-site water management could mediate regional and socio-economic disparities through increasing local water access.[2] I foreground urban disparities in local water access to advocate for the decentralization of water infrastructure and an increase in access to and support for household water and energy security. Residential-to-neighborhood structures for on-site water management could provide more equitable resource negotiation within the built environment, increasing access and widespread security as locally attuned hybrid-decentralized systems.

Keywords: water scarcity, decentralized water management, household water security.

1 Common to numerous issues in environmental degradation, those disproportionally burdened by scarcity have contributed the least to the anthropogenic precursors of scarcity within city-to-regional scales.

2 Thus far, social, and environmental justice considerations through increasing net-zero commitments at numerous levels (building-scale, by companies, by countries), has primarily been framed as a 'just transition' in the protection and accommodation of job transferability between previously polluting to greener industries. E.g., The European Union's 'Just Transition Mechanism', and the Biden Administration's focus on 'green jobs.'

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INTRODUCTION

Since the late nineteenth century, governing authorities have leveraged centralized infrastructure as a form of techno-scientific *safeguarding* of urban civil society (Shiklomanov 1998; Hays 1999; Linton 2010). The large-scale management of natural resources introduced safer distribution of drinking water and waste removal and produced sanitation reforms in public health that led to greater opportunities for urban densification. Through what was perceived as a civil success story, the utilitarian approach to hydrological cycles came to define modern socio-technical constructs of water as an environmental good and service.

Over a century later, scholars are interrogating the results of this approach: In contrast to the stated aspirations of civil engineers, town planners, and governing authorities, the centralization of natural resources has since produced inequalities, insecurity, and politics in how available resources are allocated (UNDESA, n.d.; Rockström et al. 2014). Large-scale centralized infrastructure fosters an over-reliance on throughput chemical treatment processes (Veolia 2015), which has led to the development of the market-driven paradigm of scarcity (Mekonnen and Hoekstra 2016) and the commodification of natural resources through the quantification of the hydrologic cycle (K. Bakker 2003; K. Bakker 2007, 2012; Hejazi et al. 2013; Hoekstra 2013). Resource and energy-intensive infrastructures of the twentieth century have remained materially entrenched within contemporary built environments. Their largeness perpetuates dependence on a legacy of totalizing, monolithic, and single-function modes in infrastructure development. Globally, urban environments are locked into a physical and perceived dependence on these systems, which continue to accumulate incredible social and environmental costs.

This paper draws out the environmental and social implications of centralized infrastructure as it relates to the experience of water insecurity among several households in Cape Town, South Africa.[3] The city's Day Zero water crisis in 2018 provides a case study to explore expected typological events in fast-urbanizing, climate-risk affected, highly unequal, and informal settings characteristic of urban growth globally. The discrete experiences of an informal "less serviced" household and a formal, more affluent household exemplify several interrelated water governance misconceptions that urban disciplines risk perpetuating in built form. As this case study shows, dependence on highly centralized water and energy systems within a global context of rapid urbanization is unsustainable. Firstly, these systems will be unable to provide timely responsiveness to the increased need to deliver basic services to state-supported or low-income households. Secondly, it highlights how commodifying water flows is a socially unjust and misguided water management approach, especially considering certain actors' potential for inflation of water scarcity rhetoric. Thirdly, it illustrates how technocratic impositions on social and environmental resource pathways constrain local resource access and thereby perpetuate "burden" or "demand" classification of households.

MODERN WATER AND SCARCITY

Water scarcity occurs when insufficient freshwater resources supply a given area's human and environmental demands. The concept of water scarcity includes a subset of categories that distinguish between the various levels of societal, economic, and environmental water scarcity.

The determinants of scarcity are many, including 1.) The biophysical and ecological variables that determine water's regeneration as a renewable resource within the hydrologic cycle, 2.) The distribution of periodic resource intensity, both globally and as influenced by transboundary to local infrastructure, and 3.) Numerous anthropogenic factors of the built environment and the material impacts of politics, policy, and mismanagement (Mehta 2003). At the household level, water insecurity depends on a range of factors, including water affordability, water safety, and reliability. Each of these factors is an association between the economic, infrastructural, regulatory, and environmental circumstances of the household within the civil constructs of its society. These may arise independently of one another and thereby prolong the period over which a household might suffer water-related vulnerability (Broyles et al. 2022).

Scholars describe scarcity in water management as a politics of allocation (Mehta 2013). Water's allocation, both by use and value, determines the supply-demand equation in evaluating scarcity. The highly qualitative economic and social paradigms that define resource use, necessity, and quantification are rationalized to suit the priorities in allocation. Scarcity can therefore manifest locally and selectively, thereby differing across

3 Regarding the built environment and water governance models, a household is both a unit by which consumption is monitored and tariffed and the civil, economic, and environmental conflict threshold. Often separated from the realities of a physical building premise, the household unit is generalized to represent a wide-ranging set of occupancies and social intricacies that would broadly fall into census-level demographic categories. Legality and residence in a city are defined by whether a household meets its property's tax and meter obligations, including all utilities-related surcharges for water and sewerage. At this point, the governing municipality defines the socio-economic relationship that impacts how and at what cost basic service provisions and rights are to be accessed.

households. Centralized infrastructure's capacity to channel and contain tangible environmental resources has allowed these systems to determine where periods of scarcity or abundance may occur. These systems inevitably take on what was defined as the "Commons" to represent what has been accumulated and will be competed for as an asset and commodity.

By correlating household water scarcity with the shape of the built environment, this paper is an attempt to simultaneously suggest an alternative to scarcity—namely, that building-scale water management could alternatively provide local forms of resource *abundance* (Xenos 2017). Advocacy for the greater decentralization of water management for reasons of resilience, efficiency, and accessibility could correlate with the goal to increase net-zero water and energy management on-site to protect against the local and universal threat of scarcity.[4] By reframing specific environmental goals in building performance to include social justice issues such as water access, we could avoid perpetuating scarcity by reproducing such technocratic modes in architecture.

CASE STUDY: DISPARATE EXPERIENCES OF WATER SCARCITY ACROSS A CITY

The city of Cape Town has a familiar urban fabric characteristic of global patterns of urbanization in that the older, more formalized city bleeds into a patchwork of informal urban growth on the outskirts. The cross-section of the city depicted in Figure 1, which connects the city center to the periphery, represents an extreme change in demographics, service access, and mobility, etc., and physically illustrates the socio-economic difference across households underscoring South Africa's World Bank rating as the most unequal country in the world (Sulla, Zikhali, and Cuevas 2022). In this context of significant disparity, where one in five households are in poverty, indigent homes are highly dependent upon the protection offered by their basic Human Rights and their constitutional protection as citizens of a new South Africa (SA - CoGTA, n.d.).

In 1997, the South African Constitution enshrined the right to water that through the Free Basic Water Policy of 2001, mandated that all municipalities ensure a free allocation of 6000 kL of water per "*indigent"* household a month (Water Services Act 1997).[5] [6] Each home should receive this amount through a municipal connection to a source within a walkable distance that meets the UN General Assembly criteria for Improved Water Access (2010).[7]

Households with indigent status can reside in both formal and informal housing settlements. Formal housing types have a municipal connection and receive energy and water services. In contrast, informal housing settlements are either illegal structures on non-residential or environmentally unsuitable land or are settlements acknowledged by the municipality and in the process of being formalized (Western Cape Department of Housing 2005). Cumulatively, over a third of the city's households are indigent and unable to afford their own water needs (Enqvist and Ziervogel 2019). Informal housing represents 14 percent of Cape Town households but consume only 4 percent of the residential water demand. Typically, up to fifty informal households may share a communal tap.

The City of Cape Town adopted a hybrid water governance model in 2001 that provides water services as a constitutional Human Right and an economic good. All residences receive the free allocation of 6000kL per month, and any excess consumption is charged for on an escalating water tariff structure. By increasing water rates at each level of consumption, surplus water use is constrained, and the city reaps increasing water revenues through each tier of price penalties. By doing so, the city attempts to sustain service provision through incoming water revenues without infringing upon constitutional water rights.

The maintenance and improvement of a city's centralized water infrastructure in a hybrid governance model largely depends on paying water consumers. In contrast to the households that depend on the free water allocation, the remaining two-thirds of Cape Town's population are paying water consumers who undergird the municipality's water revenues, ensuring continued

4 This paper emphasizes the constructed nature of Water Scarcity to comprehend the social and material flows around resources as entangled ecologies. Water availability is as much a material relationship dependent on how it is used, in what quantities, and whether the means of access could provide it the right quality as it is a reflection of societal values with respect to the prioritization of resources employed to ensure water security within a politics of allocation. Referring to it as a construct by no means denies environmental realities such as increased aridity in physically water-scarce regions or more significant variability in the climate. Instead, its use is a means of identifying how anthropocentric paradigms participate in socio-ecological phenomena that occur relationally, refuting the possibility of 'technical solutions' or reductive prognoses.

5 Note that, in informal settlements, one residential unit can house up to 8–15 people, far surpassing the free water allocation which is based on an average 3.2 persons per household.(Savelli, Rusca, Cloke and Di Baldaserre, 2021).

6 Indigent status is determined by households' ability to access basic services and applicable if "the combined monthly household income is below the income poverty threshold as set by the municipal indigent by-law" (SA - CoGTA, n.d.).

7 "The Resolution calls upon States and international organizations to provide financial resources, help capacity-building and technology transfer to help countries, in particular developing countries, to provide safe, clean, accessible, and affordable drinking water and sanitation for all." (UN General Assembly 2010)

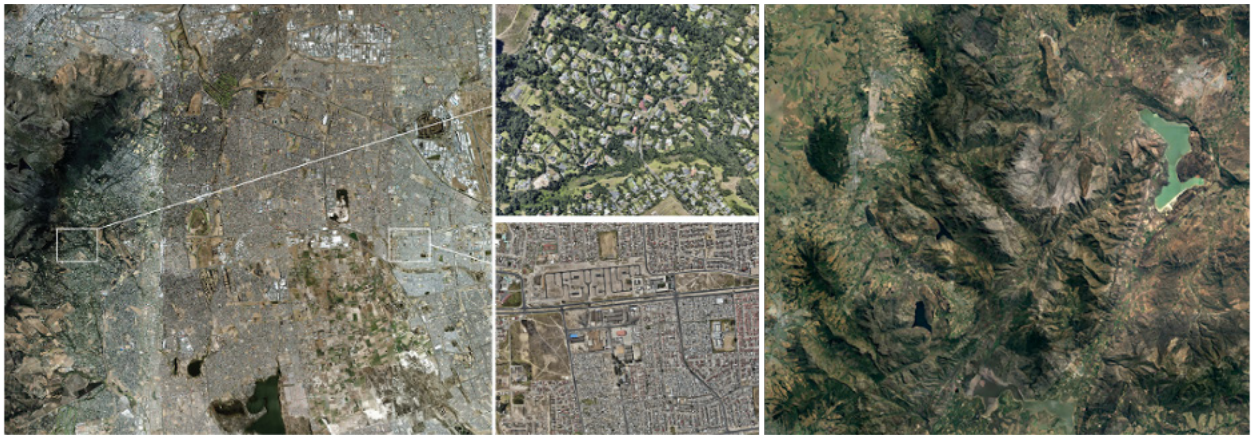


Figure 1: City of Cape Town, South Africa: Aerial view across a diverse socio-economic cross-section of varied Formal to Informal Household Types, surrounded by rain-fed dams upon which the municipal water supply depends.

city-wide service.[8] As is typical for the majority of middle-class households globally, water consumption in Cape Town's suburbs are high: Daily water consumption in municipally connected households are on average 143L per person or up to 237L per person when including outside water usage (Murwirapachena 2021).

Treating water as an economic good is highly problematic in a water-scarce context, where scarcity constructs can only drive up the cost and competition for the resource. It is especially harmful in an arid climate, particularly in a city facing high-income inequality where many households lack access to their basic needs. Pricing the allocation of water removes it from the shared resource construct of "Commons," according to which residents use water according to its natural availability. Once water stewards become water consumers in an economic framework, the communal means of protecting shared resources and one's needs is diminished.

The drought of 2018 revealed issues with water allocation as well as the scarcity politics inherent in the hybrid governance model. The Cape Town region is semi-arid, prone to dry spells, and dependent on several rain-fed dams for 95 percent of its freshwater supply. Following a prolonged period of decreasing annual rains, the region fell into a three-year drought, which was forecast to climax on April 18, 2018 (Day Zero), when the city's water would be shut off and four million people would no longer have running water (Enqvist and Ziervogel 2019; Rodina et al. 2017).[9]

THE INTANGIBILITY OF AN INFORMAL HOUSEHOLD'S RIGHT TO WATER WITH CENTRALIZED WATER GOVERNANCE

Before the drought, The City of Cape Town began to install Water Management Devices (WMDs) in indigent homes dependent upon the municipal "free allocation" of water. The City was struggling to curb excess water consumption over the daily allowance. This placed many families in arrears and destabilized the city's returns in the water supply. Choosing to take the neoliberal approach to manage lower-income households' water consumption, namely, through active intervention, WMDs could remotely throttle water supply to indigent households. These devices gave The City on-site control of each household's water consumption, allowing it to switch the taps on to supply the free-allocation and regulate flow according to what the household could afford. The WMDs were lauded as a practical means of mutually "protecting" the residents from incurring debts and the City from the resulting losses in revenue.

The introduction of prepayment technologies incited numerous protests nationally, however. In each instance, residents protested the imposition of these devices as an infringement of their constitutionally protected rights. At a more fundamental level, residents protested how the governing authority's intervention echoed the disenfranchisement imposed by racially segregated Apartheid South Africa: The WMD threatened land rights, water rights, and imposed a sense of surveilance within households, thereby challenging both a legal and perceived sense of citizenship. Residents rejected

8 Consumption revenues enable staged infrastructural investments and ongoing maintenance, as is prevalent with centralized water utilities. A hybridized water governance model commercializes water access through an Integrated Block Tariff structure that modifies water consumption through prohibitive escalated pricing adjusted to protect cost-sensitive city inhabitants. Furthermore, with the Block Tariff Structure pricing, findings showed that cheap water does not lead to an enormous waste of a scarce resource. Even if one observes the households consuming segment receiving water for free (less than six kL per month), only 29 percent of the meter readings indicate the maximum free allocation usage. See the complete study: (Jansen and Schulz 2006).

9 For a comprehensive report of the drought events, see Ziervogel (2019).

the municipality's attempts to obligate users into normative models that indiscriminately rationed what a household was to consume. Not only did communities feel disenfranchised from determining how much they needed as a basic human right, but keeping usage within the imposed allocation was paternalistically touted as a show of"'civic virtue". Residents' household security was threatened by the so-called ethics of consumer responsibility that the governing authorities defined as a precondition for their access to citizenship rights (Von Schnitzler 2008; Chipkin 2003).

> …We prepay for electricity, prepay for the phone, and now we prepay for water too, who knows tomorrow we'll have to prepay for the sun to be switched on and off. [10]

During the drought, these prepayment technologies imposed restrictive water management measures that took advantage of a household's dependence on centralized water infrastructure.[11] Indigent households experienced the intangibility of water under the ubiquitous application of a regulatory policy enforced by an on-premises regulating device. It was through this device that households came to experience the state regulation of domestic life and the application of universalist principles of rational consumption. The governance model in the water crisis defined when and how much water could be consumed by each resident. In doing so, it produced a visceral experience of the conditioned access to the right granted to all citizens by the Constitution, an access that had been worsened by systemic inequality. The prepayment technologies automated a "stick-and-carrot" method, producing an infrastructural dependency that further heightened the uncertainties of indigent household degree of informality: Via the meter, access to water was temporal, required compliance, and served as its own means of government communication and persuasion (Roy 2005).

A TRADE-OFF BETWEEN PRICING WATER AS AN ECONOMIC GOOD AND URGING HOUSEHOLD WATER RESTRICTIONS

Scholars have drawn attention to the intersecting and contradictory ways in which select cities are managing water access and supply in highly unequal societies with limited infrastructural access (Yates and Harris 2018). Each approach has distinguishable priorities; whereas the neoliberal perspective harnesses market flows to achieve efficient and effective water provision, the human right to water-orientated approach unequivocally emphasizes equitable, stable water access.[12]

During a drought, a commercial approach to water use economically conflicts with a water-deprived "communal" environment in material terms. The City of Cape Town's City Water Map—now offline and unavailable— represented the striking biopolitical context of the city in this period: Regardless of its possible defamatory consequences, sensitive water use data was made public as a behavior influencing strategy to pressure neighborhoods to self-regulate and comply with the severe water restrictions (Figure 2). The City Water Map depicts each household's monthly water consumption relative to water restriction thresholds with color-coded dots.[13] Individual homes were confronted with an aerial image corresponding to a top-down planner's viewpoint on the city's governance's civil mechanisms. These homes, all of which were residences of property-bounded paying water customers, experienced a very different form of governance than the indigent households for whom a physical device installed on their properties regulated daily water access. In a similar campaign, the mayor held a sign reading "Let's Paint the Town Green." The municipality framed the map as a positive pro-social behavior initiative that allowed select households to choose their water restriction level and bring down their total consumption. The "transparency" given to neighborhood consumption patterns was used to coax participation out of motivation or shame. At the time, the global "live feed" of a beloved tourist destination in crisis made a compelling case for the re-evaluation the anthropogenic factors in a water crisis.

ISSUES IN HYBRID WATER GOVERNANCE MODELS DURING A DROUGHT

The different households' experience of the drought and the municipality's management of the water crisis illustrates an increasingly belabored point within the discourse:"'scarcity is not felt universally by all" (Mehta 2003). In the modern construct of water scarcity, the particularities defining scarcity mean that no two

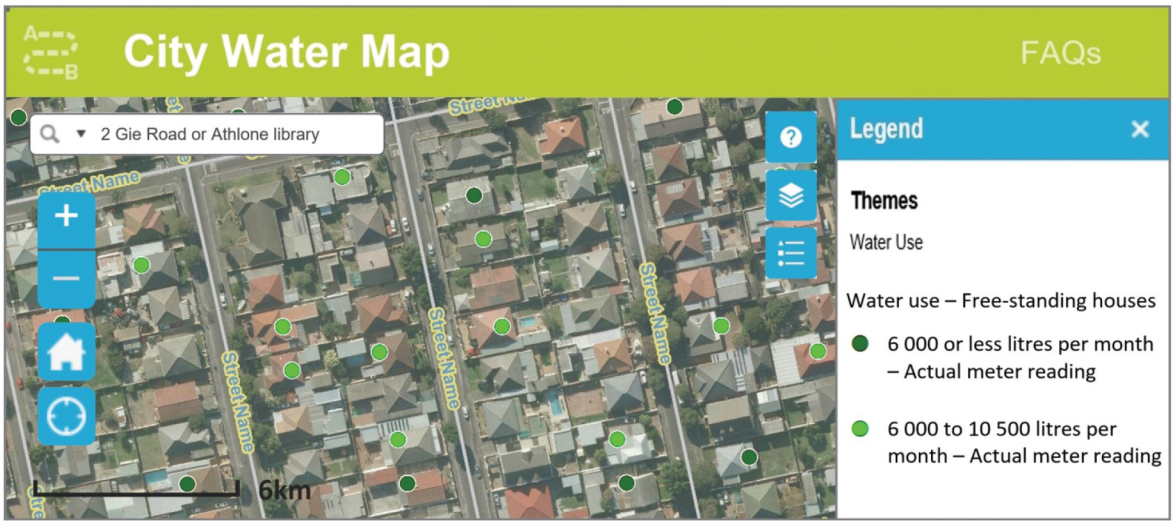
10 Schnitzler quotes a Soweto protester opposed to prepayment technologies dictating access to basic services. The introduction of prepayment technologies incited numerous protests across the country that affirmed a single message: Citizens demanded the basic services that the State promised them (Von Schnitzler 2008, p. 900).

11 Numerous authors have attributed agency to the water and water infrastructure (Larkin 2013; Acevedo Guerrero 2018; Boelens et al. 2016).

12 Neoliberal water governance utilizes commercial frameworks in commodity products to establish mechanisms for water provision, regulate demand through price-fixing, and recoups costs as revenues to fund reinvestment into utilities and infrastructure. It is very much dependent on the 1992 Dublin Proclamation that declared water as an economic good and a resource that governments could price. For this reason, we see an entirely different experience of drought in the affluent homes of Cape Town.

13 Water restriction tiers indicated on the City Water Map: 10 500 kL (87L/person/day) and 6000kL (50L/person/day) (Sinclair-Smith et al. 2018).

FIGURE 1 The Cape Town Water Map's online spatial viewer



FAQs—frequently asked questions

The spatial viewer uses geographic information system data of the city to display markers (light- or dark-green dots) on properties that either used less than 10,500 L (2,800 gal) or less than 6,000 L (1,600 gal) of water per month.

Figure 2: The City of Cape Town's City Water Map: An online spatial viewer concept that went online in 2018. Previously published in Sinclair-Smith et al. (2018, fig. 1).

households in an adjacent urban location necessarily experience the same degree of water scarcity. By allowing the continued premise that water be consumed as a commodity, even within a socio-ecological crisis, we place Human Rights in opposition to the rights of Environmental Protection. In the uninterrupted distribution of a finite resource per the market supply and demand model, the City could seemingly disregard the realities of scarcity if their near-term economic model could outweigh it. Ostensibly created to support equity and alleviate the undue burden on those in poverty, the city's hybrid governance model was anything but equitable: It perpetuated the Scarcity Postulate that presupposes that unlimited (insatiable) water consumption is an inevitability rather than a matter of volition. Indigent homes had their water cut off, whereas homes with excess consumption paid the price penalty, remained silent, and took a place on the City Water Map. A human rights matter of inequitable water access instead became an issue of affordability, as the limits to individual freedoms imposed on "users" and their water access were defined by what they could afford; while some households could choose their ration, others were marginalized to a defined ration. In this paradigm, water conservation is second to the commodification of water. As an economic good, the value of water props up unsustainable infrastructures and use patterns that further increase water costs and scarcity. In this model, the water supply becomes a financial and logistical burden to manage and regulate, by the authorities and within households, more so than would be required if consumption more closely related to the constraints of a common resource. The State and the user interact relationally in assuming to protect water as an environmental common, regarding it both as a commodity and a human right. Herein, water is a currency, a scarce resource, and a right, all at the same time.[14]

14 Sociohydrology is an area of discourse that theorizes the inter-relationship between water and society as mutually interacting flows. Representative of sociohydrological flows, the interactions in human-water systems, the city's residents, and the volume of water required to meet basic needs have continued to shape/reshape water governance. Water consumers who could afford to operate within the commercial model of the city's water policy could participate in water management through the self-regulation of their water demand. The restricted water use practice in affluent homes necessitated discomfort, whereas restricted water uses in "indigent" homes impinged the rights to free allocation. The capacity for affluent households to participate in the water restrictions by curtailing all or as much water use over their basic needs illustrates parallel social relations: water use as a paying consumer and as a "responsible" or "ethical" citizen/resident. Since the drought, it is common to see the many affluent homes with rainwater harvesting systems installed in their yards, boreholes, or retrofitted greywater supplies to toilet cisterns. These changing behaviors would constitute a social reshaping of how much water could be demanded from the centralized systems and

DECENTRALIZED WATER MANAGEMENT IN THE BUILT ENVIRONMENT

If we conceive scarcity as a local condition, we should question how its localized mitigation could similarly occur within the built environment. Several papers look at the importance of site-specific parameters as contextual and relational informants for nested water governance models.[15] The most significant issue with centralized water treatment is the lack of appropriateness, be it in the treatment techniques employed or in the infrastructure's ability to adjust to changing resource environments and stressors. In light of these issues, multi-scalar and hybridized decentralized water treatment is emerging as an alternative model to centralized infrastructure and an approach that could better manage the full spectrum of technical, social, environmental, and justice issues that have systemically defined resource access throughout the recent century.

As a first principle, and in redefining resource access, decentralized and distributed water systems contrast to central infrastructure in that each system can be smaller and more compact, serve a more immediate community, and reflect the resources of the immediate environment. Possibly occurring as a hybridized shift from conventional infrastructure, the decentralization of water treatment would offer immediate benefits to over-extended water utilities and the environment, decreasing energy and chemically intensive processes and water loss through leakages, transmission, and service costs.

Technological advances in material science and system engineering have made this alternative possible. In contrast to using emerging technologies to dominate the environment through large-scale, totalizing systems, we could reinvent resource availability by investigating a technical manipulation of the ambient resources in relation to the very demand of the site locally. Therefore, smaller-scale, renewable, and affordable treatment techniques can be deployed as adaptive component systems that serve households, multi-tenant buildings, and neighborhoods and are defined uniquely by types of urban, peri-urban, and rural settlements.

Effective resource management demands a greater awareness of contextual parameters in the design of all scales of water systems. Since water is a highly qualitative phenomenon, the design of water systems requires a more contextual approach than other large-scale infrastructures. Contextual parameters such as changing water demands, how use types define the grade of water treatment and the source water's mutable nature results in constantly changing system requirements. In developing more selective, flexible, and efficient water management practices, we could reduce the risk of scarcity by providing a structured means of producing, intensifying, and harnessing resources in periods of resource "abundance." The greater decentralization of resource use could reduce the need for centralized distribution and the commercialization of natural resources. In addition to all the environmental burdens that could be lifted with more sustainable systems, decentralized water management could relieve us of the imposed resource constraints of large-scale systems that define scarcity. Distributed water practices could upend the rhetoric of universal scarcity by showing how more effective localized resource management counteracts the adverse effects of large-scale processes.

Current infrastructure practices have resulted in water and energy systems being highly interdependent and mutually vulnerable to failings or resource constraints. The resilience of a household is much the same: No family must be made to sacrifice cooking, heating, or water due to burdens of competing utility costs, as each forms part of the Human Right to an adequate standard of living.[16]

If we reconsider the nexus between water and energy generation at the neighborhood scale, we should identify that households produce a renewable source of energy; their wastewater. The capture and reuse of wastewater for its water, nutrients, thermal, and biomass by-products could soon become an affordable and distributed practice that takes places closer to the source to reap resources where they are needed.

Furthermore, shifting to decentralized or hybrid water management should challenge zero-water and net-zero targets in buildings. Alone, these targets do not factor in accessibility or the very dire impact that a neglect of our environmental resources would have on more vulnerable communities within a given city. At the most basic level, installing solar panels, solar water heaters, or rainwater harvesting tanks needs to become subsidized for homes, not only incentivized as tax breaks.

With the Cape Town case study, many middle-class

environment more broadly.

15 Case studies in building water management are typically based on commercial office buildings (regular use pattern, lower consumption, larger facility for rainwater, and greywater management). Most make quantitative approximations using macro-scale data that omits more dynamic variables such as environmental, societal-economic, systemic context, and potential impacts. There are limited but significant attempts to investigate the transferability and scalability of these building practices across a broad spectrum of household conditions within studies focusing on household water resilience or on-site water management.

16 1948 Universal Declaration of Human Rights as part of the right to an adequate standard of living, and is enshrined in the 1966 International Covenant on Economic, Social and Cultural Rights (Office for the High Commission for Human Rights (OHCHR) 1966).

Figure 3: Solar Water Heaters have been installed on the roofs of Cape Town's N2 Gateway Housing project. Opportunities in the built environment to better equate local need with decentralized water and energy systems requires cross-sector collaboration, the provision of subsidies, training for local installers and distributors, and community participation. (Author's Image).

homes have since installed comprehensive rainwater and solar energy systems. In addition to concern for another drought, the structural collapse of South Africa's public energy provider, Eskom, has resulted in a diminished capacity for energy generation nationally. Much like the throttling of water supply during the drought, the government's approach to the electricity crisis has been scheduled blackouts or "load shedding" at a suburban level. Interestingly, in this example, the paying electricity consumer has no say in their energy access. In contrast, the government's management of indigent homes' energy needs differs significantly from how water was managed with the WMDs: In the last decade, the government has used United Nations Clean Development Mechanism funding to install solar water heaters in low-income households in social housing developments. As water heating consumes 40-60 percent of a household's energy demand, the authorities sought to reduce up to 2300 GWh national demand and up to 77 000 tons of CO2 greenhouse gas (GHG) emissions per annum through the installation of solar waters heaters (Designated National Authority, n.d.).

Inevitably, the energy crisis has produced a growing market for renewable systems and a shift to decentralized energy by necessity. By actively choosing to distribute energy production to reduce the national load, the shift in approach has benefited households while also reducing grid demand. The program has faced delays related to mismanagement, the dependence on imported systems, and poor training and installation quality of local installers (Netshiozwi 2019). Nevertheless, whether or not installing these systems relieved the government from public disapproval and total system collapse, the significant achievement was in showing how the need to move to renewable and decentralized energy could be combined with plural mutual benefits to citizens, the success of governance approaches and the environment alike.

CONCLUSION

Based on current climate scenarios, the chances of another extreme meteorological drought like that which led to Cape Town's Day Zero in 2018 have tripled (Sousa et al. 2018; Otto et al. 2018). In the face of global urban and climatic stressors, the reliance on unsustainable practices in centralized water infrastructures, such as privatization or diminished service quality, systemically contradicts the Human Right to Water assurance. If purely understood as a linear distribution of services and resource management, centralized infrastructure will continue to lack resilience. This will be especially

true wherever allocation continues to be determined by water's value as a commodity, which increasingly divorces water infrastructures from their socio-environmental context.

The dominance of centralized economic logic within the management of urban water systems has resulted in the loss of water's tangibility and accessibility in the built environment. Water flows have been diverted as a commercial product and regulated as infrastructurally delivered services to paying consumers. For this reason, the issues with linear supply-demand dependencies are most acutely felt at the household scale, where, from a city water map perspective, each residence accesses environmental resources through the systemic socio-economic confines of a citizen-consumer dynamic where services are delivered via a water meter. The alternate view, pluralizing agency, and its distribution recognize that the built environment comprises numerous means of interfacing and participating in decentralizing resource water management and that these resource flows could operate outside the current water paradigm as an economic good. The opportunity to generate or recuperate water and energy on-site may be a matter of technological advancements. Nevertheless, the nature of its distribution and built environment assimilation is a matter of continued heterogeneous determination by diverse actors and approaches.

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