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## Climate Change Adaptation in the Middle East and North Africa: Challenges and Opportunities

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and North Africa:  
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This report provides an overview of critical issues regarding adaptation to climate change in the Middle East and North Africa (MENA). It draws upon the authors' ongoing research and from the discussion and papers presented at the Dubai Initiative workshop "Climate Adaptation in the Middle East and North Africa: Challenges and Opportunities," which convened at Harvard University's Belfer Center for Science and International Affairs, May 3-4, 2010. Our thanks to the participants for their insight and enthusiasm and for financial assistance from the workshop sponsors: the Dubai Initiative, the Harvard Project on Climate Agreements, and the Nicholas School of the Environment at Duke University. Working papers by workshop participants are cited as such; comments made in discussion are not attributed. Any errors in fact or interpretation remain ours. A list of participants and the titles of their working papers are included at the end of this report. The workshop also sparked an ongoing blog on climate adaptation in the MENA, located at <http://climateadaptationmena.wordpress.com>.



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## Introduction

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The impacts of human-induced climate change are often considered a future prospect, yet in the Middle East and North Africa (MENA), indications of a changing climate are clearly evident. Most of the predicted outcomes associated with international climate models are already occurring in the region, compounding existing problems of water scarcity, water pollution, desertification, salinization, and sea-level rise. Since most of the MENA region is arid and hyper-arid, small changes in water availability and arable land have significant consequences for human security. Thus, “if mitigation is about energy, adaptation is about water” (Clausen and Berg 2010). Particularly through effects on the variability and quality of scarce and degraded water resources, human-induced climate change exacerbates already existing problems affecting urban and rural development, human health, and economic productivity in MENA.

As a result, many proactive measures to adapt to climate change can be encompassed within existing policies for the water and agriculture sectors. These include upgrading and extending water harvesting and storage infrastructures; improving demand management of water and agricultural efficiencies; extending sanitation systems, particularly to rural areas and informal urban areas, to safeguard water supplies and human health; and fostering local and provincial capacities to grapple with existing water/agricultural problems.

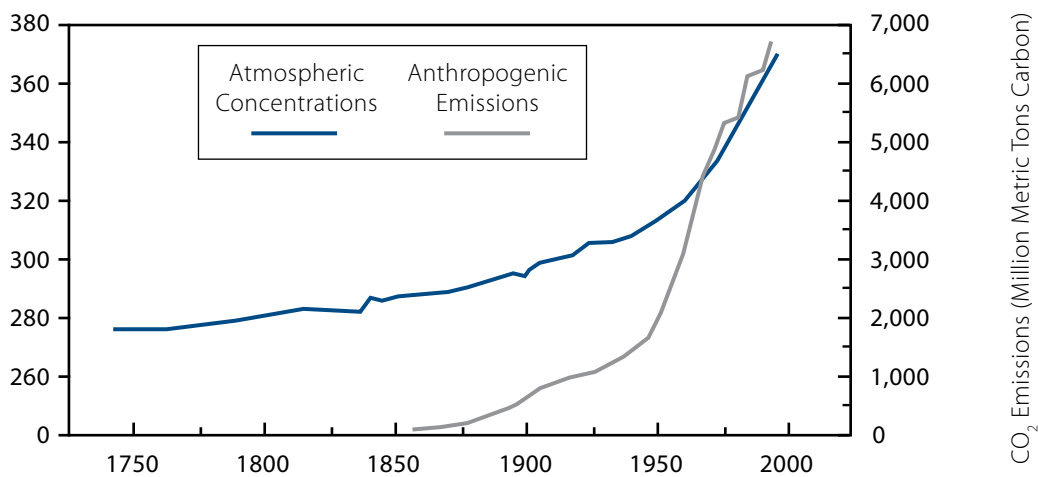
Other adaptation measures, however, are not as well integrated into existing policy menus. Participants proposed planning for vulnerable coastal areas, considering water footprints in government and private sector investments, coupling considerations of energy infrastructure with water management, and creating national and regional storage and distribution systems for agricultural exports and imported foodstuffs. Unfortunately, to date, many adaptive measures remain reactive – i.e., in response to specific crises such as droughts and aquifer depletion.

Policy interventions must consider existing political and economic obstacles to the effective and efficient provision of public goods and services. That is, while mobilization of technical expertise and financial resources at the national level and through government ministries is necessary, it is entirely insufficient. Instead, policy makers must actively remove obstacles to local mobilization of resources, allow private sector participation under adequate and transparent regulation, and provide a supportive context for community-level adaptations. For instance, a number of small-scale and community demonstration projects in water conservation, sanitation provision, renewable energy, and community resource management have not been supported or scaled up. Provision for in-country and cross-border migration from vulnerable areas, a long-time adaptation measure in MENA, is also lacking. National “top-down” and local “bottom-up” initiatives, along with regional programs, will be required to meet some of the challenges to human security posed by climate change.

## Why is Adaptation Necessary? Mitigation: the Missed Opportunity

A robust scientific consensus exists that human-induced climate change is well underway. Most climate models anticipate a doubling of pre-industrial levels of greenhouse gases, resulting in average global temperatures rising by 2-5 degrees Celsius between 2030 and 2060 (Stern Review 2007). The principal culprit is the release of carbon dioxide to the global atmosphere through the burning of fossil fuels, which accounts for three-quarters of all carbon emissions. The chart below shows how atmospheric concentrations of carbon dioxide have closely tracked anthropogenic emissions since 1850 (see Figure 1).

**Figure 1: CO<sub>2</sub> Concentrations and Anthropogenic Emissions**



Source: Oak Ridge National Laboratory. Carbon Dioxide Information Analysis Center, <http://cdiac.esd.ornl.gov/>.

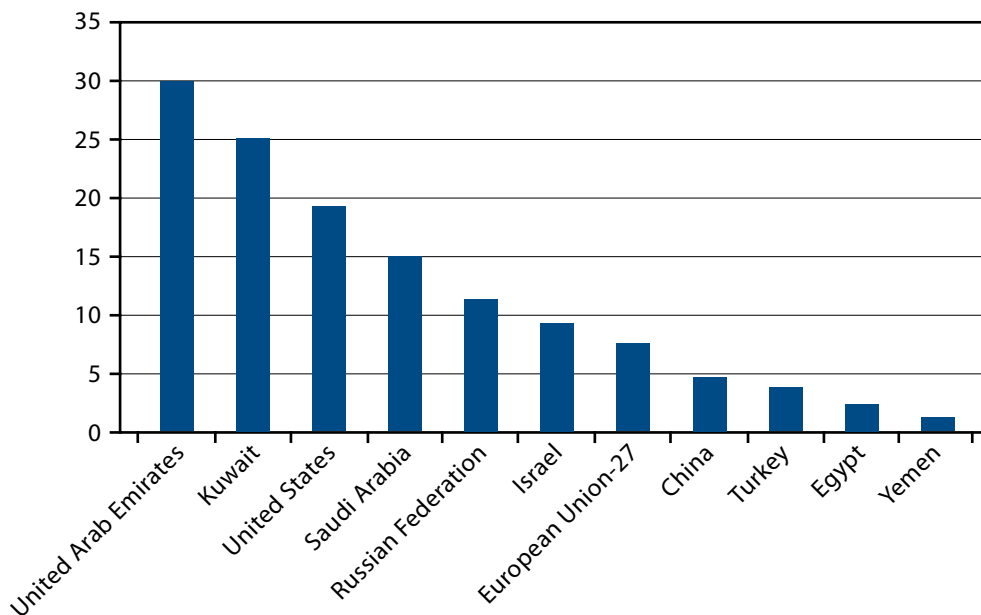
Increased energy use by individuals and industries has long been associated with higher levels of development and GDP. The result is a global “carbon disparity” that reflects different levels of consumption, production, and wealth: “Twenty percent of the world’s population is responsible for 63% of the emissions, while the bottom 20% of the world’s people are only releasing 3%” (Roberts 2001, 503).

Since greenhouse gases remain in the atmosphere for decades, historical responsibility for current accumulations of greenhouse gases lies with the industrialized countries, namely the United States, Europe, former Soviet Union, and later, Japan and newly industrialized countries. However, rapid increases in emissions in recent years have come from large industrializing countries such as China and India. On a per capita basis, however, the small Gulf countries currently emit more greenhouse gases per person than most other countries, a function of high consumption and of the key role that hydrocarbons play in the structure of their economies (see Figure 2). It is noteworthy, however, that the United States releases more carbon per person than Saudi Arabia. With only 5% of the world’s population, the United States emitted 20% of the total carbon dioxide in 2007. In contrast, China emitted a similar amount of CO<sub>2</sub> (21% of world total) but with a 20% share of the world’s population (IEA

2009). If the export-oriented nature of China’s economy and the high proportion of Chinese exports consumed in the United States are taken into account, then American per capita CO<sub>2</sub> emissions would likely be significantly higher than calculated by current methodologies, which are based largely on sectoral estimates for domestic economies.

No one knows with any certainty what constitutes “safe” levels of greenhouse gases in the atmosphere.<sup>1</sup> The pace and extent of climate change may well exceed the predictions and scenarios generated by the Intergovernmental Panel on Climate Change (IPCC). Several factors

**Figure 2: Carbon Dioxide Emissions Per Capita, 2007, for Selected Countries**



Figures from International Energy Agency Report, 2009. “CO<sub>2</sub> Emissions from Fuel Combustion,” which conducts national energy emissions inventories according to IPCC guidelines.

point to this conclusion. For instance, carbon emissions since 2000 have exceeded the estimates used in the 2007 IPCC report (Ghoneim 2009, 34), while polar ice sheets are melting more rapidly than projected (Jevrejeva et al. 2010). This means that the impacts of global warming, such as sea-level rise, may have been underestimated.

Attempts to negotiate global climate treaties have foundered on the recalcitrance of the largest emitting states to take significant action. The two largest emitters of greenhouse gases at present, the United States and China, have made no credible or binding commitments to reduce emissions in the timeframe necessary to avoid significant global temperature increases. Significant gains from mitigation – that is, reducing the rate of increase of emissions of greenhouse gases to the global atmosphere – would be achieved even if only a handful of large emitting countries take action. This is because the top ten emitting countries account for about two-thirds of global emissions. These countries can set new standards, stimulate innovation of new technologies, and provide assistance for other countries to come along later. One proposed solution is to establish a Carbon Mitigation Fund to promote low-carbon

<sup>1</sup> William Chameides, Dean, Nicholas School of the Environment, Duke University. Keynote Address, Dubai Initiative Climate Adaptation Workshop, May 4, 2010.

technology transfer to the high-emitting developing countries, funded by the leading cumulative per capita emitters (for details, see Gallagher 2009).

As one of the workshop participants noted, several countries in MENA — primarily Turkey and Saudi Arabia — have the potential to play a bridging role between the poorer, more populous countries of the region with pressing adaptation needs, and the wealthier, less populated countries that can more feasibly undertake mitigation measures, particularly within state-owned oil and gas sectors.

Countries in the Middle East will face adaptation challenges whether or not they contributed to creating the problem of climate change. They should not wait for external financial assistance or technology transfers, which may not be forthcoming from industrialized nations, before taking action. Given the lack of political will in the industrialized countries to seriously pursue mitigation at this point in time, impacts from climate change in the Middle East and North Africa are unavoidable.

## A Region Vulnerable to Climate Change

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The region is particularly vulnerable to the impacts of climate change. It is expected that the southern and eastern Mediterranean will experience greater warming trends than the global annual mean warming, with a predicted increase of 2.2 to 5.1 degrees Celsius. (Al Yaqoubi WP). At the same time, MENA has the fewest renewable water resources and the least arable land per person of any region in the world (Abu Zeid WP). Climate models predict a significant reduction in precipitation in much of Mediterranean Africa, northern Sahara, and the eastern Mediterranean, ranging from 10-30% by the next century (Evans 2008, 2009).

Climate change impacts for the MENA region include intensification of the following trends:<sup>2</sup>

- decreased precipitation and therefore decreased river flows for the eastern Mediterranean; possibility of higher precipitation in equatorial Africa
- lower yields on major food crops
- accelerated saltwater intrusion to coastal freshwater aquifers from sea-level rise
- long-term salinization of inland aquifer systems
- accelerated desertification of marginal areas
- increased likelihood of sand and dust storms
- accelerated sea-level rise in low-lying, often densely populated coastal areas
- more intensive flash floods
- accelerated snow melt in mountainous areas
- increased duration and intensity of droughts

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<sup>2</sup> Impacts on entwined land and water systems of MENA are reviewed in (Zhang 2005; Evans 2009; Sowers et al. 2010; Tolba and Saab 2009; Zereini and Hötzl 2009).

Most of these phenomena have long been part of the region's ecologies, but as one workshop participant observed, "the effects have become more acute and the timing has been accelerated." Rising temperatures, severe flashfloods, more variable precipitation, and intensified droughts are empirically documented across the MENA countries. Participants at the workshop provided concrete, verifiable examples of impacts that pose direct challenges to human security and vary significantly from historical norms. These include the following:

- *Increasing summer temperatures and decreasing winter temperatures.* This has been shown for the Middle East as a whole, based on climate indices constructed for the period 1950 to 2003 (Zhang et al. 2005). For example, increases have been observed in Turkey's western provinces over the past five decades, with the hottest summer on record in 2007, combined with decreasing winter temperatures along the coastline (Altinbilek WP).
- *Increased dust storms* affecting crops, human health, economic activity, and tourism (El Raey 2008)
- *Changes in the timing, form, and intensity of rainfall and snowfall.* Observed changes have included increased variability in rainfall volumes and more drought years over the Jerusalem mountains (Vengosh WP), decreased snowfall in Lebanon's mountains (Faragalla WP), and thunderstorms in Riyadh, Saudi Arabia (Al Tokhais WP).
- *Increased frequency and severity of drought in recent years,* including a severe drought from 2006-2009 that spanned central Turkey, Syria, and other countries of the eastern Mediterranean (Altinbilek WP)
- *Severe or unprecedented floods and landslides,* observed in the Gaza Strip (Al Yaqoubi WP, Mason and Zeitoun WP), in Saudi Arabia (Al Tokhais WP), in Turkey (Altinbilek WP), and along the Nile river (Abu Zeid WP)
- *Rising sea levels,* observed throughout the eastern side of the Mediterranean basin (Mason and Zeitoun WP), and the northern coastline of the Nile Delta (where land subsidence is a key factor)
- *Low or empty dams and water storage catchments,* noted in Turkey, where half of the dams in Ankara and Istanbul were empty, prompting the installation of a \$600 million emergency water diversion system
- *Longer and more intense seasons for forest fires* observed in Turkey and elsewhere

For policy makers, whether or not these challenges are caused by human-induced climate change is immaterial. What matters is adopting proactive strategies to minimize vulnerability for communities and ecosystems. It has become necessary to plan for extreme events that are increasingly common.

Even in the absence of climate change, water resources are increasingly scarce and polluted in the region. Population growth, increased demand with rising level standards, and limited

renewable freshwater resources combine to paint a bleak picture (Vengosh WP). Total population in the MENA region is expected to grow from 300 million in 2000 to about 540 million in 2025 (Ibid). Equally importantly, water pollution and contamination limit the usefulness of existing resources and raise the costs of using unconventional sources.

Immediate problems facing water resources in the MENA include:

*Over-extraction and consequent salinization of aquifers.* As the Vengosh WP summarized it,

Under conditions of increasing utilization, which characterizes most of the aquifer systems in MENA, the rate of recharge must exceed the pumping rate in order to keep the water budget positive. In most of the MENA aquifers, however, groundwater level has been declining during the last 50 years, inferring an unbalanced hydrological budget. Drawdown of groundwater levels is typically associated with salinization, which is the main factor that limits water utilization in MENA (Vengosh et al. 1999; 2005). In coastal aquifers, the water deficit and drawdown have resulted in intensification of seawater intrusion and salinization of wells overlying the salt-fresh water interface that is moving inland. *The salinity of water resources in many of MENA countries has become a crucial limiting factor for agricultural, economic and social developments.*

*Over-extraction of surfacewater.* Much like groundwater, rivers have been subjected to unsustainable rates of water extraction. Existing and planned withdrawals along the Nile, Tigris, Euphrates, and Jordan river basins have reduced flows dramatically and degraded water quality as water is recycled back into the system. Turkey's Guneydogu Anadolu Projesi (GAP) project, which has sought to control the flow of the Euphrates and Tigris Rivers, has had a significant impact on water variability downstream in Iraq and Syria (Daoudy 2009).

*Inadequate access to potable water and sanitation services.* With water scarcity already a fact of life, and with projected population increases, many poorer MENA states are focusing efforts on expanding potable water access and extending sanitation services. Using a 2000 baseline, these services are captured under Millennium Development Goal Seven, which includes halving the number of people without access to safe drinking water and sanitation by 2015 (Gleick 2004). The United Nations Joint Monitoring Programme (JMP) for Water Supply and Sanitation concluded in 2008 and again in 2010 that many states in MENA are well on their way to achieve these targets at the national level. The 2009 *Arab Human Development Report* also found that coverage for water services increased from 83% in 1990 to 85% in 2004, at a time when the total population increased from 180 million to 232 million (United Nations Development Program 2009). Yet, these aggregate figures tend to obscure significant differences in water entitlements among rural and urban areas and between formal and informal urban areas, as well as other marginalized populations (Zawahri et al. 2010). The reality is that many people are confronting a crisis in the quality of drinking water and the lack of effective sanitation services (Zawahri et al. 2010).

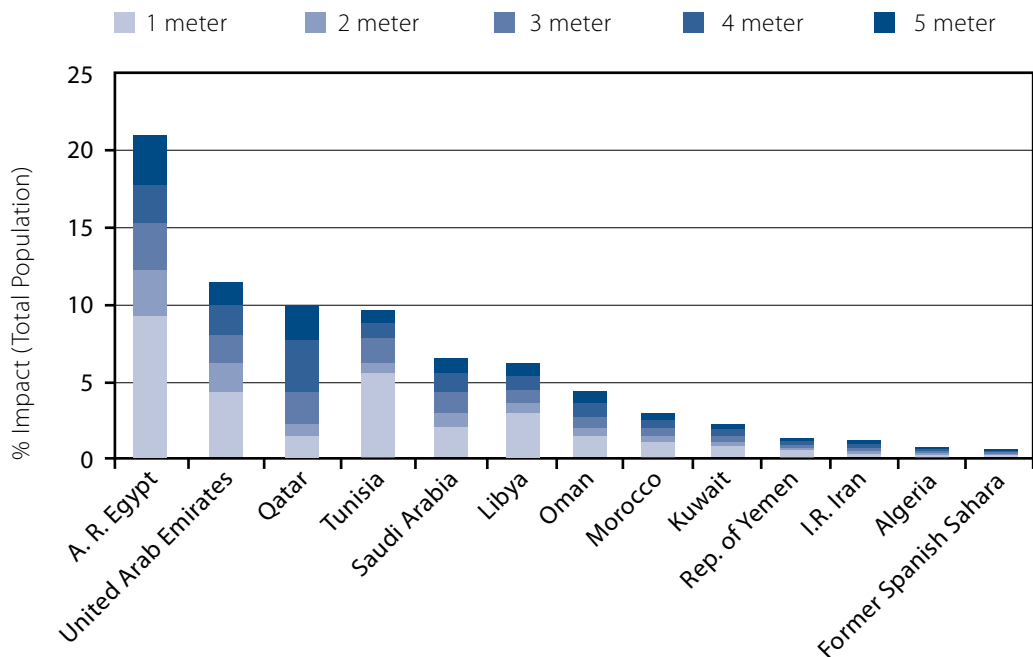
*Quality limitations on alternate water sources.* As states in the region increasingly turn to pumping "fossil" (nonrenewable) groundwater and reusing treated wastewater, new problems with water quality are arising. Several groundwater aquifers, notably the Saq aquifer used

increasingly by Saudi Arabia and the Disi aquifer in Jordan, have high levels of naturally-occurring radioactivity, which should be treated before consumption or use (Vengosh et al. 2009). Treated wastewater also poses challenges, as its use is limited by the accumulation of salts, boron, pharmaceuticals, and other inorganic substances not removed by conventional treatment (Vengosh WP).

## Unequal Vulnerabilities to Climate Impacts; Unequal Capacities to Respond

While the region faces shared environmental threats, states will be impacted differently by climate change through variations in exposure to climate risks. States reliant on surfacewater (Iraq, Turkey, Syria, Jordan, Egypt, Morocco) may experience significantly reduced flows if climate change shifts precipitation patterns in catchment areas that feed rivers upstream (Sowers et al. 2010). Similarly, sea-level rise will differentially impact coastal states with significant populations in low-lying areas, with Egypt, Tunisia and the small Gulf states most exposed (see Figure 3) (El Raey 2008, Ghoneim 2009).

**Figure 3: The Effect of Sea-Level Rise on the Middle East and North Africa Region**



Source: El Raey 2008

In addition to these “natural” vulnerabilities stemming from geography, vulnerability within the region varies by the adaptive capacity of states and communities to recover and adjust, which in turn depends upon level of wealth, patterns of governance, natural endowments, and national and local institutional capacities.

The severe drought of the past few years in the eastern part of the MENA region, spanning Turkey, Syria, Iraq, and the Levant (Lebanon, Palestine, Israel), provides a stark example of the interactions between climate-induced variability and governmental adaptive capacity. The drought highlighted the fragility of rural areas in several countries, where local and national governments were unable to cope with insufficient rainfall to sustain local agricultural production.

In eastern Syria, for example, prolonged drought (2006-2009) without effective interventions affected an estimated 1.3 million people; the loss of the 2008 harvest accelerated migration to urban areas and increased levels of extreme poverty (UN 2009, 1, 12). This pattern, where drought and water scarcity forces people to migrate to urban areas in search of alternative livelihoods, has been documented for other arid regions, such as the Sahel (UNEP 2006). Internal migrations to urban areas place additional stress on public services, such as sanitation, that were not designed for burgeoning populations. Yemen's capital city, Sanaa, provides a vivid illustration, as it may be the first capital city to run out of water. Unfettered pumping of the aquifer has resulted in the drawdown of the water table such that groundwater is being extracted at four times the replenishment rate (Stimson Center 2010).

## Where Does Adaptation Matter Most?

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"If mitigation is about energy, adaptation is about water."

T. J. Clausen and C. Bjerg (2010)

The water and agriculture sectors are not only some of the most vulnerable sectors to climate impacts, but are also areas in which proactive adaptation can yield significant benefits. Many MENA states have already embarked on a variety of infrastructural investments and institutional reforms to deal with water scarcity and pollution (For an overview and assessment, see Richards 2002, Sowers et al. 2010). It remains unclear whether climate change will serve as a frame to foster cooperation around shared water resources, or whether states will use climate impacts as another justification to pursue unilateral measures, which is the current norm in the region.

### 1. Climate change and transboundary water resources

Difficult tradeoffs and competing interests will shape the formulation and framing of adaptation strategies at both national and regional scales. Conflicting national interests are particularly evident in the unilateral actions by relatively powerful states in the region to build dams, extend irrigation networks, tap underground aquifers, and divert water for industrial and municipal uses. Regional and bilateral institutions created to cope with increased variability in surfacewater around shared river basins are weak (Zawahri WP), while consultations and commissions around shared groundwater aquifers are almost nonexistent.



Competing interests and tradeoffs are epitomized in dam construction and water diversion without consultation along shared watercourses. Dam construction offers a means to cope with increased variability in surfacewater associated with climate change, and provides much-needed storage capacity during seasonal or long-term droughts. However, dams also allow states to capture more water for irrigation, land reclamation, and cities, at the expense of other users and states along a particular watercourse. Increased water scarcity from dams is not simply a function of direct diversions; evaporation in dam reservoirs also leads to greater water losses and increased salinity. Additionally, water quality may suffer when water is used and returned untreated for re-use downstream. For international basins without water sharing agreements, these unilateral strategies to impound water upstream to cope with increased water variability have the potential to exacerbate regional tensions (Wolf et al. 2003).

Countries may well use climate impacts to justify additional unilateral interventions in managing water resources, making cooperation around shared water resources more difficult. For example, different perceptions of scarcity and need based on national perspectives were evident at the workshop. As one workshop participant from an upstream state noted, “We don’t feel we have a drop to waste. A growing population means growing water stress for us. We only look water-rich in comparison to some of our neighbors, who have much less water than we do!”

Multilateral frameworks for regional water management strategies have thus far not met with much success. The World Bank-sponsored Nile Basin Initiative has run aground between Egypt and Sudan’s claims of existing use on the one hand, and upstream riparians’ demands for equitable use on the other. In another instance of failed cooperation, an April 2010 Euro-Mediterranean Water Ministers Conference failed to reach consensus on a strategy to deal with increasing water stress around the Mediterranean (Abu Zeid WP). Existing water sharing agreements, often based on fixed volumes of flow, are also less tenable under conditions of increased variability in flows associated with climate change (Zawahri WP). Thus, even for countries with existing treaties, increasing water variability is likely to make compliance more difficult.

Specific measures can be taken to strengthen proactive planning capacities and institutional arrangements around river basins. For example, states could strengthen the capacity of transboundary river commissions by delegating commission members to hold regular meetings, establish direct communication, conduct joint inspections and monitoring, and establish robust conflict resolution mechanisms (Zawahri WP).

As another example, Egypt’s water planners have long argued that focusing on the volume of Nile flow at Aswan, as original river-sharing treaties did, misses the larger picture of total Nile flow in upstream states, rainfall patterns in upstream states, and the proportion of populations dependent on the river, which varies greatly across states. Rather than developing surfacewater flows in isolation, riparian states could incorporate planning and investment in “green water,” or precipitation and rainfed agriculture (Abu Zeid WP). Interstate coordination to improve productivity of rainfed agriculture could complement investment in hydropower

projects in upstream states that might increase total flows downstream (Ibid). However, the question remains whether such upstream investments will merely lead to the expansion of agriculture in upstream states and the reduction of downstream flows, as illustrated by Turkey's extensive dam-building and its effects on Syria and Iraq.

## **2. Agriculture and food security**

Agriculture is an obvious sector for adaptation efforts. Given the expected rise in temperature and reduction in rainfall, climate-related impacts on water used for the agricultural sector are expected to be highly significant (Cline 2007). Many crops are already cultivated at the extremes of their tolerances to heat and water and soil salinity; increasing temperature is expected to lower yield and shift cultivation patterns (Eid et al. 2007). An additional impact is the expected degradation of the quality of irrigation water, associated directly and indirectly with climate change (Sowers et al. 2010).

Agriculture may therefore offer the "low hanging fruit" in terms of the costs and benefits of adaptation, as one participant noted, especially since the sector consumes between 70 and 90% of total water withdrawals across the region. Turkey, for example, has already begun to replace open-lined canals with more efficient delivery systems, such as pressurized pipe systems, to reduce water loss. However, there are difficult trade-offs, in the water/agricultural nexus, between improving efficiency in water use and sustaining rural employment (Waterbury WP). Promoting agricultural technologies such as drip irrigation and other forms of "precision agriculture" tend to reduce demand for labor; unless labor can be absorbed through economic growth in other sectors, welfare impacts will be significant and adverse (Ibid).

In addition to concerns around rural employment, the rapid escalation in world food prices during 2007-2008 brought food security back on the agenda of Middle Eastern states. Importing food and other goods, which embodies "virtual water," has long been the principal means through which many MENA states have indirectly supplemented their water supplies (Allan 1997). Egypt, for instance, is the largest importer of wheat in the world, and other MENA states rely heavily on imports of cereals.

As Amartya Sen has long argued, foodstuffs follow purchasing power (Sen 1983). Thus the ability to import food depends upon domestic economic activity to generate hard currency and a global trading system that remains relatively open. During the recent spike in food prices, some producers of cereals enacted export bans to ensure adequate domestic supplies, as Russia did again in August 2010. Such bans contribute to rising global prices and also make large importers of food wary of further reliance on trade in virtual water to solve domestic food needs.

### ***Case 1: Food and water security in the Gulf***

The Gulf Cooperation Council (GCC) countries have the lowest renewable water supplies per capita in the world, combined with relatively high population growth rates. The result is that they import 90% of their food, at a cost estimated to reach \$49 billion in

2020. With one fifth of the world suffering from malnutrition and food shortages, and arable land acreage unlikely to increase, the question becomes: from where will the GCC import its food in the future?”

One preliminary answer has been in the form of efforts by Gulf countries to sign lease agreements and pursue agro-industrial investment abroad, in underdeveloped arable land in countries such as Sudan, Pakistan, the Philippines, Ethiopia, and others in Central Asia and South East Asia (Woertz WP). This strategy, however, overlooks the political instability and food insecurity that will likely make such agreements untenable in the longer term (Ibid). Gulf investors have also invested in controversial land reclamation projects in Egypt and elsewhere (Sowers, forthcoming).

Moreover, decades of subsidies for domestic agricultural production in the Gulf have significant consequences for attempts to limit or restructure water demand in agriculture. In prior decades the Saudi government had helped create an agribusiness sector by allocating free land and free water to influential business groups. Faced with incontrovertible evidence of overextraction of fossil groundwater aquifers, the government dramatically reduced subsidies for wheat cultivation in the past few years. However, since business groups enjoy close ties with, and include members of, the political elite, the Saudi Ministry of Water lacks the political clout to limit groundwater extraction for agriculture. For example, the Ministry has met significant resistance in attempting to inspect wells and monitor rates of groundwater use. Gulf agribusiness interests are simply switching to other crops, such as alfalfa, and importing other staple crops, such as barley, to sustain investments in large-scale dairy operations.

To compound matters, public discourses emphasizing food self-sufficiency are still quite prevalent (Woertz WP). At the same time, citizens of Gulf countries are the least concerned about water supply, given almost complete coverage in water provision and sanitation, as compared to other regions of the Middle East (Tolba and Saab 2009).

Agricultural adaptation to arid conditions is not a novel phenomenon in the Gulf, however. Indigenous communities often have extensive knowledge of local drought resistant crop varieties. These varieties, many of which are researched and stored through institutions like the International Center for Agricultural Research in Dry Lands (ICARDA), offer one avenue for scaling up shifts in agricultural sectors (Moustafa WP). This will require investment in human resources and research infrastructure in the Gulf, and expanded cooperation with regional and international institutions. Some countries, notably Qatar, are exploring using solar desalination for agricultural production (Woertz WP).

Even with such measures, however, Gulf dependence on imported food will increase. Thus, GCC states should take several steps to boost food security. These could include cooperating in regional infrastructures for strategic reserves of food, supporting the creation of a virtual international fund in food to avoid speculative price hikes, and coordinating their overseas agricultural investments with developing countries seeking reduction of US and EU agro-subsidies in international trade negotiations (Woertz WP).

## **Case 2: “Forced” adaptation in the Gaza Strip**

While the Gulf faces grave challenges, insecure food and water supplies have already forced Palestinians to undertake a variety of emergency coping mechanisms in the Gaza Strip. These measures provide a preview of the types of actions that may be “forced” onto individuals and households, where the most vulnerable may pay the price of climate adaptation in the absence of international and national mechanisms to provide adequate public goods. As noted below, some of these forced coping mechanisms are not unique to Gaza, but are also found elsewhere in the region.

In Gaza, the dire conditions that long characterized the Israeli occupation worsened considerably in the aftermath of the January 2006 siege imposed by Israel and Egypt and condoned by the West. Although ostensibly undertaken to weaken the newly elected Hamas government, the blockade has actually allowed Hamas to consolidate social and economic control over scarce resources (see *The Economist* 2010). The blockade shut down most of the trade in foodstuffs that supplied the population and blocked the import of construction materials needed to reconstruct the water and sanitation infrastructure damaged in the January 2009 Israeli campaign. Additionally, ongoing restrictions on movement continued to increase unemployment rates and virtually stopped the legal export of Gazan goods.

In Gaza, the blockade has led to hunger. In 2008, 56% of Gazans were food insecure and 75% received food assistance, according to a Joint Rapid Assessment conducted by the World Food Program, the Food and Agriculture Organization (FAO), and the United Nations Relief and Works Agency (UNRWA) (Mason and Zeitoun WP, 4). While water experts have urged Middle Eastern states to rely more on imported foodstuffs, the lesson of Gaza is that food can still be used as a weapon, but one that targets civilians with little effect on the political leadership. Instead, as was seen in Iraq during the long period of sanctions, civilian deprivation only concentrates scarce resources in the hands of the very regimes that these policies are supposed to undermine.

Several experts have documented how Gazans have struggled to cope with deteriorating water and food supplies. For water, household income increasingly goes to buying water from privately owned, neighborhood-level reverse osmosis units and under-sink filtration units (Mason and Zeitoun WP). Gaza has long had an inadequate sanitation infrastructure and, as in other areas of MENA, sewage flows have contaminated groundwater resources. Water and food insecurities also spur farmers to drill unlicensed wells that further deplete the aquifer, a process that has been ongoing since the mid-1990s (Al Yaqoubi 2008). The phenomenon of over-extraction through private pumping is endemic where agricultural sectors can access groundwater freely.

Following World Bank and USAID recommendations, Gazan farmers had increasingly focused on cultivating high-value goods for export, such as strawberries, citrus, and cut flowers. This strategy of income generation has been decimated with the ban on exports and deteriorating water quality and supply (Mason and Zeitoun WP). Instead, farmers have shifted from water-intensive crops to saline and drought tolerant crops, such as dates, olives, and local foodstuffs (Mason and Zeitoun WP, Al Yaqoubi WP). Similar patterns of crop substitution have been seen in Egypt and other areas where salinization and pollution in irrigation water is increasing.

As with the Gulf countries, Gaza's water and food insecurities cannot be solved within its (small) borders. Mobility – not just for goods and foodstuffs, as in the Gulf, but for people as well – will be a long-term solution for the Strip, in which 1.5 million people, growing at 3.4% per year, are confined in a 365 km<sup>2</sup> area. Construction of a large-scale desalination plant would help supply municipal and business needs in one of the most densely populated places on earth. The situation in Gaza, which a participant likened to a “large open-air prison,” highlights the residents' need to be able to move freely between Gaza and the West Bank, as well as outside of its borders. As exemplified by Syria's internal migration due to drought, migration is a common community-level response to highly variable climatic conditions.

## Policy Conclusions

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### 1. Mainstream adaptation in policy planning

Since the international community failed to reach an agreement at Copenhagen in December 2009, many countries no longer have a choice between mitigation and adaptation. For the most vulnerable sectors and populations, plans must be put into place to adapt to greater uncertainty in national and regional climate variability.

As this paper has shown, climate change intensifies and exacerbates already existing problems of water, agriculture, drought, migration, urban planning, and rural livelihoods. Thus, as one participant argued, states should focus on improving “existing public policies to deal with existing problems.” Or as another observed, climate change should “encourage policy makers to do what they should do anyways, even if there were no global warming.”

This approach makes sense for areas in which policy makers already face incentives to take action in the face of limited, degraded water resources and concerns with food security. These policy areas include upgrading and maintaining water treatment and distribution systems, sanitation provision, building protective coastal infrastructures, allowing further private sector involvement, subsidizing new technologies that conserve water, pursuing the creation of regional physical and virtual food reserves, and investing in agricultural storage and transport infrastructure.

However, other aspects of climate adaptation cannot be adequately dealt with through existing policy approaches. This can be seen most clearly in the possibilities of significant sea-level rise in heavily urbanized areas. Proactive coastal planning, rarely undertaken anywhere, thus becomes more important. Similarly, designing urban infrastructures, dams, and rainfall catchments to deal with increased variability needs to be a proactive concern. Already, the Toshka spillway, designed to safeguard the Aswan High Dam from high Nile floods, was opened for the first time in 1997, as one participant noted. Investing in infrastructure projects should, however, be taken with care; “embarking on large structural adaptation mechanisms without adequately assessing... expected environmental impacts... might result in adverse impacts that could be worse than predicted impacts of climate change” (Abu Zeid WP).

International donor funding and United Nations agencies have played a significant role in financing a first round of national action plans and vulnerability assessments focused on adaptation needs for states in the Middle East (for the Gaza Strip, see UNDP/PAPP 2010a and 2010b). Similarly, the process of preparing national communications under the Kyoto Protocol has prompted states to create a few staff positions within governmental ministries to generate such reporting (for Turkey, see Altinbilek WP). The United Nations Development Programme and other donors have also supported developing early warning systems for drought using data on rainfall and soil moisture. Yet only a few states have begun mainstream planning for climate adaptation in water, agriculture, and coastal investments. Turkey, for instance, has begun to design climate adaptation plans for select river basins and agricultural areas (Altinbilek WP).

For adaptive governance to be effective, institutions must be embedded within society (Dietz et al. 2003). For adaptation to be fully integrated into long-term planning, MENA countries – in which community participation is often constrained by the broader political context – will need to open up the decision-making process to include more community input and support for community-level adaptations, especially among populations that are likely to feel the impacts of climate change on their well-being most directly. As a first step, governments could lend support to local-level adaptive projects to address changing water availability and quality and ensure that such projects are vertically and horizontally integrated with other ongoing adaptive projects.

## **2. Diversify agricultural policies**

As the case studies of Gaza and the Gulf countries suggest, MENA governments may well need to reconsider their agricultural strategies to deal with increased climate variability and its effects on land and water resources. Increasingly, agricultural production in MENA follows trends in industrial agriculture elsewhere, towards large-scale, capital-intensive, spatially fixed operations supported by government incentives and subsidies. Many MENA states have also promoted exports of niche agricultural products such as citrus, vegetables, and cut flowers, to Europe and elsewhere.

To enhance resilience in the agricultural sector, MENA states should revisit agricultural policies and property regimes that penalize small-scale agriculture and marginalize agro-pastoralism (Zurayk and Tell, forthcoming). Instead, governments can support combinations of local knowledge and modern technologies to better support private production at a variety of scales, including household and communal forms of production.

## **3. Integrate planning for water/energy sectors and invest in renewable energy**

Given increased variability in surfacewater flows and increased temperatures associated with climate change, adaptation should include integrated planning of hydrological structures and energy infrastructures (Siddiqi and Anadon WP). The operation of major infrastructures, such as dams and power plants, is dependent on reliable water supplies for cooling and power generation. For example, projects and plants in China, France, and Spain have been halted in recent years because of increased cooling requirements (given higher temperatures) and lack of water availability.

Thus, planning for energy infrastructure should include consideration of the “water footprints” associated with different technologies, as well as carbon footprints associated with mitigation efforts (Siddiqi and Anadon WP). For instance, the production of corn ethanol, highly subsidized in the United States as an alternative to oil imports, consumes vastly more water than the extraction and processing of fossil fuels, regardless of their origin (Ibid).

Considerations of integrated water/energy planning are also central to reconsidering development pathways in MENA. Since many Gulf and North African countries continue to rely on hydrocarbon revenue for a significant portion of government revenues and hard currency exports, they have long considered themselves more vulnerable to climate mitigation efforts that would “tax” or otherwise reduce consumption of fossil fuels, than to the impact of climate change on water/land systems (Babiker WP).

Making the linkages between present-day problems of water and food security to climate change might induce oil exporters to support needed actions to mitigate climate change, as part of planning for a post-carbon future. Several pilot projects in large-scale solar energy production, solar desalination, and wind production have been announced and are under construction, usually with the participation of international financial institutions such as the World Bank. In addition, MENA states could adopt financial incentives to support renewable energy alternatives for a post-hydrocarbon future.

## List of Participants and Working Papers

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Climate Adaptation Workshop, Dubai Initiative, Belfer Center for Science and International Affairs, May 3-4, 2010.

### Co-conveners

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Working Paper: Adaptation to Climate Change in Turkey: Floods and Droughts

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Working Paper: On Adaptation to the Impacts of Climate Change Response Measures and Related International Policy Provisions

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Working Paper: Regional and International Mechanisms for Adaptation: Conceptual and Empirical Implications

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Working Paper: Climate Change and Its Impact on the Quantity and Quality of Groundwater Resources of the West Bank

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Working Paper: Michael Mason and Mark Zeitoun, Coastal Vulnerability to Climate Change: Lessons from the Gaza Strip?

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Working Paper: Afreen Siddiqi and Laura Anadon, Quantifying the Water-Energy Nexus for Integrated Power and Water Systems Planning

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Working Paper: Food Security and Agricultural Adaptation in MENA

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Working Paper: Hydropolitics and Adaptation

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Working Paper: Building Institutional Adaptive Capacity to Respond to Climate Change in the Middle East

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Working Paper: The MENA Region Water Sector: From Politics in Climate Change to Hydro-Politics in Adaptation

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## About the Dubai Initiative

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The Dubai Initiative is a joint venture between the Dubai School of Government (DSG) and the John F. Kennedy School of Government at Harvard University supporting the establishment of the DSG as an academic, research and outreach institution in public policy, administration and management for the Middle East. The primary objective of the Initiative is to bridge the expertise and resources of the John F. Kennedy School of Government/Harvard University with the Dubai School of Government and enable the exchange of students, scholars, knowledge and resources between the two institutions in the areas of governance, political science, economics, energy, security, gender and foreign relations in the Middle East.

The Initiative implements programs that respond to the evolving needs of the DSG and are aligned with the research interests of the various departments and centers of the Kennedy School of Government as well as other schools and departments of Harvard University. Program activities include funding, coordinating and facilitating fellowships, joint fellowships with the DSG, internships, faculty and graduate research grants, working papers, multi-year research initiatives, conferences, symposia, public lectures, policy workshops, faculty workshops, case studies and customized executive education programs delivered at the Dubai School of Government.

## About the Dubai School of Government

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The Dubai School of Government (DSG) is a research and teaching institution focusing on public policy in the Arab world. Established in 2005 under the patronage of HH Sheikh Mohammed Bin Rashid Al Maktoum, Vice President and Prime Minister of the United Arab Emirates and Ruler of Dubai, in cooperation with the Harvard Kennedy School, DSG aims to promote good governance through enhancing the region's capacity for effective public policy.

Toward this goal, the Dubai School of Government also collaborates with regional and global institutions in delivering its research and training programs. In addition, the School organizes policy forums and international conferences to facilitate the exchange of ideas and promote critical debate on public policy in the Arab world.

The School is committed to the creation of knowledge, the dissemination of best practice and the training of policy makers in the Arab world. To achieve this mission, the School is developing strong capabilities to support research and teaching programs, including

- applied research in public policy and management;
- master's degrees in public policy and public administration;
- executive education for senior officials and executives; and,
- knowledge forums for scholars and policy makers.





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