

The Research and Policy Forum on Climate Change and Environment in the Arab World

at the

Issam Fares Institute for Public Policy and International Affairs, AUB

presents

***"Climate Change, Water and the Policy-Making Process
in the Levant and North Africa"***

A closed workshop with leading water experts from the Levant

AUB, Tuesday, August 4, 2009

Climate Change in the Levant and North Africa Region: an assessment of implications for water resources, regional state of awareness and preparedness, and the road ahead.

HAMED ASSAF, PH.D., P.ENG.

INTRODUCTION

It is now widely acknowledged that climate change is fast approaching us and many assert that it is already underway. Are we ready for it?

The bad news is that the Levant and North Africa (LNA) region is projected by most climate general circulation models (GCMs) to be the most severely impacted region in the world as it is expected to undergo severe water scarcity that will jeopardize its socio-economic development and potentially the very integrity of its nations. Countries of the LNA are already some of the most water impoverished in the world and are ill prepared to managing with even less water having some of the fastest expanding populations in the world with growing appetites for more water and water consuming goods and services.

It is ironic that climate change is actually projected to bring more water to the world, yet it is expected to bring more to those who have more of it, mainly equatorial and high latitude regions, and less for those who have less of it, mostly the subtropical mid-latitude areas such as the LNA. A more water polarized world is going to emerge as climate change intensifies.

If the projections of a very recent study by Japanese and Israeli researchers (Kitoh et al 2008) are accurate, the Fertile Crescent, the cradle of civilization, will cease to be fertile and will turn into a dust bowl that will no longer sustain the welfare of its people after making the longest journey in human history. Could this be what the future is holding for our region? An end to our nations and the turning of our future generations, and possibly us, into refugees seeking better life in more humid regions.

Are we ready then? What is the current knowledge and awareness of climate change and its potential impacts on water resources among the different sectors of the society including researchers, policy makers, civil society activists and the public at large? What is the state of readiness in our institutional framework to avert this impending disaster? These are the questions this study is trying to answer. The authors have also attempted to chart a preliminary road map for action. The study findings and recommendations are presented for open discussion and deliberations with colleagues to improve our understanding of and readiness for climate change and its impact on water resources.

To help frame the study in a climate related context we start the paper by presenting a general overview of the current climatic conditions of the region. We move then to present what is known now about climate change projections for the region relying on the most recently published results of GCMs simulations. The role of the Westerlies as the global atmospheric carrier of moisture to the LNA region, and its sensitivity to climate change will be emphasized.

We will then discuss the pressing issue of chronic water scarcity in the region, water governance, research efforts and its links to policy making, and the roles of civil society, media and donor organization. An important component of this study is understanding how these different key players are engaged and interacting in dealing with this global phenomenon.

CLIMATE OF THE LEVANT

The climate of the Levant is shaped not only by global circulation systems, but also by its highly complex and sharply variable topography. The change from hyper-arid deserts to steppes to cool highlands all occur within few hundred kilometers. The coastal mountain range along the Eastern Mediterranean arrests moisture from the humid Westerlies wind system moving across the region in the winter. Stored as snowfall to be released later as snowmelt or rainfall that run off the surface or percolates into aquifers, these water resources give rise to the Levant rivers of Jordan, Litani and Assi as well all other smaller Lebanese rivers. Similarly, but at a much larger scale, the Taurus and Zagros Mountains that flank the Fertile Crescent to the north and east capture orographic precipitation to form the headwaters of the Euphrates and Tigris Rivers (Jason et al 2004) which have sustained the longest human settlement in otherwise barren desert.

The Levant is characterized by rainless and hot summers. This stark disparity between winter and summer moisture conditions has evolved over few thousand years and is believed to have been the drive for the invention of agriculture and irrigation (Issar and Zohar 2007). Water works were developed to bring water to drier areas and made it possible to establish a solid foundation for organized societies and states.

The Westerlies are the prevailing winds in the mid latitudes driven in the Northern Hemisphere by the gradient in atmospheric pressure between the Atlantic high and the Arctic low expressed in terms of the North Atlantic Oscillation (NAO) index (Hurrell 2003). Due to the Earth's rotation the Westerlies blow northwesterly in the Northern Hemisphere. In years when the difference between the Arctic low and Atlantic high is large (positive NAO) the Westerlies shift to the north which results in less precipitation over southern Europe, North Africa and Eastern Mediterranean (See Figure 1-a). Conversely when the NAO is negative, i.e. weaker difference in pressure gradient, the Westerlies drift south towards southern Europe, North Africa and the Eastern Mediterranean bringing more water to these areas (See Figure 1-b). Several studies have confirmed the strong association between the NAO and drought cycles in the Mediterranean

(Cullen et al 2002). Recent studies have also shown that the NAO is positively linked to climate change (see Figure 2).

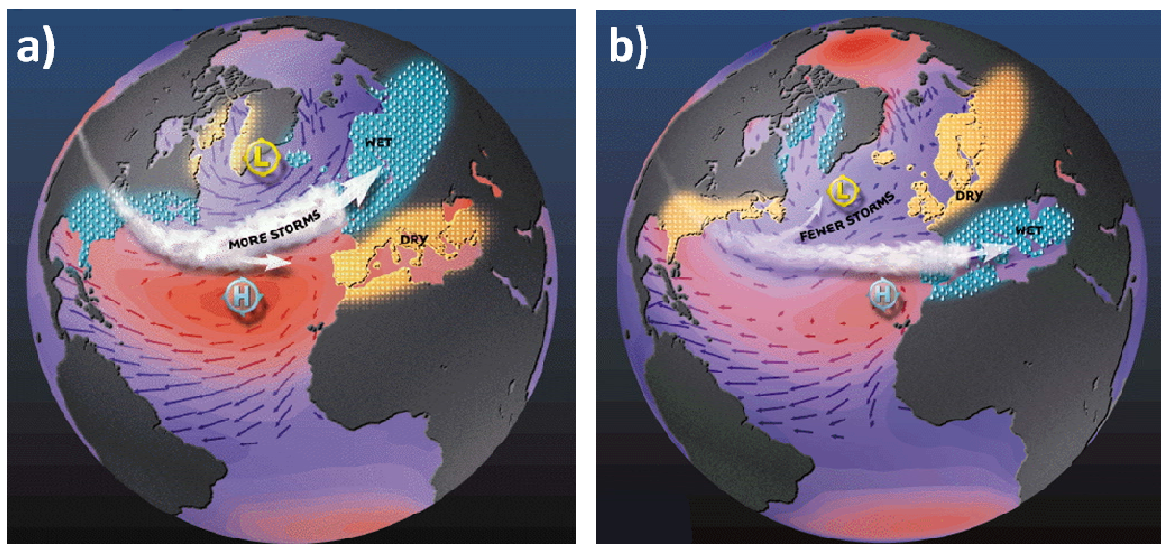


Figure 1. Impact of NAO on the Westerlies climate system: a) high NAO; b) low NAO. (source <http://www.ldeo.columbia.edu/NAO>).

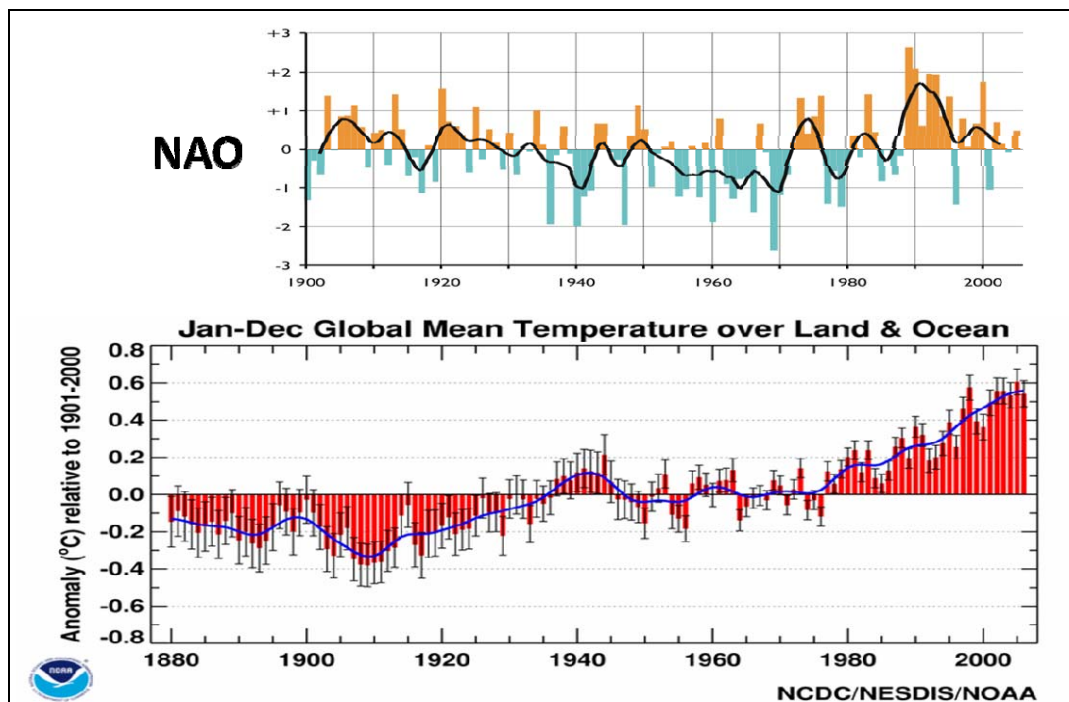


Figure 2. Link between NAO and climate change.

END-OF-CENTURY CLIMATIC OUTLOOK FOR THE LNA

A recent analysis of climate change projections simulated by 20 leading GCMs has placed the Mediterranean basin particularly its southern and eastern banks (i.e., the LNA region) on top of the list of regions to undergo a severe process of aridification characterized by hot and drier conditions with extensive and prolonged droughts (Giorgi 2006). These dire projections have been reiterated by the Intergovernmental Panel on Climate Change (IPCC) in its comprehensive state-of-the-art review of climate change literature across the globe (IPCC 2007).

Figure 3 presents results from the IPCC analysis of climate simulations from fifteen leading GCMs comparing changes of annual means of four hydrological variables (precipitation, evaporation, soil moisture and runoff) for the period 2080-2099 relative to 1980-1999 for the emission scenario A1B, which represents average GHGs emissions (about 700 ppm of CO₂ equivalent by year 2099). Stippled areas indicate regions where 80% of the models agree on the sign of the mean change. The LNA region clearly stands out not only as the one with the highest projected reductions and increases in annual precipitation and evaporation, respectively, but also as the region where 80% percent of the models agree on the direction of this change. These projections are also reflected in projected decreases in soil moisture and river runoffs - two key factors for sustainability of agriculture and water supply. The ramifications of these projections would be phenomenal given that the region is already experiencing severe water scarcity.

The LNA region also scores high on projected increases in the annual maximum number of consecutive dry days, a measure of drought severity, as shown in the right map of Figure 4. Stippled areas indicate regions where 5 out of 9 models used in this analysis agree on the direction of change. The left map shows projected changes in precipitation intensity calculated as the total precipitation divided by wet days. The LNA regions indicate a moderate to negligible change with respect to this indicator.

Analysis of observed annual precipitations in Lebanon since 1967 showed significant downward trend that brought down total precipitation by 12% over the past 40 years (Shaban 2008). Temperature rise in the order of 2°C was assessed to result in an earlier depletion of snowpack in the Nahr Ibrahim watershed which would shift the peak of runoff from February to April (Hreiche et al 2007).

An assessment of the impact of climate change on the water balance of the Zarqa river basin in Jordan has shown that precipitation reduction in the range of 10% to 20% are bound to have significant impact on the total yield of the semi-arid basin (Abdulla et al. 2009). In contrast, the same study has shown that the basin is less sensitive to projected changes in temperature in the range of 1°C to 3.5°C.

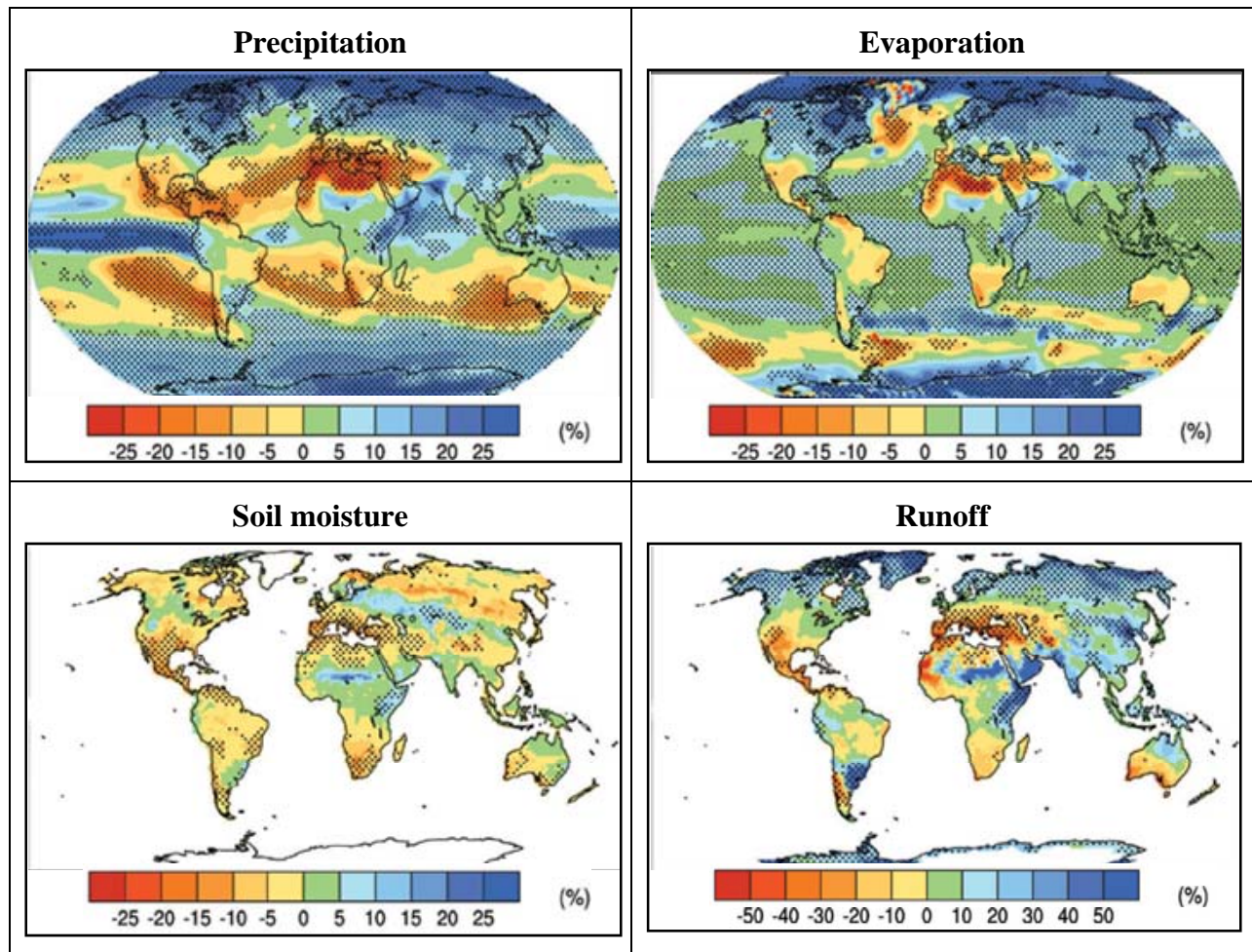


Figure 3. Climate change projections for selected hydrological variables (IPCC 2007).

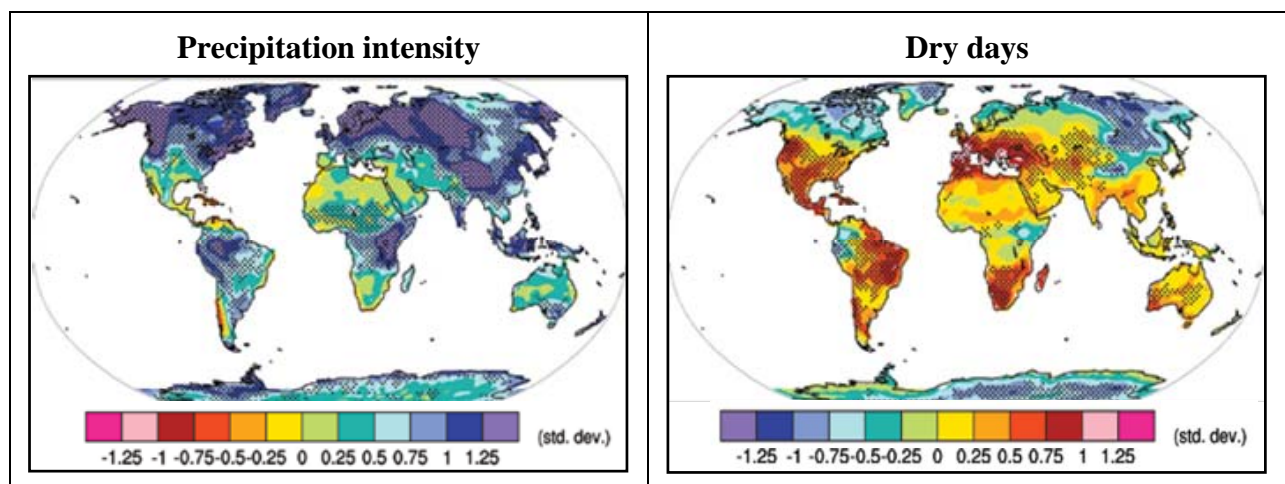


Figure 4. Global projections of precipitation intensity and dry days (annual maximum number of consecutive dry days) (IPCC 2007).

PUBLIC AWARENESS OF CLIMATE CHANGE AND THE ROLE OF MEDIA

When did the world at large start to get worried about or even be aware of climate change? Year 1998 is possibly the milestone when there was a shift from public skepticism about the very existence of climate change to the conviction that it is the most significant global issue. This is the year when Mann et al (1998) declared in their well known article in the “Nature” journal that “the 1990s are likely the warmest decade, and 1998 the warmest year in at least a millennium” warning the world that the climate is changing in an unprecedented way. The outlook looks even bleaker as the next several years showed increasingly higher global average temperatures (see Figure 5) with year 2005 hitting a record of 14.75 °C, well above the 14.72 °C recorded in 1998. Significantly, the mean of average global temperatures of the first seven years in the 21st century was the highest in record. The evidence of climate warming was corroborated with reports of melting of ice sheets in the Arctic and glaciers in different parts of the world, and noticeable rises in sea levels. The trend of warming suddenly changed in 2008 with the global temperature dipping to 14.55 °C. However some scientists were quick to report that the cooling is not related to current efforts in reducing emissions of GHGs, but rather the result of relatively cold sea surface temperatures in the eastern equatorial Pacific caused by a recent La Niña event (Vaughan 2008).

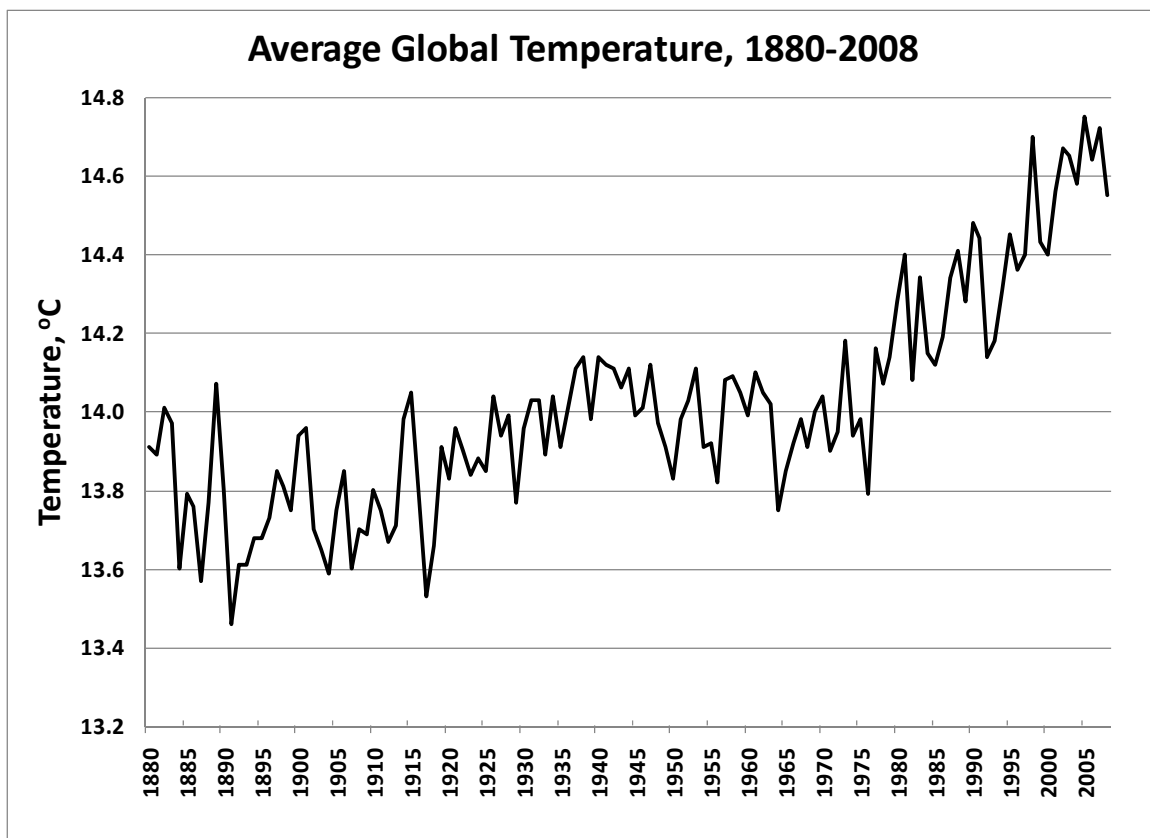


Figure 5. Average global temperatures (1880-2008) (data source: Goddard (2009))

The Media in the western world has taken a great interest in the issue of climate change. Large media organizations including the BBC and CNN have launched dedicated programs to inform and update the public on climate change issues. Full-time correspondents with support from highly qualified climate change experts have articulated complex issues about climate and advanced model in simple, yet accurate language.

In comparison, the LNA region as the rest of the Arab world has taken longer time to react to these developments. This is possibly due to several reasons, not the least of which is the preoccupation with economical and political issues including those related to the conflicts in Iraq and Palestine. However, the rapid growth in LNA region's access to western media through satellite networks and the internet has increased people's awareness of climate change issues.

Regional media outlets have generally adopted a passive approach of rebroadcasting information obtained via western media. An exception was Aljazeera who has adopted a proactive approach through providing a more comprehensive coverage including documentaries, interviews with regional experts and talk shows, that are more tuned to the region's pertinent climate change issues. Aljazeera has also played an important role of breaking the language barrier through reaching out to large segments of the society that can only speak Arabic. Other large media corporations, such as LBC and Alarabia are improving their coverage of climate change. A less formal internet-based media, such as personal blogs, are playing an increasingly important role in climate change awareness (e.g., see ArabEnvironment (2009)).

RESEARCH EFFORTS

Early research activities on climate change and its impact on water resources in the Levant dates back to the turn of this century, which comes at the heel of Mann et al's warning of impending climate change. One of the earlier studies belongs to Abu-Taleb (2000) who examined the impact of climate change on water supply/demand in Jordan. El-Fadel and Bou-Zeid (2003) evaluated the impact of climate change on water resources in several Middle Eastern countries including those of the Levant. However, their analysis is based on "outdated models from the mid-1990" (Michaelowa 2006).

Regional research is mostly based on information and technology developed abroad. Although these resources are valuable they may not be reliably and consistently applied in the Levant region due to significant gaps in climate and water related data. This information deficiency hampers many local research efforts. Jason et al (2004) described the Middle East as "a data-sparse area", with few climatic regional studies. Interestingly many of these studies are conducted by Israeli researchers, for example Mariotti et al (2008) and Krichak et al (2005). Despite the urgent needs for information and development of regional climate models no initiative has been reported to be directed towards achieving these goals.

Weak support for research in the Levant and the Arab world in general are the outcome of decades of neglect to place research in the priority list for public and private funding. Research on climate change in the Levant is generally conducted on an ad-hoc basis by individual researchers who naturally adhere to limited scope research interests. These efforts in isolation can not be expected to adequately prioritize and address pertinent climate change issues facing the region. This can be only achieved via sound national research policies with strong backing and buy-in at the highest levels.

Collaboration has become more prevalent in the region to leverage and compliment research skills and limited research resources and data. For example, researchers from the International Center for Agricultural Research in the Dry Areas (ICARDA) in Syria and INRGREF in Tunisia have worked together in investigating measures to improve irrigation efficiency and exploring methods for utilizing treated wastewater and low quality water (Pereira et al. 2002). Recently, researchers from the American University of Beirut (AUB) and Jordan University for Science and Technology (JUST) have investigated the impact of climate change on water balance in the Zarqa watershed (Abdulla et al. 2009).

Most of the collaborative research efforts on climate change are initiated and supported by foreign donors and research institutes. For example the Global Change in the Hydrological Cycle (GLOWA) program supports regional research on integrated water resources management in the Jordan River. The program has placed great emphasis on the impact of climate change on the Jordan River (GLOWA 2009).

The German Federal Institute for Geosciences and Natural Resources (BGR) and the Arab Centre for the Studies of Arid Zones and Dry Lands (ACSAD) have collaborated for many years on groundwater modeling and management research. They have recently organized a conference on water resources management in Damascus, which drew a large number of researchers mostly from the Levant region (ACSAD 2009).

Regional conferences focusing on climate change and water issues pertinent to the region provide a conducive environment for researchers to exchange information and ideas and develop working relationships. The German-Arab Scientific Forum for Environmental Studies, headed by Dr. Fathi Zerieni, has organized the “Climatic Changes and Water Resources in the Middle East and in North Africa” conference in Fez, Morocco. The conference had a large gathering of researchers from the Arab world, mostly from the Levant and North Africa region. Several new research findings were presented at the conference.

The Issam Fares Institute for Public Policy and International Affairs (IFI) of AUB has been actively pursuing an initiative to bridge the gap between researchers and policy makers. Several workshops were organized over the past two years bringing together policy makers, including

ministers, NGOs and researchers from the LNA region and the Arab world. The role of IFI is discussed in more detail in a later section.

WATER GOVERNANCE

Despite climate change projections of severe reduction in water resources in the Levant, there seem to be no indication this issue is considered in the current water governance system. In fact, the countries of the Levant are still lagging in reforming their institutional frameworks to deal with the chronic water scarcity. Jordan has prepared a progressive water strategy that, if implemented, will resolve several flaws in Jordan's water governance. However, only a general reference was made to climate change in the document (Jordan 2009).

The following sections provide brief description of the current water governance structure in each country of the Levant

Jordan

Water resources in Jordan is formally managed by the Ministry of Water and Irrigation which oversees two authorities: the Water Authority of Jordan (WAJ) and the Jordan Valley Authority (JVA). However, there is lack of communication and coordination among the three agencies which results in overstaffing, overlapping in responsibilities and general operational inefficiencies. The new water strategy acknowledges these institutional deficiencies and calls for drastic reformulation (Jordan 2009).

Jordan water strategy adopts an IWRM approach that emphasize water demand management, reduction in inefficient agricultural activities, involvement of stakeholders especially through water users associations, water quality management, wastewater reuse, and conservative utilization of non-renewable water resources. Although the strategy acknowledges the expected negative impact of climate change on water resources, it does not offer specific adaptive solutions.

The newly created Ministry of Environment is currently active in pursuing policies for reducing GHGs releases. Its minister Khaled Irani has been active in participating in several conferences in the Levant and Arab region addressing the issue of climate change (e.g., conference organized by IFI).

Lebanon

The Ministry of Energy and Water (MoEW) is responsible for setting water resources policies and overseeing water resources management through recently created four water authorities organized along the main geodemographic regions of Lebanon. However the authority of these agencies is still being challenged by several of the previous 21 utilities they had replaced few

years ago. The current Lebanese water legislative system does not address the issue of climate change.

The MoEW has prepared in 1999 a decennial water master plan with a budget of \$1.5 billion (Comair 2006). Despite having some IWRM features, the water master plan mostly focuses on developing water supply projects. The plan makes no reference to the potential impact of climate change.

The Ministry of Environment is actively involved in raising public awareness of climate change. It campaigns for energy conservation and protection of forests.

Palestine

The water sector in the Palestinian territories was organized according to a water law enacted in 2002 that separates between policy making, regulatory and operational bodies. However, due to political instability and the interference of Israel, the actual governance system is mired with overlapping in responsibilities and blurred separation among the different authorities (Zeitoun 2008).

No specific legislation was reported to have been developed to address climate change. However, the president of the Palestinian authority was quoted to have ordered the planting of several million trees to “combat” climate change (WAFA 2009).

Syria

The Ministry of Irrigation is responsible for water resources planning and management. A new water law was enacted to streamline the ministry water governing structure. Climate change is not considered in the current water regulations. Successive 5-year water plans focus mostly on water resource infrastructure and development of water resources supplies.

ENGAGING POLICY WITH RESEARCH

As indicated above, water policies and regulations in the Levant are mute on the issue of climate change, despite the mounting evidence of its projected devastating impact on water resources in the region. This is partly due to the general disconnect between the research community and policy makers, and that the latter are not accustomed to keeping up with rapid changes in knowledge as in the case of climate change. Even in more advanced societies, policy makers generally prefer to only acknowledge more established technology and information. However, the highly significant consequences of climate change in the LNA necessitate actively engaging policy makers with the research community.

In pursuing this objective, the Issam Fares Institute (IFI) for Public Policy and International Affairs at AUB has launched the “Research and Policy Forum on Climate Change and Environment in the Arab” program. This initiative supports series of workshops and seminars that brings together climate change researchers with policy makers, NGOs and the public from different parts of the Arab world. Several key policy makers¹ and active representatives of civil society² have participated in these events and provided valuable insights and different perspectives on climate change issues. Lively dialogues and discussions have characterized these gatherings and facilitated interaction and feedback among these otherwise disparate groups. IFI’s climate change program has also attracted the attention of the media which has further raised public awareness of climate change through parallel coverage of the program’s events. To further increase the program’s outreach the IFI has consistently issued policy memos summarizing experts’ recommendation and the outcome of these lively dialogues on climate change (see for example Assaf (2009) and Farajalla (2008).)

THE CIVIL SOCIETY

It can be argued that the civil society groups are possibly the most dynamic player in the climate change arena. Due to their general fluidity and informality they tend to link to each other quickly and foster collaboration across different countries in the LNA region and the Arab world at large. This can be seen in at least three active umbrella groups: Arab Integrated Water Resources Management Network (AWARENET), the Arab Network for Environment and Development (RAED) (RAED 2009) and the Arab NGO Network for Development (ANND) (ANND 2009).

Activists in climate change can be generally categorized into those who adhere to mitigation strategy and those who focus on adaptation. In the climate change terminology, mitigation refers to efforts to curb release of GHGs, while adaptation refers to efforts in making social and environmental system capable of withstanding the impact of climate change.

On the mitigation front, IndyAct stands out as the most vocal and outreaching group. Over the past few years, they have organized several public campaigns including street protests, workshops and media coverage. The group takes a strong stand on the mitigation efforts and generally shuns away from adaptation as they considered it, based on comments from its executive director Wael Hmaidan, acquiescence and sell out to those who want maintain the status quo of GHGs releases. The group has also publicly criticized some Arab oil producing countries who, according to the group, are to trying to foil attempts to ratify a strong international agreement on curbing GHGs. It is fair to say that the group has lessened its stance as it entered into alliance with other civic groups in the ANND.

¹ For example, Mr. Khaled, Minister of Environment in Jordan, and Berj Hatjian, Director General of the Lebanese Ministry of Environment.

² For example, Wael Hmaidan, Executive Director of IndyACT.

In contrast to IndyAct, RAED has adopted an active adaptation strategy. RAED which is composed of several Arab NGOs have strong ties to the Arab League, and have an observer seat in the League. They have recently launched in Beirut a program to support small scale adaptation projects in selected Arab countries.

AWARENET as an advocate of IWRM has been recently active in promoting this approach as an adaptation strategy. They have leveraged international effort spearheaded by UNDEP CapNET and WMO and supported their capacity building program on IWRM and climate change. AWARENET have recently formed a Climate Change working group which held its first meeting in Beirut on July 29-30, 2009.

Another well established environmental NGO, Arab Forum for Environment and Development (AFED) (AFED 2009a), has also been quite active on raising awareness of climate change through public conferences, TV interviews, and publications. AFED have recently moved its office from Cairo to Beirut. The NGO is organizing a conference on Aug 19 – 20, 2009 in Beirut to present findings from a report prepared by regional experts on climate change issues (AFED 2009b). Aljazeera interviewed its co-founder along with other experts to discuss climate change. The AFED is associated with the Beirut-based Environment & Development Magazine, edited by an AFED co-founder Dr. Najiib Saab.

These recent flurries of NGOs activities are related to the upcoming Copenhagen meeting, which is considered a new landmark in the international efforts to manage climate change. It is hoped that the momentum generated by these activities is cultivated to pursue a more steady support for climate change activities in the region.

WATER CONFLICTS

The exasperation of water scarcity by climate change is expected to increase tension over shared water resources which may lead to conflict including armed one. Brown and Crawford (2009) has concluded that climate change will undermine national economies in the Levant, exasperate food insecurity, and lead to extreme competition and possibly violent conflict over dwindling water supplies.

Rising water scarcity not only in the headwater regions of the Euphrates and Tigris, but across other regions of Turkey could lead Turkish authorities to transfer significant amounts of water out of these river basins to satisfy out-of-basin water deficient regions. This would lead to direct confrontation, and possibly war, between Turkey and Iraq and Syria. What increases the risk of this confrontation is the heavy investment Turkey has already made not only in building reservoirs but also in developing extensive water transfer for moving water out of the basin.

THINKING AHEAD

The above review has shown that the Levant region is both highly vulnerable and severely exposed to the aridification of climate change. Independent of whether the climate change impact materializes or not, the vulnerability of the Levant is a function of the region's poverty in water and other natural resources, poor management of these resources, heavy food imports, weak economies, and consequently the inability of governments to provide for their rapidly growing populations. Consequently, designing a strategy to adapt to the climate change in relation to water resources requires both assessing the impact of climate change on these resources, and identifying measures to reduce the region's vulnerability and enhances its resilience. We have identified five areas of action that the region should consider in planning for climate change. These areas are water policy and governance, research, role of civil society and the public, management of population growth, and water planning and management. The order of this list does not imply significance of one area over the other. Each of these areas of action is discussed below.

Water policy and governance

Governments of the Levant have not given climate change a priority that signifies its severe implications to water resources. At best, issues of climate change have been delegated to newly created ministries of environment, which are considered secondary to other posts³. The ministries of environment mostly focus on the mitigation side with little emphasis on water resources. This is mainly a result of the mandate of these ministries, which restrict their involvement in the management of water resources. A more beneficial arrangement is to involve ministries responsible for managing water resources to play an active role on setting climate change policies. This requires both building the capacity to achieve this objective, and more importantly having the political will to pursue this objective.

California provides a good model for developing water policies addressing specifically climate change. The top administrators in this economically powerful state have realized at an early stage that climate change will have significant impact on their water resources which supports possibly the largest irrigated area in the world. Several assessment and policy studies were commissioned, and the state has made it a law to incorporate climate change in their water planning and legislation.

Setting unequivocal policies on climate change and water resources will pave the way to reform water institutional framework and laws to manage increasing water scarcity and reduce the overall vulnerability of the region to climate change.

³ This is based on a statement made by Dr. Berj Hatjian, Director General of the Lebanese Ministry of Environment, in a public presentation.

Research

As indicated earlier, climate change research in the Levant suffers from underfunding, availability of data and facilities, and the lack of national policies that prioritizes areas of research. Governments blame weak economic base for the inability to support research. However, the problem is more related to priority setting, and that climate change is either at the bottom of the priority list or not there in the first place. Raising the profile of climate change research on the national agenda requires bringing policy makers closer to the research community. As presented before the IFI is playing a key role in providing the forum for such interaction.

There are several climate change research gaps that need to be addressed. Several researchers strongly recommended the development of regional climate model that will better capture the influence of the region unique topography on climate. This effort requires however solid basic research and climate modeling expertise, which are absent in the region. This can be only achieved through long-term planning that involves the development of specialized departments and programs in academic and research institutes.

The lack of data and information is another major obstacle in climate change research. There should be a concerted effort to support the development of an extensive network for climate data including utilizing advanced technologies to develop new data networks and rehabilitate existing ones.

The media and civil society

As the dominant medium for passing, interpreting and potentially biasing information, the media has a significant role to play in helping the public and also policy makers develop a balanced understanding and appreciation of the climate change phenomena and its projected impacts. With few exceptions, the media in the Levant has acted at best as a passive carrier of information passed on western media. The Arab media is encouraged to follow the path of western news agencies, in particular the BBC and CNN, who have dedicated programs with full time correspondents and support from highly qualified experts for reporting, analyzing and disseminating climate change information on a timely basis.

The Aljazeera has set a good example of a pan Arab media committed to a high quality journalism and accurate reporting on different issues including climate change. The news agency has given extensive coverage of climate change with relevant focus and relevant reflection on the Arab world. As in the western media, their coverage gain credibility through inviting regional and international experts to discuss and answer question raised by a live audience.

The civil society has recently been quite active in organizing workshops and campaigns to raise awareness of climate change and promote mitigation and/or adaption actions on the part of the

government and the public. Civil societies do not necessarily agree on the same issues and measures. Although this may cause confusion to their audience, it nevertheless reflects a healthier and democratic atmosphere that in the long run encourages more active participation of the public and policy makers. Civil society activists should more actively engage the research community to avoid the trap of over-popularizing certain climate change outlooks in the rapidly evolving discipline of climate change.

Management of population growth

Our scarce water resources and natural resources in general are being depleted at alarming rates to keep up with growing populations. This is simply unsustainable. Although fertility rates have halved in the region over the past 30 years (Dyer 2008), national policies should strongly focus on encouraging further reduction in fertility.

Water planning and management

A climate change strategy for the Levant should incorporate a solid integrated water resource management (IWRM) component that emphasizes sustainability with its social, economic and environmental dimensions. Water resources management is not a matter of expanding water supply through building dams and aqueducts or increasing pumping of groundwater. It is a balancing act, where both water demand management as well as water supply development is considered while assuring availability of water resources to future generations. These efforts should not harm the environment or create inequities in access to clean and affordable water.

Water demand management involves controlling users' demand through proper water pricing policies that send users the right signal about the value of water, increasing efficiency of water utilities, raising public awareness of the damaging effect of water scarcity, and reviving the culture of water conservation that characterized the region in the near and far pasts. Water demand management essentially allows users to gain ownership of water scarcity problems and become active partners in managing it.

Due to long rainless season, high evaporation rates, low soil moisture conditions agriculture in the Levant have high irrigation requirements during times of the year when water availability is low. This is compounded by the general wasteful use of water due to the inefficiency of irrigation methods and poor cropping planning. Overall analysis of water balance and allocation clearly shows that irrigated agriculture in many parts of the Levant is unsustainable especially when it results in the depletion and subsequent salinization of strategic aquifers. Some countries like Jordan have acknowledged these problems and set long-term plans to reduce significantly irrigated agriculture or phase out it completely in other areas (Jordan 2009). Many argue that these policies may harm large and underprivileged segments of the society (Schiffler 1998). However, phasing out agriculture should be accompanied with retraining and job creation

programs that focus on more productive sectors of the economy. Under water scarcity conditions, agriculture should be treated as an industry measured by its water productivity and its contribution to the national economy.

Increasingly treated wastewater is becoming a viable water supply option, particularly to the agriculture sector, which is expected to lose a large share of fresh water resources. Jordan has taken major steps in setting up a flexible system to utilize wastewater loads from major urban area to be used mostly in the Dead Sea valley. A system has emerged where Amman receives freshwater supplies pumped from the valley, with treated wastewater sent by gravity to farmers in the valley. A recent study by AHT (2009) has shown that wastewater can be a viable water supply under conditions of water scarcity, which increases the value of freshwater.

Climate change impact studies have shown that the reliability of a water supply system especially in the face of extended drought periods is largely dependent on its storage and transfer capacities (Kirshen et al 2006). Consequently, our water resources infrastructure should be planned or rehabilitated to include adequate storage capacity made geographically accessible through a system of water conveyance and transfer systems. Considering the extensive capital requirements and long development stage, these systems should be planned well ahead of critical water scarcity conditions.

A successful water adaptation strategy is not necessarily contingent on introducing novel ideas and complex schemes. Looking into our past we see examples of societies that have weathered through difficult journeys strewn with droughts, famine, and bitter conflicts. Example of earlier adaptations including the Qanat groundwater systems, landscaping techniques to reduce soil erosion and mitigated impact of floods, and conservation and maintenance of strategic reserves to manage through droughts.

REFERENCES

Abdulla, F., Eshtwai, T. and Assaf, H. (2009), "Assessment of the Impact of Potential Climate Change on the Water Balance of a Semi-arid Watershed". *Water Resources Management*, 23(10): 2051-2068.

Abu-Taleb, M.F. (2000). "Impacts of global climate change scenarios on water supply and demand in Jordan". *Water International*, 25(3), 457–463.

ACSAD (2009). "Regional conference on integrated water resources management."
<http://www.acsad-bgr.org/activities/conference.html>.

AHT(2009). "Identification and removal of bottlenecks for extended use of wastewater for irrigation or for other purposes." EuroMed.

Assaf, H. (2009). "Climate Change: Potential Impact on Water Resources in the Middle East and Adaptation Options" Research and Policy Memo #2, Research and Policy Forum on Climate Change and Environment in the Arab, Issam Fares Institute for Public Policy and International Affairs, American University of Beirut (AUB), Lebanon.

AFED (2009a). "Arab Forum for Environment and Development".
<http://www.afedonline.org/en/>

AFED (2009b) "AFED Conference in Beirut – Aug. 19-20, 2009",
<http://www.afedonline.org/conference/why.html>.

Aljazeera (2009). "Interview with Experts on Climate Change issue", (in Arabic)
<http://www.aljazeera.net/Portal/Templates/Postings/PocketPcDetailedPage.aspx?PrintPage=True&GUID=%7b8FC4CED1-90EA-448A-9AF6-2DE859636ECE%7d#L1>.

ANND (2009). "The Arab NGO Network for Development". <http://www.annd.org/>

ArabEnvironment (2009). "Personal blog: Arab Environment",
<http://www.arabenvironment.net/archive/2009/6/893581.html>.

AWARENET (2009). "Arab Integrated Water Resources Management Network."
<http://www.awarenet.org/>.

Brown, O. and Crawford, A. (2009). "Rising temperatures, rising tensions: Climate change and the risk of violent conflict in the Middle East." International Institute for Sustainable Development, Ministry of Foreign Affairs of Denmark.

Comair F. (2006), "Water Sector in Lebanon: an operational framework for undertaking legislative and institutional reforms. United Nations Economic and Social Commission for Western Asia (ESCWA).

Cullen, H.M., Kaplan, A., Arkin, P.A., and Demenocal, P.B. (2002). "Impact of the North Atlantic Oscillation on Middle Eastern climate and streamflow." *Climatic Change*, 55, 315–338.

Dyer, P.D. (2008). "Demography in the Middle East: Implications and Opportunities", Chapter 4, Transnational Trends: Middle Eastern and Asian Views. Edited by Amit Pandya and Ellen Laipson. Stimson Center.

El-Fadel, M., and Bou-Zeid, E. (2003). "Climate Change and Water resources in the Middle East. Vulnerability, Socioeconomic Impacts and Adaptation", in "Climate Change in the Mediterranean: Socioeconomic Perspectives of Impacts, Vulnerability, and Adaptation", Edited by Giupponi, C. and Shechter, M., Edward Elgar, Cheltenham, UK.

Farajalla, N. (2008). "How Climate Change will Impact Multiple Sectors in Society: Scenarios for Lebanon." Research and Policy Memo #1, Research and Policy Forum on Climate Change and Environment in the Arab, Issam Fares Institute for Public Policy and International Affairs, American University of Beirut (AUB), Lebanon.

- Goddard (2009). “Global average temperatures”, Goddard Institute for Space Studies, <http://data.giss.nasa.gov/gistemp/tabledata/GLB.Ts.txt>.
- Giorgi, F. (2006). “Climate change hot-spots”, *Geophysical Research Letters*, 33: L08707. Doi:10.1029/2006GL025734.
- GLOWA (2009) “GLOWA Jordan River”, Global Change in the Hydrological Cycle (GLOWA), http://www.glowa.org/eng/jordan_eng/jordan_eng.php.
- Hreiche, A., Najem, W., and Bocquillon, C. (2007). “Hydrological impact simulations of climate change on Lebanese coastal rivers.” *Hydrological Sciences–Journal–des Sciences Hydrologiques*, Special Section: Dryland Hydrology in Mediterranean Regions, 52(6), 1119-1133.
- Hurrell, J. W. (2003). The North Atlantic Oscillation: Climate Significance and Environmental Impact, Geophysical Monograph Series, 134, edited by Hurrell, J. W., Kushnir, Y., Ottersen, G., and Visbeck, M.
- Intergovernmental Panel on Climate Change (IPCC) (2007). Climate Change 2007; Impacts, Adaptation and Vulnerability. Working Group II Contribution to the Fourth Assessment Report of the IPCC. Cambridge University Press, UK.
- Issar, A.S., and Zohar, M. (2007). Climate Change: Environment and History Of The Near East. Springer–Berlin Heidelberg, New York.
- Jason, P., Smith, R.B., and Oglesby, R. J. (2004). “Middle East Climate Simulation and Dominant Precipitation Processes.” *International Journal of Climatology*. 24, 1671–1694.
- Jordan (2009). “Water for Life: Jordan’s Water Strategy 2008-2022”, Hashemite Kingdom of Jordan.
- Kirshen, P., Ruth, M., and Anderson, W. (2006). Climate’s Long-term Impacts on Urban Infrastructures and Services: The Case of Metro Boston. In *Regional Climate Change and Variability: Impacts and Responses*, edited by Matthias Ruth, Kieran Donaghy, and Paul Kirshen. Northampton, MA: Edward Elgar, 190-252.
- Kitoh, A., Yatagai, A. and Alpert, P. (2008). “First super-high-resolution model projection that the ancient “Fertile Crescent” will disappear in this century.” *Hydrological Research Letters*, 2, 1–4.
- Krichak, S.O., Alpert, P., Dayan, M. (2005). “Simulation of the surface climatology over the eastern Mediterranean region using the RegCM3 model”. *Geophysical Research Abstracts*, 7.
- Mann, M. E., Bradley, R. S., and Hughes, M. K. (1998). “Global-scale temperature patterns and climate forcing over the past six centuries.” *Nature*, 393(23), 779-787.

Mariotti, A., Zeng, N., Yoon, j., Artale, V., Navarra, A., Alpert, P. and Li, L. Z. (2008) "Mediterranean water cycle changes: transition to drier 21st century conditions in observations and CMIP3 simulations". *Environ. Res. Lett.* 3.

Michaelowa, A. (2006). "Climate Change in the Mediterranean." *Climatic Change*, 75(4) 513-515.

Pereira, L.S., Oweis, T. and Zairi, A., (2002) "Irrigation management under water scarcity, *Agric. Water Manag.* 57 (), 175–206

RAED (2009). "The Arab Network for Environment and Development", <http://www.aoye.org/about.htm>.

Schiffler, M. (1998). *The Economics of Groundwater Management in Arid Countries*. GDS Book Series II. Frank Cass, London.

Shaban, A. (2008). "Impact of Climate Change on Water Resources of Lebanon: Indications of Hydrological Droughts". *Climatic Changes and Water Resources in the Middle East and in North Africa*, Edited by F. Zereini and H. Hötzl, Springer.

Vaughan, C. (2008). "Cooler, 2008 Still Ranks in the Top 10." The Earth Institute, Columbia University. <http://blogs.ei.columbia.edu/climate/2008/12/22/cooler-2008-still-ranks-in-the-top-10/>.

WAFA (2009). "Report by Palestine News and Information Agency" <http://www1.wafa.ps/wafa/arabic/index.php?action=detail&id=46074>.

Zeitoun, M. (2008). "Power and Water in the Middle East: The Hidden Politics of the Palestinian-Israeli Water Conflict". I. B. Tauris.