Saudi Arabia: The Strategic Dimensions of Environmental Insecurity

James A. Russell

Dr. Russell is an associate professor in the Department of National Security Affairs at the Naval Postgraduate School in Monterey, CA.[*]

Saudi Arabia sits in the middle of the world's climate furnace. There are fewer hotter, drier places on the planet, and it's only going to get worse as the world continues to dump carbon into the atmosphere. Since 1995, the world's atmosphere has seen carbon amounts increase from 360 parts per million (ppm) to an estimated record-crushing 400 in 2015.[1] Some researchers predict an increase in temperature of around 3 degrees Celsius throughout the Middle East by 2050. According to climate-change researchers, the Arabian Peninsula eventually will become too hot for people to remain outdoors for more than six hours at one time. Writing in the journal *Nature Climate Change*, Jeremy Pal and Elfatih Elfatir categorically state, "by the end of the century certain population centres in the same region are likely to experience temperature levels that are intolerable to humans owing to the consequences of increasing concentrations of anthropogenic greenhouse gases (GHGs)."[2] Quite simply, these temperatures will overwhelm the human body's capacity to cool itself through ventilation and sweating.[3]

Other indicators have emerged pointing to inexorable climate-change trends in Saudi Arabia and the wider Middle East. The summer of 2015 saw a "heat dome" settle over the region, sending temperatures skyward — a harbinger of what is to come.[4] As noted by *New York Times* columnist Tom Friedman, a heat index of 163 degrees Fahrenheit was reported in the Iranian city of Bandhar Mahshar on July 31, 2015, described by a weatherman at the time as "one of the most extreme readings ever in the world."[5] Meanwhile, in the midst of their war with the Islamic State, Iraqi citizens in Baghdad rose up in spontaneous protest at the inability of the government to deliver enough electricity to keep the city's air conditioners running. As noted in a poignant report describing everyday life in Baghdad during the summer of 2015, "The lucky ones drive around in their cars with the air conditioning on, visit shopping malls, or wait for the air coolers to switch on and huddle around them in a single room. Those without that wherewithal find cool where they can, sometimes swimming in dirty, sewage-tainted pools and canals."[6]

[*] The author wishes to thank Robert Springborg for comments on an earlier draft. The views expressed here are his own.

Israel in September 2015 experienced its worst sandstorm since record keeping began, a storm almost certainly made worse by abandoned farmland in drought-stricken and war-torn Syria.[7] During the storm, air pollution in Jerusalem reached 173 times the national average, and power usage broke all national records.[8] The same storm produced high winds and torrential rains in Mecca, Saudi Arabia, and undoubtedly played a role in the collapse of a crane that killed 107 and injured 238.[9] Elsewhere in the Gulf, Iran remained in the grip of a seven-year drought as reservoir levels throughout the country sank to new lows.[10]

These extreme cases will become future norms, regardless of the December 2015 Paris Agreement. The tidal wave of looming environmental stresses adds yet another systemic factor to a region already torn asunder by civil wars, failed states, regional balance-of-power conflicts, militant Islamic extremism, massive refugee populations, foreign military interventions, and oppressive governments seeking to rein in their citizens' demands for change. The world is seeing only the opening phase of a multidimensional crisis that promises to get progressively worse. While changes in the weather and further deterioration of the environment may not appear as serious as civil wars and terrorist bombings, the long-term impact of these changes may be just as serious. As noted by *Haaretz* contributor David Rosenberg, "It's easy to imagine the sudden emergence of a Mad Max world where environmental disaster has plunged humanity into war, famine and financial chaos. More likely, we'll experience climate change as a creeping process with heat waves and droughts that disrupt normal life for short periods, or whose economic and political impact is so gradual that it's difficult to make a direct connection to the weather."[11] This perfect storm indeed will break over Saudi Arabia and the Middle East during the rest of the century — and we have almost certainly only witnessed the first cloudburst.

A GATHERING STORM

There has been plenty of warning of the region's building environmental catastrophe. As poignantly noted by researchers in 2009, "The Arab countries are in many ways among the most vulnerable in the world to the potential impacts of climate change, the most significant of which are increased average temperatures, less and more erratic precipitation, and sea-level rise (SLR), in a region which already suffers from aridity, recurrent drought and water scarcity."[12]

The year 2015 was the hottest since data started being collected in the late nineteenth century — coming on the heels of records set in 2010 and 2014.[13] The summer 2015 heat wave in the Middle East comes after five Arab countries set new high-temperature readings in 2011.[14] Some scientists predict that the successively hotter annual temperature readings may suggest a dramatically faster overall increase in the world's temperature.[15] As temperatures keep rising, the region is going to become even drier. The Middle East already contains less than 1 percent of the world's fresh water resources and is generally recognized as the most water-stressed environment on the planet. By 2040, projections by the World Resources Institute indicate that the Middle East will contain 14 of the 33 most water-stressed countries on the planet.[16] Summers will get hotter and winters shorter and drier, with annual rainfall forecast to decrease by as much as 20 percent over the rest of the century.

Some estimates suggest that annual rainfall may decline by as much as 50 percent.[17]

All but six Arab countries of the Middle East suffer from freshwater scarcity, defined by the World Bank's minimum requirement as 1,000 square meters per person per year. What little freshwater there is above ground will decline significantly by the end of the century. Higher temperatures will cause a reduction of water runoff of 10 percent by 2050, at the same time that demand for freshwater is forecast to increase by 60 percent.[18] Two of the region's major aboveground freshwater sources, the Jordan and Euphrates Rivers, are predicted to see dramatically decreased water flows by the end of the century.[19] Those aboveground sources that remain will be severely stressed by pollution and decrepit public-works infrastructures. Researchers estimate that several cities in the Middle East lose as much as 40 percent of their freshwater due to leaky pipes.[20]

For centuries, the MENA population hovered around 30 million, reaching an estimated 60 million early in the twentieth century. ... By 1950, the region's population had reached 100 million; today it is estimated at 340-350 million and is projected to increase to 588 million by 2050.

The story of the region's underground sources of freshwater is not any better. Underground aquifers are being sucked dry by growing, freshwater-hungry societies. In war-torn Yemen, for example, the capital of Sanaa and its projected population of over 4 million may exhaust its groundwater by 2025. Some sources estimate that as much as 50 percent of Yemen's 24 million people already do not have access to safe drinking water.[21] Iran is in the midst of what some describe as an epic water crisis as a result of persistent drought and disastrous water management. Over the last 50 years, it has exhausted 70 percent of its groundwater.[22] Jordan and Saudi Arabia are sucking an estimated 9 billion cubic meters a year from the Disi/Saq aquifers — water that has been underground for tens of thousands of years and has also been found to contain potentially dangerous levels of natural radiation.[23] Today, an estimated 50 percent of Saudi Arabia's freshwater comes out of the ground. In short, the region's already scarce natural supplies of water — rainfall and aquifers — are drying up.

Further stress on freshwater supplies is now coming in the form of salt-water intrusion from sea-level rises (SLR). According to the Intergovernmental Panel on Climate Change (IPCC), the average rate of sea-level increase has doubled since 1993 to an annual rate of 3.2 millimeters a year. Researchers forecast annual SLR of 16 millimeters a year by 2081. By the end of the twenty-first century, the world's oceans may rise a total of three feet as ice in the Arctic and Antarctic inexorably melts.[24] If the West Antarctic ice sheet breaks apart, researchers estimate that the world's oceans could rise by as much as 12 feet by the end of the century.[25] Egypt is the regional state most vulnerable to SLR, although the Gulf states will not be immune. An estimated 6 percent of Egypt's GDP is at risk with an SLR of 1 meter. Some estimates show that 30 percent of

the Nile Delta could be underwater by the middle of the century and that Alexandria, one of Egypt's largest and most important cities, will be threatened. Tel Aviv and Haifa will also become waterlogged, placing an estimated 5 million Israelis at risk of dislocation.[26] Qatar, Kuwait and the United Arab Emirates are also particularly vulnerable to SLR over the rest of the century. Qatar's land area could be reduced from 2.6 percent to 13 percent depending on the level of SLR.[27] Saudi Arabia is somewhat less vulnerable, as its cities are further inland.

Two systemic stresses must also be added to this cauldron: population growth and urbanization. For centuries, the Middle East/North Africa (MENA) population hovered around 30 million, reaching an estimated 60 million early in the twentieth century. Since then, the region has experienced one of the most rapid population growth rates in the world. By 1950, the region's population had reached 100 million;[28] today it is estimated at 340-350 million and is projected[29] to increase to 588 million by 2050.[30] Population growth rates are slowing, but the bow wave of population growth will break over the region during the next quarter century.[31]

As in the rest of the world, MENA's population is shifting from rural to urban areas.[32] These transformations are not always peaceful.[33] In the Middle East, an estimated 56 percent of the population currently lives in urban centers; this is expected to rise to 75 percent by mid-century. Persistent drought and hotter temperatures will speed the growth of the region's cities, as subsistence farming becomes untenable. The emptying of Syria's countryside due to the extreme drought from 2006 to 2009 is a window on the future of other societies in the region.[34] The move to the cities from the countryside will also cause a decrease in food production, making societies ever more dependent on imports.[35] New arrivals in cities will face inadequate, dilapidated and aging infrastructures, overcrowded housing, and governments already struggling to provide water, electricity and basic social services. Cairo's population is expected to double by the middle of the century, to 40 million.[36] Life promises to be difficult in the region's concrete heat islands, where a small minority of well-off citizens will sit in air-conditioned buildings while the others will literally bake outside.

THE CASE OF SAUDI ARABIA

According to the United Nations, Saudi Arabia's population is expected to grow from approximately 30 million in 2015 to 40 million by the middle of the century. Over 90 percent will live in urban areas by 2050.[37] These populations will continue to be overwhelmingly young. The World Economic Forum estimates that 60 percent of the MENA population is under the age of 25, with unemployment rates in some states for this group as high as 40 percent.[38] In Saudi Arabia, 37 percent of the population is below the age of 14; 51 percent is under 25. Youth unemployment is variously estimated between 20 and 30 percent.[39] As a demographic, this group is generally well educated, with as many as 100,000 graduates annually entering the job market. By 2030, this market will have to accommodate 4 million additional workers. Education received in the Saudi system, however, remains overwhelmingly focused on religion and rote memorization — of little use in a diversified private sector, where foreign nationals predominate. The International Monetary Fund estimates that 60 percent of Saudi Arabia's labor force of 3.3 million are employed in

the public sector.[40] According to the Saudi Arabia Monetary Agency, only 10 percent of the Saudi labor force works in the private sector.[41]

The Middle East remains systemically vulnerable to the forces unleashed by urbanization. For the most part, the region's political systems remain controlled by security-sector and familial elites with little space for wider popular participation and the development of civil society. To substitute for the lack of private-sector development, regional states have relied instead on bloated and inefficient government bureaucracies to provide jobs. In petrostates like Saudi Arabia and its sister Gulf monarchies, this is a means of distributing wealth to the citizens in exchange for their acquiescence to the political status quo.

DILEMMAS AND OPPORTUNITIES

The central strategic problem facing Saudi Arabia is simply this: it depends on pumping increasing amounts of oil out of the ground to keep the state afloat for the foreseeable future at a time when the world is attempting to limit the carbon release produced by burning fossil fuels. There is an inherent contradiction between trying to slow the increase of the world's temperature and Saudi Arabia's requirement to pump oil to fund its state and slake the world's growing thirst for oil.

The kingdom is in a race against time as it simultaneously addresses a series of strategic, political, economic and environmental challenges:

- Build and pay for an infrastructure to accommodate its burgeoning population that includes an environmental mitigation and adaptation program.
- Make the necessary investments and political commitment to diversify its economy away from domination by the public sector. Saudi Arabia needs the private sector to become the engine of economic growth that will provide jobs for an estimated 4 million entrants to the workforce over the next 20 years. One recent study estimates the price tag at as high as $4 trillion.[42]
- Transition from a carbon-based economy to one in which energy needs are increasingly met by renewable and cleaner energy sources, to help it meet its carbon-reduction commitments under the Paris accord of 2015.
- Continue to manage the politics of energy markets while simultaneously meeting commitments to reduce carbon output in such a way as to maintain the kingdom's relative power and influence around the world.
- Preserve the shape and identity of the state and the ruling family's position as it manages all of the above.

It is difficult to overstate the magnitude of these simultaneous challenges, with the attendant wrenching and even revolutionary changes they portend for the kingdom.

It is hard to conceive of Saudi Arabia as anything other than the quintessential petrostate. Oil revenue today accounts for approximately 85 to 90 percent of the government budget, 90 percent of all export revenues and 45 percent of GDP. In 2015, some estimates indicate that oil revenues generated $160 billion of government revenue in a total budget of $223 billion, $38 billion supported by deficit financ-

ing.[43] Saudi revenues are distributed to its citizens in many forms: government jobs, generous unemployment benefits, subsidized gasoline, water and housing, and free education and healthcare. The kingdom spent an estimated $36 billion in 2013 on subsidies for gas, water and electricity.[44] Saudi consumers paid 45 cents a gallon for gasoline in 2015 and received electricity at a fraction of the cost paid by consumers around the world.

During 2015, Saudi Arabia's oil production totaled between 9.75 and 10.3 million barrels per day, an increase of 6 percent over 2014 levels, reaching a 30-year high.[45] The kingdom is thought to have a production capacity of approximately12.3 million barrels, 2.6 million barrels of which constitutes spare production capacity. No other oil producer boasts this kind of flexibility. Saudi Arabia has historically used this capacity to smooth supply disruptions in world markets.[46] The world is expected to continue demanding more oil, despite commitments to limit carbon release. Indeed, the world's economic growth depends on access to reasonably priced energy supplies. According to the U.S. Energy Information Administration (EIA), if left unchecked, world demand for oil could reach 120 million barrels a day by 2040,[47] an increase from 95 million barrels a day in 2015.[48] Much of the additional oil needed to keep pace with global demand will come from Gulf states, including Saudi Arabia, where oil is much cheaper to get out of the ground than in other oil-producing countries.

The contradiction between the need for more oil and the need to mitigate climate change is addressed with great clarity in the scientific community. Recent research conclusively demonstrates that much of the world's vast fossil reserves (coal, natural gas and oil) must be kept in the ground indefinitely if the world is to have any chance of limiting the world's climate increase to 2 degrees Celsius over the rest of the century. Figures published in the journal *Nature* indicate that as much as 260 billion barrels of oil in the Middle East — approximately the amount of Saudi Arabia's estimated oil reserves — would have to remain in the ground under such a scenario.[49] Such an outcome would certainly reorder the geostrategic map that places Gulf oil producers at the epicenter of global energy markets — to say nothing of the associated political and economic challenges that would be created in each of these states if significant portions of their oil reserves had to remain in the ground. In the past, Saudi Arabia has demanded compensation for any oil left in the ground as part of an agreement to limit global carbon release.

The strategic dilemma confronting Saudi Arabia is significant, but it is better positioned than many of its neighbors to withstand systemic pressures. Therein lies the opportunity to sensibly manage the kingdom's transition to an economy with reduced fossil-fuel income and output and an increased role for the private sector. Over the decade 2003-13, oil prices skyrocketed from $36 to $110 a barrel by 2011. The kingdom doubled its GDP to an estimated $750 billion (somewhat larger than Sweden's and Switzerland's) and become the world's nineteenth-largest economy. GDP grew at an annual rate of 6 percent over the decade, one of the most rapid rates in the world. Monthly household income increased by 75 percent, from $2,100 to $3,600; 1.7 million jobs were created (1 million in the public sector). Moreover, women started to enter the workforce, reaching an estimated 1.8

million, or 18 percent of the working-age female population. Saudi Arabia is today regarded as a high-income country; its estimated 2014 per capita GDP was $24,000.[50]

While the House of Saud has a deserved reputation for extravagant lifestyles within its extended family, it must also be pointed out that the family responsibly invested oil revenues in infrastructure during the period. The regime also brought down the national debt and put cash in the bank. It did not gamble with its money. Unlike much of the rest of the world, Saudi investments remained in conservative instruments during the boom in equities markets in the first half of the decade. As a result, during the 2008-09 world financial meltdown, Saudi Arabia remained in a strong position, paying down its debt at a time when many other countries underwent grave macroeconomic crises and had to borrow to avert meltdowns. Over the decade, it virtually eliminated its public debt and compiled financial reserves totaling nearly 100 percent of GDP. The period saw a staggering $1.6 trillion economy, including $300 billion in foreign direct investment, mostly in the petroleum sector. McKinsey & Co. estimates that by 2015 the state had compiled $1.4 trillion in financial and other assets. Approximately $450 billion was spent over the decade on transportation infrastructure, healthcare, education and social welfare. Electrical generation capacity was increased by 32 percent. Eighty-one new hospitals and 20 new universities were created.[51] Giant construction projects like the Kingdom Tower in Jeddah were also launched; when completed, it will reach 3,300 feet, making it the tallest building in the world.

In addition to infrastructure investment, the flexibility provided to the House of Saud by its stockpile of cash was dramatically illustrated during the uprisings around the region in 2011. To forestall potential unrest, the regime pumped another $130 billion into the country's economy virtually overnight in the form of higher salaries and bonuses for government workers, increased unemployment benefits, additional housing, and more mosques for the powerful religious establishment. An estimated $70 billion was spent on 500,000 low-income housing units alone.[52] The windfall has also provided the Al Saud with political leverage over its neighbors. In a reversal of fortune from the bitter disputes of the Nasser era in the 1960s, Saudi Arabia pumped an estimated $6.5 billion into the teetering Egyptian economy following the ouster of the Muslim Brotherhood government by the security services in 2013. Riyadh and its Gulf state partners have replaced the United States as the principal benefactor of Egypt's ruling security-sector corporation now headed by President Abdel Fattah el-Sisi.

The oil boom is funding one of the longest-running and largest environmental-mitigation programs ever attempted. At the top of the list is Saudi Arabia's investment in water desalination.

Environmental mitigation and adaptation investments figured prominently in spending during the decade. It is no exaggeration to say that the oil boom is funding one of the longest-running and largest environmental-mitigation programs ever attempted. At the top of the list is Saudi Arabia's investment in water desali-

nation. The kingdom consumes nearly 7 billion cubic meters a day, 50-60 percent of which is desalinated; annual demand is growing at 8 percent a year. The Saline Water Conversion Corporation operates 36 plants that produce an estimated 3 trillion cubic meters of water a day, 50 percent of the kingdom's water and 70 percent of all water consumed in cities.[53] In 2014, the kingdom brought into production the $7.2 billion Ras al-Khair plant, the world's largest desalinization plant. Located northwest of Jubail, it is expected to produce 264 million gallons (1.025 million cubic meters) of freshwater per day, as well as 2,600 megawatts of electricity. In 2014, the kingdom invested an estimated $4.4 billion in desalinization projects.[54] It will need an additional $53 billion in investment and 20-30 new desalination plants over the next 15 years to meet the projected demand for water.[55]

Unsurprisingly, Saudi Arabia will need more electricity in the years ahead. According to the EIA, the kingdom in 2013 began bumping up against its power-generation capacity, estimated at 58.4 gigawatts. Air conditioning accounts for 70 percent of electricity demand, which will steadily increase as the region gets hotter.[56] Saudi Arabians consume an estimated nine times more electricity per capita than their neighbors.[57] The kingdom will need to generate an additional 35 gigawatts in electricity capacity over the next 15 years, requiring an investment up to $120 billion both to add to and modernize inefficient and aging turbine systems. Some estimates suggest that the kingdom will have to double its power-generating capacity over the next 20 years to 120 gigawatts.[58] Until now, Saudi Arabia has used oil and natural gas to power electricity generation, helping to fuel a steep increase in domestic energy consumption. Saudi Arabia today has one of the highest per capita energy consumption rates in the world: 25 percent of all the oil it produces, with internal consumption projected to grow at 7 percent annually. Saudi Arabia is expected to triple its domestic oil consumption over the next 15 years. If current trends continue, one study estimates that the kingdom could become a net oil importer by the middle of the century, depriving itself of its principal source of income.[59]

Diversification of energy sources is an essential part of Saudi planning. To help lead the effort, the kingdom established the King Abdullah University of Science and Technology located on the Red Sea north of Jeddah. In May 2012, the kingdom announced an ambitious 20-year, $109 billion plan to generate 41 gigawatts of electricity through a new solar program that would meet 25-30 percent of its needs. In parallel, it sought to generate another 21 gigawatts in geothermal and wind power. There is virtually no human or industrial infrastructure in the kingdom to execute or support a program of such magnitude. Perhaps unsurprisingly, the projects have been delayed. In January 2015, Hashim Yamani, president of the King Abdullah City for Atomic and Renewable Energy, the royal agency established to oversee renewable-energy policy, delayed the projects by eight years: "We have revised the outlook to focus on 2040 as the major milestone for long-term energy planning in Saudi Arabia."[60] Under even the most optimistic of scenarios, renewable energy sources will provide no immediate relief from the kingdom's overwhelming dependence on oil and natural gas for power.

The kingdom has also taken steps to increase energy efficiency. In December 2014, it announced the imposition of mini-

mum fuel/mileage standards for new and used vehicles, light trucks and automobiles imported into the kingdom. The standards, based on the U.S. Corporate Average Fuel Economy (CAFE) standards, are to be phased in between 2016 and 2020. As part of the National Energy Phase II program launched in partnership with the UN Development Program, the kingdom introduced a campaign to put energy efficiency ratings on all new air conditioners and replace aging and inefficient units still in use.[61] As many as 50,000 noncompliant air-conditioning units have been seized and destroyed by the government under the joint government-UN program.[62] Finally, Saudi Arabia has adopted international building codes that make thermal insulation mandatory in all new construction across the kingdom's 23 cities.[63]

POLITICS OF CLIMATE CHANGE

Saudi Arabia has been seen around the world as one of the main impediments to a global deal to limit carbon output. During negotiations in Copenhagen in November 2014, one observer estimated that the Saudis were responsible for 40 percent of all of the objections raised during the sessions.[64] Most recently, the kingdom led a group of 22 nations in successfully lobbying to prevent the adoption of more aggressive climate-change objectives. According to many observers, Saudi Arabia worked to water down the text throughout the final environmental negotiations in Paris in December 2015. It has also resisted pressures to contribute to a fund to help poorer developing countries shoulder the costs of climate mitigation. Nonetheless, Saudi Arabia joined 194 other nations in signing on to the Paris Agreement of December 2015.

Under the terms of commitments made to the treaty as its Intended Nationally Determined Contribution (INDC) submitted in November 2015, Saudi Arabia seeks to reduce carbon emissions by 130 tons annually by 2030. The plan offered no specifics on how its carbon-reduction commitments will be met and offered no numerical benchmarks by which to judge its progress. In 2012, Saudi Arabia was rated as the fourteenth-largest emitter of greenhouse gases in the world, releasing 572 metric tons annually, or 1.2 percent of the world's total.[65] The Saudi INDC submission stated: "The Kingdom will engage in actions and plans in pursuit of economic diversification that have co-benefits in the form of greenhouse gas (GHG) emission avoidances and adaptation to the impacts of climate change, as well as reducing the impacts of response measures."[66] The Saudi submission also vaguely warned that its emission targets would be adjusted between 2016 and 2020 if the Paris Agreement creates an "abnormal" burden on the Saudi economy.[67]

The plan acknowledges the link between climate mitigation and adaptation efforts and high levels of oil exports. In addition to pursuing economic efficiencies and diversified economic growth, the plan calls for Saudi Arabia to develop carbon-capture and utilization technology. The plan calls for the kingdom to build the world's largest capture-and-use plant, capable of purifying 1,500 tons of carbon per day, which will be recycled back into the country's growing petrochemical industry. Another initiative calls for the insertion of carbon into underground oil reservoirs. Using a technology called carbon-dioxide-enhanced oil recovery, 40 million cubic feet of carbon dioxide will be captured, processed and injected into the Othmaniya oil reservoir as part of a pilot project to determine feasibility. One can only hope

that the Saudis are more successful than the Canadians, who attempted to use this technology on oil fields operated by Shell in Saskatchewan.[68]

By recent standards, the Saudi submission to the Paris accord is significant, since the kingdom has been seen as one of the major resisters to any attempt to limit carbon release. It was accused by some observers of trying to wreck the whole deal, refusing to support more stringent actions to limit temperature-release targets to 1.5 degrees Celsius, balking at the idea of trying to decarbonize the world's economy by the middle of the century, and demanding compensation for potential lost revenues from oil income.[69] The German organization Climate Action Tracker remained unimpressed by the kingdom's INDC submission, referring to it as "inadequate" and among the world's worst plans. The organization caustically stated, "If all countries adopted this level of ambition, global warming would be likely to exceed 3-4 degrees Celsius this century."[70] The organization particularly criticized Saudi Arabia for refusing to establish any baseline levels for carbon emissions through which to measure progress or the lack thereof.

The politics of Saudi Arabia's approach to the Paris negotiations remain inextricably intertwined with the politics of international energy markets. As negotiators gathered in Paris to set limits on carbon release, Saudi Arabia's oil production and exports reached an all-time high. In the arena of energy markets, the kingdom has been playing a different game. After profiting from oil averaging $110 a barrel between 2011 and 2014, Saudi Arabia and other producers lost big when prices tumbled to $50 in 2015. Breaking with its past practice of cutting production to restore price stability, the House of Saud instead opened the oil spigots, ignoring repeated entreaties of its OPEC partners. While, on the one hand, tumbling oil prices hurt the kingdom's short-term revenues, lower prices served a number of broader strategic interests. Conventional wisdom suggests that Saudi Arabia's refusal to moderate supply was a way to pressure oil-dependent rivals in Tehran and Moscow and drive high-overhead producers out of business to preserve Saudi market share.

Oil prices north of $100 a barrel helped stimulate a glut in world oil production in places like Canada and the United States, where it became economical to produce shale oil in ever-increasing quantities. These additional oil supplies also threatened Saudi Arabia's share of world markets, particularly those in fast-growing Asia. By March 2015, for example, U.S. production of shale oil reached 5.3 million barrels per day (mb/d), boosting the dramatic overall increase in U.S. oil production to a 40-year high of 9.4 mb/d in May 2015. There is some evidence that U.S. shale-oil producers are feeling the pinch, with production slated to decline in early 2016. Opinion suggests that the Saudis have been successful in preserving their market share with their refusal to cut production.[71]

High-cost producers, however, represented only one part of Saudi Arabia's problems, according to some analysts. There was a deeper and more profound fear: a leveling off of the global demand for oil.[72] According to this point of view, higher oil prices not only brought the more expensive oil onto the market; it also reduced demand for oil and further encouraged the move to renewable sources of energy. The slowing demand for imported oil in China was particularly concerning to Saudi officials, though some believe that

depressed oil prices actually buy Saudi Arabia and its OPEC partners more time by averting a leveling off of global demand in a higher-priced market.[73]

Another line of analysis suggests that Saudi Arabia is attempting to maximize income from a commodity that will gradually recede in importance as the world shifts to a non-carbon-based future. The Saudis must recognize reality: the inexorable move towards limits on carbon emissions will mean that some portion of their most valuable commodity will have to remain in the ground.[74] The essential logic of the argument is that any barrel of oil sold at a profit, however small, is more valuable than one that is not. Oil that remains in the ground eventually will cease to have value. Preserving the primacy of their market share would thus allow the Saudis to maximize the value of their commodity.

STRATEGIC IMPLICATIONS

The economic and environmental pressures on Saudi Arabia are clear. It needs to continue pumping oil for at least the next couple of decades to generate the revenue needed for the infrastructure to accommodate its growing population. There is no substitute for oil income over the near term. The kingdom needs to figure out how to pay for more of everything: electricity generation, freshwater desalination, housing, public transportation and road systems, health care and education, to name but a few of the claimants on state resources. As previously noted, the kingdom's strong financial position provides a good start toward meeting its daunting economic challenges, although the decline in oil prices gives leaders less direct capital for their investment priorities. Some economists estimate that the decline in oil prices is forcing the Saudis to spend $10-$15 billion a month from their reserves.[75]

Perhaps more difficult is the parallel political challenge that must also be met if the state is to move to a model in which the private sector drives economic growth. The domestic political challenges are complex and varied. If the political leadership attempts to develop a viable private sector, it will be asking more of its citizens at a time when subsidies are slowly but surely being reduced. The workforce will no longer be able to live off handouts from the regime or rely on public-sector jobs and religiously focused education.[76]

There is some evidence that the ruling family is acutely aware of these problems and is taking steps to address the myriad challenges facing the Saudi economy. Deputy Crown Prince Mohamed bin Salman is coordinating a multifaceted effort to develop an ambitious five-year National Transformation Plan to map the road towards economic diversification and the development of the private sector. Under consideration are such steps as asset sales, tax increases, spending cuts and changes to the way the kingdom manages its investments. Among other things, the plan calls for Saudi Aramco to transform from an oil company into an industrial conglomerate. Power to implement the plan reportedly rests with the newly created 22-member Council of Economic and Development Affairs. In April 2016, pursuant to this direction, Mohamed bin Salman announced plans to sell 5 percent of the world's largest oil company, Saudi Aramco, with the proceeds being used to set up a public investment-development fund that could reach $2 trillion in assets. The Saudis appear interested in following the trail blazed by the Al Nahyans in the UAE, who established the Abu Dhabi Investment Authority to provide the emirate with a source

of income from a diversified portfolio of investments.[77] These efforts dovetail with an aggressive campaign by the Saudi Arabia Basic Industries Corporation (SABIC) to attract international investors to a series of new development projects.[78]

A better-educated Saudi workforce comprising both men and women will be needed if a viable private sector is to be developed to drive economic growth. Opening up opportunities for women and changing the country's education system to give workers the skills they need will require the House of Saud to take on domestic political stakeholders like the religious establishment, which has been empowered and funded in the oil era. Past efforts by the Al Saud to open up their society to the forces of modernity have been met with ardent internal opposition. The most dramatic expression of these protests was the takeover of the Grand Mosque by Juhayman al-Otaybi and his followers in 1979. Otaybi proved to be a precursor of militant Islamic extremist opposition to the ruling family that found expression with al-Qaeda in the 1990s and with the latest iteration as found in the Islamic State.[79] The ruling family has in the past placated and co-opted these opponents, but this balancing act promises to become significantly more challenging if the country is to move in the directions outlined by the deputy crown prince.

Managing this transition as the world slowly but inexorably clamps down on carbon production and consumption adds another layer of complexity to a difficult situation. The commitments made in Paris represent the opening round in an ever-tightening noose around the necks of the world's carbon producers. Saudi Arabia can survive for a time through oil revenues, but its days of profligate welfare spending are coming to an end.

For much of the twentieth century, Saudi Arabia and the Middle East served as the strategic epicenter of the West's own economic and strategic security. Cheap and readily available oil from Saudi Arabia and the Gulf states helped support a century of relative political stability and sustained economic growth. The kingdom was the "prize," a role embraced by the House of Saud as it fashioned its security partnership with the United States.[80] Outsourcing its external protection to the United States suited the Al Saud as they focused on building a peaceful and stable internal political order. In some sense, the family always correctly foresaw that the most significant challenges to the state came from internal enemies. It remains unclear just how relevant that security system will be in the future as challenges to the internal stability of states throughout the Middle East multiply. The wisdom of the House of Saud's prescient choices all those many decades ago will certainly be on trial over the coming transformative, and hotter, quarter century.

[1] As noted by Juraj Mesik, "Arab World Vulnerable to Global Warming," *Arab News*, August 13, 2015.
[2] Jeremy S. Pal and Elfatih A. B. Elfatir, "Future Temperature in Southwest Asia Projected to Exceed a Threshold for Human Habitability," *Nature Climate Change*, October 26, 2015.
[3] As noted in John Schwartz, "Deadly Heat Is Forecast in Persian Gulf by 2100," *New York Times*, October 26, 2015.

[4] Poignantly described by David Rosenberg, "Apocalypse Soon: Climate Change Hits the Middle East, *Haaretz*, November 4, 2015.
[5] Thomas L. Friedman, "The World's Hotspot," *New York Times*, August 19, 2015.
[6] Anne Barnard, "120 Degrees and No Relief? ISIS Takes a Back Seat for Iraqis," *New York Times*, August 1, 2015.
[7] Paul Rivlin, "Climate Change Has Happened: The Middle East's Climate Crisis," *Middle East Economy* 5, no. 10 (October 22, 2015).
[8] "Sandstorm Plaguing Israel Is the Worst in Country's History," *Times of Israel*, September 11, 2015.
[9] Staff report, "Crane Collapse Kills at Least 107 in Mecca Grand Mosque," *Al Jazeera*, September 11, 2015.
[10] Thomas Erdbrink, "Scarred Riverbeds and Scarred Pistachio Trees in a Parched Iran," *New York Times*, December 18, 2015.
[11] Rosenberg, "Apocalypse Soon."
[12] Mostafa K. Talba and Najib W. Saab, eds., *Arab Environment Climate Change: Impact of Climate Change on Arab Countries*, 2009 Report of the Arab Forum for Environment and Development (Beirut, Lebanon, 2009), 7.
[13] Summarizing data from a variety of sources, Justin Gillis, "2015 Was the Hottest Year In Historical Record," *New York Times*, January 20, 2016.
[14] Reported in Dorte Verner, "Adaptation to Changing Climate in the Arab Countries," *MENA Knowledge and Learning: Quick Note Series* 79 (January 2013).
[15] A variety of scientists quoted in Gillis, "2015 Was the Hottest Year…"
[16] Andrew Maddocks, Robert Samuel Young and Paul Reig, "Ranking the World's Most Water Stressed Countries in 2014," August 26, 2015. Posted on World Resources site at http://www.wri.org/blog/2015/08/ranking-world%E2%80%99s-most-water-stressed-countries-2040.
[17] *Climate Change and Impacts and Impacts in the Eastern Mediterranean and the Middle East*, Cyprus Institute 2008 Annual Report.
[18] Dorte Verner, ed., *Adaptation to a Changing Climate in the Arab Countries* (World Bank, 2012), 2.
[19] Sundeep Waskelar, *Blue Peace Report: Rethinking Middle East Water* (Strategic Foresights Group, 2011); and Scott Greenwood, "Water Insecurity, Climate Change and Governance in the Arab World," *Middle East Policy* 21, no. 2, (Summer 2014), http://www.mepc.org/journal/middle-east-policy-archives/water-insecurity-climate-change-and-governance-arab-world.
[20] Verner, 2.
[21] Adam Heffez, "How Yemen Chewed Itself Dry," *Foreign Affairs*, July 23, 2013.
[22] Erdbrink, "Scarred Riverbeds." See also Jason Rezaian, "Iran's Water Crisis Is the Product of Decades of Bad Planning," *Washington Post*, July 2, 2014.
[23] Markus Becker, "Contaminated Acquifers: Radioactive Water Threatens Middle East," *Der Spiegel*, November 5, 2012.
[24] As reported in Nicholas Bakalar, "3.2 Millimeters: A Troubling Rise in Sea Level," *New York Times*, November 30, 2015.
[25] Justin Gillis, "Climate Model Predicts West Antarctic Ice Sheet Could Melt Rapidly," *New York Times*, March 30, 2016.
[26] As noted by Rosenberg, citing United Nations data, in "Apocalypse Soon."
[27] Mahmoud Medany, "Impact of Climate Change on Arab Countries," 131.
[28] United Nations data summarized in *Population Trends and Challenges in the Middle East and North Africa* (Washington DC: Population Reference Bureau, 2001).
[29] While population growth rates are generally slowing, fertility rates in Egypt and Morocco are increasing.
[30] Pew Research Center, "The Future of World Religions: Population Growth Projections," April 2, 2015.
[31] Inside these numbers, however, there are some disquieting signs. Egypt's population growth rate may be increasing once more. See Caroline Kraft and Ragui Assad, "Beware of the Echo: The Impending Return of Demographic Pressures in Egypt," *Policy Perspectives*, Economic Research Forum, no. 12, May 2015.
[32] *World Urbanization Prospects* (New York: United Nations, 2014).
[33] Donatella della Porta and Mario Diani, *Social Movements: An Introduction*, 2nd Ed. (Blackwell, 2006).
[34] Henry Fountain, "Researchers Link Syrian Conflict to Drought Made Worse by Climate Change," *New York Times*, March 2, 2015.

[35] The issue of food shortage in the Middle East is addressed comprehensively in Eckart Woertz, *Oil For Food: The Global Food Crisis and the Middle East* (Oxford University Press, 2013).
[36] Further background in Patrick Kingsley, "A New Cairo," *Guardian*, March 16, 2015.
[37] Saudi Arabia Country Profile, United Nations, Department of Economic and Social Affairs, Population Division. *World Urbanization Prospects: The 2014 Revision*.
[38] Omar Kutayba Alghanim, "Solving the Problem of Youth Unemployment in the MENA Region," World Economic Forum, May 27, 2015.
[39] Figures drawn from the World Bank and the United Nations cited in Stasa Salacanin, "GCC Countries and Their Diversification Efforts," *Business in Qatar and Beyond Magazine*, July 1, 2014. Also see Caryle Murphy, "Saudi Arabia's Youth and the Kingdom's Future," Occasional Paper Series no. 2, Woodrow Wilson International Center for Scholars, Winter 2011; and Julia Glum, "Saudi Arabia's Youth Unemployment Problems among King Salman's Many New Challenges after Abdullah's Death," *International Business Times*, January 23, 2014.
[40] International Monetary Fund, *Saudi Arabia: Selected Issues*, IMF Country Report 13/230, Washington DC, June 24, 2013. Also see figures from "Saudi Labor Market Report — October 2015," Jadwa Investment, Riyadh, Saudi Arabia, October 11, 2015, published by Saudi-U.S. Information Service.
[41] 2009 figures cited in John Sfakianakis, "Saudi Youth Struggle to Find Work Raises Urgency for Reform," Arab News, February 17, 2011.
[42] McKinsey Global Institute, *Saudi Arabia beyond Oil: The Investment and Productivity Transformation*, December 2015.
[43] Andrew Torchia, "Saudi 2015 Budget Based on Oil Price around $60 — Analysts," Reuters, December 28, 2014.
[44] Figures cited by Saudi economist Turki al Haqeel as quoted in Ubaid Al Suhaimy, "Saudi Arabia: The Desalination Nation," *Asharq al-Awsat*, July 2, 2013.
[45] Saudi Arabia Crude Oil Production Chart, YCharts.com, at https://ycharts.com/indicators/saudi_arabia_crude_oil_production/chart/.
[46] See figures in Grant Smith, "Saudi Arabia Set to Pump Maximum Crude As Battle for Market Share Heats Up," *Bloomberg News*, June 19, 2015.
[47] Table A4, *International Energy Outlook 2014* (Washington DC, Energy Information Administration, September 9, 2014).
[48] *Oil Market Report* (International Energy Agency, November 13, 2015).
[49] Christopher McGlade and Paul Ekins, "The Geographical Distribution of Fossil Fuels Unused When Limiting Global Warming to 2 Degrees Celsius," *Nature,* vol. 517 (January 8, 2015): 187-190. Also summarized in Damian Carrington, "Leave Fossil Fuels in the Ground to Prevent Climate Change," *Guardian*, January 7, 2015.
[50] Figures drawn from a variety of sources and summarized in *Saudi Arabia beyond Oil: The Investment and Productivity Transformation* (McKinsey Global Institute, December 2015), 19-44. The report draws on data from the World Bank, International Monetary Fund, Saudi Ministry of Economy and Planning, Saudi Ministry of Labor, Saudi Ministry of Health, Saudi Arabia Monetary Agency, Saudi Ministry of Finance, Central Department of Statistics and Information, and U.S. Energy Information Administration, among others.
[51] Ibid.
[52] Neil MacFarquar, "In Saudi Arabia, Royals Buy Peace for Now," *New York Times*, June 8, 2011.
[53] Ubaid Al Suhaimy, "Saudi Arabia: The Desalination Nation," *Asharq al-Awsat*, July 2, 2013.
[54] Deema Almashabi, "Saudis Start Production at World's Biggest Desalination Plant," Bloomberg Business, April 23, 2014. Also see Jeffrey Ball, "Why the Saudis are Going Solar," *Atlantic*, July/Augst 2015.
[55] Y. Alyousef and M. Abu-ebid, "Energy Efficiency Initiatives for Saudi Arabia on Supply and Demand," in *Energy Efficiency — a Bridge to Low Carbon Economy*, ed. Zoran Morvaj (InTech, March 16, 2012).
[56] "Summer Demand Taxes Saudi Power Sector, But Kingdom Is Working on Solutions," International Energy Agency, August 6, 2014.
[57] Saudis Use Nine Times More Electricity Than Fellow Arabs," *Arab News*, February 19, 2014.
[58] A. Al-Ghabban, *Saudi Arabia's Renewable Energy Strategy and Solar Energy Deployment Roadmap* (King Abdullah City for Atomic and Renewable Energy, 2013).
[59] Glada Lahn and Paul Stevens, *Burning Oil to Keep Cool: The Hidden Energy Crisis in Saudi Arabia* (Lon-

don, Chatham House, 2011).
[60] As quoted in Anthony DiPaola, "Saudi Arabia Delays $109 Billion Solar Plant by 8 Years," Bloomberg News, January 19, 2015.
[61] Details of plan at National Energy Efficiency Program Phase II, United Nations Development Program, posted online at http://www.sa.undp.org/content/saudi_arabia/en/home/operations/projects/environment_and_energy/national-energy-efficiency-programme--phase-2-.html.
[62] "Saudi Arabia: Government Join Forces to Implement Energy Efficiency Labels," United Nations Development Program, posted online at http://www.sa.undp.org/content/saudi_arabia/en/home/ourwork/environmentandenergy/successstories/ee_implementation.html.
[63] Irfan Mohammed, "All New Buildings Must Have Thermal Insulation," *Arab News*, March 24, 2014.
[64] Antonio Juhasz, "Suicidal Tendencies: How Saudi Arabia Could Kill the COP 21 Negotiations in Paris," *Newsweek*, September 12, 2015. The piece quotes Alden Mayer of the Union of Concerned Scientists: "most of them [40 percent of the objections] attempt to try and water down the language, to not express certainty and urgency, and the need to move to lower temperature ranges."
[65] Alex Pashley, "World Carbon Emissions in One Handy Graphic," World Resources Institute, June 7, 2015.
[66] *The Intended National Determined Contribution of the Kingdom of Saudi Arabia under the UNFCC* (Riyadh, November 2015).
[67] Ibid.
[68] Issues summarized in Kelly Cryderman and Shawn McCarthy, "Keeping the Faith in Carbon Capture and Storage," *Globe and Mail*, May 8, 2013.
[69] Suzanne Goldenberg, "Saudi Arabia Accused of Trying to Wreck Climate Deal," *Guardian*, December 8, 2015.
[70] Climate Action Tracker, Saudi Arabia, November 24, 2015.
[71] Gaurav Aginhotri, "Decoding Saudi Arabia's Strategy in Its Oil Price War," Oilprice.com, October 7, 2015; and Anjil Ravai and Simeon Kerr, "Saudi Arabia Oil: No Pain without Gain," *Financial Times*, October 11, 2015.
[72] Views summarized in Peter Waldman, "Saudi Arabia's Plan to Extend the Age of Oil," BloombergBusiness, April 12, 2015.
[73] Ibid. The piece cites Mohammed al-Sabban, an economist who served as adviser to the Saudi Petroleum Minister Ali Al-Naimi from 1998-2013. The piece also quotes Wiki Leaks cables from the U.S. Embassy reporting on the Saudi fears of collapsing demand for oil.
[74] Elias Hinckley, "Everything Has Changed: Oil and the End of OPEC," *Energy Trends Insider*, January 20, 2015.
[75] Rachel Ziemba, an analyst with Roubini Global Economics, as quoted in Ben Huubard and Stanley Reed, "Saudis Moving to Reduce Dependence on Oil Money," *New York Times*, April 1, 2016.
[76] Ben Hubbard, "Young Saudis See Cushy Jobs Vanish Along With Nation's Oil Wealth," *New York Times*, February 16, 2016.
[77] Details of these recent developments are drawn from a variety of sources. Ben Hubbard and Stanley Reed, "Saudis Moving to Reduce Dependence on Oil Money," *New York Times*, April 1, 2016; Katie Paul, Marwa Rashad, and Andrew Torchia, "How Saudi Arabia Plans to Shake Up Its Economy," Reuters, April 14, 2016.
[78] As outlined in "A Tale of Three Cities," *The Business Year*, 2015. The article is an interview with SABIC Chairman Prince Saud bin Abdullah bin Thunyan al Saud; Riad Hamade, Alaa Shahine, "Saudi Arabia's Post Oil Plan Starts April 25, Prince Says," Bloomberg, April 16, 2016.
[79] Background in Thomas Hegghammer, *Jihad in Saudi Arabia: Violence and Pan Islamism since 1979* (Cambridge University Press, 2010). For recent reporting on domestic support for ISIS within the Kingdom, see Ben Hubbard, "ISIS Turns Saudis Against the Kingdom, and Families Against Their Own," *New York Times*, March 31, 2016; Ben Hubbard, "Saudi Police Colonel Is Killed and ISIS Claims Responsibility," *New York Times*, April 5, 2016.
[80] A term coined in Daniel Yergin's *The Prize: The Epic Quest for Oil, Power and Money* (Simon & Schuster, 2008).