Sociopolitical Consequences of Severe Heat in Saudi Arabia: An Existential Dilemma

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ABSTRACT

Scientists have set upper limits for the degree of heat stress humans are able to endure, and have projected likely levels of temperature increase due to anthropogenic climate change in the Middle East. The combined forecast presents formidable findings with implications for Saudi Arabia's economy, society, and political stability. Saudi Arabia and other oil-producing Gulf states serve as interesting case studies because they possess high adaptive capacity but suffer from paradoxical incentives regarding mitigation and adaptation. However, predicted trends in the incidence of extreme heat suggest that adaptation will be necessary for Saudi Arabia's survival. These adaptations will reshape the spatialization of Saudi society, facilitate the policing of social activity, and exert asymmetric pressure on particular segments of Saudi society (i.e. marginalized groups, the very young and very old). Further study is recommended to improve understanding of the impact of extreme heat on Saudi Arabia.

Key terms: heat, climate change, Saudi Arabia, adaptation, stability, spatial, spatialization

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In order to maintain large urban settlements in the face of environmental challenges, humans have demonstrated capacity for sophisticated feats of organization and engineering. However, such efforts generally also require significant wealth. Cities such as New Orleans, Las Vegas, and London serve as prime examples of urban locations which utilize massive engineering projects to maintain a habitable urban environment in the face of environmental challenges. Oil producing states on the Persian Gulf, like the Kingdom of Saudi Arabia (KSA), are of particular interest for future studies on urban adaptation precisely because of their substantial wealth. We might therefore expect them to have more adaptive ability compared to other countries facing severe environmental challenges. This would also be an oversimplification of Saudi Arabia's situation, and adapting to climate change will not be an easy task for any country. Despite its oil wealth, Saudi Arabia may actually derive less adaptive capacity from its oil wealth than its neighbors. Saudi Arabia's larger population undercuts its impressive wealth, and makes it poorer per capita than a small country like Kuwait. Still, Saudi Arabia's large territory which encompasses more diverse environmental character may suggest adaptation capacities which are unavailable to Qatar, the UAE, Bahrain, or Kuwait. Furthermore, Saudi Arabia's landmass is not confined to the Persian Gulf coastline, where severe heat is anticipated to be at its worst.

When the idea of climate change first broke on the scene, research initially focused on average global temperature increase and struggled to explain the complexity of what that would mean to the world in terms of experienced temperatures. Amid the many dramatic consequences which have since been added to the roster of climate change threats (e.g. sea level rise, freshwater scarcity), it is important not to underestimate the continuing challenge of adapting to temperature extremes. While the nature of the problem remains slippery and complex, we now have enough information to expand the discussion beyond climate data trends. Recently introduced predictions for heat trends in the Persian Gulf and Arabian Peninsula provide the point of departure for this paper and open up the opportunity to begin analyzing the ways in which anticipated severe heat will affect society and politics in Saudi Arabia. Increased frequency of severe heat in Saudi Arabia and the Gulf will have complex consequences which demand unprecedented adaptation. Modes of adaptation to severe heat in Saudi Arabia raise new questions regarding the implementation of technology, political economy, and spatialization of social activity. These questions illuminate what promises to be an existential challenge for Saudi governance and human survival in the region.

Climate Change and Heat: Cause for Concern

Heat presents a significant threat to human life, and yet it tends to be perceived as a rather ambiguous threat. It can be challenging to explain how a severe heat event differs from a 'normal' heatwave or 'typical' seasonal heat, and the human tendency to underestimate heat risk makes it challenging to respond to. However, anticipating heat threat and implementing proactive plans to protect populations during severe heat is key to reducing mortality from those events, as demonstrated by the historic 2003 heat wave in Europe (Poumadere, Mays, Le Mer, & Blong, 2005; Maloney & Forbes, 2010; Hanna & Tait, 2015). Europe logged approximately 20,000 casualties due to heat during the 2003 event, but Portugal, despite its tendency toward higher temperatures than other European countries and the fact that it hit a historic temperature of 47°C that summer, experienced a comparatively small number of casualties. This success was attributed to the fact that previous heat events had prompted the creation of a response plan to

safeguard vulnerable populations in severe heat events (Poumadere et al., 2005). Thus, while it may be difficult to overcome the public and political ambivalence due to a lack of urgency, it is clear that it is critical to do so.

Anticipating Heat in the Middle East

While there is some variation, a significant portion of the Middle East is arid and already experiences punishing temperatures in the summers. Under current circumstances heat in the region can pose a threat to human health if precautions are not observed (Hereher, 2016; Hanna & Tait, 2015; Russell, 2016). Steven Sherwood and Matthew Huber concluded that "Any exceedence of 35°C for extended periods should induce hyperthermia in humans and other mammals, as dissipation of metabolic heat becomes impossible." (Sherwood & Huber, 2010, p.1)[1] Sherwood and Huber proceed to define a limit of 6 hours for human endurance at 35°C, but understanding of this limit should be moderated by the fact that Sherwood and Huber's limit, "…applies to a person out of the sun, in gale-force winds, doused with water, wearing no clothing, and not working," (Sherwood & Huber, 2010, p.3). A set of temperature trajectories produced by Jeremy Pal and Elfatih Eltahir (2015) predict that by 2100 some areas in the Middle East will regularly experience temperatures above 45°C and occasionally temperatures above 60°C. This would render these areas uninhabitable according to Sherwood and Huber. The most lethal predictions in Pal and Eltahir's models exist around the Persian Gulf coastline and Arabian Peninsula for a number of reasons, but primarily because of the way that humidity reduces the human body's ability to regulate internal temperature.

With such formidable predictions in hand, it is urgent for regional populations and governments to develop response plans to address severe heat. In this paper I aim to explore relevant considerations for developing such a plan specifically as regards Saudi Arabia. For the purposes of this endeavor I exclude from consideration an array of corollary issues in the region related to climate change which merit investigation in their own right. Many of these other issues will likely interact dynamically with temperature trends. They include, but are not limited to: freshwater shortages, groundwater and seawater evaporation, dust storm frequency and severity, weather variability, sea level rise, seawater salinity, reef bleaching, disease vectors, and agricultural collapse.

Human Approaches to Climate Change

Humanity's relationship with the environment has traveled a long way from the dualism which viewed people in conflict with nature. More recent conceptualizations of the human-environment relationship have applied a narrative of sustainability and sustainable development which attempt a reconciliation of human with environment, but these terms have been criticized as difficult to define and fraught with unresolved contradictions (Giddens, 2011). However, forecasts for climate change and its fallout, such as severe heat, present scenarios in which reconciliation becomes increasingly difficult, if not impossible. Climate change thus far has been predominantly framed in terms of mitigation, but discussion of adaptation strategies is gaining

[1] All measures of temperature provided in this paper are wet-bulb temperatures (TW), a measure which accounts for humidity and indicates the maximum cooling effect achievable by evaporation (e.g. human sweat), unless otherwise indicated. At 100% relative humidity, the wet-bulb temperature equals the dry-bulb temperature. Otherwise, it will be lower than dry-bulb temperature (T).

prominence (Fussel & Klein, 2002; Javeline, 2014; Howell, Capstick, & Whitmarsh, 2016). Mitigation of climate change depends on the reduction of greenhouse gases (GHGs) in the atmosphere, and the greatest source of GHG emissions lies in human oil and gas consumption. For a country like Saudi Arabia, which relies almost entirely on oil and gas for its national income, mitigation efforts present serious near-term difficulties. Conversely, unmitigated climate change presents unprecedented long-term challenges.

The glacial pace of global mitigation efforts and the marginal progress made towards an international agreement on climate change have diminished optimism for mitigation as a strategy. A 2°C rise in average global temperature is often treated like a foregone conclusion, and if emissions continue at unmitigated rates then global temperatures are likely to rise past the 2°C threshold (Hanna & Tait, 2015). Scientists estimates have tended toward conservatism in an effort to protect the credibility of their findings, but we now see that not only are the effects of climate change likely to exceed these estimates, but the opportunity window for mitigation is closing (Kjellstrom, 2013; Hanna & Tait, 2015). For these reasons, the conversation is shifting away from mitigation and increasingly including adaptation strategies as serious realities (Davoudi, 2010; Pizarro, 2010). Adaptation can be adopted concurrent with any mitigation efforts, but for some countries adaptation is likely to be the main response to climate change.

Heat Adaptation in Saudi Arabia

The human body has the ability to adapt to temperature changes through acclimation and acclimatization. For sudden variation in temperature the body sweats in order to regulate internal body temperature through evaporation from the skin. However, humidity impairs this mechanism by preventing the evaporation of moisture. For this reason, researchers use two measures to discuss temperature, ‘dry bulb’ temperature and ‘wet bulb’ temperature. Dry bulb temperature expresses a simple temperature reading, whereas wet bulb temperature accounts for the effect of humidity. Given more time, a human body can also acclimatize to some degree by shifting other body mechanisms such as heart rate, which are not dependent on evaporation (Maloney & Forbes, 2010; Hanna & Tait, 2015). However, heat stroke and mortality are the observed consequences of the body’s failure to adapt, and highlight the limits of human biological adaptability. In the trajectories described by Pal and Eltahir, severe heat in Saudi Arabia will necessitate constraining most outdoor activities, which include the annual Hajj attended by millions of Muslims, construction, outdoor markets, and general pedestrian activity (Kjellstrom, 2013; Pal & Eltahir 2015; Dunne, Stouffer, & John, 2013).

Human biological adaptability is often enhanced by technology and infrastructure . This can be as mundane as choice of clothing and as grandiose as fundamentally redesigning the urban environment. These adaptations help humans exceed their biological resilience, but they also have their limitations (Hanna & Tait, 2015). Severe heat also directly affects existing technology and infrastructure in complicated ways. For example, heat can warp rail ties and alter the runway length required for airplanes to safely land (Pal & Eltahir, 2015).

Furthermore, the rapid urbanization of Saudi Arabia will mold adaptive concerns and responses. Urban environments have been shown to facilitate efficiency and economies of scale, but they can also create counterproductive phenomena such as the formation of urban ‘heat islands’ which reduce nighttime cooling, reduction of tree cover and vegetation, and entrapment of air between tall buildings on narrow streets (Kjellstrom, 2013; Hereher, 2016; Harlan, Brazel,

Prashada, Stefanov, & Larsen, 2006; Guindon & Nirupama, 2014). Sustainable urban design also offers insight into the ways that building design and coloration can heat or cool a city (Pizarro, 2010).

However, it is not always straightforward how best to apply these insights in order to achieve maximum cooling effect, and it is necessary to confront the already existing architecture and infrastructure in any heat reduction plan. For example, Saudi cities tend to be relatively spread out and characterized by low buildings and broad speedways. This urban sprawl is good for airflow around individual buildings, but creates challenges for public transportation, utilities, and shade cover provision (Pizarro, 2010; Kamel, 2013; Harlan et al., 2006; Menoret, 2014). However, recent proposals in Saudi Arabia tend to advocate a more dense urban construction and emphasize walkability, which can facilitate shade cover (Kamel, 2013; Ware, 2015; Abou-Korin & Al-Shihri 2015). Given Pal and Eltahir's heat trajectories, an emphasis on walkability in Saudi urban design may prove overly optimistic.

Also, Saudi Arabia is building a massive subterranean metro rail project in Riyadh, an ambitious and highly costly venture which demonstrates Saudi Arabia's present adaptive capacity (Varinsky, 2016; "Space stations", 2013; "Let's Go", 2016). However, that oil wealth represents a 'deal with the devil' that Saudi Arabia is making by forgoing mitigation in order to facilitate adaptation. Ultimately, Saudi Arabia's population is likely to rely increasingly on technology and technological solutions in order to inhabit the region. What will be needed if temperatures rise according to Pal and Eltahir's projections is complete isolation from the environment, as opposed to slight modifications in urban behavior and design. For Saudi Arabia, climate change is converting heat adaptation from a comfort measure to a requirement for human viability.

The single most critical technology for Saudi Arabia's ability to withstand severe heat is air conditioning. Already a central feature of life in Saudi Arabia, Saudi residents will increasingly depend on air conditioning for survival. Like the other solutions considered above, air conditioning is not a straightforward solution. Electricity for air conditioning in Saudi Arabia is powered by oil and gas, which is problematic for several reasons. First, Saudi Arabia foregoes significant income benefits by consuming its own oil and gas rather than selling it abroad. Second, the supply of oil and gas is expected to peak in the not-so-distant future, if it has not already. Third, the use of oil and gas to generate electricity contributes to global warming and will increase the frequency and severity of severe heat. Furthermore, individual A/C units vent heat into the outside environment which increases the exterior temperature and contributes to the urban heat island effect (Kjellstrom, 2013).

Air conditioning requires an extensive electrical infrastructure, and Saudi Arabia is already investing in improving and expanding its electrical grid capacity. Saudi Arabia is projected to grow by 45% by 2050, so these reinforcements will need to not only solve capacity and reliability issues for the current population, but will need to keep pace with rapidly expanding demand (Abou-Korin & Al-Shihri, 2015; Alghamdi & Moore, 2014). Multiple blackouts have been experienced throughout the region, including Saudi Arabia ("Record highs", 2010; "Power outage", 2015; "Power outage", 2016). Electrical blackouts in Baghdad in 2015 inspired protests, demonstrating the importance of electrical grids to state stability (Russell, 2016).The consequences of such blackouts will become increasingly catastrophic. To make matters worse, it is likely that for populations confined in air conditioned environments acclimatization will not occur, which will make their situation all the more perilous if air conditioning fails (Maloney &

Forbes, 2010).

In addition to expanded grid capacity, Saudi Arabia will need to use backup networks which currently exist with other GCC countries, but the entire region is projected to be vulnerable to increased heat and those networks may not be available when they are needed. Also, dependence on electrical systems makes Saudi Arabia vulnerable to direct attacks on those systems. It is possible that decentralized backup solutions may be available, such as solar-powered A/C units, but they have not been explored yet. However, Saudi reliance on technological solutions will mean that backup systems and disaster response plans will become critical. A central question for Saudi adaptation to severe heat is going to be how to respond when a system which is necessary for human survival, whether it be the electrical grid or a personal vehicle, fails.

Political Economy Dimensions of Severe Heat

Severe heat will have a profound impact on the Saudi economy and national security. Limitations on outdoor activity imposed by severe heat would make performing the Hajj in summer impossible, potentially damaging a leading source of Saudi prestige, authority, political power, and revenue. The inability to perform outdoor labor for significant portions of the year would impact Saudi Arabia's real estate industry and hamper its ability to build and maintain infrastructure (Dunne et al., 2013). Saudi Arabia, like other GCC countries which employ a high number of imported labor to perform such tasks, is unlikely to be overly concerned with the welfare of these workers. Evidence of this can be found in an anecdotal encounter Pal (2017) described to me with one of his interlocutors, who told him that even though, officially, outdoor work in Saudi Arabia is supposed to stop when temperatures reach 45°C (dry-bulb) and above, the government agency in charge of reporting the temperature frequently fails to accurately report that the temperature has crossed this threshold and as a result this rule is effectively not enforced. Qatar has made headlines in recent years for abusive labor practices as it prepares for the World Cup 2022, and unfortunately this exemplifies the treatment of imported labor across the region (Pattisson, 2013; Ingraham, 2015; "Abandoned", 2016; "Bad Dreams", 2004). If heat extremes reach the level of Pal and Eltahir's models then it would become infeasible to continue such labor practices; the mortality rates and the corresponding rate of worker replacement would simply be too high.

Severe heat will also have consequences for Saudi Arabia's agriculture industry, which Saudi Arabia has sunk significant investment into in recent years. A combination of heat and freshwater scarcity will likely condemn the industry, and Saudi Arabia will have to decide whether to move agriculture indoors (e.g. greenhouses and hydroponics), or to accept that it must import its food. The feasibility of transferring an entire industry indoors is doubtful, and does not resolve all the issues (such as water supply and livestock management) (Al-Kolibi, 2001). Saudi Arabia has already purchased land in places like Tanzania, Ethiopia and the American Southwest for agriculture production for import (Wilkerson, 2009; Daniels, 2016; Swanson, 2015). In this case Saudi agriculture will be subject to the stability of the host country and its relations with that country.

While Saudi Arabia has generally obstructed international climate change mitigation efforts because of its reliance on a strong oil and gas sector, it also has significant incentives to wean itself off oil and gas and transition to a diversified economy (Russell, 2016). Domestic consumption of Saudi oil is costly to the Saudi state because it heavily subsidizes its oil at home.

Indeed, Saudi Arabia's domestic pricing is the third lowest after Venezuela and Iran (Alhoweish & Orujov, 2016). This leads to inefficiencies such as illegal exports of oil for profit on the black market, which affects global demand for oil. It also deprives Saudi Arabia of the income it might have earned from selling that oil abroad. In 2010, domestic consumption of oil by the power and water sectors was equivalent in value to 8.2% of Saudi Arabia's GDP, and is projected to equal 24% of GDP by 2030 (Taher & Hajjar, 2014). Consumption needs are projected to equal 8 million barrels a day, which would cause oil exports to net zero by 2050, in order to meet domestic energy needs (Husain & Khalil, 2013, p. 10). It is also expected that oil producing states will experience a decline in revenue and political influence due to falling oil prices as global demand rises for new energy sources (Russell, 2016). Saudi Arabia is aware of these dynamics and is already looking at ways to diversify its economy and implement renewable energy sources at home (Russell, 2016; Gelil, 2016; Alhoweish & Orujov, 2016; Taher & Hajjar, 2014).

However, the shift away from oil presents a paradox for Saudi adaptation efforts. Systemic change to Saudi Arabia's economy and the decline of oil revenues could potentially destabilize the country because of the nature of the Saudi government's political contract with its population. Oil wealth facilitated the creation of a rentier state in which the government uses cash payouts to citizens, as well as key domestic and international players, in order to legitimize the royal family's power and promote its policy preferences abroad. If Saudi Arabia is unable to continue current benefits and handouts this could create issues for Saudi society and stability. Those handouts include easy access to cheap (a.k.a. heavily subsidized) oil and gas. Furthermore, the infrastructure changes demanded by severe heat (and other climate change consequences) are costly. Even now, at the height of oil profitability, Saudi Arabia relies on mechanisms such as public-private partnerships to source funding for its current infrastructure projects (Biygautane, 2016; Taher & Hajjar, 2014). Additionally, dependence on electricity infrastructure and desalinization plants for survival will expose Saudi citizens to attacks on or failures in these systems. To confront this risk, Saudi Arabia will need to increase its military expenditures, which are already extraordinarily large. Saudi Arabia will also need to invest in military capacity in order to defend overseas food production. It will be challenging to cover all these costs without easy income from oil.

Spatialization of Severe Heat

The impact of severe heat on Saudi economy and infrastructure will have profound consequences for Saudi society and the spatiality of Saudi urban life. These, if not addressed, may be additional sources of discontent and political tension. The intensity and duration of heat events predicted means that the Saudi population will be driven to inhabit artificial environments which insulate them from the environment, much in the way a space shuttle creates inhabitable space in the hostile environment of outer space. Public space in Saudi Arabia, for a significant portion of the year, will be limited to indoor spaces such as mosques, restaurants, malls, lecture halls, banquet halls, sporting arenas, gyms, and public transportation. While Saudi society is already accustomed to spending a significant portion of their time indoors, during severe heat public space will vanish as parks and streets become unendurable. This will be especially true for certain segments of the population, such the elderly or very young or physically inactive persons, (Curtis & Oven, 2012).

As a topic of particular concern for Saudi Arabia, it is likely that traditional identities and

lifestyles based on the environment will be threatened. If severe heat prevents outdoor activity, then many aspects of tribal and pastoral life will be disrupted (Verner, 2012). While much of Saudi society left behind these traditional lifestyles with the advent of oil and urbanization, this highlights the way in which new spatialities will affect social inequalities and differ for various communities in Saudi society, such as women, imported labor, lower-class Saudis, Bedouin, and persons who possess darker skin or express tribal or pastoral identities.

Understanding who has access to air conditioned environments and who does not is key to understanding how these communities will be affected by severe heat. For example, informal housing arrangements such as those used by the urban poor and shoddy, crowded living situations such as those provided for imported labor would become uninhabitable (Menoret, 2014; Rashad & Paul, 2016; Human Rights Watch, 2004). Saudi Arabia is already experiencing a shortage of housing and rising housing prices (Abou-Korin & Al-Shihri, 2015; Ware, 2015). Saudi Arabia's present housing crunch will only be worsened by the need to elevate all housing to a minimum standard, which includes reliable air conditioning.

Trading genuinely public space for exclusively private or semi-private spaces will also be a significant factor in determining who has access to air conditioning and society. All built environments, with the exception of homes, are semi-private or privatized spaces. This raises questions regarding citizen rights to the city and state control and is likely to alter the spatialization of Saudi social activity. An entire society confined indoors is unprecedented, but we can surmise based on previous studies of enclosed semi-private space that it will constrain and shape Saudi freedom of movement and expression, protest, social deviance, and social relationships. Many of these semi-private or private spaces impose entry fees, which may be overt or hidden, such as transit fares, shopping or food consumption, clean/fashionable clothing and hygiene, or memberships. Not all members of Saudi society will be able to afford these costs. Access to these semi-private spaces may be also denied on the basis of non-conformity to social standards and may be enforced by private agents such as mall security personnel or bouncers at clubs, rather than government officials (Wakefield, 2008; Sogaard, 2014).

Individuals also self-select from such spaces. As one young man stated, "For example, let us say there are two shops in the same place, but one of them is inside the shopping mall and the other outside, which one would you choose to go to? Simply the one outside of the shopping mall because the other one will be very much controlled by religious police and that creates many problems which I do not want to be involved in," (Almahmood, Scharnhorst, Carstensen, Jørgensen & Schulze, 2017, p. 242). Here, the increased social control in enclosed semi-private spaces is a reason for avoiding them. It is surmisable that severe heat will reduce access to outdoor spaces where greater behavioral freedom is possible.

The elimination of public spaces such as outdoor streets and parks may have additional cascade effects in Saudi society. The gender dynamics of public space in Riyadh are such that public streets are largely a male domain, while women express preference for semi-private spaces like malls because they provide security and social propriety (Almahmood et al., 2017). At present, single men in Riyadh are not allowed to enter shopping malls in the afternoons and evening, which are prime time slots for socialization (Almahmood et al., 2017, p. 242). If the public spaces of streets become inaccessible, then men may encroach on the interior spaces currently dominated by women. This could result in the displacement of women from these semi-private indoor spaces. Alternatively, it could leave men with reduced access to social space and

behavioral freedom, force further desegregation in semi-private spaces, or require other innovations in the shape of gender segregation in Saudi Arabia.

Adaptation measures have the ability to alter social structures by enforced interaction or to reinforce social divisions by institutionalizing them further. Public transportation adaptation, for example, presents several decisions that provide a demonstration of this dynamic. Currently Saudis strongly prefer private cars and private ride-sharing arrangements to using public busses (Al-Atawi & Saleh, 2013). The result is a class division in public transit, as those who can afford to avoid using busses do so, thereby preventing the mixing of classes in busses. Saudi Arabia's extensive metro project in Riyadh could either reinforce these divisions or ameliorate them. The answer to this question will be determined by factors such as how admission to the metro system is priced, whether the cars are equally accessible or restricted by social group, and whether wealthy Saudis will choose to use the metro. Air conditioning and transport present just two examples which highlight the ways in which social inequalities and unequal vulnerability to severe heat need to be factored in to adaptive planning.

Conclusion

Adaptation efforts responding to severe heat in Saudi Arabia will require leadership from the government, although there may be opportunities for partnerships with the private sector. Individual and social adaptations to climate change which are attributable to heat are difficult to identify, as Saudi Arabia already experiences very high summer temperatures on a routine basis and it can be challenging to distinguish between 'normal' heat events and climate change attributable heat. While slight warming trends have been observed, severe heat as considered in this paper is largely a future phenomenon, but it is a future which requires present action. Future severe heat will elicit changes in social spatiality and the economy in Saudi Arabia, both of which hold potential to disrupt political equilibrium. Extreme heat will pose a significant threat to human life and livelihood in the region. Further geographical and social study on the effects of heat would help understand how Saudi Arabia is presently affected by heat and how increased incidence of severe heat will affect it in the future. It is hopeful that the Saudi government is already investing in expanding its electrical grid and building heat-resilient infrastructure such as underground metro systems, although it remains to be seen how successful Saudi Arabia will be at transitioning to renewable energy and a diversified economy. There are many variables at play in climate change and the cumulative threat is substantial. However, vague statements of severity are easy to underestimate. It is important to recognize that the threat posed by heat alone is sufficient enough to call into question the long-term sustainability of Saudi governance in its current form, and, more fundamentally, human habitation of the region. Unenviably, it may become necessary for Saudi Arabia to determine the point at which it will become too costly to maintain its cities. The ultimate adaptation strategy available is migration, however undesirable it may be. Studies of current seasonal or long-term migration and immigration patterns in Saudi Arabia and their drivers would also assist in creating projections for future behavior.

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