The Infinity of Water: Climate Change Adaptation in the Arabian Peninsula

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If climate change mitigation is about energy, adaptation is about water. While mitigation efforts attend to the main drivers of climate change, specifically by limiting emissions through innovation in renewable energy and clean technology, adaptation work concentrates on managing the already observed impacts of climate change as well as those predicted to happen with a high degree of certainty, such as water scarcity. Accordingly, the Intergovernmental Panel on Climate Change (IPCC 2015), the transnational body responsible for climate change governance, defines adaptation as "adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts" and adds that "it refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change."

In the Arabian Peninsula, adaptation takes a slightly more nuanced form. Drawing on seventeen months of fieldwork on climate change governance in the United Arab Emirates (UAE), ethnographic research at climate change summits in Durban (COP17) and Doha (COP18), and recent interviews with climate change consultants, this article analyzes how the definition of climate change adaptation becomes negotiated and reinterpreted in the region in ways that shape how

I am indebted to Eric Klinenberg for his engagement with various versions of this piece and to Stephen Twilley and Tim Neff for their editorial assistance. Sarah El-Kazaz, Bridget Guarasci, and Sophia Stamatopoulou-Robbins read an earlier draft and made helpful comments. Wenner Gren Foundation, Cornell University, Rice University, and the ACLS Foundation provided funding for research. Finally, I thank my interlocutors in Abu Dhabi and elsewhere for taking the time to share their perspectives on climate change.

Public Culture 28:2 DOI 10.1215/08992363-3427463

oil-rich nations articulate and act upon environmental problems.[1] I argue that climate change adaptation projects in the Arabian Peninsula are often attempts at reframing water-related challenges that are already present, regardless of the effects of climate change; for instance, the groundwater sources in the UAE will be destroyed not necessarily due to the predicted impacts of climate change but because they will soon be sucked dry. These challenges are born of not just environmental but also social, political, and economic conditions, such as high levels of per capita water consumption or increasing population, which receive less attention from policy makers. In other words, in the Arabian Peninsula climate change adaptation is about water, while water is not necessarily about climate change adaptation.

In this article, I show how the UAE government advances a view that I call the "infinity of water," by relying on technological solutions, particularly desalination, the process of removing salt and other minerals from seawater. The UAE (along with Kuwait, Libya, Saudi Arabia, Jordan, and Singapore) suffers from absolute water scarcity, which means that it has an annual renewable water capacity of less than five hundred cubic meters per capita, a rate that worsens every year due to increasing population levels (Baba et al. 2011: 39).[2] However, the renewable sources are supplemented by nonrenewable nonconventional desalinated water. The "man-made" quality of water—where more can be generated through desalination whenever necessary—allows the actors in the area to envision and embrace its infinity, regardless of existing water scarcity. Such attempts at imagining the infinity of water deny and efface the "natural" characteristics of this resource. In the UAE, water has become a product of sophisticated technical procedures, social relations, and historical trajectories that can be manipulated and governed.

The imaginary of "infinite water" mirrors what happens in the energy sector. Timothy Mitchell (2012) argues that conceptions of endless oil supplies enabled progress to be conceived as infinitely expandable, without any material constraints. In the mid-twentieth century, the cost of energy did not present a limit to economic growth, as oil prices continuously declined. Given how simple it was to ship oil across the world, this resource could easily be treated as inexhaustible. This belief in the infinity of oil also played a key role in producing the "economy"

1. COP17 and COP18 stand for the 17th and 18th sessions of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC). Recent works in history, anthropology, and political science that share this focus include Jones 2010, Limbert 2010, Luomi 2012, and Mitchell 2012.

2. For an inquiry into the production of water scarcity in Egypt, see Barnes 2014: 35–71.

as an object, which could expand without any limits. In Abu Dhabi, the imagined infinity of wealth engenders an illusory capacity to construct water infrastructures whenever necessary. Through its ever-expanding oil economy, the Emirates can perhaps manage its water.

We now know that the age of abundant fossil fuel supplies is ending, but we seem unable to abandon the ways of living and thinking that fossil fuels made possible. In preparing for a future without abundant oil, the Arabian Gulf, and especially the Abu Dhabi government, attempts new strategies of resource management, hoping to generate a new type of infinity through what I call "technical adjustments": imaginative responses to environmental problems and energy scarcity that open up certain interventions (such as extending technological complexity), while foreclosing others (such as asking larger-scale questions regarding how to live).[3] Such adjustments provide a means for vaulting into a future where humans will continue to enjoy abundance without interrogating existing social, political, and economic relations.

Next, I demonstrate how the complexities of water pricing inform a strategy for regulating water consumption for the climate change consultants working in the region. Climate change consultants come to the UAE from all over the world for professional purposes and assist in the production of national and international climate change policy, serving as key players in the climate debate.[4] The consultants I met in the UAE worked for state-funded organizations such as the Directorate of Energy and Climate Change at the Ministry of Foreign Affairs and Masdar and pursued opportunities in intergovernmental institutions such as the International Renewable Energy Agency (IRENA) and the United Nations Framework Convention on Climate Change (UNFCCC) as well as consulting companies, namely, Ernst and Young, Deloitte, KPMG, and PricewaterhouseCoopers. The climate consultants attended climate change summits, followed the debates related to various aspects of climate change governance, drafted reports for internal use and for the development of low-carbon technologies in other countries, and contributed

3. For a lengthier discussion, see Günel, forthcoming.

4. During my fieldwork in the UAE, I worked at Masdar's climate change consultancy unit, Masdar Carbon, which was responsible for preparing a policy submission to the United Nations Framework Convention on Climate Change about carbon capture and storage, a controversial climate change mitigation technology. In 2011 and 2012 I followed the process of composing this submission in Abu Dhabi, tracked the submission to Bonn, and subsequently observed the final stages of decision making at climate summits in Durban and Doha. Generally speaking, my experience with climate change consultants related to the making of carbon capture and storage policy. In this article, I not only draw on my experiences in 2010–12 but also rely on recent conversations with some of these professionals, focused on climate change adaptation.

to the policy production and implementation landscape at the intergovernmental level. Given their global experiences, they changed jobs, moved between organizations, and often left the UAE for positions elsewhere some years after their arrival. The climate consultants I met did not necessarily identify as "environmentalists"; rather, in the words of one consultant, they believed that "the environment is a sexy part of the economy." Accordingly, in the UAE they attempted to employ market mechanisms such as water pricing to change human behavior regarding consumption. In providing an overview of the climate change adaptation process, this article draws on recent conversations with climate change consultants on adaptation strategies, in addition to reports and scientific assessments on climate change dynamics in the region.

Finally, I analyze the impact that debates on climate change and energy scarcity have on the establishment of research organizations in the region. By exploring water-related research at the Masdar Institute and the King Abdullah University of Science and Technology (KAUST)—two institutions that have been put together to form the foundations of a knowledge-based economy in the Arabian Peninsula—I seek to demonstrate how these research centers participate in the making of technical adjustments that enable the extension of fossil fuel–based lifestyles.[5] At the same time, however, these emergent institutions have the potential to serve as spaces where the existing modes of living will be interrogated, eliciting new imaginaries that do not rely solely on such technical adjustments.

Water in the Arabian Peninsula

Toby Craig Jones (2010) starts his book *Desert Kingdom* with a story about the efforts to tow a 100-million-ton iceberg from Antarctica to the Red Sea. In 1976 Mohammed al-Faisal, a nephew of the Saudi king, invested millions of dollars to establish Iceberg Transport International, a company whose only purpose was to haul icebergs to the water-poor regions of the world. The goal was to complete the 5,000-mile voyage in six months to a year for a cost of around $100 million. For a combination of reasons, the project never came to be realized and the company went bankrupt.

The irony of the attempt to transport icebergs is not in its ambition, however, but in the fact that al-Faisal abandoned desalination projects to implement this

5. The Masdar Institute is part of Abu Dhabi's flagship renewable energy and clean technology company, Masdar. It was established in 2009 and began to occupy an ecofriendly building inside Masdar City in September 2010. In 2014 the institute employed 91 faculty from thirty countries and 491 students from sixty-six countries around the world.

seemingly less plausible idea. While icebergs never became popular or feasible water infrastructures (since it was unclear how they would be utilized once they reached the coast or how they would be integrated with the existing water pipelines), desalination now constitutes one of the foremost sources of water in the region. Saudi Arabia alone currently produces about 18 percent of the desalinated water in the world.[6]

In the Arabian Peninsula, most of the natural water supply comes from groundwater and shallow or deep aquifers—resources that are exploited at a rate far outpacing their natural replenishment. Increasing population, rapid urbanization, agricultural production, and the construction of infrastructures and energy-heavy industries have intensified demand for already stressed resources, especially in the past three decades. The shift is perhaps most vivid in Saudi Arabia and the UAE, two countries that have attracted larger populations and related urbanization efforts.[7]

In this context, desalination has become vital to the provision of cities and industries in the region with supplies of potable water. Bahrain and Kuwait were the first to make use of desalination plants, in the mid-twentieth century, but the technology quickly spread across the Gulf. Out of approximately 17,500 desalination plants in the world today, Saudi Arabia, Oman, the UAE, Kuwait, Bahrain, and Qatar (otherwise known as the Gulf Cooperation Council, or GCC countries) host 7,500—roughly 43 percent of the share. The global desalination capacity of these plants is approximately 94,500,000 cubic meters per day—from which 62,340,000 cubic meters per day come from Saudi Arabia, Oman, the UAE, Kuwait, Bahrain, and Qatar, with a share of almost 70 percent (al-Hashemi et al. 2014).

Despite the challenges of producing potable water, the average daily per capita water use in the UAE, a country with a population of about 9 million people, is estimated to be 360 liters. In Abu Dhabi, the wealthiest of the emirates, this number is as high as 550 liters a day, two to three times the world average of 180–200 liters (Solomon 2010). In some ways, these high levels of consumption are related to an environmental imaginary rooted in a colonial sensibility of the environment

6. For a review of these figures, see al-Suhaimy 2013.

7. Climate change adaptation protocols throughout the Arabian Peninsula share some tendencies in terms of technical adjustments. However, it is important to keep in mind that population dynamics and economic policies in the region differ drastically. For instance, while the UAE and Qatar seek to provide comfortable living conditions to all of their citizens, this is not the case for countries with larger income disparities such as Bahrain and Saudi Arabia, where such lifestyles are available to a select few.

in the Arabian Gulf that places Abu Dhabi's arid saline landscape outside the possible normalcy of European geographies. As Diana K. Davis (2011: 4) writes, "Much of the early Western representation of the Middle East and North Africa environment, in fact, might be interpreted as a form of environmental orientalism in that the environment was narrated by those who became the imperial powers, primarily Britain and France, as a 'strange and defective' environment compared to Europe's 'normal and productive' environment." In this context, Davis continues, "the perceived extreme aridity and the constraints that this was seen to place on 'normal' agricultural production fueled an intense interest in hydraulic management by the British and the French." The ability to manufacture and consume water at these excessive rates thereby becomes a symptom of successful hydraulic management, this time by the Emirati government. The presumably successful management of its environment helps the state increase its legitimacy and power.

Desalination, an energy-intensive process, costs the UAE about $18 million each day. The UAE, which is the second-biggest producer of desalinated water after Saudi Arabia, desalinates the equivalent of 9 million cubic meters of water, roughly the size of 3.6 million Olympic pools, in exchange for this $18 million. The desalination capacity of Abu Dhabi in particular increased by over 360 percent between 1998 and 2007 (EAD 2009). These practices attract businesses, immigrants, and tourism to the Arabian Gulf, while at the same time contributing to the production of sovereignty, where the seemingly reckless expenditure generates social standing and prestige. The prevalent use of technical adjustments such as desalination enables and facilitates the imaginary that current social, political, and economic relations can be extended indefinitely.

Ben, a British expatriate who lives in the UAE and has been an active participant in climate change governance for the past twenty years, working for think tanks and nongovernmental organizations as well as national governments, tells me about an unforeseen consequence of the imagined infinity of water:

> In Abu Dhabi, if you drive around, you still see people hosing down their driveways to get rid of the dust. In some of the areas around Abu Dhabi, because a lot of the rocky ground here has a lot of salt, people have been watering their gardens so much that it dissolves the rock, so people get these pitholes under their houses. You know, essentially, you have this area where, for a million years, there has been one day of rain a year, and now suddenly somebody is watering their garden every day. So it dissolves the salt.

The materiality of water—as a costly man-made product with low levels of salinity—leads to geological transformations in the area and operates in a way that the Abu Dhabi residents or policy makers cannot predict.

Landscaping also appears to be a way of performing the infinity of water, generated by technically sophisticated water infrastructures. For about thirty miles, the road from Abu Dhabi to Dubai is ornamented with date palms, green grass, and, at times, wildflowers. While there are no clear estimates of how much water is required for these landscaping practices, many suggest that the Abu Dhabi government expends an extraordinary amount of resources to keep these roads verdant, second only to military expenses, using desalinated water to take care of the imported plants. As we chat, Ben points out that people in the UAE "are starting to move away from this idea that everywhere needs a green, grassy lawn like it's the South of England. But at the same time, of course, people are doing a lot of golf courses and all that." And yet he does not expect consistency and welcomes the rock gardens and cacti arrangements that are beginning to replace the expansive landscaping work.

Through these discussions and practices, water ceases to be a "natural" entity; instead, it emerges as an assemblage of complex technical procedures, social relations, and historical trajectories. As Jessica Barnes (2014) argues in the case of Egypt, water in the Arabian Gulf is not a given. Rather, it is created by and through various groups of experts, technologies, policies, and users who formulate decisions based on a variety of factors, making water the outcome of a social, political, and economic process. As Ben Orlove and Steven C. Caton (2010: 401) suggest, it is necessary to examine "the multiple, often conflicting knowledge systems through which actors understand water." To understand these "multiple, often conflicting systems," it is essential to investigate the specific technologies of water management and desalination, which give rise to multiple, often unexpected concerns, such as rising levels of salinity and algal blooming.

Most of the desalination in the UAE, and more generally in the Gulf, relies on multistage flash (MSF) technology. Here the MSF distillation plants, especially large ones, are paired with power plants in a configuration where they cogenerate water and electricity. Waste heat from the power plant is used to heat seawater; at the same time, seawater provides cooling for the power plant. This reduces the energy needed and drastically alters the costs of running the plant, since energy is the largest operating cost of MSF desalination plants. However, this arrangement also has disadvantages, because it renders water production dependent on electricity generation. For instance, while the demand for electricity varies greatly

between winter and summer, given the higher need for air-conditioning in the summer months, water needs remain roughly consistent. As a consequence, in the summer months the MSF plants produce much more water than necessary.

Faced with this imbalance in seasonal production and consumption levels, the UAE started a pilot activity in which it collects the excess water and injects it into groundwater aquifers, creating strategic reserves rather than dumping it back into the Gulf, a practice that has received criticism. The location of the reserve remains secret, to prevent people from digging wells around the area and extracting water for private use. In the case of a possible disruption in desalination infrastructures, these reserves might become the UAE's lifelines.

As the Gulf countries increasingly rely on desalination for their water supply, the associated energy costs and environmental consequences become ever more incontrovertible. The *Abu Dhabi Water Resources Master Plan* (EAD 2009: 19) notes that "overall fossil fuel use in the cogeneration plants is around 21 million tons equivalent of CO_2 per year and the share attributed to water production and use lies between 20 and 45%." "Thus water use probably contributes between 4 and 9 million tons of CO_2 equivalent per year" and promotes ways of thinking past these issues, such as research and development of newer, less resource-intensive desalination technologies. Reverse osmosis desalination technology, which delinks the practices of electricity generation and water generation, has been one way of avoiding the problems associated with MSF. Mimicking cellular processes, reverse osmosis involves pumping water under pressure through a series of membranes. Since it eliminates the need to heat the water, reverse osmosis requires lower capital investments and less energy. In some parts of the region, reverse osmosis plants are expected to rely on solar energy, an effort currently spearheaded by the Japanese conglomerate Hitachi and supported by Masdar.[8]

But there are problems with desalination that membrane technologies cannot solve, including rising levels of salinity in the sea. As a result of increased desalination activities, the Arabian Gulf's salinity levels have risen to forty-seven thousand parts per million, from thirty-two thousand about thirty years ago (Alderman 2010). The rivers that used to flow into the Gulf, such as the Tigris and the Euphrates, have long been dammed, decreasing the yearly freshwater input. Nor are the precipitation levels high enough to keep salinity levels under control. This results in conditions that threaten the already stressed marine ecosystems in the Gulf, generating future risks for the coral reefs, the mudflats, the seagrass beds, and

8. For some examples, see Hitachi 2015. For an overview of Masdar's proposed program, see Masdar 2015.

the mangrove swamps (Naser 2014). "Never mind peak oil, or even peak water," one article in the English-language UAE newspaper *The National* starts: "Some experts are pondering the possibility of the UAE's development being limited by 'peak salt'—the notional point at which the Arabian Gulf becomes so salty that relying on it for fresh water stops being economically feasible" (Todorova 2009).

Another problem with desalination is the risk of harmful algal blooming, more commonly known as red tide (although the symptoms of algal blooming are not always red). Red tide takes place in the Gulf as a result of increasing seawater temperatures, low current movement, and high nutrient content, especially nitrogen and phosphorus. The algal blooms increase the levels of toxicity and absorb the oxygen in the ocean, suffocating the fish. The blooms also have adverse effects on desalination infrastructures, forcing the plants to close, mainly to prevent the clogging of intake filters. To avoid these circumstances, researchers and policy makers in the Gulf have stressed the need to control pollution and reduce nutrients in coastal waters. Red tide motivates the policy makers in the region to examine the human activity that indissolubly binds together land and sea (see also Helmreich 2011).

It is also important to keep in mind the materiality of the water and to trace its multiple ways of being in the Arabian Gulf. Through its salinity, toxicity, or mere availability on or under the ground, water as a material directly affects the livelihoods of humans and nonhumans in the region and influences decision-making practices. The emergence of increasing salinity levels and algal blooming as significant problems in the region also proves that environmental governance is elusive. Despite the efforts to contain and manage the environment through new business models and emergent technological advancements, there is always a remainder that refuses and escapes control.[9] Not even the more ecologically benign technical adjustments, such as solar-powered desalination techniques, can adequately restrain and subdue this remainder.

Environmental problems have done little to limit expectations for future population growth in the region. Due to an increasing expatriate labor force, the UAE's

9. Like all modern state builders, the governments of the Arabian Peninsula perceive their power over the environment as being instrumental to having power over their constituencies as well as their brand image abroad. Through environmental governance, the UAE manages to attract profitable business enterprises and large numbers of tourists to the region, in addition to generating prestige. However, as many scholars have already shown, the practices of environmental management remain an impossibility, always leading to unintended consequences and unexpected results that challenge these practices of state building and the related claims to power. For a fitting example of this scholarship, see Scott 1998.

population has grown dramatically, from under three hundred thousand people in 1971 to about 9 million today. "By 2030, Abu Dhabi's population is expected to more than triple," states a key report on the economic development of Abu Dhabi (Government of Abu Dhabi 2015). Another report predicts that the UAE's population will exceed 12 million people in 2060 (UNDESA 2015). This surge in population will happen in a context of increasing environmental stress, water scarcity, and climatic transformation, leading to risks and uncertainties regarding how to inhabit the cities of the Gulf.

The Price of Water

While there are a variety of technical adjustments under way in the Gulf that aim at resolving the problem of water scarcity, there is little emphasis on transforming the human relationship with water. As Mohamed Daoud, of the state-run Environment Agency–Abu Dhabi (EAD), explains: "We need to convince [people] that water here isn't a free resource. It's not even a natural resource, it's manmade. It is costly, and it has a big environmental impact" (quoted in Solomon 2010). However, this expectation does not match the luxurious lifestyle that the UAE promotes on an everyday basis, with amenities such as water parks, indoor ski slopes, golf courses, and large water fountains, all supplied by desalination plants.

Emergent water infrastructures in the Gulf are typically not directed at changing or regulating human behavior, as some demand-based systems in other parts of the world are. For instance, in the case of South Africa, Antina von Schnitzler (2013) shows how prepaid electric and water meters (enacted as part of a "save water" campaign) emerge as political terrains and sites of negotiation, motivating consumers to use fewer resources and to pay on time and thereby creating new forms of citizenship and community belonging. In the Arabian Gulf, however, emergent water infrastructures, such as new desalination plants, confront water scarcity from the supply side and help residents sustain their everyday habits of consumption, therefore performing a political feat and signifying that the state will be able to maintain carbon-intensive lifestyles in the years to come.

Climate change consultants who live and work in the region argue that human behavior needs to be transformed and offer demand-related strategies to achieve just that. They propose market-based mechanisms as means of emphasizing water conservation and, at times, push for unprecedented changes. For instance, in January 2015, Emirati nationals began to pay for water for the first time, between AED 1.70 and 1.89 (about US$0.46–$0.51) for one thousand liters (roughly 264 gallons). The new water pricing mechanism also calls for additional price increases for the

expatriates, raising the rate from AED 2.20 per one thousand liters to between AED 5.95 and 9.90. The price of water will vary based on consumption benchmarks and will take into account whether the consumer occupies an apartment or a villa.

Abu Dhabi's water supply had been set up in the 1960s, when the Emirate was under British control and provided water to all residents of the city free of charge. Slowly, pricing mechanisms started being implemented. The first transformation was the flat rate, where expatriates began to pay AED 50 (about US$14) regardless of the amount of monthly consumption. In 1997 water meters were installed in buildings for the first time, and non-Emirati residents began being charged AED 2.2 for one thousand liters. The 2015 price increase, which introduced tiered rates for both Emiratis and non-Emiratis, is presumably the first hike in utility prices since 1997. In its current configuration, the UAE is among the Gulf countries where water is relatively more expensive. In contrast, Saudi Arabia has the cheapest water rates in the region (Wasmi 2014).

Celebrating this transition, climate change consultants and researchers perceive water pricing as a tool that will generate awareness and have an immediate impact on overall consumption patterns. Some propose that increased water prices should be able to partially cover the costs of desalination, an undertaking that is heavily subsidized by the government, while promoting water conservation. In some ways, the consultants I met in Abu Dhabi and at climate change summits in Durban and Doha aspire for what Andrea Ballestero (2015: 265), writing about Costa Rica, calls a "calculation grammar," a process that "governs the relative weights and proportions of the elements that constitute a price, infusing those numeric propositions with distinct meanings." In this way, water price would account for the ethical and environmental aspects of water scarcity while satisfying the population's everyday consumption needs.

Charging for water became a popular conservation strategy and policy tool in many parts of the world in the 1990s, prompting debates on whether water should be conceptualized as an economic good, for sale to the highest bidder, or a social good, available to everyone.[10] One side of this debate argues that consumers do not have any incentives to save water when it is free or underpriced. Yet if water were to be sold at the full price of production, then consumers would behave more carefully and conserve water. Others claim that, however scarce it is, water

10. This debate is a result of two contradictory protocols: the 1992 Fourth Dublin Principle and the 1992 First Rio Principle. While the Dublin principle asserted that water is an economic good, the Rio principle underlined how safe water was a social good that had to be available to everyone. For more information on this debate, see Dinar, Pochat, and Albiac-Murillo 2015 and Page 2005.

should not be commodified in this manner, because privatization dispossesses local populations from a basic resource that was once freely accessible while also generating a dependency on global water companies.[11] In India, for instance, there have been struggles to keep out the companies that are there to bottle the groundwater (Aiyer 2007).

The commodification of water in the Arabian Gulf has its own particular set of connotations. Given that freshwater in the Arabian Gulf is synthetic and already expensive, many climate change consultants advocate that charging for water is the only plausible way to control consumption. According to the consultants I spoke with, the fact that water is close to being free for the Emirati nationals makes it harder for consumption patterns to change. Although water production costs billions of dollars, this cost never surfaces in everyday calculations. For these professionals, pricing the water and formulating it as a commodity is a first step toward showing people in the region that they may soon run out.

In some ways, this debate is reminiscent of the pricing of water use in California. Many advocates of water conservation push for creative water pricing systems there, where drought has led to mandatory reductions of use, with heavy fees for overuse. Despite growing discussions about water pricing, a court decision dated April 2015 rejected the proposal for a tiered-rate structure for water in the Orange County city of San Juan Capistrano. According to the tiered-rate structure proposal, all users would pay a relatively small amount per unit for their basic needs, but as their usage increased they would pay not just for more gallons but more per gallon, giving them an increased incentive to make do with less. However, the court ruled that water price could not be increased purely for the sake of conservation. The state, which sought to implement the tiered-rate price increase, would have to prove that it costs it more to deliver the hundredth gallon of water than the first, because the state constitution bars the government from charging more for a service than it costs to provide.[12] Yet tiered-rate pricing has been adopted in other areas of the United States, such as in Santa Fe (Schwartz 2015). Little by little, water pricing has emerged as a go-to conservation mechanism in various water-scarce parts of the world.

One major difference between the Arabian Gulf and California is that the for-

11. For good examples of these discussions, see Shiva 2002 and Goldman 2005.

12. However, there are other policies that have proved more effective in California. For instance, researchers found that public information campaigns decreased household water consumption by 8 percent, retrofit subsidies by 9 percent, water rationing by 19 percent, and water restrictions (which prohibit certain water-intensive practices, like watering lawns) by 29 percent (Renwick and Green 2000).

mer does not significantly rely on rainwater or groundwater supplies for everyday domestic consumption needs. Instead, the water resources can be produced whenever necessary, through desalination. At the same time, the lack of a calculative grammar through which actors discuss water price prohibits climate change consultants from demonstrating that water is a technical product, whose production depends on a combination of factors and which may become inaccessible to many in the near future.

In the case of the Arabian Gulf, water infrastructures produce an added layer of sovereignty for the authorities who demonstrate an ability to control such natural flows.[13] The infinity of water—its consistent waste, its possible end, its future destruction—translates into a particular type of exuberance and related value, which grants further legitimacy to the authorities in the region. The production of water infrastructure is not only a technical but also a political accomplishment. Managing hydraulic infrastructures in a famously arid climate not only performs a mark of progress for the Gulf countries at the international scale but also generates domestic legitimacy (see also Luomi 2012), ensuring that life will be infinitely available to those who seek to reside there.

Climate Change Adaptation

Despite the lack of needed engagement with water scarcity in the Emirates in particular and in the Gulf in general, research on climate change adaptation processes in the region suggests that there are real, emerging constraints. For instance, the 2011 United Nations report on climate change adaptation and water vulnerability in the Arab world states: "Climate change and climate variability can increase the risks and the costs of water resources management, impact the quantity and quality of water resources, and generate secondary effects that influence socio-economic vulnerability and environmental sustainability." It also proposes further research in regard to the social impacts of such environmental transformations (UN-ESCWA 2011). The environmental conditions of the region have been examined in several Arab Human Development Reports (AHDRs) as well, leading to further proposals about sea level rise, coastal infrastructures, and water scarcity. While the reports' authors strive to contribute to the making of climate change policy in the Middle East and North Africa, their social and political impacts have been minimal (see also Spiess 2008).

In June 2015, Said, a Jordanian citizen who had worked on the United Nations report cited above, told me how climate change adaptation discourses and prac-

13. For a similar argument, see Jones 2010.

tices influenced the existing conditions of water usage in the Arabian Peninsula. Said had spent more than a decade working on climate change adaptation and water scarcity in the Gulf and had contributed to academic and governmental research on this issue. He held a PhD in water resources engineering and had been utilizing his training in various institutions around the Middle East and North Africa for the past twenty years. Said insisted that climate change adaptation and mitigation were marginal political issues in the region. He complained that nobody cared, mostly because people had trouble imagining climate change or responding to environmental problems unless they experienced them firsthand. Said thought that the profligate production and usage of water gave elites in the region a feeling of immunity from ecological reality and environmental responsibility.

When I asked Ben, the British climate change consultant living in the UAE, how he felt about the impact of the climate change adaptation discourse and practice, he gave me a rather similar response. He told me that the EAD had been conducting studies looking at the potential impact of climate change on Abu Dhabi: "Conveniently for them, they've concluded that there won't be much." This finding was partly the result of the model the EAD was using, which did not include much in terms of global glacial melt. In this case, the sea level rise that the model postulated was small. However, the implications of higher levels of sea level rise for this region are drastic. For instance, coastal zones in the UAE, home to approximately 85 percent of the population, over 90 percent of the infrastructure, many sensitive ecological subsystems, and important cultural heritage sites, are highly vulnerable to such impacts of climate change. As a report on the impact of sea level rise in the Arab region illustrates, even a one-meter rise in sea levels will lead to the inundation of 1,155 square kilometers of land in the UAE (el-Raey 2010).

There are factors other than sea level rise that may affect the UAE in particular and the Arabian Peninsula in general. For instance, the IPCC reports that temperatures in the Arabian Peninsula region could increase by 1ºC–2ºC by the 2030–50 period and that precipitation levels could significantly decline. Ben explained, however, that the region was already equipped to deal with the higher temperatures that might arise from climate change. He imagined that a research project by the EAD could have been useful to promote the production of sturdy coastal infrastructures, which would become imperative in the next fifty-year period. Ben's comment showed that despite the financial resources, physical capacity, and breadth of institutions, there was not adequate monitoring of climate change–related transformations in the UAE.

In a critical article on climate change adaptation in the Arabian Gulf, Andy Spiess (2008) touches upon this lack and explains how the implementation of cli-

mate change adaptation strategies requires strong institutions, transparent decision-making systems, formal and informal networks that promote collective action, human skills and knowledge, and financial capital and natural resources. Nevertheless, he writes, in confronting climate change "the GCC member states still believe that their financial resources will be sufficient to buy solutions" whenever they are necessary. In some ways this is understandable, because fulfilling Spiess's requirements would challenge and perhaps subvert the political system of the UAE in its entirety. In this context, technical adjustments such as desalination or low-carbon technologies that will be bought by or manufactured inside institutions such as the Masdar Institute and KAUST emerge as tools to manage the existing and impending problems of climate change and energy scarcity, without challenging the social, economic, and political landscape.

At the same time, conversations with climate change consultants show that the idea of water as infinite—and the efforts to realize this idea through technical adjustments—was not uniform in the UAE in particular or the Arabian Peninsula in general. Professionals like Ben and Said participated in the production of knowledge, technology, and governance regarding energy and climate change, but also understood the problems associated with their innovations, and tried to explain why technological solutions or business models may not resolve the climate change problem.

"Now they are rich, but who knows what the conditions are going to be in 2030?" Said wondered at the end of our conversation. "Will the economic power of oil continue, especially now with renewable energies stations being produced at such accessible prices?" According to him, climate change could affect the Arabian Gulf in an unexpected way, initiating investments in renewable energy and clean technology and negatively influencing the significance of oil as a fuel and a commodity. By asking whether oil will still be valuable in 2030, Said pointed to an anxiety that persists among policy makers in the Gulf. In confronting the possibility of a future with less oil, the UAE aims to boost the non-oil share of the economy to more than 60 percent of the gross domestic product, from just over 40 percent today (Government of Abu Dhabi 2015). Like other oil-producing countries, such as Saudi Arabia, the UAE seeks to improve its capacities of innovation and invention through investing in the growth and sustenance of technical and cultural institutions, leading to more "technical adjustments" in the region.

Knowledge-Based Economy

Faced with concerns regarding the future of the oil economy, some governments in the region have been promoting institutions of higher education to build up local expertise, diversify the economy, and transform the countries into global centers of innovation in science and technology. In this model of economic development, which marks a transition from the fossil fuel–based models of development, research centers are expected to function as test beds from which new, exportable ideas and goods will emerge. The guiding premise is that knowledge will constitute a resource in its own right (Callon 2007), with the underlying assumption that innovative intellectual products and services may be exported for a high-value return, eventually triggering the expansion of a high-tech industry, similar to Silicon Valley or Boston 128.

Knowledge production is one of the most prominent ways in which the UAE handles climate change mitigation as well as adaptation, investing in the construction of hubs that will implement technical adjustments in the coming decades. Emergent institutions of knowledge production in the Gulf, such as the Masdar Institute in Abu Dhabi and KAUST in Saudi Arabia, are notable players in climate change debates, because they are expected to engender developments in science and technology that respond to future energy and climate challenges by collaborating with partners inside and outside the region.[14] The Masdar Institute was established and is supervised by the Technology and Development Program at the Massachusetts Institute of Technology, while KAUST receives research support from institutions including but not limited to Stanford University; the University of California, Berkeley; and Cambridge University. Diverging from the branch campus model prevalent in the region (New York University [NYU] Abu Dhabi, the Sorbonne Abu Dhabi, etc.), these hubs propose alternative models for building global universities.[15] Thanks to the aesthetic value of their campuses and their extensive research contracts with third parties, these research centers are expected to operate as networking platforms, creating a buzz outside their walls and drawing attention to the growing landscape of science and technology in the Arabian Peninsula.

These hubs are also expected to form the foundations for research and develop-

14. For a commentary on KAUST and its political and economic significance in Saudi Arabia, see Jones 2010.

15. The founders of NYU Abu Dhabi and Sorbonne Abu Dhabi have at times claimed theirs are stand-alone institutions, with unique intellectual makeups, and challenge the notion of a branch campus. For an analysis of the global university, see Looser 2012 and Günel, forthcoming.

ment in water management. For instance, as the Masdar Institute website (2015a) argues, "water has been one of Masdar Institute's key focus areas since inception, with diverse research looking to address challenges in desalination, water treatment, preservation and monitoring." The website (ibid.) continues, "Serving as a key pillar of innovation and human capital, Masdar Institute remains fundamental to Masdar's core objectives of developing Abu Dhabi's knowledge economy and finding solutions to humanity's toughest challenges such as climate change." Accordingly, the Institute Center for Water and Environment (iWater) at the Masdar Institute (2015b), on the one hand, seeks to become "a regionally focused but globally recognized university research center that produces knowledge and technologies that address the clean water production and management, climate change and the environment, and water resource challenges faced by the UAE and the region." On the other hand, the center features projects that fill research gaps regarding regional climatic dynamics. For instance, one of the research projects in the center concentrates on improving the accuracy of future water availability scenarios in the Middle East, specifically by analyzing large-scale atmospheric models, expected precipitation levels, and land surface processes. In particular, the center aspires to deliver research on water technologies, water resource management, and environmental conservation.

In Saudi Arabia, KAUST promotes a similar message. The Water Desalination and Reuse Center at KAUST focuses its activities on the optimization of current technologies and development of new ones and argues for exporting its findings in other parts of the world that suffer from water challenges. "This mandate will serve the Kingdom of Saudi Arabia (KSA), deprived of sufficient fresh water supplies and already heavily involved in desalination, as well as the proximate region spanning the Arabian Gulf/Peninsula, the Middle East, Northern/Eastern Africa, and South Asia," its mission statement notes (KAUST 2015a). "The Center will help thrust the KSA to the global forefront of desalination and reuse technology research, development, adaptation, and dissemination" (ibid.).[16] In addition to conceptualizing knowledge production as an economic development strategy, these hubs assemble innovations from across different geographies and promote them regionally.

What separates these institutions from their counterparts in other wealthy economies is not only that they are brand-new but also that they aim to train local citizens for the workforce, contributing to the Emiratization movement (and, in

16. For more specific information on the research activities at KAUST, see the "Publications" page in KAUST 2015b.

the case of Saudi Arabia, Saudization). Of the 9 million people who live and work in the UAE, almost 8 million are not Emirati citizens. These immigrants come to the UAE on temporary renewable work contracts sponsored by their employers, a system known as *kafala*. Although work contracts can be renewed indefinitely, many immigrants know that eventually their visas will expire and they will have to leave the country. The temporary nature of these contracts impedes immigrants from forming communities or feeling a sense of belonging in the UAE and underscores how they will remain perpetual outsiders, without the prospect of cultural assimilation or naturalization as Emirati citizens.[17] Some of these immigrants hold white-collar jobs in tourism, finance, and construction; many others are low-wage male workers from South Asia. The UAE's violations of workers' rights, especially on construction sites, are well documented by international institutions as well as the media.[18]

As Christopher M. Davidson (2009) notes, since the founding of the UAE in 1971, Emirati nationals have been consistently provided with the material benefits of the oil-extraction economy, thereby depriving them of motivation to participate in a competitive labor market. While there are no reliable statistics on the issue, Davidson (ibid.: 149–52) suggests that the nationals constitute about 9 percent of the workforce. In resolving this problem, he argues, "the only long-term solution is improved education at all levels," through which Emirati citizens will acquire the necessary skills to compete with the large number of expatriates living in the UAE. Studying the history of the education sector, Davidson finds that the major problem leading to a lack of education among Emiratis has been, rather shockingly, a "lack of funding." He writes, "Although the federal budget allocation for education now exceeds $2 billion, this is only a third of the allocation for military expenditure and, in relative terms, is about a quarter of the educational expenditure of some other Arab states." Accordingly, Davidson understands the new emphasis put on education, as seen in the founding of the NYU Abu Dhabi, the Masdar Institute, or the Sorbonne Abu Dhabi, to be positive, both in terms of training more qualified Emirati youths and of making the education sector more high profile within domestic politics.

In this economic vision, knowledge—in both the technical and cultural spheres (the latter promoted in particular via museums, art fairs, and biennales)—becomes a direct agent in the UAE's transformation into a "more elite" country, powered

17. For an analysis of how these policies affect migrant communities in the UAE, see Vora 2013. For an exposé of the types of exploitation that the *kafala* system facilitates, see Human Rights Watch 2014.

18. For a good example, see Human Rights Watch 2015.

by a knowledge-based economy.[19] In this vision, categories of the technical and the cultural merge seamlessly, both serving as products and generators of innovation. The two types of knowledge share an emphasis on products: the technical knowledge infrastructure is expected to incubate new technologically advanced artifacts, while the cultural sector will facilitate investments in the art market. Knowledge is a method for producing profitable innovation strategies, which may create marginal differences that allow these countries to succeed in the world economy. Through these knowledge infrastructures, some of the countries in the region seek to reengineer and refashion themselves for a future that relies less on oil export revenues.

The timeline of the knowledge-based economy emerges as a significant problem in the implementation of research infrastructures in the UAE in particular and in the Arabian Gulf in general. On the one hand, the decision makers in the region, such as university presidents, warn the authorities that it will take time to build the social context that facilitates knowledge hubs with capacities to trigger technological transformation, and they stress the thought processes and socio-cultural attributes that elicit the production of knowledge.[20] On the other hand, regional authorities, including the executives at Abu Dhabi's renewable energy and clean technology company Masdar, are critical of the fact that there are not enough start-up companies in the region, despite the extensive investment in institutions of higher education. A university president I met during my fieldwork, a US-trained expatriate with considerable experience in building institutions in the UAE, explained that the Emiratis were not farmers who would know that it takes time to harvest any produce, but rather they were traders who expected quick gains from their ventures. In this way, the president tried to describe how the temporalities of knowledge did not overlap with the expected timeline of economic development in the Emirates.

While the emphasis on domestic knowledge production and the cultivation of a national (as opposed to immigrant) workforce is a significant transformation in the region, it is unclear how much of this transformation will lead to climate change adaptation or mitigation work, especially if knowledge production capacities are

19. For a critical analysis of the production of Guggenheim Abu Dhabi as well as other institutions of knowledge, see Ross 2015.

20. For instance, Wasim Maziak (2005), a Syrian scientist who published in *Science* about the production of knowledge in the Arab world, underlines how "most Arabs view science as a commodity that can be separated from the thought processes and socio-cultural attributes of its producers." While Maziak's perspective may have changed since the publication of the piece, investments in high technology continue to characterize knowledge production in Abu Dhabi. The Masdar City project is a good example of these types of investments.

perceived as ways to extend the lifestyles and thinking that fossil fuel exports make possible. At the same time, however, these emergent institutions may serve as spaces where the existing modes of living will be interrogated, leading to the cultivation of alternative futures in the region that do not rely solely on technical adjustments. By involving the local population in the production of knowledge, such alternative futures may allow for the informal and formal networks and spaces of collective action, which trigger more informed ways of engaging with climate change. The involvement of the local population may also contribute to a sense of belonging to the landscapes, the same landscapes that are under threat by climate change.

Conclusion

It is clear that the affluent oil economies of the Arabian Peninsula wield considerable influence in the production of global environmental policy and practice; nonetheless, to date, they have received little attention from scholars working on climate governance. To better understand the global workings of climate politics, however, it is useful to examine how these economies conceive and mold energy and climate futures. Perceptions of climate change mitigation and adaptation shape and become reshaped by the social context in which they are interpreted. Therefore it is necessary to complement the scientific reports on the environmental conditions of the region with *why* and *how* questions that delve into the social, political, and economic context.

While professionals like Daoud of the state-run EAD argue that stressing the man-made qualities of water will make water seem more valuable, or less of a free source, in fact these qualities have the opposite effect: the man-made character of water leads to a celebration of water's interminable abundance; more of it can always be manufactured, regardless of the environmental conditions of the region. Or, as Said argues, climate change will not have much of an impact on desalination plants. The expectation is that even under dire environmental conditions, the plants will continue to operate and provide water to their constituents.

In preparing for a future rife with energy scarcity and climate change, some countries in the Arabian Peninsula are building knowledge hubs that can prompt innovation domestically. Saudi Arabia and the UAE, to construct a post-oil economy, capitalize on the networks and wealth that their current oil production makes available. Currently, these hubs are at work to create technologies that can be exported, serving as methods of economic diversification as well as marketing and branding, making the Gulf, as one of my interlocutors put it, "more elite." These

efforts are also a call to the nationals in the region to participate in the economy, to help constitute a new permanent workforce with different types of expertise. These emergent institutions of knowledge, despite their multiple problems, appear to be the most promising pieces of the climate change puzzle in the Arabian Peninsula, since they may allow for the flourishing of new ideas, new collectivities, and perhaps new forms of living.

This article grounds technical adjustments in the Arabian Peninsula; however, it is easy to observe such adjustments in other parts of the world. Electric cars, biodegradable plastic bags, and energy-efficient lightbulbs characterize contemporary methodologies of engaging with energy scarcity and climate change and provide the piecemeal means through which humans seek to extend their lifestyles into the future while at the same time tackling climate change. Perhaps here "technical adjustments" emerges as an ethnographic category, one that finds various expressions in different contexts, that guides living arrangements and shapes social possibilities in technocratic and, typically, anthropocentric manners, along the lines drawn by affluent nations. But in fact climate change and energy scarcity should propel humans to challenge such ideals of technological development and economic growth, to pay attention to the alternative futures rendered invisible by the drive for infinity, and to cultivate a new mode of inhabiting the planet.

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