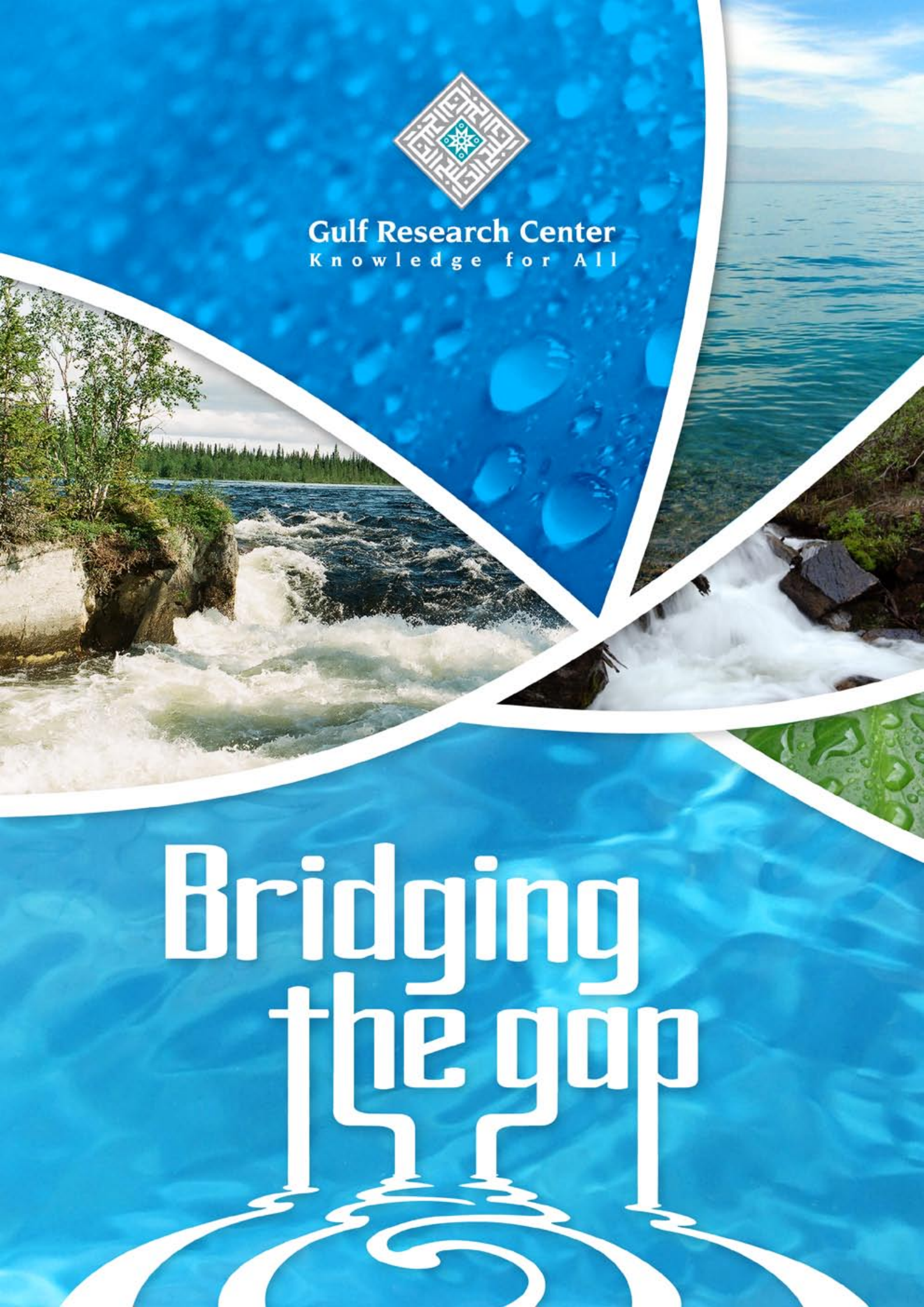
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Between Water Science and Policy Making

A Report on the First Conference on
Water Policy and Associated Technological Challenges
in Arid Dynamic Environments:
The Special Case of Arabian Gulf Countries

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People have always faced excessive heat, lack of rainfall, sand storms, and harsh climate in the GCC countries. Climate change and industrial development brought many environmental impacts and health problems recently. Arab land is being threatened by desertification and urbanization. Coastal zones are being excessively damaged with oil, threatening the marine life and fishing area. Scarce fresh water is being over consumed and polluted by hazardous and agricultural waste. The continuous migration of rural people to cities, mismanaged urbanization, and industrialization leading to air pollution; are all part of the new developments that are damaging the environment.

The limited availability of freshwater in the Gulf region has for decades presented a significant challenge to the people and the governments of the region. Scarce rainfall, together with a high rate of evaporation and consumption, leads to deficits in the water budgets of the countries of the region.

One of the critical problems that hinder the sustainable development in the GCC countries is the lack of renewable water resources. Over-exploitation of fossil groundwater resources, mostly to meet irrigation demands and create greenery, has already affected the productivity of the region's aquifers, both quantitatively and qualitatively. A large portion of the freshwater demand in the GCC countries is met by desalinated water. However, after the Gulf wars and the volatility of oil prices, construction of more desalination plants may not be economically feasible.
Many attempts have been made by the authorities and various concerned institutions to find solutions to the Arab world's water problems. Nevertheless, there is still a long road ahead before a sustainable and effective solution can be reached.

Against the backdrop of all the above-mentioned concerns related to water supply and demand, this conference report was prepared to shed further light on the significant problem of water scarcity in the GCC countries and aims to propose possible solutions as well. We hope this report will trigger more interest in studying water issues. Further, we hope that policy makers will find this report beneficial in helping to plan new policies for a comprehensive resolution of the region's water problems.

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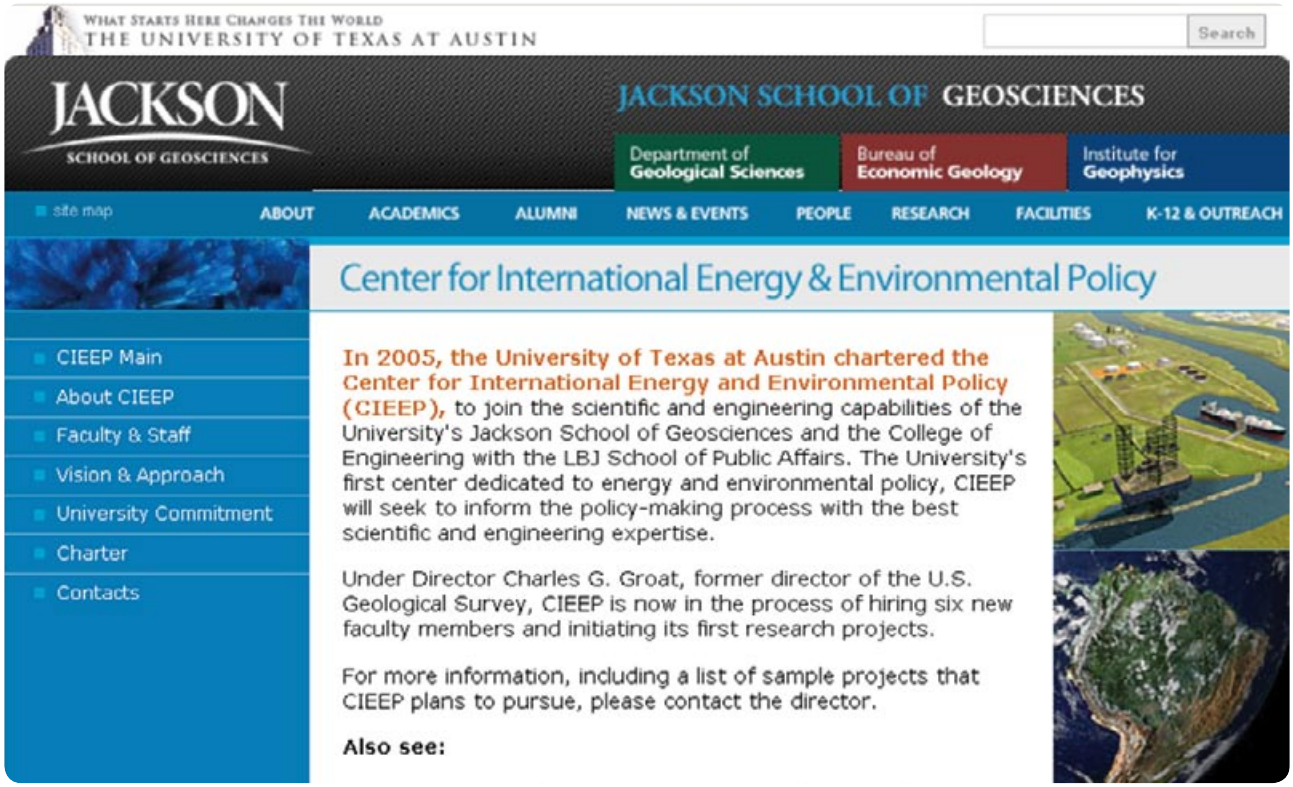
Former Director of the United States Geological Survey

Preface

The development of water resources in the arid parts of our world is among the most serious challenges of the present century, especially in light of declining water resource availability as a response to natural conditions e.g. droughts or increased demand as a result of economic growth. The water problems in the Middle East and North Africa (MENA) region and particularly in the Gulf Cooperation Council (GCC) countries are unique due to geographic, economic and cultural factors which will be discussed in this report. Our ongoing activities at the University of Texas Center for International Energy and Environmental Policy (CIEEP) have indicated that one of the main challenges facing water policy developers and water professionals in this part of the world is how to develop sufficient water resources to sustain not the current but the future economic development. To some extent, economic advantage and technology have so far been used wisely and to good effect in order to control adverse impacts associated with water shortages in countries with sufficient financial resources**.**

This report on water policy and associated technological challenges in arid areas is one of the first steps in CIEEP toward bridging the gap between water science and policy making in our arid and semi arid parts of the world. This report draws on outcomes from a conference on water policy and technological challenges in arid regions that took place at the American University of Kuwait during April 2008 and from a featured plenary session on water challenges and opportunities in the Middle East in conjunction with the US-Arab Economic Forum held in Washington, D.C. during May 2008. The meeting goals were to place an emphasis on water policy objectives that would shape a research agenda that water professionals would pursue. The



intent of the meetings was to make water resources-related science in arid regions more relevant to high-priority policy issues and by doing so, strengthen the link between water scientific research and the needs of various countries and their consumer sectors. This requires involvement from water experts and key decision makers to shape policy and input from them about what these priority issues are. An outcome of these meetings is the establishment of working groups on water policy that actively follow up on the main themes of the meetings. The meetings provided an opportunity for decision makers, scientists, young researchers, and private sector representatives to interact on this important topic for the arid regions of the world.

It is widely documented in many local, national and international reports that mismanagement of water and increase of population in parts of the MENA region are the most important factors that aggravate the water crisis in this region. This report attempts to look beyond current problems, though they are real, urgent and poignant. It is a call to action. The report indicates that GCC countries have an important role in solving water problems in this region through investment in water use and management science as well as by encouraging the exchange of experiences in the area of water between scientists, engineers and policy makers. The report looks more closely at the nexus between water and energy production and consumption; it also addresses specifically the consequences of heavily subsidized agriculture on water resources and describes the way forward.

We hope that this report will encourage a wide audience to think holistically about water issues in the arid part of the world. CIEEP with its affiliated scientists and engineers will continue to play an important role to shape scientific research that considers priority needs of the countries in arid region as articulated by key policy makers, and will continue to promote capacity building and training activities. The problems of water sharing and distribution among nations that share water sources will be the theme of the next meeting.

Executive Summary

The First Conference on Water Policy and Associated Technological Challenges, held in Kuwait in April 2008, was attended by 60 experts in science, engineering, and social aspects of water issues in arid regions. Participants came from various countries in the Middle East as well as the United States, United Kingdom, and France. The attendees from the Gulf Cooperation Council (GCC) countries (Saudi Arabia, Kuwait, Qatar, United Arab Emirates, Oman, and Bahrain) mainly represented the following institutions: the Environment Agency of Abu Dhabi; Qatar Ministry of Municipal Affairs and Agriculture; Oman Ministry of Regional Municipalities, Environment and Water; Bahrain Ministry of Agriculture; United Arab Emirates University; Sultan Qaboos University; King Fahd University of Petroleum and Minerals; Kuwait University; Kuwait Institute for Scientific Research; Gulf Research Center; King Faisal University King Saud University.

Representatives from the GCC countries highlighted the water policies implemented in their respective countries, along with shared successes, failures, and challenges of these policies, and proposed plans for the future. Panelists provided examples from dozens of papers, reports, and studies which indicated that developing water resources on a business-as-usual basis will leave the region with serious water shortages. They pointed out that the annual water deficit in some places could increase to as much as 67 percent of demand by 2015.

The various conference sessions made it clear that in most GCC countries, with the exception of Oman, the legal, regulatory, and institutional framework for water issues and water production does not adequately address some of the major problems or new challenges, such as consideration of new alternative energy sources or the impact of biofuels production. The framework is highly fragmented, which results in conflicting information. Greater coordination is needed at the country level, especially concerning the management of surface water and groundwater. Economic incentive programs were suggested as a means to reduce pressure on groundwater, because it is the only available natural freshwater resource in GCC countries. This is particularly important in water conservation and reuse issues, which must be considered in water policy strategies.

During the conference held over two days (April 28–29, 2008), panels also discussed other topics, such as the role of inter-sectoral regional and international cooperation and its impact in shaping the regional water policy agenda; the regional status of academic and research cooperation in the field of water resource availability and sustainable water technology; and water and energy policy under conditions of economic and climate change, with focus on the solar and nuclear options. Additional aspects of water resources, such as consumption, pricing, cost recovery, and their social implications, were also discussed. In addition, the conference evaluated many ideas that have been put forward for the transfer of water through pipes and across countries, ideas that have not been implemented because of economic and/or political considerations.

Panelists raised some concerns about the use of agricultural crops for the production of alternative fuels, such as ethanol, and its impact on higher food prices for products such as wheat, corn, and sugarcane. These concerns may well re-activate previous calls for food self-sufficiency in some countries, despite its negative environmental impacts and the pressure it will impose on already declining water resources if no regional integration is considered. An additional dimension of interest, also discussed during this conference, was the rising energy demand for water desalination. There is an increased need for investment in sustainable energy options to maintain and increase water production as the region cannot depend on conventional fuels forever. The participants concluded that governments and the private and public sectors should work together to create incentives, reallocate water and fossil energy subsidies, and invest these subsidies in Public-Private Partnership (PPP) and Build-Operate-Transfer (BOT) water projects. A working group was formed to draft a joint proposal to regional foundations to address these issues. However, the regulatory framework must be improved to foster such a change. Conference participants agreed on options for policy makers in the following areas: preparation of a knowledge base; policy frameworks, including legal and operational options at all levels; structural, technical, and organizational capacity building; and inclusion of food security concerns in existing financial mechanisms and development. Two major joint papers with new data and case studies on the topics discussed in the conference are under preparation. The participants acknowledged the fact that this meeting and the follow-up publications would create the conditions for capacity building and set priorities for action at the national, regional, and international levels.

Introduction and Background

The threat of impending water crises in arid and semi-arid regions of the world is intensifying in response to population growth, rapid economic growth, periodic drought, climate change, and mismanagement of water resources. There is a common belief that water problems in the Middle East, and in particular the Arabian Gulf countries, are straightforward and simply a question of management. This could be partially true, yet an accurate assessment of the main causes and possible solutions depends on many factors, including geographical, geopolitical, geoeconomic, and socioeconomic factors. As regards the water situation in the Gulf Cooperation Council (GCC) countries, the fact that water is naturally scarce cannot be ignored. "Water resources" should not be understood to include manufactured water, which is created through either desalination or wastewater reuse, both of which are very important in the GCC water situation and in country budgets. Due to the arid nature of GCC countries, water is a precious commodity of strategic importance, and water issues should be treated accordingly. Water policies must consider securing essential water resources for emergency situations, especially in times of drought and lack of sufficient water. One suggestion is underground storage of desalinated and treated wastewater. In addition, considerable efforts and research are needed to explore the linkages between water issues, agricultural issues, and high food prices in light of the controversy surrounding production of biofuels.

Overall, Arab countries, especially GCC countries, must prioritize water resource development, conservation, and sustainable water production when designing their security strategies. Because of the region's lack of abundant natural water resources, water security must be at the top of the list of priorities, and hard work will be required to both maintain development of resources and explore new water resources or alternative energy resources for water desalination. Water specialists, therefore, must focus on the management of water resources to sustain natural water resources and increase the quantity of output, while also improving the quality. Toward this end, water planners and decision makers should work on (1) rationalizing the consumption of available water resources, (2) developing available water resources through restoring the deterioration in quality and quantity and associated infrastructure, and (3) adding new water resources. However, these are difficult and challenging tasks as many countries in the Middle East, and particularly the GCC, fall under the "absolute water scarcity" category, which means that, according to projections, they will be unable to meet their water needs by 2025. Limited natural freshwater resources and increasing dependence on large-scale fossil fuel-based desalination facilities, as well as desertification, are the major concerns that complicate the water situation in the region. Adding to the problem of natural water scarcity is the lack of information on leakage rates, high unaccounted-for water (UFW) metering performance (25-40 percent), water networks, insufficient and old infrastructure, high subsidies, and low tariffs. Modern orientation toward research in water sciences and engineering is urgently needed.

To respond to these water challenges, and as a part of its international commitments, the University of Texas Center for International Energy and Environmental Policy (CIEEP) organized the conference on Water Policy and Associated Technological Challenges in Kuwait (hosted by the American University of Kuwait) with generous funding from the University of Texas and Schlumberger Water Services. CIEEP also organized a follow-up plenary session in Washington, D.C., entitled "Water Challenges and Opportunities in the Middle East," in conjunction with the US-Arab Economic Forum. One of the overarching goals of the CIEEP conference in Kuwait and the follow-up session in Washington was to establish working groups on water policy to follow up on the main water issues that face arid regions and to provide an opportunity for decision makers, scientists, young researchers, and private sector representatives from arid regions to interact on this important topic as well as find mechanisms to fund related innovative research in cooperation with regional major initiatives, especially those announced in United Arab Emirates (UAE), Kingdom of Saudi Arabia (KSA), and Qatar.

The Kuwait meeting concentrated on several problems of prime importance to water research and policy issues in the region. Conference panels focused on integrating concepts and scientific understanding from various academic disciplines and organizational partners to inform evidence-based decision making at multiple levels of governance. The link between water production, consumption, conservation, and the industrial sector was one of the main themes. The intent was to make water resources-related science in the region more relevant to high-priority policy issues, and by doing so, to strengthen the link between water research and the needs of the industrial sector and others as well. This requires involvement of the industrial sector to shape policy and input from the sector by spelling out what its priority issues are. The conference tried to answer some urgent questions, such as, how can we bring together innovation, technology policy, and regulation to maximize the efficiency of any new supplies and to manage demand? How are we going to manage the challenges of climate change without greatly adding to an already large carbon footprint? How can we bring into play economic and regulatory instruments where current voluntary/information actions are not working?

While the conference laid emphasis on policy definition, its role was also to shape fundamental science and engineering research programs on the many traditional topics that scientists and engineers engage in: groundwater recharge, flow, and geochemistry; desalination technology, waste disposal, and source-water chemical characterization; groundwater and surface water modeling and information systems; wastewater reuse; and geographic information systems development. On the social science side, the conference recognized that cultural, religious, and societal factors influence water resources priorities, and included this emphasis to define future research topics in this area. The conference was very well received, as was evident from the extensive media coverage.

The following sections briefly summarize the main points discussed. However, data from the conference presentations will not be presented here but are available upon request; a large portion of the significant data will be presented in two major papers as agreed upon with the coauthors.

Current Policies and Needed Policy Formulation

The rapid economic development in the GCC countries, with its associated increases in water demand due to both rapid growth in population and business activities, means that the demand side in the water economy is experiencing an exponential increase that far exceeds existing supplies. However, government policies have primarily focused on the supply side, producing water from either aquifers or desalination plants, while demand management has been neglected in most cases. Taken

together, these factors pose major challenges and put pressure on water policy developers and planners to maintain sufficient water resources so as to ensure that there is no break in the current rate of economic development. Economic advantage and technology have so far been used to good effect in tackling this issue. Water technology transfer has played an important role in the past, especially in the treatment and desalinations fields, and could continue to provide some solutions to reach reasonable sustainable water technologies. Given their specific economic, social, and climatic conditions, however, the GCC countries still face water challenges. These challenges require quick action to stimulate investment and enhance efficiency in water and renewable energy sectors to avoid future crises.

Conference panelists and participants argued over whether clear national and regional policies exist, and if so, whether they are implementable or implemented. As a matter of fact, local and regional water policies are based on legislation, strategies and plans, institutions and research, and the civil society community all aiming to protect, conserve, and make the best use of water resources. Water policies exist but are inefficient. There is a need to modify agricultural policies that have allowed the destruction of water resources. Water policies, which are fragmented, need to be coordinated. Water specialists and decision makers should focus on setting up a number of communication channels on different policy-making and policy-drafting levels –meetings, websites, publications, and workshops for stakeholders – and encourage cooperation through international and regional platforms. Close contacts and effective interaction need to be achieved between centers of research and development and local markets in order to put newly developed products into use.

There are several potential future scenarios regarding water policy and the water crisis. No matter how severe water scarcity becomes, it seems quite certain that the crisis will bring about some new policies as a result of the exponential increase of water demand over water supply. A critical issue in the nexus of water, agriculture, and sustainable development is the need for a vision and an initiative to develop the region's economy and create jobs outside of the agricultural sector. However, the policy implications are dramatic and wide-ranging and include reforms such as creating a transparent free-market economy, establishing micro-credit to develop small businesses, encouraging foreign investment, investing in education, introducing a merit-based system, streamlining bureaucracy, and fighting corruption. This is only one example of the complexity of the problems in policy reform.

Evidence was presented at the conference on two alternative policies that have been examined in the region: one in which water supplies increase, and the other in which water supplies increase and policies are altered. Scenarios show that water deficits could be reduced, though not eliminated, especially if emphasis is placed on cutting the wasteful use of water in agriculture, and also by shifting current policies away from stressing food self-sufficiency. Water policies in the region should encourage water reallocation from one use to another. The obvious choice would be to shift water use from irrigation to urban or industrial usage.

Through joint technology programs, financial assistance, and private investments from local and international organizations, water specialists can promote the development of sustainable water technology, the needed renewable energy sources, and measures for rational use of energy through conservation and also through CO_2 sequestration, and thus support the improvement of

the region's rational use of energy. Integration and policy coherence must exist between national and global levels and between public and private sectors.

Policies in the region should also create incentives for sustainable water technology and green energy as well as collaboration in these fields to improve regulatory frameworks, and create networks of experts and supportive programs for nontechnical action in the field of energy efficiency, especially for transferring know-how and exchanging experiences. Government subsidies for oil and electricity generation inhibit the chances of developing renewable energy to compete with the commercial energy sources, and thus the possibilities of green water desalination technology remain limited. Regional and international cooperation can help work out the best policies possible in terms of sustainable water production based on renewable energy options and the field of water resources management. International cooperation and networking will help the cause of water and renewable energy advancement and will solve some of the technological hiccups. From this standpoint, policy makers should consider an alternative energy supply for water desalination based on technical analysis and economic, geographical, and political considerations.

The politics of bioenergy, markets and trade, and perspectives on global food security and energy security were discussed. Conference participants focused on the current situation and future prospects for biofuels and identified priority areas for action to counter the effects of climate change and biofuel production on food security. Overall, participants concluded that modern water policies and related research programs in the GCC countries should include variables stemming from the natural sciences (hydrological and hydrographic); demographic, social, cultural, and political considerations; the changing nature of energy resources; economic and security issues; questions of environmental sustainability; and climate change. All these are important factors to be considered for effective water policies in the arid zone. Understanding the role of these factors in water policy formulation process requires new tools, new knowledge, and new skills. These must be provided by high-quality research programs and innovative regional and international cooperation with an eye toward the creation of new policies and the elimination of some of the technological obstacles that water and sustainable water production still face, as well as emphasizing the focus on demand-based policies.

Energy and Sustainable Water Production

Although oil was discovered in the Middle East early in the twentieth century, it was only from the time of the Second World War that it began to play a dominant role in the economies of certain countries. The socioeconomic advantages and disadvantages of oil in the region were beyond the scope of this conference. However, several related references were made.

As for the addition of new water resources, a topic most important from the GCC point of view, this can be achieved through both wastewater treatment and desalination. Desalination has become a reliable source of freshwater in the Gulf region due to the availability of fossil fuel energy. New energy options for desalination are very important, because the region is the largest user of desalination technology, with over 50 percent of the world's capacity employed by GCC countries such as Saudi Arabia, the UAE, and Kuwait, which use dual-purpose power and desalination plants. Yet this comes at significant energy, economic, and environmental costs. As for their future energy options, GCC countries are considering nuclear power, which could be adapted for water and electricity co-generation. However, much needs to be done before harvesting the benefits from this option. There was obvious disagreement among panelists as to whether nuclear or other options, such as solar, are the way to go in this area.

Research-wise, the nexus between energy and water production and consumption, particularly under conditions of energy, economic, and climate changes, has received limited attention from the international research community. Yet in considering energy and water policies, we cannot exclude technical solutions and options. Both nuclear- and hydrogen-based solutions are influenced by economics, law, and societal and governance structures. Those factors will impact the development of energy and water production and consumption policies in light of post–carbon fuel concepts.

It is well known that sustainable energy is and will be a restricting factor of development in other Arab countries outside the Gulf region. For example, in several papers and presentations, projections for water and electricity demand in the Arab world, up to 2025, are made according to population growth rates. As of 2025, domestic and industrial water demand will reach 360 million m^3 d-1; meanwhile, electrical power consumption will be 4.5 trillion kWh d-1. In the Gulf region, limited energy sources are not a current problem, but they will become a problem in the future due to the increased consideration of carbon concerns. For example, according to International Energy Database for 1999/ 2000, the Arab world emits 986 million tons of CO_2, and the majority of the GCC countries rank among the top five CO_2 emitters, with Qatar in the first position followed by UAE, and Kuwait, and Bahrain taking the fifth position. Additional concerns about fossil energy are related to price fluctuations, rapid population growth, and increasing energy demands, all of which contribute to the increased necessity for sustainable energy investments, as the region cannot depend on conventional fuels forever. Renewable energy policies for research and development and public awareness exist in several countries, especially the UAE and KSA. However, cooperation with industrialized countries to develop appropriate renewable energy business opportunities could maximize benefits. Such cooperation is crucial in the innovation of technological options to mitigate pressures on declining water resources and adapt water resource management to the changing climate, energy, and economic circumstances that directly and indirectly affect the region.

The Way Forward

Overall, the Middle East and the Gulf region enjoy an abundance of indigenous, clean, and nondepletable energy resources, specifically solar, geothermal, wind, and biomass. The region particularly has high potential for solar energy: the average number of hours per year that can feasibly produce solar energy in Europe is 100, while in the Middle East it is 3,000. This energy

could be tapped in several ways, including the Salinity Gradient Solar Pond option which can be hooked up with desalination units. Making sustainable investments in renewable energy such as solar in the Gulf region would support the water sector as well as play an important role in a cleaner and more environmentally sound energy market. Although the Gulf region is blessed in abundant measure with solar potential, this valuable renewable energy resource is not fully exploited and oriented toward water desalination. The lack of emphasis on technical and policy dimensions of sustainable water desalination options has been attributed to several factors, among them the region's huge conventional fuel resources, lack of funds, financial risk, a lack of environmental awareness, inadequate national institutions in the area of research and development, a lack of coordination among these institutions, and conflicts of interest surrounding the promotion of alternative energy sources. It is imperative that the region deal with these issues in order to move forward.

Agriculture and Its Impact

Up until the early part of the twentieth century, almost all Middle Eastern countries relied upon agricultural production as their main source of wealth. Any industries that existed were small-scale. Until recently, rain-fed agriculture was dominant. However, farmers are currently using groundwater for agriculture in addition to traditional farming methods that exhaust their water and soil resources. Several examples and case studies presented during the conference indicated that agricultural and environmental awareness programs and underpriced water and energy resources do not encourage the rationalization of the use of water.

The agricultural water demand in GCC countries and its contribution to the national economies is out of balance with other sectors and their contributions to national economies. The municipal and industrial water demand in GCC countries is 5.31 billion m^3/y, and agricultural water demand is 24.35 billion m^3/y. Yet the contribution of the agriculture sector to the national economies of these countries is limited – 6.5 percent, 3.6 percent, 2.1 percent, and <1 percent in Saudi Arabia, UAE, Oman, and Kuwait, respectively. Besides, agriculture in the Gulf region causes soil sodicity and secondary salinization and demands higher-than-average water consumption due to the high evaporation rate. The quality of agricultural products is not as high as that in water-soil-rich countries, thus the products are not competitive. This is basically a direct consequence of agricultural and irrigation policies, the policy of high water supply management, and the lack of water demand management.

Essentially, the agricultural water policies in the Middle East in general should be reworded in terms of yield per cubic meter of water instead of yield per hectare. This would provide a better means of deciding on a food security policy with achievable aims. It would also provide a better vision as to what needs to be done on the technology research front. In discussing water, agriculture, and food issues, panelists attributed the recent increase in food prices to a combination of several factors including the rise in the price of both oil and agricultural fertilizers, climatic changes, increased consumption in developing nations, speculation on commodity markets, and protectionist policies imposed by rich nations.

The region is benefiting and should continue to benefit from the experience of countries that have developed techniques and knowledge in agricultural practices. These include conservation and irrigation techniques, drainage management, purification and treatment for agricultural purposes, pricing policy, and laws that encourage rationalization. Such changes will facilitate the potential to build on these experiences, establishing more such projects throughout the region, thus spreading the benefits. However, agricultural management of water resources must not rely solely on experience and expertise from outside the region; there must be a high degree of cooperation on water policy among countries in the Arab world so as to establish joint projects that ensure the security of the region's water for agriculture and other uses before it is too late. Conference participants underlined the urgency of the problem. However, they acknowledged the fact that cooperation at the regional level is difficult at the present time because of political differences among neighboring countries.

The Way Forward

Gradual reallocation of water from irrigation to other uses can be brought about by a reduction in subsidies for irrigated agriculture, and this could contribute to solving water problems in some countries. But social change and acceptance are needed due to the high social, and sometimes economic, value of agriculture for individuals. New, non-saline water can be produced by desalination and wastewater treatment. But energy resources and costs will be a problem for some countries in the future, as it is now for the region's countries outside the Gulf. For the rationalization of agricultural consumption there are several possible methods, among them: upgradation, maintenance, and development of water transport and distribution networks; development of irrigation systems; upgradation of irrigation methods; changing the crop structure; and developing new varieties and strains of crops that consume less water and tolerate higher degrees of salinity. The conference participants acknowledged the need for better assessment of the linkages between climate change, water security, and food, the effects of climate change on pests and diseases affecting animals and plants, and the spread of exotic invasive aquatic species. Participants discussed scenarios involving the effects of climate change on the global water system and its possible effects on water management for food production.

The panelists discussed policy options and recommendations, and the possibility of a partnership between the public and private sectors to produce the water needed for food security in light of the challenges posed by climate change and biofuels with a focus on identifying opportunities for funding mechanisms, cooperation and partnership. Recommendations also dealt with management

scenarios and alternative energy options as well as the possibility of finding other areas of cooperation between the institutions represented at the conference.

Water-Energy Subsidies and Implications

The heavy fiscal burden of water subsidies in most of the GCC countries could reach 10 percent of GDP by 2025. On an average, the tariff for water is no more than 10 percent of cost. The reduction of subsidies and the reallocation of the resources toward non-oil activities would go a long way in reducing wasteful use, protecting the economy from trade shocks, creating new jobs, and ensuring intergenerational equity in the distribution of the resources. For a cost recovery option, the discussion during the conference outlined some of the current practices and suggested new ones to encourage water conservation. Aspects of the flat rate or constant fee, the uniform rate (price per liter), decreasing or increasing block rates, and seasonal rates were discussed.

Panelists believed that increasing block rates could economize water use. A recent example that was discussed is the tariff slab for residential use and the commercial slab adopted by the Dubai Electricity and Water Authority. Conference panelists also agreed that water should be priced and that the price should be fair, and that tariffs should take low-income customers into consideration. However, the psychological barrier is to be found in the public's reluctance to bear the real costs of water and to change water consumption habits. At the national level, governments should reconsider their heavy subsidies for water, especially in the agricultural sector. Public-Private Partnership and Build-Operate-Transfer models in UAE, Kuwait, and KSA should be duplicated and generalized on a wider scale. However, new concepts and ideas, research and development, and commercialization are required. Toward this end, regulations and laws need to be formulated to facilitate investment and funding, and encourage cooperation and innovation. The participants also commended the investments of GCC countries in agriculture and livestock in countries with fertile agricultural lands, particularly Sudan, Egypt, India and Pakistan. This integration model is expected to provide basic food items to cover local market needs of the participating countries.

Demand Management, Regional Universities, and Research Institutions

Water demand management should become a driving force in water resources management in all GCC countries. Ingenuity and creativity are required to quench the ever-rising thirst for water without detrimental effects on citizens. It also requires new water policies that recognize the growing significance of finding alternative energy sources for desalination plants and reallocation of water use. To accomplish this, a policy agenda should be set with realistic objectives. This agenda should include the government, public sector, private sector, and research institutions and universities. We must keep in mind that what worked in the past, and what is working now, might not work in the future. This is actually what is happening in the water sector. Until recently, the region relied on outdated water and agricultural policies. However, now there is a need for new concepts. These can be developed at universities, and can be implemented by the industrial or private sector. However, universities need to develop high-quality research and education programs designed to observe, focus on, and influence water issues in GCC countries and the Middle East. These, in turn, could

lead to enhanced economic, social, and environmental benefits for the countries concerned and the region in general.

The need for holistic thinking in water policy is, therefore, becoming a priority. Advanced research centers that focus on classical engineering solutions to water resource issues exist in many of the Gulf state universities; however, a holistic approach to policy formulation is missing. Important issues relating both to developing research and capacity building need to be addressed so that GCC states are able to develop policies that work within their own institutional, social, cultural, religious, and economic frameworks. Regional and/or international cooperation are obviously required to develop innovative forms of cooperation and solutions. Research should focus on solar- and hydrogen-based ideas, which could have a direct impact on managing water resources. It should also focus on elements of sustainable energy generation from water, membrane process technology, removal and reuse of salts from inland water, electrochemistry, and bioconversions as well as on techniques suitable for processing and reuse of sewage water and removal of all contaminants and pathogens. As for the development of water resource availability, there are several aspects to be addressed, such as projects, dams, reservoirs, and the reduction of water lost through evaporation of surface water reservoirs and streams as well as the diversion of water transport systems. There is a need for a well-funded major research program aimed at the development of sustainable energy and water technologies that will play an important part in any future policy development and management strategies. Various energy sources other than carbon-based fuels – such as solar, nuclear, and hydrogen, coupled with water supply technologies – are being explored to this end.

Conclusions and Recommendations

The main challenges to the water sector are: (1) rapid growth in domestic and industrial water demands; (2) agricultural management and associated water policies; (3) increasing costs of water development; (4) wasteful use and misuse of existing water supplies: (5) threats to ecosystems; (6) declining water quality; and (7) subsidies, distorting incentives, and limited cost recovery. But the overarching challenge is to secure water for future generations. It is imperative to focus on reducing the demand for water, rather than increasing water supply; in my opinion, this topic is a question of design and technology as well as policy. That is, while policy is essential, so too is proper design of technological options so that policy and practice can be better integrated and more durable at the architectural, landscape, urban, industrial, and agricultural levels. Reduction of water supply and water use, for example, need to be implemented at the domestic level as well the regional levels. Because of a lack of incentives, proper allocation of funds and innovative planning and policy research are mostly forgotten in favor of classic, basic research. It is time for research institutions to work together. Even demand policies cannot provide solutions to all water scarcity problems if climatic, energy, and economic circumstances are not favorable. Fossil fuels, which provide energy for water desalination, transportation, or pumping, could present a problem in the future due to the fact that they are depletable and have environmental costs. A portion of the current heavy subsidies for water, oil, and electricity should be invested in the water-saving market as well as for the development of green energy options in which users can claim credits for saving beyond certain limits.

There is a need to replace various ruler directives with formal water laws; Oman has done so. This should be followed by the creation of monitoring authorities and agencies. There should also be gradual incorporation in policy development of new policy actors from the private and voluntary sectors. Attention should be given to the creation of a water-saving market to enhance trading and accounting for use between sectors. The field of sustainable water production should be bolstered by the investment of ideas and technological and research cooperation. Structured programs should be implemented for underground water storage through artificial recharge, or water banking. And the systematic monitoring of groundwater and support water recharge projects should continue.

There is an urgent need to reform domestic water pricing policy in the GCC countries. Users should be made aware through education and civic programs that water is scarce, and demand-based water policies or reallocation of subsidies should not make it tougher for people to live. The objective of such programs is water saving, and thus energy saving and better environmental quality. Water security is an important issue as well. Underground storage, enhancing water recharge, and preserving groundwater from seawater intrusion/pollution are the best ways to enhance water security. The environmental impacts of desalination, such as reject brine and carbon emissions, can no longer be ignored. Brine recycling remains a problem and a solution must be found to brine disposal in the sea or deep in the aquifers. Carbon emissions can be stored in brine aquifers or used to enhance oil recovery applications after capture, compression, and separation. There is a gap between water scientists and decision makers, and that gap needs to be bridged. Encouraging economic and political studies would help to bridge this gap. There is also a lack of collaboration among specialists in the region. Incentives and funds for joint research programs should be provided to enhance the exchange of knowledge and ideas.

Conference participants identified a set of priorities for action which stems from their local needs: (1) review of agriculture policy in the GCC countries; (2) reduction of direct and indirect subsidies; (3) prevention of cultivation of high-water-demand crops, including importation of high-water-demand crops; (4) modernization of irrigation systems, including the prevention of wasteful use of water in irrigation, full utilization of treated wastewater, and development of awareness among farmers; (5) installation of accurate flow meters at outlets in order to report consumption levels to consumers on a monthly basis; (6) improvement of tariff structure; (7) prevention and awareness of leakage from water supply networks, as well as prevention of water leakage in governmental and public buildings; (8) enhancement of public water-use awareness and promotion of water conservation habits; (9) focus on the demand management of the agricultural sector and agriculture policy in Saudi Arabia and the UAE; and (10) integration of knowledge and institutional support.

Acknowledgements

We would like to take this opportunity to thank every one involved with the organization of this conference. Particularly, we would like to express special thanks to our sponsors, the University of Texas Center for International Energy and Environmental Policy, Schlumberger Water Services, American University of Kuwait, and Gulf Research Center. Last but not least, we would like to thank all the authors and speakers, without whom this workshop would not have been possible.

The First Conference on
Water Policy and Associated Technological Challenges in Arid Dynamic Environments: The Special Case of Arabian Gulf Countries

"Bridging the gap between water science and policy making"

10:00	Welcome & Introduction Dr. Marina Tolmacheva, President of AUK
10: 15	First session Thoughts on the Linkages between Energy and Sustainable Water Production: Technical and Policy Dimensions Dr. Fares Howari, Center for International Energy and Environmental Policy University of Texas at Austin
10:55	Bringing Together Our Understanding: New Needs in Arid Region Water Policy Research Development Dr. Rachael McDonnell, Oxford University Centre for Water Research
11:20	Remarks and notes from Dr. Dominique Pajot, Vice President, Schlumberger Water Services
11:40	Break
12:00	An Overview of the Water Resources in Kuwait: The Reality and the Ambitions Mr. Adnan Akbar Water Resources Division Kuwait Institute for Scientific Research
12:35	Panel 1- Water Resource Availability and Sustainable Water Technology: Regional Academic and Research Cooperation Dr. Ali Mohammed Akbar Chairman of Petroleum and Environmental Service Co based in Kuwait Former Vice Rector, Kuwait University, Former Dean for the College of Engineering and Petroleum, Kuwait University. Dr. Abdel Kaher El-Zaemey (M) Deputy Director and Manager of Water & WastewaterSection of Mott MacDonald based in Abu Dhabi Former Vice President of Hodiedah University, Yemen Former Vice Dean of Faculty of Engineering at Sana'a University Dr. Alaadin A. Bukhari Director, Center for Environment & Water The Research Institute King Fahd University of Petroleum & Minerals Dhahran 31261 Saudi Arabia Dr. Mahmoud Abdel-Jawad Principal Research Scientist Water Technologies Department Water Resources Division Kuwait Institute for Scientific Research

1:30	Lunch Break - Auditorium,
2:30	"Understanding and Responding to the Technological Challenges towards Water Policies" Mr. Nauman Rashid, Schlumberger Water Services
3:00	Panel 2- Water Resource Policy, Current Policies, and Their Implications in the Future Dr. Kamel Mostafa Water Resources Expert, Department of Agricultural and Water Research (DAWR) Ministry of Municipal Affairs and Agriculture (MMAA), QATAR Editor in Chief for the book "Policy Perspectives for Ecosystem and Water Management in the Arabian Peninsula" Dr. Mohamed A. Dawoud, Manager of Water Resources Department with the Environmental Research and Wildlife Development Agency at Abu Dhabi, United Arab Emirates and Researcher and at Research Institute for Groundwater of National Water Research Center, Egypt Dr. Aschalew Debebe, Business Development Manager Schlumberger Water Services, Abu Dhabi, UAE Dr. Neamat Mossad (M) Gulf Studies Center American University of Kuwait
4:30	End of First Day

Tuesday April 29, 2008	
10:00	Third Session: Feasibility of Water Resources Utilization in GCC Countries, Water Availability versus Demands in the GCC Countries, and Demand Management of Water Resources in the GCC countries Dr. Mohsen Sherif, Professor of Water Resources; Director, Water Resources Master Program, UAEU, Civil and Environmental Engineering Department, College of Engineering, UAE University
10:30	Panel 3- Water and Energy Policy under Conditions of Economic and Cimate Change Dr. Walid Ahmed Abderrahman Director, Water Section, Center for Environment and Water, King Fahd University of Petroleum and Minerals (KFUPM), Dhahran, Saudi Arabia Eng. Zahir Al Suleimani Director General Water Resources Affairs Ministry of Regional Municipalities, Environment And Water Resources Sultanate of Oman, Dr Rachael McDonnell (Moderator) Senior Research Scientist, Oxford Centre for Water Research Eng. Abdulla Al-Thary Deputy, National Water Resources Authority (NWRA), Ministry of Water & Environment, Government of Yemen. Dr. Yousef Al-Dakheel Director, Water Studies Center, King Faisal University
12:00	Break

12:30 1:00	Fourth Session: "Alternative Primary Energy for Power-Desalting Plants in Kuwait: The Nuclear Option I" M. A. Darwish, College of Engineering, Kuwait University; Fatma Al Awadhi, [2]Kuwait foundation for Advances of Science, KFAS; Ali Akbar, College of Engineering, Kuwait University; and Ali Darwish,,American University in Cairo, Egypt "Strategic Water Reserve for Emergency: New Policy for Old Concept in GCC Countries" Dr. Mohamed A. Dawoud Manager, Water Resources Department, Environment Agency - Abu Dhabi,
1:30	Panel 4- Water Resources: Consumption, Pricing Water, Cost Recovery, Social Aspects Dr. Abdullah M.M. Alshankiti (M) Former Assistant Director General, National Agriculture and Animal Resources Research Center (NAARRC), former Head of Soil and Irrigation Section National Agriculture and Water Research Center (NAWRC) Ministry of Agriculture and Water, Riyadh, Saudi Arabia. Dr. Mohammed A. Raouf, Senor Environmental Researcher at the Gulf Research Center, Dubai. Dr. Slim Zekri, Department of Natural Resource Economics, Sultan Qaboos University. Dr. Ahmed Murad, International Association of Hydrological Sciences (IAHS) National Correspondent of the United Arab Emirates.
2:30	Lunch -
3:30- 4:30	Technical session Dr. Shereef Abu. Almaati, Chair and Dr. Slim Zekri, Co-Chair Technical short presentations/ 15 minutes each Constrains and Management Practices of Water Resources in UAE Dr. Ahmed Murad, Chairman Geology Department, United Arab Emirates University. Policy Perspectives for Ecosystem and Water Management in the Arabian Peninsula Dr. Kamel Mostafa Water Resources Expert, Department of Agricultural and Water Research (DAWR) Ministry of Municipal Affairs and Agriculture (MMAA), Qatar Management of Water Resources, The Challenges of Developing Countries, (Case of Jordan) Yousef Abu-Rukah, Dept. of Earth and Environmental Sciences-Yarmouk University, Irbid - Jordan Water Crisis in the Middle East Region Khalid A. Al-Thour & Naif. Abu Lohom, Department of Earth and Environmental Sciences; Sana'a University Water Crises and Desalination Technology Future in Yemen; Dr. Mohamed Fara Mohamed Al-Dubai; Department of Earth and Environmental Sciences, Sana'a University;

	Those who did not give final confirmation for attendance are not listed but they are welcome to present their work as a poster. **Networking - Posters** • Analyses of Water Scarcity Problem in the Arab World Using the Virtual Water Concept Kifah Hsayan, Mohamed Nasr Allam, Mostafa Ghaith and Hesham Bekhit Irrigation and Hydraulics Department, Faculty of Engineering, Cairo University, Giza, Egypt • Aspects of Water Quality Consideration of Main Aflaj and Spring in Oman Ghrefat, Habes King Saud University, Geology Department, P.O. Box 2455, Riyadh 11451, Kingdom of Saudi Arabia; Jamarh, Ahmad, University of Jordan, Civil Engineering Department, Amman, Jordan; Al-Abri, Badr, Public Establishment for Industrial Estates, P.O. Box 1, Muscat, Sultanate of Oman • Geoenvironmental Studies on the Water Wells in the Eastern Egyptian Desert Elsayed Ahmed El Gammal, National Authority for Remote Sensing and Space Sciences, Cairo • Advanced Application for Water Information System Based on GIS in Palestinian Water Authority Basheer Obaid; Director of Geographic Information System, Palestinian Water Authority, Msc. Infrastructure Engineering • The Role of Water Resources during Drought in Tunisia Noureddine Gaaloul, National Research Institute for Rural Engineering, Water And Forestry (INRGREF), Rue Hedi Karray, B.P.10, 2080 Ariana, Tunisia • Water Crisis in the Gaza Strip, Palestine Adnan M. Aish, Department of Geology, Faculty of Science, Al Azhar University, P.O. Box 1277 Gaza, Palestine, and Mahmoud Abdel Lateef; Department of Water information, Palestinian Water Authority
5:30	Closing of Conference

Additional related readings

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Short Biography

Dr. Fares M. Howari

Dr. Fares Howari is the MENA Regional Coordinator at the Center for International Energy and Environmental Policy (CIEEP), and an Environmental Geoscientist at the Bureau of Economic Geology at the University of Texas at Austin. He received his Ph.D. in Environmental Sciences and Engineering from the University of Texas at El Paso while working at the Center for Environmental Resource Management in Texas. His duties at CIEEP include developing projects, writing proposals for external funding, and coordinating CIEEP activities in the MENA region with local, regional and international partners. CIEEP activities in the MENA region cover policy-oriented research, developing research opportunities in integrated and interdisciplinary energy and environmental sciences, bridging the gap between energy/environmental sciences and policy making. CIEEP's interests and expertise include policy development and management, providing support and consultations for evidence-based decision making, strategic research planning as well as training, organizing workshops and conferences geared towards supporting capacity building. At the Bureau of Economic Geology, Dr. Howari focuses on soil and water management, and CO2 sequestration projects among with other research interests.

Before joining the University of Texas at Austin, Dr. Howari worked as an Associate Professor at United Arab Emirates University (UAEU), and served as a research fellow at Washington University in Saint Louis. At UAEU, Dr. Howari served as a secretary for the Water Resources Graduate Program, supervisor for the Environment Society, was a member of several committees, taught several courses, successfully obtained several grants, and conducted numerous consultations. Prior to his position with UAEU, Dr. Howari served about two years at Texas A and M University System where he worked as a research scientist on water and soil management, remote sensing, and the reuse of saline wastewater. Dr. Howari also worked as international environmental volunteer in Jordan, US-Mexico border, UAE, and other places.

Dr. Howari has wide international experience in the area of environmental geosciences, water resource management and planning, resource development, and project coordination in the Middle East. He was the General Secretary of the 6th International Conference of the Geology of the Middle East, held in Al Ain, 2006, and served as a board member of the Gulf Seismic Forum, Abu Dhabi Emirates in 2004. He was the Coordinator of CIEEP's Conference on Water Policy and Associated Technological Challenges in Arid Regions, held in Kuwait, 2008. He chaired and organized the featured plenary session "Water Challenges and Opportunities in the Middle East" in conjunction with the US-Arab Economic Forum, in Washington, D.C., in 2008. He also served as a consultant for the International Atomic Energy Agency Technical (IAEA) Meeting on Uranium Geology, Exploration and Mining Methods in the Middle East.

Dr. Howari has participated in more than 40 international technical meetings across continents. He has a broad and interdisciplinary grasp of environmental-energy issues and their technical, policy, human and social dimensions. He has to his credit more than 68 publications in refereed journals, conference proceedings and technical reports.

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