2017 Report of the Arab Forum for Environment and Development

# ARAB ENVIRONMENT IN 10 YEARS

EDITED BY:
**NAJIB SAAB**

المنتدى العربي للبيئة والتنمية
ARAB FORUM FOR
ENVIRONMENT AND DEVELOPMENT

AFED

Dedicated to AFED Founding Board Members

**Mostafa Kamal Tolba**
1922-2016

**Maroun Semaan**
1955 -2017

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# Preface

This report on Arab Environment in 10 Years culminates a decade of the series of annual reports produced by the Arab Forum for Environment and Development (AFED) on the state of Arab environment. It tracks and analyzes changes focusing on policies and governance, including level of response and engagement in international environmental treaties. It also highlights developments in six selected priority areas, namely water, energy, air, food, green economy and environmental scientific research.

AFED was founded in 2006 at a regional conference which featured the release of a public opinion survey that tracked people's perception of environment in 22 countries. Based on the priorities as seen by the public and experts, AFED launched in 2008 the first report in its annual series entitled "Arab Environment: Future Challenges". It covered topics including Air Quality, Water Resources, Marine Environment, Desertification, Waste Management, Energy, Climate Change, Environmental Legislation and Financing. This inaugural report provided for the first time a comprehensive baseline on the status of environment in the region, which the present report relied on to track changes over the past decade.

The 2008 report became a major reference in its field and was the launching pad for the AFED annual reports which followed, covering eight topics: Climate Change (2009), Water (2010), Green Economy (2011), Ecological Footprint (2012), Sustainable Energy (2013), Food Security (2014), Sustainable Consumption (2015) and Sustainable Development in a Changing Arab Climate (2016).

The current report has found that the state of environment in the Arab countries over the past ten years has been characterized by disparities. While progress was slow and the situation deteriorated in many aspects, there were advances in others, especially in matters related to governance and commitment to international treaties, particularly regarding climate change. Despite the lack of real progress in several countries, mainly those which are facing political unrest and instability, others have made strides towards shifting to a more sustainable path, with major financial resources directed towards investments in environmental infrastructure.

However, diversification of the economy and the shift towards a green and sustainable economy were largely sparked by the inevitability of addressing critical problems and shortages in resources such as water, food and energy. For example, phasing out subsidies and implementing major investments in energy efficiency and renewable energy have been driven by increased local demand for energy and budget constraints prompted by lower oil prices. Water shortages have also led to investments in water efficiency and renewable sources of water, including wastewater recycling and reuse. In order to achieve food security, many Arab countries started introducing sustainable agricultural practices, including

more efficient irrigation and increased productivity. Moreover, adopting a nexus approach comprising water, food, and energy is increasingly being considered in order to enhance synergies and complementarities between water, food, and energy policies in the region.

AFED reports have repeatedly emphasized the importance of diversifying the economy, promoting better efficiency and fair access to energy, water and food, reducing waste, and pricing natural capital, as there are tough limits to what Arab ecosystems can support.

Despite slow progress, we noted with satisfaction that what AFED called for in its reports has become a prime driver for policy reforms in many Arab countries. This falls in line with the stated AFED mission: "To advance prudent environmental policies and action in the Arab countries based on science and awareness". AFED continues to engage many regional players, including public policy officials, corporations, academia, NGOs, and the media, mainly through its annual policy-oriented reports.

As part of the 2017 report, AFED carried out a public opinion survey across the Arab countries to track environmental perceptions and attitudes, in cooperation with AFED's partner media outlets. The online questionnaire repeated main questions included in the survey carried out in 2006. A majority of 80 percent still thought that the environmental situation has deteriorated or did not improve, while 95 percent said that their country is not doing enough to tackle environmental challenges. A positive aspect is that most of those surveyed expressed willingness to abide by stricter environmental laws and engage in personal action to protect the environment.

Public engagement and participation can have a direct impact on whether or not there will be policy changes that make the environmental goals achievable. It is for this reason that AFED always highlights the urgent need to invest in people-centered development, embracing the principles of genuine public participation, accountability, transparency, and non-discrimination. Ultimately, democracy, governance and the rule of law are indispensable for protecting the environment and managing natural resources.

AFED wishes to thank all those who made this report possible, especially our institutional partners: Islamic Development Bank (IDB), Kuwait Foundation for the Advancement of Sciences (KFAS), OPEC Fund for International Development (OFID), Food and Agriculture Organization (FAO), Kuwait Fund and United Nations Environment, alongside all corporate and media partners who supported this endeavor.

Celebrating the birth of its tenth report, AFED remembers two founding members who played a pivotal role in the creation and advancement of this initiative – Mostafa Kamal Tolba (1922-2016) and Maroun Semaan (1955-2017). It was with my mentor, Mostafa Kamal Tolba, Executive Director of the United Nations Environment Programme between 1973 and 1992 and father of environment diplomacy, that I started the AFED series of reports in 2008. It was his idea for AFED to produce topical reports after the first general one, and to evaluate changes in the tenth year. Maroun, a successful businessman and philanthropist, had been a lifetime friend since we met in 1973 as students at the American University of Beirut, sharing from that time a dream to affect positive change in

society. He joined AFED's Founding Board of Trustees at its inception, and was the driving force behind attracting colleagues from the business community to our Corporate Environmental Responsibility program. Maroun was a member of AFED's preparatory Executive Committee, together with Mostafa Tolba, Adnan Badran, Abdulrahman Awadi and myself, and stayed active until illness stole him untimely. This report is dedicated to the memory of these two great men, who passed away before they could celebrate this milestone with us.

By assessing the knowledge gained and innovations made over the last ten years, this report comprises a solid foundation for a new decade of sustainable development. It is hoped that the report will assist in developing robust policies and implementation plans for better environmental management, as a pillar of sustainable economic and social development.

*Beirut, 2 November 2017*

**Najib Saab**
*Secretary General*
*Arab Forum for Environment and Development (AFED)*

INTRODUCTION

# ARAB ENVIRONMENT IN 10 YEARS

**2017 Report of the Arab Forum for Environment and Development (AFED)**

The state of the environment in Arab countries over the past ten years has been characterized by disparities. While the situation continued to deteriorate in many aspects, there has been progress on some fronts. Despite the lack of real improvement in several countries, mainly those that are facing political unrest and instability, others have made strides towards shifting to a more sustainable path by introducing adequate policies and allocating more financial resources for investments in environmental infrastructure.

The initiation of certain policies that promote a green and sustainable economy was sparked by the inevitability of addressing emerging critical financial problems, alongside shortages in natural resources. For example, phasing out subsidies and implementing major investments in energy efficiency and renewable energy have been driven by increased local demand for energy and budget constraints prompted by lower oil prices. Water shortages have also led to investments in water efficiency and in renewable sources of water, including wastewater recycling and reuse. In order to achieve food security, many Arab countries started introducing sustainable agricultural practices, including more efficient irrigation and increased productivity. Moreover, adopting a nexus approach comprising water, food, and energy is increasingly being considered as a way to enhance synergies and complementarities between water, food, and energy policies in the region. It is true that policies in the right direction have already been introduced, but they still are in their infancy, and tangible results are still to be seen. There is an urgent need for a fast move from declarations to implementation. Key to such developments is increased coordination and cooperation at the regional level, which should not be overshadowed by political conflicts.

An AFED survey showed that the Arab public's sentiments are in line with analyses by experts that the environment has continued to deteriorate over the last ten years. Despite some bright spots, governments are not doing enough to tackle the challenges and manage the environment properly, as a main pillar of sustainable development.

## 1. PUBLIC OPINION

A public opinion survey carried out by AFED in 22 countries revealed that a vast majority of Arabs believe that the environment has deteriorated in their countries over the last ten years. Results were compared to a similar survey carried out by AFED in 2006. Those who thought that the situation deteriorated comprised 60 percent, the same as in 2006, while 20 percent said it improved, down from 30 percent in 2006, and 20 percent said it has not changed, reflecting a negative outlook. A vast majority of 95 percent think that their country is not

doing enough to tackle environmental challenges, a similar result as in the earlier survey.

The most important environmental challenges according to the survey are solid waste, followed by weak environmental awareness, deterioration of water resources, pollution and climate change. This is in line with the results from ten years ago, except for air pollution, which was ranked the biggest challenge in 2006.

The top causes for environmental deterioration as indicated by the respondents were bad environment management, non-compliance with environmental legislation, weak environment institutions and inadequate government spending on the environment – all in line with the results from 2006.

When asked about what personal action they were ready to take to protect the environment, 73 percent of the respondents said they were ready to participate in environmental awareness campaigns and 65 percent were prepared to fully comply with environmental legislation. Regarding fiscal measures, 45 percent accept government taxes to protect the environment, while only 20 percent are willing to pay donations to an environmental protection fund.

Changes were evident on issues related to climate change in the past ten years, reflecting a higher level of awareness. The adoption of the Paris Agreement should have stimulated further recognition of the serious impacts of climate change. 93 percent say that climate is changing due to human activities and 90 percent of the respondents believe that it poses a serious challenge to their countries. This represents a 6 percent increase over ten years. 75 percent thought that their government was not doing enough to deal with climate change, similar to previous results.

83 percent say they know what the aims of sustainable development are, 98 percent think that changing consumption patterns can impact the environment, and 95 percent believe that environmental protection helps economic growth.

Results evidently show more understanding of environmental issues among the public, including their interrelation with economic and social factors. Perhaps as a result of this increased awareness, the survey indicates that Arabs are also more adamant on their governments placing more tangible steps towards environmental development.

## 2. POLICIES AND GOVERNANCE

Environmental initiatives at the regional level remain fragmented and largely ineffective. This can be attributed to problems hindering proper cooperation within regional Arab institutions, and the misperceptions caused by the inclusion of the environment as an integral component of sustainable development.

The League of Arab States (LAS) has attempted over the past decade to handle the inclusion of environment as a pillar of sustainable development. This was in line with the shift in global governance, which culminated in the endorsement of the Sustainable Development Goals (SDGs) in 2015. Historically, the Council of Arab Ministers Responsible for the Environment (CAMRE) handled this task, but its mandate was too limited to attract other players for developing regional policies. To address this gap, a Joint Committee on Environment and

Development in the Arab Region (JCEDAR) was created, with the aim to include other ministries alongside that for the environment – mainly economy, finance and planning. As this mechanism was not effective enough, a new department on Sustainable Development and International Cooperation was established in 2016 within the LAS, whose success remains to be seen.

CAMRE, under the auspices of the LAS and with the support of international agencies and specialized civil society organizations, prepared background papers for negotiations on international environment agreements, and played an active role in these negotiations, especially regarding climate change. The LAS adopted a regional Strategic Framework for Sustainable Development, in addition to regional strategies on water, agriculture, climate change and others. Those regional strategies have not significantly influenced national efforts to achieve sustainable development.

At the national level, environmental institutions have been generally strengthened, resulting in some improvements in environmental management, but with limited ability to fully address all three dimensions of sustainable development. In response, some Arab countries created national councils for sustainable development, which remained ad hoc in nature.

At the public policy front, sustainable management of natural resources was introduced to the development agenda in many Arab countries. A major shift in public policy has been the recent reforms in energy and water prices across the region, including the major oil producing countries of the GCC. In addition to reforming subsidies, the region witnessed the adoption of sustainable energy polices such as energy efficiency targets and action plans, efficiency labels for appliances and cars, green building codes, and renewable energy policies, including targets, feed-in-tariff and net-metering. However, to achieve the global goals, regional institutions need to move from rhetorical declarations to implementation on the ground, and Arab countries need to strengthen their legislative and institutional frameworks.

As the Arab region is one of the most vulnerable regions to the impacts of climate change, both economically and environmentally, the commitment of Arab countries to the international climate change process, culminating in the Paris Agreement, was evident. All 22 members of the LAS, except Syria, signed the agreement, 15 countries ratified it and 13 submitted their first Nationally Determined Contributions (NDC). However, the regional approach to address climate change risks has been unsuccessful, due to lack of political commitments to regional cooperation.

Water, food and energy form a complex web of inter-linkages, and due to their strong interdependence, policies and subsidies in one sector strongly influence the other two sectors. Arab policymakers should therefore revisit their current and future development strategies and plans with a new nexus lens. This would help achieve the mandate and targets of the Sustainable Development Goals (SDGs) and the Paris Climate Agreement. National and regional efforts to address the climate change challenge offer an unprecedented opportunity for a much-needed institutional reform to mainstream the nexus thinking in policy development and implementation.

Furthermore, to achieve social justice, universal subsidies should give way to targeted subsidies for the disadvantaged segments of Arab society. These pricing

policies should ensure that basic human needs are met, should promote resources efficiency, and recover the cost of their service provision without impacting the poor.

## 3. GREEN ECONOMY AND FINANCE

The last decade has witnessed a rather significant transition of Arab countries to green economy. From almost no country adopting green economy or a sustainable strategy, to more than seven countries that have either developed such strategies or have included elements of green economy and sustainability in their plans. Green strategies have been translated in a package of regulatory and incentive measures introduced in these countries to facilitate such a transition. This gave a strong signal to the private sector to increase investments in green economy sectors by many folds, especially renewable energy, which is evident in Morocco, Jordan and UAE, where billions have been invested in solar and wind farms. Morocco is implementing a plan to generate over half of its electricity from renewable resources by 2030.

Such a transition has been prompted by increased awareness and recognition of the real economic, social, and environmental gains resulting from transitioning to a green and sustainable economy. This is reflected in the increased job opportunities created by green investments, efficiency in the use of natural resources, competitiveness and market access. The economy can be diversified and revitalized by creating new activities and opportunities such as: renewable energy, new renewable sources of water in the form of wastewater treatment and reuse of treated water and desalination, sustainable and organic agriculture, green industrial products, sustainable communities and green buildings, green public transport system, ecotourism, alongside integrated solid waste management systems which can generate energy, produce organic compost, and re-use materials.

Egypt, Morocco, Qatar, and the UAE have already incorporated green building codes in new urban and coastal communities such as the Galala City and Al Alamein New City in Egypt, Masdar City in Abu Dhabi, and the Mohammed VI Green City in Morocco. Some public policy strategies, such as the Saudi Vision 2030, endorsed a type of natural capital accounting concepts. The Saudi Vision 2030 sets an example as a radical improvement, compared to previous more timid attempts at reform. Fiscal measures introduced by the central banks in Lebanon, the UAE and Jordan have led to a sharp increase in the number and value of commercial loans given by banks to environmentally-friendly projects. These include big projects executed by the private sector, as well as household installations boosting efficiency, mainly in the field of solar and renewable energy in general.

The adoption of the Sustainable Development Goals (SDGs) in 2015 has provided another impetus for countries around the globe, including in the Arab region, to intensify efforts aimed at developing sustainable and green strategies and policies for achieving the SDGs.

The amount of financial resources channeled to fund green investments in the Arab region has been steadily increasing, and an increasing share of total investments is expected to be directed to green and sustainable development projects in the region in the coming years. One indication of the new trend is that

financing for development operations coming from Arab national and regional development institutions during 2006-2016 amounted to USD 51 billion, nearly 57 percent of total cumulative funding (USD 90 billion) over the entire 40-year period since 1975.

However, much more is needed, as Arab countries must earmark an additional USD 57.38 billion annually, from domestic and external sources, to support the implementation of sustainable development goals. Only a small portion of this amount is available now.

## 4. WATER

Water scarcity continues to intensify in the Arab region due to limited renewable freshwater resources and deterioration in quality on one hand, and population growth and lack of funds to finance water infrastructure on the other. Moreover, water scarcity in the region has been exacerbated by an increasing frequency of drought cycles. During the past 10 years, the combined average per capita freshwater availability of the 22 Arab countries dropped from about 990 $m^3$ to less than 800 $m^3$ per year (about one-tenth the world's average). If Mauritania, Iraq, Sudan and Lebanon are taken out of the total, the average per capita availability of freshwater drops to below 500 $m^3$. Per capita water availability in nine countries is already below 200 $m^3$. Thirteen Arab countries are among the world's 19 most water-scarce nations. This means that about 40 percent of the Arab population is already living in conditions of absolute water scarcity.

Most Arab countries continue to rely heavily on groundwater resources to meet their rising demands, particularly for irrigation and domestic use. Currently, all renewable groundwater resources in the region are experiencing water level decline and quality deterioration, while non-renewable groundwater basins are experiencing fast depletion. Desalination continues to emerge as a major water source in the region, especially in energy-rich countries. However, desalination technology and equipment remain imported, with limited added value to the economies of the Arab countries.

Reuse of treated wastewater has generally been limited across the region, despite the scarce conditions and the relatively large volumes generated, representing major lost opportunities. While 60 percent of wastewater is treated, more than half of the treated water is discharged and not re-used. In the past 10 years, a clear trend of competition on water use among different sectors could be observed, where the region's overall percentages of sectoral water utilization have been shifting from the agricultural sector towards the municipal and industrial sectors, reflecting rapid urbanization and industrialization trends in the region, which are expected to continue in the future.

During the past 10 years, the proportion of the Arab population with access to safe drinking water has improved from 85 percent to 90 percent, nearing the global average. This was achieved in most parts of the region, except in the Mashreq where the proportion of the population with access to safe drinking water has deteriorated during this period, decreasing from 94 percent to 88 percent. Challenges in these countries are attributed mainly to military occupation, civil conflicts, and insufficient investments. Access to improved sanitation facilities has considerably increased in the past ten years, reaching 85 percent of the population.

As the supply side management has reached its technical and financial limits, several Arab countries have started to make a more effective shift in their water policies to demand management and conservation, with economic tools being increasingly used to materialize this shift. Water subsidies have been reformed in many countries from general to more targeted, a move which is expected to enhance water use efficiency and increase cost recovery.

The past 10 years have witnessed major regional and sub-regional initiatives. The Arab Ministerial Water Council (AMWC) was established in 2008 within the Arab League, and in 2010 it released the Arab Water Security Strategy 2010-2030. At the sub-regional level, in 2016 the GCC Unified Water Strategy 2016-2035 was launched. The development of both strategies represents a major milestone for coping with the water scarcity in the arid Arab countries. Success needs fast implementation and higher levels of regional cooperation.

## 5. FOOD SECURITY

Agriculture and food production cannot function without a healthy environment and a conducive climate. Food security has deteriorated further in several Arab countries over the last 10 years, despite some advances in others. The Arab region continued to be the largest food deficit region in the world, with an ever-growing food gap between domestic production and consumption. In terms of monetary value, the total Arab food gap has increased drastically from USD 18 billion in 2005 to about USD 29 billion in 2010 and USD 34 billion in 2014. The growing food gap is due to several interrelated factors and developments in the Arab world. Specifically, those include high population growth (2.3 percent annually compared to 1.9 percent in developing countries); low agricultural productivity due to poor investment in science and technology and in agricultural development; further natural resource degradation; climate change implications, mainly less precipitation, more frequent droughts, higher temperatures, shorter growing seasons and seawater intrusion; high food wastage, at about 35 percent; and widespread political instability and civil strife in several Arab countries in the last six years, and a resulting rural to urban and overseas migration. Due to the civil war in Syria, for example, the overall financial cost of damage and loss in the agriculture sector over the 2011-2016 period is estimated at over USD 16 billion.

The quantity and quality of both surface and ground water resources deteriorated drastically due to climate change and poor water management, including non-sustainable utilization. Salinity already contributed to exacerbated land degradation and desertification in vast areas of the Arab world. With the exception of Oman and Jordan, Arab countries invested less than 1 percent of their GDP on agricultural research and development (R&D). Despite their high agricultural growth potential, Algeria and Sudan seriously underinvested in R&D, each spending only 0.2 percent of their GDP on agricultural research, which is insufficient given the importance of agriculture for their national food security and economic growth.

While taking into account the current overall food security risk, Arab countries were categorized by the International Food Policy Research Institute (IFPRI) based on economic and social development. In this regard, the categorization is assessed following two major indicators: a macro-economic status of the trade balance and a micro-household nutritional and health status level as measures of food insecurity. Another important forward-looking classification is based on the natural resources and agricultural potential of Arab countries to enhance food

and nutritional security. Arab countries with high agricultural potential include Algeria, Egypt, Iraq, Morocco, Sudan and Syria; those with medium potential are Mauritania, Saudi Arabia, Tunisia and Yemen; limited potential countries include Jordan, Lebanon and Libya; while Bahrain, Kuwait, Oman, Qatar and the United Arab Emirates fall in the extremely low potential category.

The current agricultural productivity in all Arab countries is way below their potential and even below the average of developing countries globally. Thus, it is essential for Arab countries to tap into their full agricultural potential to bridge the yield gaps and promote regional collaboration based on their comparative advantages to enhance food security. This will close the growing gap between domestic food production and consumption to reduce the rising food imports and enhance food security, while strengthening collective cooperation.

## 6. ENERGY

The Arab region's rapidly growing domestic energy demand challenges its traditional energy policy. In 2014, the region accounted for 5.1 percent of the world's total primary energy supply and 7.8 percent of its carbon dioxide emissions, much of it generated in the Gulf Cooperation Council (GCC) countries. This pattern has led to position some GCC states among the world's top carbon dioxide emitters.

Current trends of energy use put the Arab economies among the least efficient globally. Average losses in generation, transmission and distribution of electricity are 19.4 percent, which is more than double the world average. Growth in energy consumption has been 8 percent, which is twice as fast as the average economic growth. Energy efficiency, therefore, presents ample opportunity for achieving energy savings in Arab countries.

For decades, the energy sector has been playing a crucial role in the Arab region's development, with oil and gas making up over 25 percent of the total Arab GDP, and bringing in more than 70 percent of the combined government revenues. Fossil fuels also dominate the domestic energy mix, with oil and natural gas accounting for around 95 percent of the region's own energy needs. Still, over 50 million Arab people have no access to modern energy services.

All Arab countries are highly vulnerable due to overdependence on oil, and have embarked on programs to diversify the economy. Saudi Arabia launched Vision 2030, which aims to boost non-oil revenues six-fold to USD 266 billion by 2030, along with bold plans to better manage natural resources, phase out subsidies and enhance energy efficiency. Major energy subsidy reform plans have been endorsed in eight Arab countries.

Although many Arab countries have made remarkable strides towards promoting renewable energy, its contribution in the energy mix remains marginal, at about 3.5 percent. However the outlook for wind and solar power in the Arab region is mostly positive, provided further policy reform continues to incentivize investment in new sources of energy. The International Energy Agency (IEA) projects that renewable generation in the Middle East will double in size between 2013 and 2020. Most big developments are expected to be in Saudi Arabia, which announced plans to produce 9.5 gigawatts of renewable electricity by 2023 and 54 gigawatts by 2040.

Most Arab countries have announced national renewable energy targets. Morocco's clean power target of 52 percent by 2030 stands out as the most ambitious in the Arab region. Twelve Arab countries have announced targets for renewable energy, including the UAE, Jordan, Algeria, Egypt, Saudi Arabia, and Tunisia, which announced ambitious targets in excess of 20 percent. In addition, several countries have adopted different kinds of policy measures to enhance energy efficiency.

The discovery of large gas deposits in the Eastern Mediterranean is expected to boost economies of the countries concerned, and provide a source of less polluting energy, as a bridge towards clean renewables. The industry, however, should follow strict rules that take into account the fragile nature of this almost locked sea.

Fast-growing energy demand in the Arab region, coupled with prospects of the Middle East becoming a global economic center by 2030 alongside the Asia-Pacific region, necessitates diversifying energy sources in order to move to a more sustainable energy sector. However, the energy mix model needs not to be used as a pretext to introduce additional environmentally-harmful fuels such as coal. Nuclear energy is another source which some Arab countries have been attempting to bring in, under the label of energy mix. Both need to be examined with close scrutiny to evaluate real benefits and risks, at a time when the overwhelming global trend is to phase out existing coal and nuclear plants and hold back on new ones.

Achieving sustainable energy requires decoupling economic growth from resource utilization through efficient use, the decarbonization of the energy mix to reduce the carbon footprint, and the eradication of energy poverty to achieve social equity and remove disparity in energy and economic indicators.

## 7. AIR QUALITY

Air quality in the Arab countries has deteriorated over the past few decades. Emissions of carbon dioxide ($CO_2$) have nearly doubled. Changes in the power sector were driven by strategies that have been successfully implemented in many countries in the region to improve energy access, leading to more fossil fuels being burnt in the thermal power plants to meet the increase in power demand. Electricity consumption has increased by 75.5 percent, leading to a total amount of 766.5 million tons of $CO_2$ being emitted in 2015, compared to 436.6 million tons in 2006. Emissions from the transport sector have increased due to the substantial growth in the sector, with no effective mitigation measures and weak public transport in most countries.

A study conducted in major cities in the region claims that the unrest in some countries has led to a drop in emissions. This might hold for some gases due to the slowing of industries and personal transport, but dust and other pollutants resulting from conflicts have obviously increased.

The Arab region was among the worst performers in air quality, according to the World Health Organization (WHO). Recorded levels of air pollution often exceeded 5 to 10 times the WHO limits, and several Arab cities are among the 20 most polluted cities in the world. Excessive emissions include carbon monoxide that results from the transport sector, oxides of sulfur and oxides of nitrogen, leading to the formation of acid rain, ozone, and volatile organic compounds

(VOCs). Reduction of sulfur content in diesel fuel in most Arab countries has been achieved by tightening the standards, which resulted in a drop from levels as high as 1000 ppm to around 50 ppm. Also, a shift to unleaded gasoline has been achieved by implementing cost differentials, followed by a complete ban on the use of leaded fuel.

Mitigation measures that could be implemented to further reduce emissions from the power sector include enhancements of fuel quality and deployment of renewable technologies and energy efficient devices. Most Arab countries are developing a viable market for renewable energy investments. Between 2012 and 2015, total renewable installed capacity witnessed a 150 percent increase, exceeding 3GW, excluding hydropower, compared to 1.2GW in 2012.

Most sustainable transportation strategies fall into one of three categories: vehicle/fuel technology enhancement, road/vehicle operations improvements and demand management. A formal, mass transport system is yet to be implemented on a wide scale in the region. Gasoline engines generally produce less harmful emissions compared to diesel, thus tightening the standards related to petrol quality will lead to a substantial reduction in emissions.

The successful introduction of hybrid and electrical cars in Jordan over the past eight years is a shining example of how targeted fiscal policies can influence the market. Within a few years a package of tax exemptions on cleaner cars, and greater levies on those with higher emissions, helped boost the number of hybrid and electrical cars in Jordan to half of those newly registered.

## 8. ENVIRONMENTAL RESEARCH

The Arab world is facing many environmental pressures ranging from challenges in resource management and water shortage to pollution and climate change, which all require serious scientific research. Arab nations contribute 1.7 percent of the total value of budgets embarked for environmental research worldwide. Egypt, Saudi Arabia, Morocco and Tunisia are the most active research countries in general science and environmental research. Scientific research has increased in the last ten years, with Egypt leading the Arab world, followed by Saudi Arabia for both the number and rate of publications produced. Egypt has contributed at least double the amount of publications compared to other Arab countries since 2008, effectively contributing on average 26 percent of environmental publications cumulatively by 2015. This can be attributed in part to the size of Egypt's population, accounting to a quarter of the Arab countries combined. Saudi Arabia has been enjoying a linear increase in research rates since 2008 (1.67 percent average annual document contributions per year), followed by Morocco (0.59 percent), Iraq (0.35 percent), and Qatar (0.18 percent).

Health and pollution as well as water science and technology are the fastest growing research subjects under environmental science in the Arab world, where research has increased twofold on average since 2008, with Egypt leading the Arab world in both disciplines. The slowest growing subjects are climate change and environmental policies, as well as biodiversity and conservation.

Beyond the numbers, results of research projects and publications in Arab countries are rarely reflected in policies, and they seldom contribute to solutions to environmental problems. In contrast to the weak contribution and impact

of researchers working in the Arab countries, Arab researchers working abroad contributed well in many areas related to environmental science, with a profound impact on society.

The enhancement of environmental research to produce impact in the Arab countries requires creating enabling conditions and a stimulating work environment, and linking research to policy. A fundamental step towards achieving this goal is building an infrastructure that connects research institutions, industry and society and creates an integrated system that ensures sustainable development. Budgets dedicated to environmental research should be enhanced, centers of excellence created, and research collaborations among Arab countries and with other centers worldwide strengthened. Publication mechanisms for research institutes have to be improved and modernized in order to facilitate the publication process. In order to fill a growing gap, research in the areas of policy development and climate change should be encouraged. Finally, in order to reverse the brain drain caused by a large proportion of Arab students who study abroad never returning, investment in young researchers and intellectual capital should be promoted.

## CONCLUSION

Although the Arab environment continued to deteriorate, there has been slow progress on some fronts. But even this little improvement is threatened to be wiped off by conflicts, wars and instability.

In order to ensure a successful transition to better environment as a main pillar of sustainable development, Arab countries urgently need to translate their many political declarations and regional strategies into tangible programs of action. Regional cooperation among Arab countries needs to be promoted, including joint projects in the fields of water, energy and food production, as well as research, education and capacity building.

Environmental components and resources have to be valued as assets, attaching a monetary value for resource depletion and pollution, and including those in national budgets. It is necessary to adopt prudent governance which embraces stable and predictable fiscal policies, regulations and market incentives, and encourage domestic and foreign investment in green infrastructure projects.

Ultimately, political stability and security in Arab countries is a necessary requirement for the formulation and implementation of long term strategic sustainable development plans which embrace the environment.

# Arab Public Opinion and the Environment

## *AFED 2017 Survey in 22 Countries*

Najib Saab

A public opinion survey carried out by the Arab Forum for Environment and Development (AFED) in 22 Arab countries revealed that a vast majority, exceeding 60 percent, believes that the environment has deteriorated in their countries over the last ten years. An even bigger majority of 95 percent thinks that their country is not doing enough to tackle environmental challenges. The questionnaire, circulated between March and June 2017 via internet, in cooperation with Arab media outlets, attracted 20,460 responses from across the Arab region.

The survey was conducted on self-completion basis, and filled voluntarily by those who chose to respond to public invitations announced online and through print media. The sample included responses from all the 22 countries which are members in the League of Arab States, according to the following demographic distribution: Age- 30-49: 46%, 20-29: 34%, above 50: 13%, under 20: 7%. Gender- male: 66%, female: 34%. Family income compared to standard of living in country of residence- average: 69%, above average: 16%, below average: 15%. Education- university: 87%, secondary: 6%, vocational: 5%, intermediate and elementary: 2%.

Respondents who thought that the environmental situation has worsened comprised 60 percent, reflecting findings of a similar AFED survey in 2006. In contrast, 20 percent said the situation has improved, down from 30 percent in 2006, and 20 percent said it has not changed. Overall results reflect a negative outlook, with the highest levels of public dissatisfaction recorded in Syria (96%), Lebanon (91%), Yemen (90%), Tunisia and Libya (78%), Iraq (74%) and Egypt (66%). It is obvious that war, conflict and political instability reflected negatively on the environmental situation in those countries. The only country where a majority of just over 50 percent thought that the environment improved was the United Arab Emirates (UAE).

The most important environmental challenges according to the survey are solid waste, followed by weak environmental awareness, deterioration of water resources, pollution and climate change. This is in line with the results from ten years ago, except for air pollution, which was ranked the biggest challenge in 2006. Differences were observed in this regard among countries, where priorities chosen reflected specific problems at the national level. Food contamination due to improper use of pesticides and fertilizers was chosen as the top environmental threat in Egypt, reflecting increased concerns about food safety. The majority of respondents in Kuwait considered marine and coastal pollution the prime problem, which took second place in Lebanon. This can be explained by the repeated loss of thousands of tons of fish in Kuwait over the past decade due to the discharge of waste in the sea, and the worsening coastal pollution in Lebanon caused by untreated sewage.

The top causes for environmental deterioration chosen by those surveyed were bad environment management, non-compliance with environmental legislation, weak environment institutions and inadequate government spending on the environment – results that are all in line with 2006 findings. Results of Saudi Arabia and UAE highlighted weak environmental awareness as the main cause for environmental decline.

When asked about what personal action respondents were willing to take to protect the environment, 73 percent said they were ready to participate in environmental awareness campaigns and 65 percent were prepared to fully comply with environmental legislation. Regarding fiscal measures, 45 percent accept government taxes to protect the environment, while only 20 percent are willing to pay donations to an environmental protection fund.

Changes over ten years were evident on issues related to climate change, reflecting a higher level of awareness. The adoption of the Paris Agreement should have stimulated further recognition of the serious impacts of climate change. 93 percent say that the climate is changing due to human activities and 90 percent of the respondents believe that it poses a serious challenge to their countries. This represents a 6 percent increase over ten years. A regional average of 75 percent thought that the government was not doing enough to deal with climate change, with the highest levels of condemnation noted in Libya, Lebanon, Yemen, Syria and Iraq. A majority of over 50 percent in Oman, the UAE and Morocco indicated satisfaction with government action to tackle climate change. This can be attributed to the specific inclusion of climate change in the cabinet portfolios in those countries, culminated, for example, in the Ministry of Climate Change and Environment in the UAE.

The AFED survey shows that the public has become more familiar with the terminology and the concept of sustainable development goals. 83 percent of those surveyed say they know what the aims of sustainable development are, 98 percent think that changing consumption patterns can impact the environment, and 95 percent believe that environmental protection helps economic growth.

Results evidently show more understanding of environmental issues among the public, including their interrelation with economic and social factors. They also reveal that people are worried about the deterioration of the environment and depletion of resources, and that they are generally dissatisfied with the level of response of governments. On the other hand, the survey shows an overwhelming readiness from the public to support positive change, by encouraging stricter laws to protect the environment and preserve natural resources, alongside engaging in personal action in this regard.

The AFED report on the state of Arab environment in 10 years found that the situation deteriorated, and called for immediate remedial action. As the people agree with the expert prognosis and are ready to endorse change, it is the right time for governments to enact appropriate policies and implement action plans to enhance the environment, with the engagement and support of the public.

FIGURE 1 IN YOUR VIEW, DURING THE PAST 10 YEARS, THE ENVIRONMENTAL SITUATION IN YOUR COUNTRY

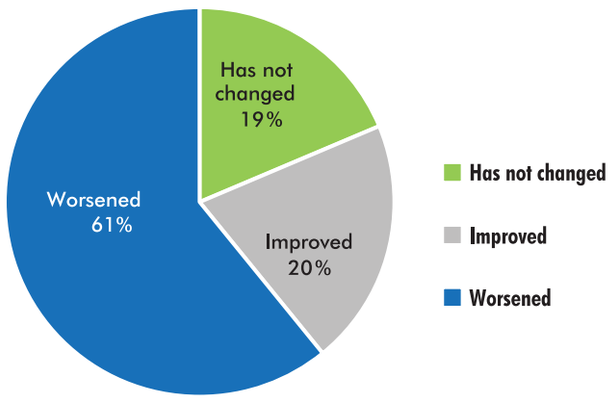


FIGURE 2 CLIMATE IS CHANGING DUE TO HUMAN ACTIVITY

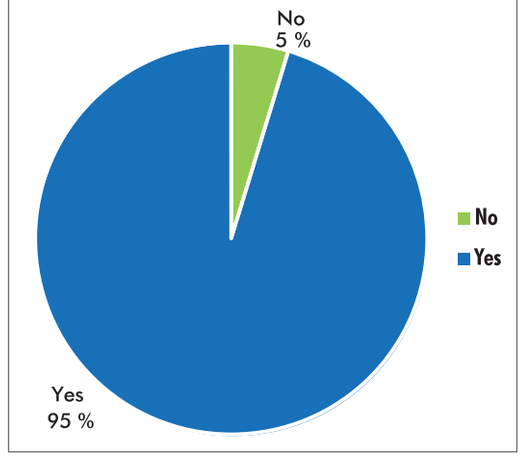


FIGURE 3 MY GOVERNMENT IS PUTTING GOOD EFFORTS TO DEAL WITH CLIMATE CHANGE

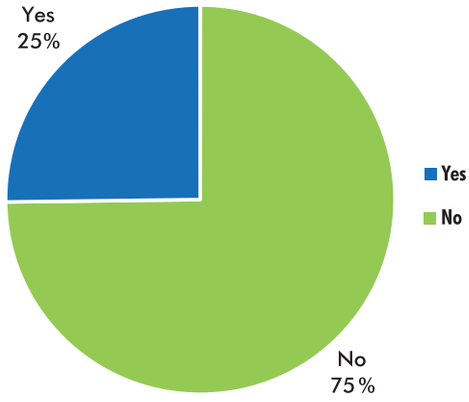


FIGURE 4 CLIMATE CHANGE IS A SERIOUS PROBLEM FOR YOUR COUNTRY

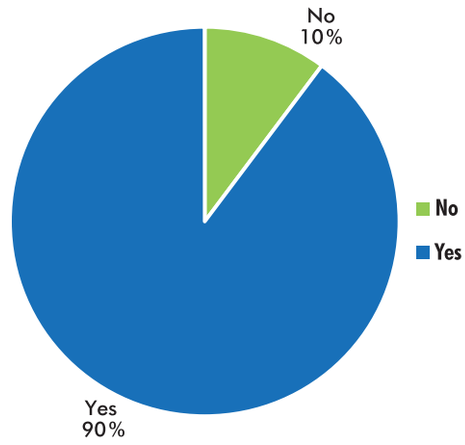

FIGURE 5 **WHICH OF THE FOLLOWING ACTIVITIES ARE YOU WILLING TO DO?**

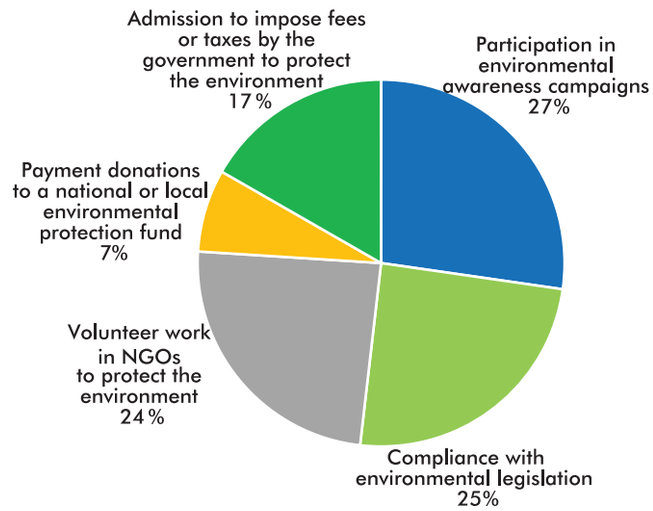


FIGURE 6 **DO YOU THINK YOUR COUNTRY SHOULD DO MORE OR LESS THAN IT IS DOING NOW TO PROTECT THE ENVIRONMENT?**

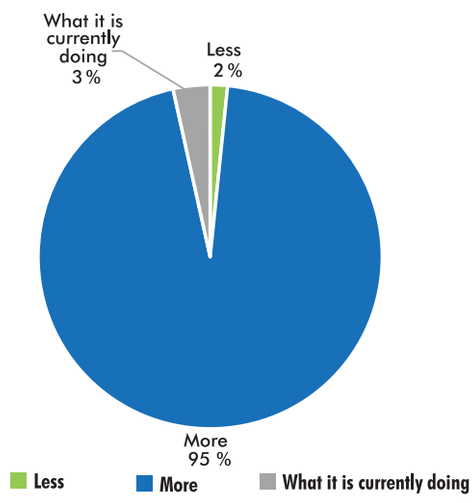


FIGURE 7 **WHAT ARE THE 3 MOST IMPORTANT ENVIRONMENTAL PROBLEMS / CHALLENGES IN YOUR COUNTRY?**

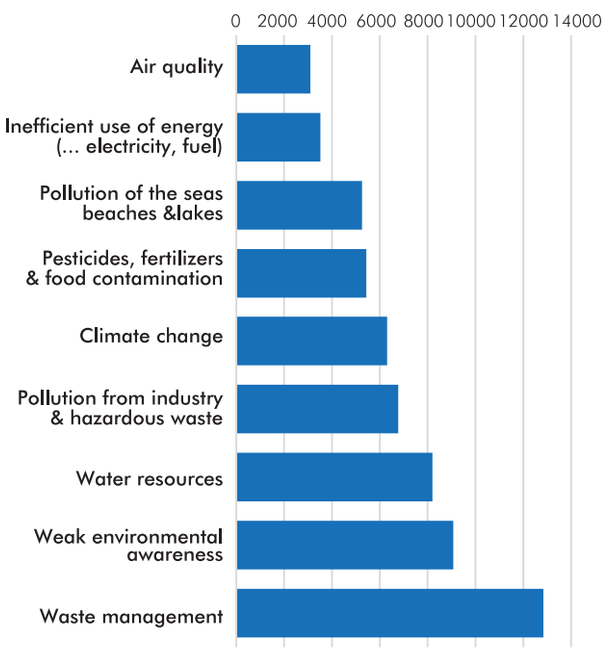


FIGURE 8 **WHAT ARE THE MAIN 3 REASONS FOR THE DETERIORATION OF THE ENVIRONMENT IN YOUR COUNTRY? (CHOOSE 3 ONLY)**

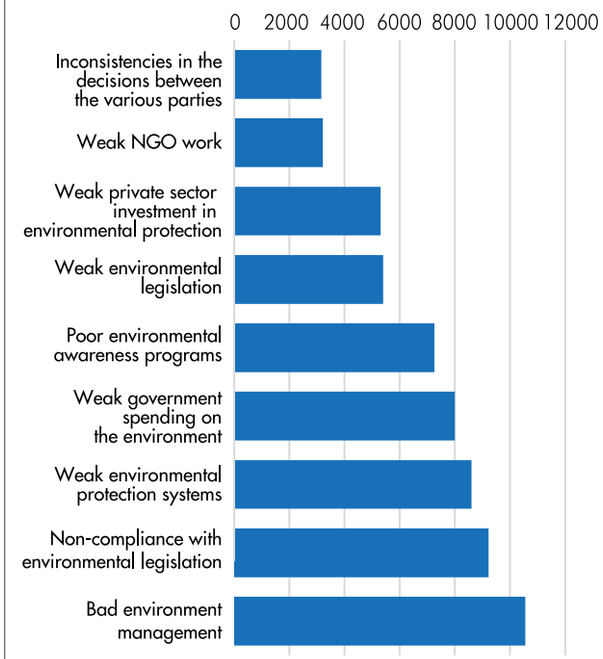

FIGURE 9 **DO YOU KNOW WHAT ARE THE SUSTAINABLE DEVELOPMENT GOALS (SDGS)?**

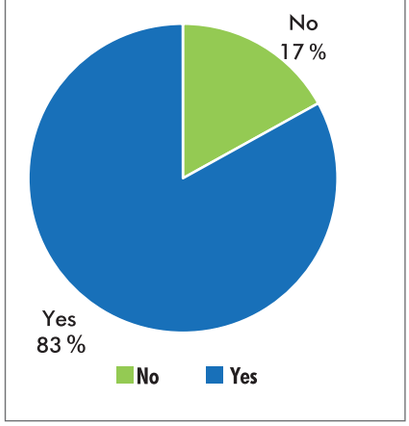


FIGURE 10 **DOES SOUND ENVIRONMENTAL MANAGEMENT HELP SUSTAINABLE ECONMIC GROWTH?**

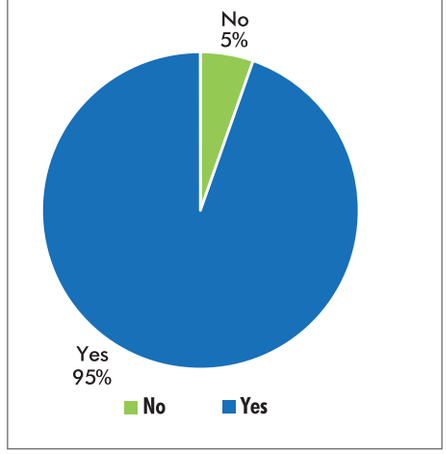


FIGURE 11 **DO OUR CONSUMPTION PATTERNS AFFECT THE ENVIRONMENT?**

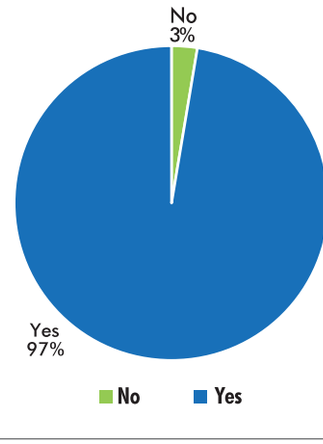


TABLE 1 **MOST IMPORTANT ENVIRONMENTAL PROBLEMS / CHALLENGES (SELECTED COUNTRIES)**

| | Air quality | Climate change | Inefficient use of energy (electricity, fuel ...) | Pesticides, fertilizers and food contamination | Pollution from industry and hazardous waste | Pollution of the seas and beaches and lakes | Waste management | Water resources | Weak environmental awareness |
|---|---|---|---|---|---|---|---|---|---|
| Algeria | 3.78% | 12.13% | 6.37% | 7.11% | 11.73% | 6.43% | 21.49% | 10.94% | 20.02% |
| Egypt | 5.27% | 8.68% | 4.65% | 22.64% | 12.56% | 3.88% | 14.73% | 13.64% | 13.95% |
| Jordan | 6.45% | 14.70% | 7.89% | 7.89% | 7.53% | 0.36% | 18.28% | 20.07% | 16.85% |
| Kuwait | 11.11% | 11.11% | 5.56% | 9.26% | 7.41% | 18.52% | 12.96% | 12.96% | 11.11% |
| Lebanon | 8.98% | 4.49% | 6.22% | 6.22% | 9.67% | 18.39% | 29.27% | 11.57% | 5.18% |
| Morocco | 2.02% | 17.68% | 1.18% | 8.92% | 8.75% | 7.07% | 18.52% | 18.69% | 17.17% |
| United Arab Emirates | 8.33% | 10.71% | 9.52% | 7.14% | 14.29% | 13.10% | 5.95% | 23.81% | 7.14% |
| Tunisia | 3.70% | 8.83% | 3.70% | 5.13% | 17.38% | 13.96% | 19.66% | 17.09% | 10.54% |
| Yemen | 0.81% | 9.76% | 2.44% | 22.76% | 4.88% | 5.69% | 16.26% | 17.07% | 20.33% |
| Saudi Arabia | 12.96% | 9.26% | 9.26% | 12.96% | 9.26% | 1.85% | 16.67% | 7.41% | 20.37% |
| Iraq | 4.94% | 10.19% | 9.88% | 6.79% | 13.89% | 0.93% | 24.38% | 9.26% | 19.75% |
| Bahrain | 3.70% | 8.15% | 5.93% | 2.96% | 18.52% | 14.81% | 15.56% | 16.30% | 14.07% |

TABLE 2 **MAIN SOURCES FOR THE DETERIORATION OF THE ENVIRONMENT (BY COUNTRY)**

| | Bad Environment Management | Inconsistencies in the decisions between the various parties | Non-compliance with environmental legislation | Poor environmental awareness programs | Weak environmental legislation | Weak Environmental Protection Systems | Weak government spending on the environment | Weak NGO work | Weak private sector investment in environmental protection |
|---|---|---|---|---|---|---|---|---|---|
| Algeria | 15.68% | 3.95% | 15.00% | 13.93% | 6.32% | 14.33% | 9.59% | 8.80% | 12.41% |
| Bahrain | 17.78% | 8.89% | 13.33% | 17.04% | 8.15% | 9.63% | 12.59% | 2.22% | 10.37% |
| Djibouti | 0.00% | 0.00% | 0.00% | 33.33% | 0.00% | 33.33% | 0.00% | 0.00% | 33.33% |
| Egypt | 17.83% | 4.81% | 15.66% | 13.64% | 8.84% | 16.28% | 12.09% | 4.50% | 6.36% |
| Iraq | 24.69% | 6.79% | 10.80% | 11.42% | 11.42% | 14.81% | 12.04% | 1.23% | 6.79% |
| Jordan | 16.85% | 5.02% | 19.71% | 8.60% | 11.11% | 11.47% | 15.05% | 3.58% | 8.60% |
| Kuwait | 7.41% | 5.56% | 22.22% | 12.96% | 9.26% | 12.96% | 14.81% | 3.70% | 11.11% |
| Lebanon | 21.59% | 7.25% | 16.32% | 6.65% | 13.56% | 11.49% | 19.00% | 1.12% | 3.02% |
| Libya | 16.05% | 0.00% | 9.88% | 14.81% | 7.41% | 17.28% | 20.99% | 3.70% | 9.88% |
| Mauritania | 19.05% | 7.14% | 9.52% | 14.29% | 4.76% | 19.05% | 16.67% | 0.00% | 9.52% |
| Morocco | 15.15% | 4.88% | 16.50% | 13.97% | 7.91% | 15.99% | 10.27% | 6.06% | 9.26% |
| Oman | 0.00% | 16.67% | 33.33% | 16.67% | 0.00% | 0.00% | 16.67% | 0.00% | 16.67% |
| Other | 25.00% | 0.00% | 8.33% | 33.33% | 16.67% | 8.33% | 8.33% | 0.00% | 0.00% |
| Palestine | 14.67% | 9.33% | 10.67% | 10.67% | 9.33% | 17.33% | 12.00% | 4.00% | 12.00% |
| Qatar | 22.22% | 33.33% | 0.00% | 11.11% | 0.00% | 11.11% | 0.00% | 11.11% | 11.11% |
| Saudi Arabia | 12.96% | 5.56% | 11.11% | 20.37% | 7.41% | 14.81% | 11.11% | 9.26% | 7.41% |
| Somalia | 0.00% | 0.00% | 16.67% | 0.00% | 16.67% | 33.33% | 33.33% | 0.00% | 0.00% |
| Sudan | 17.71% | 2.08% | 17.71% | 14.58% | 5.21% | 15.63% | 17.71% | 3.13% | 6.25% |
| Syria | 14.97% | 4.08% | 12.93% | 11.56% | 8.16% | 16.33% | 16.33% | 5.44% | 10.20% |
| Tunisia | 17.09% | 3.99% | 13.11% | 9.69% | 7.12% | 16.24% | 13.11% | 7.41% | 12.25% |
| United Arab Emirates | 4.76% | 11.90% | 13.10% | 15.48% | 10.71% | 14.29% | 8.33% | 10.71% | 10.71% |
| Yemen | 15.45% | 0.81% | 17.89% | 10.57% | 7.32% | 12.20% | 20.33% | 8.13% | 7.32% |

TABLE 3 **MY GOVERNMENT IS PUTTING GOOD EFFORTS TO DEAL WITH CLIMATE CHANGE (BY COUNTRY)**

| | No | Yes |
|---|---|---|
| Algeria | 64.81% | 35.19% |
| Bahrain | 71.11% | 28.89% |
| Djibouti | 0.00% | 100.00% |
| Egypt | 80.47% | 19.53% |
| Iraq | 87.04% | 12.96% |
| Jordan | 76.34% | 23.66% |
| Kuwait | 61.11% | 38.89% |
| Lebanon | 98.96% | 1.04% |
| Libya | 100.00% | 0.00% |
| Mauritania | 78.57% | 21.43% |
| Morocco | 40.91% | 59.09% |
| Oman | 0.00% | 100.00% |
| Other | 75.00% | 25.00% |
| Palestine | 72.00% | 28.00% |
| Qatar | 66.67% | 33.33% |
| Saudi Arabia | 61.11% | 38.89% |
| Somalia | 50.00% | 50.00% |
| Sudan | 78.13% | 21.88% |
| Syria | 87.76% | 12.24% |
| Tunisia | 85.47% | 14.53% |
| United Arab Emirates | 14.29% | 85.71% |
| Yemen | 90.24% | 9.76% |
| **Grand Total** | **74.81%** | **25.19%** |

TABLE 4 **DURING THE PAST TEN YEARS, THE ENVIRONMENTAL SITUATION (BY COUNTRY)**

| | Has not changed | Improved | Worsened |
|---|---|---|---|
| Algeria | 26.57% | 32.32% | 41.12% |
| Bahrain | 24.44% | 28.89% | 46.67% |
| Djibouti | 0.00% | 100.00% | 0.00% |
| Egypt | 19.07% | 14.88% | 66.05% |
| Iraq | 21.30% | 4.63% | 74.07% |
| Jordan | 23.66% | 23.66% | 52.69% |
| Kuwait | 44.44% | 27.78% | 27.78% |
| Lebanon | 7.77% | 1.04% | 91.19% |
| Libya | 18.52% | 3.70% | 77.78% |
| Mauritania | 35.71% | 28.57% | 35.71% |
| Morocco | 14.65% | 44.44% | 40.91% |
| Oman | 50.00% | 50.00% | 0.00% |
| Other | 0.00% | 25.00% | 75.00% |
| Palestine | 12.00% | 28.00% | 60.00% |
| Qatar | 33.33% | 33.33% | 33.33% |
| Saudi Arabia | 11.11% | 44.44% | 44.44% |
| Somalia | 50.00% | 0.00% | 50.00% |
| Sudan | 18.75% | 6.25% | 75.00% |
| Syria | 4.08% | 0.00% | 95.92% |
| Tunisia | 11.97% | 10.26% | 77.78% |
| United Arab Emirates | 39.29% | 53.57% | 7.14% |
| Yemen | 9.76% | 0.00% | 90.24% |
| **Grand Total** | **18.64%** | **20.48%** | **60.88%** |

# ENVIRONMENTAL CONSERVATION IN THE UAE: AN AUTHENTIC CULTURAL HERITAGE AND EXPERIENCE

**Thani bin Ahmed Al Zeyoudi**

The United Arab Emirates (UAE) has prioritized the conservation of the environment and natural resources, both being integral to its national heritage, almost since the establishment of the federation in 1971. The founding father of the UAE, late Sheikh Zayed bin Sultan Al Nahyan, considered the environment and sustainable development to be cornerstones of the nation's progress.

In line with the rapid economic and social developments over the past four decades, the UAE has restructured and refined its environmental policies and plans in a strategic and well thought out manner. Sustainability is an essential component of all development plans, as reinforced by the UAE Vision 2021. Sustainability represents the ultimate goal and emphasizes the fundamental value of protecting the environment towards achieving the objectives of this vision.

Despite our efforts and achievements, increasing pressures and global challenges such as climate change, population growth, economic growth, change in land use and lifestyles have led us to seek an alternative approach that focuses on mitigating these pressures and limiting their impact.

As part of this approach, the adoption of renewable and clean energy in 2006 within the energy diversification policy was a major turning point. The UAE followed up on this revolutionary step with the early adoption of several game-changing environmental policies towards achieving a green economy, green architecture, sustainable transport and enhanced resource efficiency. The adoption of such policies is part of an ambitious national vision and a comprehensive government approach that prioritizes innovative technologies, solutions and best practices in a bid to make the UAE one of the most innovative countries in the world by 2021.

## Clean Energy

The impact of these policies has not yet been fully demonstrated. However, it is safe to say that they have become an integral part of the UAE's environmental landscape and we have begun to reap the rewards of these policies. In 2013, the UAE President His Highness Sheikh Khalifa bin Zayed Al Nahyan, launched the Shams 1 Solar Power Station Project, the first concentrated solar energy project in the UAE that aims to generate 7 Percent of Abu Dhabi's renewable energy requirements by 2020. Furthermore, the first phase of the Sheikh Mohammed Bin Rashid Solar Energy Complex in Dubai was launched in October 2013 and the second phase in March 2017, which aim to contribute 7 Percent of Dubai's energy requirements by 2020, 25 Percent by 2025 and 75 Percent by 2050.

We have also established four nuclear power plants in Abu Dhabi with a capacity of 5.6 GW, which represents about 26 Percent of the energy mix in the emirate of Abu Dhabi. These plants will start producing energy in stages for peaceful purposes between 2017 and 2020.

Following these successes, we aim to continue developing our plans and nurturing our ambitions by increasing the share of clean energy in the national energy mix from 24 Percent to 27 Percent by 2021 and 50 Percent by 2050 as per the UAE Energy Strategy 2050, announced in January 2017.

## Green Economy

Since its launch in 2012, we have taken important steps to put the UAE's Green Development Strategy into action. In 2015, the Cabinet adopted the Implementation Mechanism of the National Strategy and Green Agenda (2015-2030) and launched national action programs that we have begun to implement towards transforming the UAE's national economy into a low-carbon green economy.

The green agenda is based on five key objectives, spread across 12 national programs and 31 sub-programs, designed to cover all key aspects of the UAE's transition to a green economy. It includes technology, human capital, regulatory and financial environment, international trade, intellectual property, consumer awareness and integrated national planning.

In recognition of its pioneering role in this field and the dissemination of green economy concepts on a global scale, the UAE announced at the end of 2016 the

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establishment of the World Green Economy Organization, with the support of the Government of Dubai and the United Nations Development Programme (UNDP). Furthermore, the government has announced the establishment of the Dubai Green Fund with a capital of AED 100 billion.

**Climate Change**

The policies I have referred to thus far are the key pillars of our efforts to mitigate climate change and achieve sustainable development. We are confident that the UAE National Climate Change Plan that we are currently in the process of finalizing will focus on broadening interest in green projects and practices in general and lead to innovative solutions to reduce emissions. It also aims to maintain economic growth and leverage clean energy applications in large energy-intensive industries such as power generation, desalination, carbon capture and storage technologies.

In 2015, we inaugurated our first renewable water desalination plant, and stepped-up our sustainability efforts by launching the first commercial carbon capture and storage project in 2016.

**Sustainability of environmental systems and resources**

Furthermore, the United Arab Emirates has strengthened its efforts to protect its environmental systems and resources and to develop environmental procedures and practices in various related areas, some of which are briefly explained below:

- Enhance air quality by developing more stringent controls and standards for activities affecting the quality of air, building a national air pollution monitoring network of 41 stations, developing monitoring tools that utilize modern technologies such as satellites and remotely monitor all activities that have a high impact on air quality. The UAE has also recently inaugurated the first central control

room that leverages networking and TV monitoring for facilities operating in the country's quarry fields.

- Strengthen national efforts to protect and develop biodiversity by expanding habitat rehabilitation and establishing more protected areas. Our stringent policy in this domain has led to an increase in the number of declared protected areas - from 19 in 2010 to 43 in 2016 - exceeding 14% of the country's total land bank that comes within the purview of protected areas. We have also enhanced our programs for the protection of endangered species and their proliferation and distribution across their natural habitats within and outside the UAE. We have achieved remarkable successes in this area, launching more than 1,750 falcons between 1995 and 2015, and over 200,000 Houbara Bustard birds as well as hundreds of Arabian oryx.

- Sustain the marine and coastal environment and their living resources, including protecting environmentally sensitive areas and enhancing their ability to adapt to the impacts of climate change, developing our capacity to monitor pollution incidents and changes in the marine environment, establishing more marine protected areas and synthetic armaments to provide suitable habitats for the protection and sustainability of marine life. We are truly privileged to maintain our first place ranking since 2012 in the Marine Protected Areas (EPI) Standard. We have successfully rehabilitated several coral reef areas and increased the area of mangrove forests under cultivation from nearly 8,800 hectares in 1990 to more than 13,600 hectares in 2013.

- Develop the fish farming industry and promote private sector investment to increase its contribution and bridge the gap between supply and demand. The Sheikh Khalifa Bin Zayed Al Nahyan Marine Research Center, launched in Umm Al Quwain in 2014, is an important achievement in the field of aquaculture and in the development of marine environment research. Seamlessly integrating modern laboratories and technologies on the one hand and innovative practices on the other, it boasts our production capacity to 10 million economic fish per year.

- Implement integrated waste management by focusing on reducing generated waste, expanding interest in the recycling industry - both quantitative and qualitative - including waste-to-energy conversion, improving waste collection and safe disposal of waste. The ongoing integrated waste management projects in Ajman, Umm Al Quwain, Ras Al Khaimah and Fujairah will boost our efforts to increase the proportion of treated waste to 75% by 2021 to meet the objectives of the UAE Vision 2021.

**Future Plans**

Today we are proud to highlight that our plans in the environment domain are founded on a rich heritage and experience spanning more than four decades - making us optimistic about the future and confident in our capacities to achieve our ultimate goals as a nation. These plans derive from our comprehensive national vision and ambitious objectives, including the UAE's Green Development Strategy 2014, the National Agenda of the UAE Vision 2021, the UAE Energy Strategy 2050, and the National Climate Change Plan that is already underway and factors in our commitments to international conventions as well as the United Nations Sustainable Development Goals 2015-2030.

To implement these plans, in addition to our extensive experience and national capabilities in the field of environmental protection and development, we rely on the favorable conditions provided by the national strategies in the field of education, innovation, foresight and smart government. We also rely on the concerted efforts of all national institutions working in the field of environment, the development of partnership initiatives with the private sector, the academic community and civil society organizations, as well as the awareness of the members of the community and their environmental consciousness.

The UAE has already paved the way for collective environmental consciousness by conceptualizing and implementing sustainable environment policies and establishing national councils and committees, including the UAE Council for Climate Change and Environment, the Environmental Business Council and the UAE Sustainability Research Committee. We look forward to a day in the near future when we achieve our zero-carbon goal and as a nation have a minimal environmental impact on our planet.

# ENVIRONMENTAL POLICY FRAMEWORK

Ibrahim Abdel Gelil

## I. INTRODUCTION

Many changes regarding environment policies in relation to development have taken place in the Arab region and globally since the Rio Earth Summit of 1992 on Environment and Development, the follow-up conferences in Johannesburg on Sustainable Development (2002), Rio de Janeiro in 2012, and finally the UN summit in New York in 2015. During the latter, the Sustainable Development Goals (SDGs) were adopted as the agenda for 2030. In parallel, the development of the regime of multilateral environmental agreements (MEAs) has been playing a major role in such changes.

Several reviews of the institutional arrangements for sustainable development in the Arab region have been coordinated, including during the preparatory processes for Rio+20 (Abdel Gelil, 2011). Rio+20 has highlighted the continued need to accelerate implementation of sustainable development and enhance the integration of its three dimensions – economic, social, and environmental – at all levels. The two themes for the conference were the institutional framework for sustainable development and the green economy in the context of sustainable development and poverty eradication. The outcome document for the conference, entitled "The Future We Want", includes several key outcomes relating to institutions for sustainable development including the establishment of a High-Level Political Forum (HLPF) for sustainable development to replace the Commission for Sustainable Development (CSD). At present, the HLPF for Sustainable Development is the central United Nations platform for political guidance and follow-up and review of the 2030 Agenda for Sustainable Development. The evolution of global governance for sustainable development has had significant implications at the regional as well as national levels.

### *A. The Regional Level*

Several regional institutions and organizations are working in the Arab region to help advance environmental and sustainable development agendas since the eighties. These include institutions that are part of the League of Arab States (LAS), the UN system, institutions created because of adopting regional conventions, and non-government organizations (NGOs).

The LAS provides the main institutional

BOX 1

## MAJOR REGIONAL ARAB NGOs

- The Arab Forum for Environment and Development (AFED) groups civil society, the business community, academia and media, together with government bodies as observers to promote prudent environmental policies and action based on science and awareness. AFED carries a policy program under its flagship annual report on the state of Arab environment, a corporate environmental responsibility (CER) program, alongside environmental awareness and education programs, with a wide-ranging presence on social media. It runs a comprehensive environmental information portal in Arabic (www.afedmag.com).
- The Arab Network for Environment and Development (RAED) is a network of NGOs focusing on the integration of environment and development. It opened the door to NGOs to attend the Council of Arab Ministers Responsible for the Environment meetings after obtaining observer status in the League of Arab States in 1995. RAED carries out various national and regional programs, mainly at the grassroots level.
- The Arab NGO Network for Development (ANND) is a regional network of NGOs working in ten Arab countries, advocating social and economic rights in the Arab region. It works in three main areas: development policies; social and economic reform agendas and the role of international and regional organizations; and economic and trade liberalization and its social and economic implications.

Sources: ESCWA and UNEP, Arab Sustainable Development Report, 2015, AFED, 2016.

framework for Arab country coordination and collaboration. It comprises the Economic and Social Council (ECOSOC), several ministerial councils, and a range of other regional specialized organizations. The Council of Arab Ministers Responsible for Environment (CAMRE) was established in 1987 to provide the first Arab political forum for addressing environmental issues in the Arab region. The establishment of two additional institutional supporting bodies followed this:

- The regional joint secretariat developed in 2004, which comprises the technical secretariat of CAMRE, the technical secretariat of the Arab ECOSOC, UNEP and ESCWA.
- The Joint Committee for Environment and Development in the Arab Region (JCEDAR), which was established as an inter-ministerial advisory committee to CAMRE with regional institutions serving as advisors. JCEDAR comprises the heads of the national environmental affairs agencies, NGOs, private sector bodies and regional organizations (Abdel Gelil, 2011) .

Additional institutions have been established under the auspices of LAS at the regional level to address priority sustainable development issues, including the Arab Water Council (AWC), the Arab Organization for Agricultural Development (AOAD), and the Committee for Renewable Energy and Energy Efficiency under the Arab Ministerial Council for Electricity (AMCE). Additionally, for the last two decades, multi-lateral environmental agreements (MEAs) have catalyzed regional coordination on common global environmental concerns.

However, CAMRE and JCEDAR's limited memberships and the focus of their mandates on environmental affairs have prevented them from becoming effective institutional mechanisms for developing regional policies on sustainable development. As such, there have been key gaps in implementation and a lack of integration of the three dimensions of sustainable development in the major work programs of LAS. This significant gap in developing a fully integrated approach to environmental, social and economic policy-making represents a major challenge for the Arab region. However, this gap was recently addressed by the establishment of a new department within the LAS's institutional structure entitled "Department of Sustainable Development and International Cooperation". The new department was established pursuant to the Arab Summit Resolution No. 26 in March

2015. Its aim is supporting Arab countries in areas of sustainable development, as well as developing a unified Arab vision for the implementation of the SDGs, in addition to an Arab plan for sustainable development and monitoring of its implementation. Furthermore, the LAS has adopted the establishment of an Arab committee on sustainable development, which comprises the Arab national focal points concerned with monitoring the realization of the SDGs. This committee is currently working on revisiting the Arab Strategic Framework for Sustainable Development (ASFSD) to become potential guidelines to support the achievements of the SDGs in the Arab countries (LAS, 2017).

The UN organizations have also had an important role in facilitating the implementation of sustainable development in the region. ESCWA and UNEP (with LAS) form the Technical Secretariat to support the work of JCEDAR. ESCWA, UNEP and their regional partners have led the coordination of regional implementation meetings as part of the preparatory processes for Rio+20 and the UN summit (2015).

ESCWA has established a Regional Coordination Mechanism (RCM) to support regional coordination and coherence of the UN's activities. The RCM includes several thematic working groups relevant to sustainable development, including on climate change, food security and MDGs. Regarding the MDGs, UNDP has played a lead role in implementing country programs against the various goals and targets.

In accordance with General Assembly Resolution 70/1 of 15 September 2015 entitled "Transforming our world: the 2030 Agenda for Sustainable Development", ESCWA, in its twenty-eighth session in Tunisia, adopted Resolution 314 (XXVIII) on the Arab Forum on Sustainable Development (AFSD). It is a high-level regional platform for dialogue and coordination of mechanisms for the implementation, follow-up and review of the 2030 Agenda for Sustainable Development in the Arab region. The forum, which will meet annually, is intended as a primary regional platform for cohesive and coordinated implementation of the 2030 Agenda in the Arab region. It will serve as a participatory consultative dialogue engaging government officials, civil society, academics and international organizations on the implementation of the 2030 Agenda. Its multi-stakeholder engagement distinguishes it from other formal regional institutions, which are primarily intergovernmental. The forum held meetings in 2014, 2015, and 2016, and in May 2017. The findings and recommendations, conveying key messages from the region, will be submitted to and presented at the HLPF.

Non-governmental organizations (NGOs) have been also playing a relatively active role in promoting environment and sustainable development issues. Examples of such organizations with strong regional and international presence are exhibited in Box 1.

In terms of regional sustainable development strategies, the League of Arab States, based on the Ministerial Declaration on Sustainable Development issued in Cairo on 25 October 2001, adopted a comprehensive regional approach that aims to develop a regional program for sustainable development and was entitled the Sustainable Development Initiative in the Arab Region (SDIAR). The SDIAR aims to address the challenges faced by Arab countries to achieve sustainable development and it asserts the commitment of those countries to implement Agenda 21, the Millennium Declaration and the outcome of the World Summit on Sustainable Development (WSSD). It provides an important framework for the implementation of programs and activities (using available resources) in Arab countries, relevant Arab regional and international organizations, and in Arab regional and international financial institutions (Abdel Gelil, 2011).

An Action Plan for the implementation of the SDIAR was developed by CAMRE and calls for cooperation with all partners, governments, specialized Arab organizations, regional and international organizations, the private sector, academia, and relevant civil society organizations. The Action Plan established a joint secretariat comprising the technical secretariat of CAMRE, the secretariat of ECOSOC, UNEP and ESCWA which oversees the coordination and implementation of the Action Plan. Implementation is followed up within the framework of JCEDAR and CAMRE and reports on implementation are submitted to the Arab Summit through ECOSOC on a periodic basis

(three progress reports have been completed in 2008, 2009 and 2011).

The SDIAR and its Action Plan, while they have provided an important regional framework for progressing sustainable development in the Arab region, have been criticized for having no measurable goals or indicators, no clear time frame, no clear allocation of responsibilities, and no additional funding for implementation.

In addition to the SDIAR, a range of other regional strategies have been developed under the auspices of CAMRE, other ministerial councils, and other regional organizations, to address priority issues. These include the Strategy for Water Security in the Arab Region, the Sustainable Agricultural Development Strategy for the Next Two Decades, the Arab Framework of Action on Climate Change, the Arab Regional Strategy for Sustainable Consumption and Production, and the Arab Strategy for the Development of Renewable Energies, and others. It is to be noted that the progress of implementation of those strategies have never been made publically available.

During preparations for Rio+20, the Arab Ministerial Declaration on Rio+20 reaffirmed political commitment to achieve sustainable development in the Arab region and reiterated commitment to continue the implementation of the SDIAR to build on the progress made in its implementation, face current challenges, fill the gaps and update it when needed. That update was envisioned to be undertaken considering the emerging and new challenges that the Arab region is facing including the risks of climate change, the global financial crisis and its impacts, and the repercussions of political developments in the Arab region. Thus, responding to those regional and global development challenges, the League of Arab States decided to update the SDIAR to address key ongoing and emerging challenges as well as opportunities and priorities for sustainable development in the region across the economic, social and environmental dimensions. An updated SDIAR, the Arab Strategic Framework for Sustainable Development (ASFSD), aims at addressing the key challenges faced by the Arab countries in achieving sustainable development during the period 2015-2025 (ESCWA; UNEP; LAS, 2014). This framework is currently being updated by the new department at LAS.

Three main observations are worth noting – first is that Arab countries rely heavily on command and control strategies rather than market-based instruments. As an illustration, for the last four decades, energy and water policies in the region have mostly focused on supply strategies aimed at overcoming shortages through technical solutions including building power and desalination plants. This supply-focused approach has resulted in good progress towards meeting some MDG's energy and water targets, particularly in urban areas. However, the ongoing prevalence of unsustainable consumption and demand patterns

encouraged by distorted energy and water pricing have resulted in depletion of natural resources and widespread environmental deterioration. Thus, there is an urgent need for using additional policy instruments such as incentives, monitoring mechanisms, environmental assessment tools, environmental education and public awareness strategies.

The second observation is the lack of mainstreaming environmental considerations into sectoral strategies such as energy, industry, agriculture, and others to ensure greater synergy in both existing and new policies. Greater involvement of all stakeholders is needed to make governance work and to ensure that environmental considerations are incorporated into the development of economic, social and cultural policies. This would avoid potential sectoral conflicts, overlapped institutional mandates and conflicting regulations, and ultimately lead to efficient use of natural and financial resources. The recent recognition of the importance of adopting and promoting the water-energy-food nexus approach is a positive step forward to ensure the policy coherence of managing these three vital resources.

The third observation is the lack of policy monitoring and evaluation. This situation is almost prevailing in the region both at the regional and at the national levels. The experience of implementing and monitoring regional sustainable development strategies has proven to be ineffective. Neither the SDIAR nor the ASFSD nor any other regional strategies or declarations have significantly reported in order to influence national efforts to achieve sustainable development. This is due to many weaknesses, especially the lack of political commitment and failures of the institutional structure, specifically in monitoring and evaluation, which makes it difficult to judge with any level of certainty whether policies are successful in meeting their intended aims. It seems in many cases, that many regional declarations and strategies lack political commitments so that the absence of policy evaluation reduces the accountability of decision makers and limits environmental advocacy from civil society, which would eventually compromise environmental management. As emphasized before by AFED (2016), it is time to move from political declarations and rhetoric to implementation on the ground. To achieve the SDGs, as reported by the first Arab sustainable development report: "The time has come to build an effective regional institutional framework for sustainable development that addresses past challenges and weaknesses experienced with the MDGs" (ESCWA and UNEP, 2015).

## *B. The National Level*

As noted in the 2008 AFED report, a significant increase in the environmental awareness in most of the Arab countries was stimulated by the 1992 Rio conference, including the establishment or restructuring of environmental agencies, the adoption of national environmental strategies and action plans, the ratification of multilateral and regional environmental agreements and the enactment of many environmental laws and regulations. The scope and mandate of environmental agencies had gradually expanded to include many issues that are historically put under the jurisdictions of line ministries and municipalities such as water quality, environmental health, solid waste management, industrial pollution, public awareness and many other similar issues. This, in many instances, expanded the administrative burdens of the environmental agencies, created many overlaps in responsibilities of government institutions, and led to a lack of coherence in policy formulation. Further, the difficult task of coordination between government agencies on those issues was mandated to the environmental agencies, which have been unable to execute due to many reasons. These reasons include lack of resources and expertise, a power struggle between older and politically strong ministries and the environmental agencies, complexities of the environmental problems, and lack of awareness on the importance of mainstreaming environmental considerations in development policies, strategies, and programs (Abdel Gelil, 2012).

While the scope of issues included in sustainable development has widened, especially after the Johannesburg conference, the mandate of environmental institutions in the Arab region has remained generally constant. Thus, the current institutional framework is ill-equipped to address the expanded multi-sectoral scope of sustainable development issues. Environmental institutions do not have the mandate to address cross-

sectoral issues such as poverty, trade, education and shared resources. This institutional legacy is the principle challenge to effective governance for sustainable development in the Arab region (Abdel Gelil, 2011)

While environmental institutions have been progressively strengthened in many Arab countries, resulting in some improvements in environmental management, they still have limited ability to fully address all the three dimensions of sustainable development. The main limitations identified by a stakeholder survey conducted by ESCWA (2013) included "lack of comprehensive national planning, limited engagement of stakeholders, lack of technical capacity, poor coordination, lack of follow-up and limited transparency". The results of the same stakeholder survey indicate that "in most Arab countries, responsibilities for sustainable development are spread across a wide range of ministries, including environment, planning, health, water resources, energy, agriculture, fishery, forests and tourism" (p.33). The lead role most commonly rests with ministries of environment or planning. Institutional arrangements for horizontal coordination between government authorities were weak in most countries and non-existent in some. In some Arab countries, civil society organizations are active on issues of sustainable development such as poverty eradication, health, education and public awareness. In most cases, however, policy mechanisms for civil society involvement in decision-making were weak.

Most Arab states are still seeking to develop institutional frameworks for preparing and adopting national sustainable development plans that are nationally owned to ensure inclusiveness and integration, and are linked to national planning mechanisms and structures. Several Arab countries created some form of National Councils for Sustainable Development, but these remained ad hoc in nature. Most of them had either ceased to exist or had little influence. Morocco was pioneering in establishing an economic, social and environmental council, with representatives from the public and private sectors, NGOs and academic institutions (Moroco, 2017).

In response to the challenges, some Arab governments have begun adopting new approaches to enhance integration. For example,

in the post-Rio+20 context, Tunisia has taken a lead by preparing a national roadmap for post-Rio+20 follow-up. Green economy has also become a focus of national efforts for sustainable development in some Arab countries. The UAE Green Growth Strategy was launched in January 2012 under the slogan "A Green Economy for Sustainable Development". Jordan was the first country in the region to conduct a national green economy scoping study with the assistance of UNEP in 2011, which led to the adoption of the National Green Growth Plan (NGGP) in 2016. Similarly, Morocco has begun work on a national green growth plan with the assistance of the Global Green Growth Institute (GGGI) and the UAE (see Box 2).

With regards to follow-up of the implementation of the SDGs, Arab states recognize the importance of strengthening the capacities of statistics organizations and improving the comprehensiveness and quality of data, as well as the methods for the collection and dissemination thereof. Two Arab states, Egypt and Morocco, have offered to be part of the first group of states to submit voluntary national follow-up reports to the high-level political forum for 2016 (UN Economic and Social Council, 2016). Qatar and Jordan are planning to do the same for the 2017 HLPF.

## II. EVOLUTION OF ENERGY AND ENVIRONMENTAL POLICIES

During the past decade, Arab countries have been pursuing policy developments aimed at

BOX 2

**EXAMPLES OF RECENT NATIONAL DEVELOPMENT STRATEGIES IN THE ARAB REGION**

- Tunisia's sustainable development strategy was adopted in 2014
- Qatar's National Vision 2030 (2009) and National Development Strategy 2011-2016
- Saudi Arabia's Vision 2030 and National Transformation Program 2020
- The United Arab Emirates' National Agenda Vision 21; National Green Growth Strategy; and Abu Dhabi Economic Vision 2030
- Jordan's National Vision 2025, and National Green Growth Plan (NGGP) in 2016
- Lebanon's National Sustainable Development Strategy (in preparation)
- Bahrain's Vision 2030
- Development Strategy of the New Tunisia (2012); National Sustainable Development Strategy 2016-2020 (2014)
- Iraq's National Development Plan 2010-2014 (2010)
- Egypt's Vision 2030
- Algeria's National Strategy for the Fight against Poverty (2005-2015) and Five-Year Plan (2010-2014)
- The Sudan's Interim Poverty Reduction Strategy Paper (2012)
- Djibouti's Poverty Reduction Strategy Paper (2009)
- Morocco's National Sustainable Development Strategy (2015)

Source: modified from (ESCAW and UNEP, 2015) by the author

achieving sustainable management of natural resources, especially water, energy, and land resources. This section will focus on major energy and environment policy developments that would have far-reaching impacts on improving environmental quality in the region.

### *A. Energy Pricing Policies*

In the Arab countries, universal subsidies have for many years been part of the "social contract" and are still common in some countries. Advocates of subsidies insist that energy prices must be kept low to tackle poverty, promote economic development and, in the case of oil-rich countries, to share national wealth amongst their citizens. However, energy subsidies promote wasteful consumption behaviors, encourage energy-intensive activities such as petrochemicals, discourage investment in sustainable energy options, and support smuggling and black market activity, which can lead to shortages of subsidized products.

Though subsidies may reach the poor and vulnerable to some extent, they benefit mostly the better off, who consume more subsidized fuels and electricity. For example, in Egypt in 2008, the poorest 40 percent of the population received only 3 percent of gasoline subsidies (IMF, 2014). Lower income households in Saudi Arabia (about 40 percent of the population) benefit from only around 30 percent of energy subsidies (Saudi Arabia, 2016).

In 2012, preliminary IMF estimates showed that pretax subsidies for diesel and gasoline, which represent about half of the total energy subsidies in the MENA region[1], were 3.8 percent of regional GDP. In 2013/14 energy subsidies in Egypt amounted to about USD 21 billion or 8.5 percent of the GDP (Griffin, Robertson, & Laursen, 2016). The World Bank estimated the fossil fuel subsidy for power generation in Saudi Arabia to equal nearly 14 percent of the government's revenues in 2013/14 (World Bank, 2016).

The issue of energy price reform has always been affected by the political situation in the Arab region. Energy subsidies, widely perceived as having fundamental economic and social benefits, have placed huge pressure on governments' finances, undermining their financial sustainability. Because of these pressures, subsidy reform has recently gained new momentum in the region. Since 2011, several Arab countries have taken steps to reform energy prices. Table 1

summarizes these initiatives. Price reforms were initiated earlier by oil-importing countries such as Jordan and Morocco, while they were introduced more recently by the oil-rich GCC countries under fiscal pressures due to oil price declines.

It is to be noted that countries have taken different approaches in reforming energy subsidies. Some countries such as Egypt, and Saudi Arabia undertook several price reforms on an ad-hoc basis. However, both have recently announced price reform programs to phase out subsidies. Egypt announced a plan to phase out electricity subsidies but had to change the announced program due to recent currency devaluation. Saudi Arabia announced a program to link energy prices to international benchmarks by 2020, as part of its Fiscal Balance Program (Saudi Arabia, 2016). The prices in these two countries were raised based on a political decision by governments at a time that was determined solely by governments. Other countries, such as the UAE, Qatar, and Oman have recently depoliticized the energy pricing reform by applying automatic adjustment mechanisms using pricing formulae that are linked to the international market prices. This would transfer the changes in the international market prices directly to the domestic consumers, without any governments' interventions.

A remarkable development is the recent price reforms in the GCC. Given the increasing economic pressures due to decline of oil prices, it was also an opportune time for those countries to undertake the long-awaited energy prices reform. Though the current prices of the GCC are still the lowest in the region and globally (see Figure 1), these price reforms are significant for global agendas, as the GCC countries are influential in international forums on issues related to energy and sustainability. For example, Saudi Arabia's role in the G20 (in which price reforms remain an issue), and its role in the international climate-change negotiations and various UN forums. At the same time, GCC countries set an example as donors and investors in developing countries and serve as models for other petroleum-exporting states, especially through their role in OPEC. Another observation from Figure 1 reveals a sharp decrease of gasoline prices in Egypt in 2016, though nominal prices were increased. This is due to recent currency devaluation as part of the economic reform program.

A third remark is that three Arab countries (Egypt, Morocco, and UAE) have included energy price reform as climate mitigation policies in their first Intended Nationally Determined Contributions (IISD, GSI, GIZ, 2015). Lastly, energy price reforms could free up hundreds of billions of dollars for implementing multiple SDGs. The SDGs call to "rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions" (Target 12.c) (Gerasimchuk, 2017).

### *B. Policies of Energy Efficiency*

The Arab region has been characterized as one of the least energy efficient regions globally. The League of Arab States has initiated an effort to promote and harmonize energy efficiency initiatives in the Arab region through a standardized format for national energy efficiency actions plans (NEEAP). The Arab Ministerial Council for Electricity adopted a guideline entitled the "Arab Guideline for Improving Electricity Efficiency and Rationalize its Consumption at the End User" during the twenty-sixth meeting of its executive bureau in 2010. Only a few countries have developed their NEEAP (Tunisia, Egypt, Jordan, Bahrain, and Palestine), while other countries have developed similar energy efficiency strategies or plans such as Saudi Arabia, Qatar, and the UAE.

The Regional Center for Renewable Energy and Energy Efficiency (RCREEE) has developed the Arab Future Energy Index (AFEX), which is the first native Arab index dedicated to monitoring and analyzing sustainable energy competitiveness in the Arab region. AFEX offers both quantitative and qualitative analysis for key energy efficiency market dimensions. Countries are ranked under 30 indicators that illustrate key energy market aspects including policies, institutional and technical capacities, strategies, socioeconomic data and investments (RCREEE, 2015). In 2015, 17 Arab countries were evaluated and ranked as per the specified indicators. The overall ranking is shown in Table 2.

Similarly, the World Bank has developed a global scorecard with an exhaustive set of indicators that rank national policy and regulatory frameworks for sustainable energy. The Regulatory Indicators for Sustainable Energy (RISE) offer

TABLE 1 **ENERGY PRICE REFORMS IN THE ARAB COUNTRIES**

| Country | Year | Reform Measures |
|---|---|---|
| **Egypt** | 2012 | Gasoline, diesel, and liquefied petroleum gas prices increased by 47 percent, 23 percent, and 15 percent, respectively; jet fuel liberalized. |
| | 2013 | Diesel prices increased by 74.7 percent, gasoline by 68.0 percent, and liquefied petroleum gas by 66.7 percent. |
| | 2014[2] | Gasoline prices increased by 35-67 percent, diesel prices increased by 55 percent, fuel oil prices increased by 23-33 percent, and natural gas prices increased by 11-122 percent. |
| **Jordan** | 2012 | Electricity tariffs increased for selected sectors (banks, telecommunications, hotels, mining) and large domestic corporations and households; fuel subsidies were eliminated. |
| | 2013 | Monthly fuel price adjustment mechanism resumed. |
| | 2014 | Electricity tariffs increased by 7.5–15 percent for selected consumers |
| **Mauritania** | 2012 | New automatic diesel price formula introduced, bringing domestic fuel prices up to international levels. electricity tariffs increased for the service sector. |
| **Morocco** | 2012 | Diesel prices increased by 14 percent, gasoline by 20 percent, and industrial fuel by 27 percent. |
| | 2013 | Implementation of a partial indexation mechanism for certain petroleum products. Thus, diesel prices increased by 8.5 percent, gasoline by 4.8 percent, and fuel by 14.2 percent. |
| | 2014 | Gasoline and industrial fuel subsidies eliminated, their prices are reviewed twice a month. The per-unit subsidy on diesel was reduced, with additional quarterly reductions announced for the remainder of 2014. |
| **Sudan** | 2012 | Gasoline, diesel, and liquefied petroleum gas prices increased by 47 percent, 23 percent, and 15 percent, respectively; jet fuel liberalized. |
| | 2013 | Diesel prices increased by 74.7 percent, gasoline by 68.0 percent, and liquefied petroleum gas by 66.7 percent. |
| **Tunisia** | 2012 | Gasoline and diesel prices and electricity tariffs increased by 7 percent, on average. March 2013: further 7-8 percent price increase, on average, for the same products. |
| | 2014 | Energy subsidies to cement companies reduced by half by increasing electricity tariff by 47 percent and natural gas price by 35 percent, with a view to fully eliminate these subsidies by June 2014. Electricity tariff and natural gas prices increased for medium- and low-voltage consumers with a10 percent rate hike in January 2014 and another 10 percent in May 2014. An automatic gasoline price formula was adopted. |
| **Yemen** | 2011-2012 | Gasoline prices increased by 66 percent and diesel and kerosene prices doubled. |
| | 2013 | Diesel price unified across users, including the electricity sector. |
| **UAE** | 2015 | Fully liberalized gasoline and diesel prices, introducing a pricing mechanism where domestic prices are set monthly and are directly linked to international prices. |
| **Oman** | 2015 | Doubled domestic gas price in January 2015 from USD 1.5/mm Btu to USD 3 /mm Btu. |
| | 2016 | Increased the price of premium gasoline from USD 0.31/liter to USD 0.42/liter and prices for diesel were raised from USD 0.38/liter to USD 0.42/liter. The prices of these fuels will be set based on a pricing formula that would consider international levels as well as levels in neighboring UAE. |
| **Bahrain** | 2015 | Bahrain raised its gas prices from USD 2.25/mm Btu to USD 2.5/mm Btu. The government has set in place a process whereby the price is increased by 25 cents on April 1 each year until it reaches USD 4/mm Btu by April 1, 2022. |
| | 2016 | Raised the price of super gasoline from USD 0.27/liter to USD 0.42/liter and confirmed the implementation of its four-year plan to increase the cost of diesel by 5 cents/liter each January to USD 0.32/liter |

TABLE 1(Contd.) **ENERGY PRICE REFORMS IN THE ARAB COUNTRIES**

| Country | Year | Reform Measures |
|---|---|---|
| **KSA** | 2016 | Premium gasoline prices were raised by 50 percent to USD 0.24/liter, while diesel for commercial transport was raised to USD 0.12/liter. Raising the gas for power generation from USD 0.75/mm Btu to USD 1.25/mm Btu.<br>Increased residential electricity tariffs from SAR0.12/kWh ($0.03/kWh) on average to around SAR0.20/kWh (USD 0.053/KWh) for consumption levels between 4,000 kWh and 6,000 kWh per month and unified prices at SAR 0.30/kWh (USD 0.08/KWh) for consumption levels above 6,000 KWh per month. |
| **Qatar** | 2011 | Increased the price of gasoline and diesel by as much as 25 percent. |
| | 2015 | Increased the price of gasoline (super 97 Octane) by 30 percent from USD 0.27/liter to USD 0.36/liter. |
| | 2016 | Petrol and diesel prices would be liberalized from May onwards, with frequent adjustments each month thereafter, based on global and regional factors, and costs linked to fuel production and distribution. |
| **Kuwait** | 2016 | Kuwait raised the prices of both gasoline and diesel to 0.34 and 0.23 USD/liter respectively. A government committee would revise the new prices every three months depending on the international oil prices. |

Source: IMF, 2014; Griffin, Robertson; & Laursen, 2016

a critical, objective overview of the sustainable energy framework in countries. RISE reports on 27 indicators and 80 sub-indicators to capture the quality of policies and regulations for energy access, renewable energy and energy efficiency. In 2016, 12 Arab countries were included in the evaluation of 111 countries globally. Table 2 exhibits the ranking of selected Arab countries according to the two methodologies of RCREEE and the World Bank. Tunisia, the UAE, and Jordan stand as best performers in the two scales.

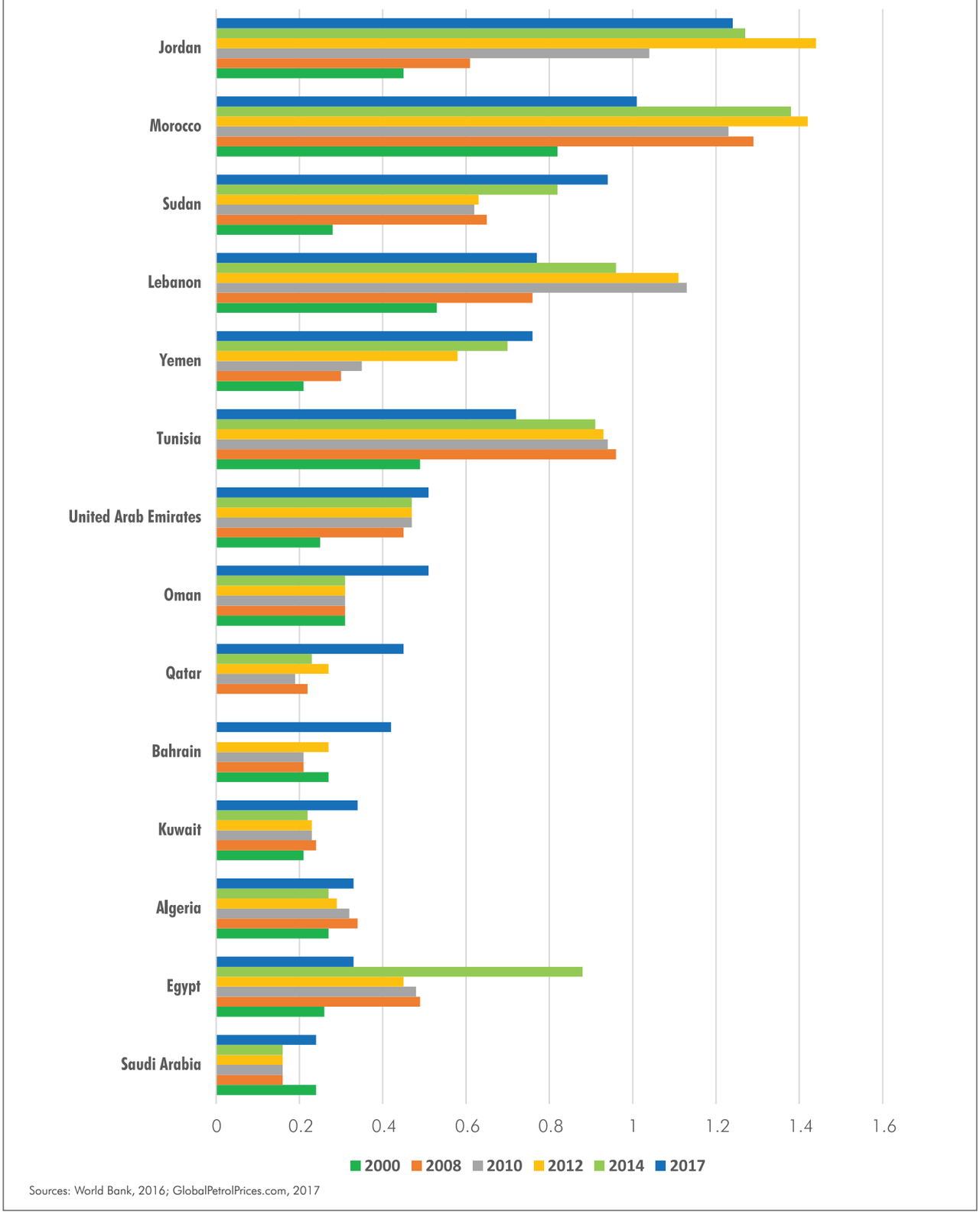
In addition to reforming energy subsidies, examples of energy efficiency (EE) policies that have been adopted in the Arab region include announced EE targets, implementation of EE action plans/ strategies, provide fiscal incentives, enforcing Minimum Energy Efficiency Performances Standards (MEPS), energy efficiency labels for appliances and vehicles, developing green building codes, and others. A commendable achievement of Saudi Arabia is the issuance of the first fuel economy standard in the Arab region. KSA has also issued a requirement for vehicle fuel efficiency labels to be prominently displayed on all new vehicles, backed up by a rigorous program of monitoring and enforcement (SEEC, 2014).

## *C. Policies to Improve Air Quality*

Generally, the energy sector would have the highest pollution loads to the environment. Development of energy policies in the region has positive impacts on improving environmental quality. Transport fuels (gasoline and diesel) emit large quantities of pollutants (CO, HC, NOx, PM, $CO_2$, SOx) and toxic substances such as non-methane volatile compounds (NMVC)). These pollutants contribute to the serious air pollution and health problems increasingly common in the urban centers of the Arab countries – exposure to fine particulate matter in urban areas of Egypt, GCC countries, and Mashreq countries, and Tunisia are substantially above global average levels (CEDARE, 2015). According to the WHO data of particulate air pollution, some cities in the GCC such as Riyadh in Saudi Arabia are listed amongst the 20 most polluted cities in the world (WHO, 2016). Doha is the only Arab city to rank inside the top 20 for $PM_{2.5}$ particles (Doha News, 2014).

A set of energy policies has positively contributed to improving air quality in the region. Phasing out lead from gasoline has contributed to reducing the concentration of lead in the ambient air. Only Yemen, Iraq and Algeria are now partially selling leaded gasoline in the domestic market.

FIGURE 1 **EVOLUTION OF GASOLINE PRICES IN SELECTED ARAB COUNTRIES**




Sources: World Bank, 2016; GlobalPetrolPrices.com, 2017

Production of low-sulfur diesel in Kuwait, Bahrain, and other countries has reduced the emission of sulfur dioxides from vehicles, power stations, desalination facilities, and industrial plants. Figure 2 shows the developments of complying with EU sulfur contents in diesel in selected Arab countries. It also reveals that several Arab countries are aiming at complying with Euro 5 by 2018.

Additionally, improving energy efficiency and upscaling renewable energy in the region have contributed to improving urban air quality as well as curbing carbon emissions to the atmosphere. Lack of empirical research on the impacts of energy policies on environmental quality in the region makes it difficult to assess such impacts with a reasonable degree of accuracy.

TABLE 2 **RANKING OF EE INITIATIVES IN SELECTED ARAB COUNTRIES**

| Country | RCREEE EE Index (2015) | World Bank (SE4ALL) EE Score (2016) |
|---|---|---|
| Tunisia | 66 | 68 |
| Jordan | 58 | 55 |
| Morocco | 55 | 42 |
| Palestine | 55 | N/A |
| UAE | 55 | 63 |
| Qatar | 42 | 50 |
| Algeria | 41 | 55 |
| Lebanon | 39 | 35 |
| Egypt | 38 | 48 |
| Bahrain | 36 | 27 |
| Saudi Arabia | 33 | 50 |
| Syria | 31 | N/A |
| Sudan | 30 | 19 |
| Kuwait | 26 | 30 |
| Yemen | 25 | 13 |
| Libya | 18 | N/A |
| Iraq | 18 | N/A |

Sources: RCREEE, 2015 and World Bank, 2016.

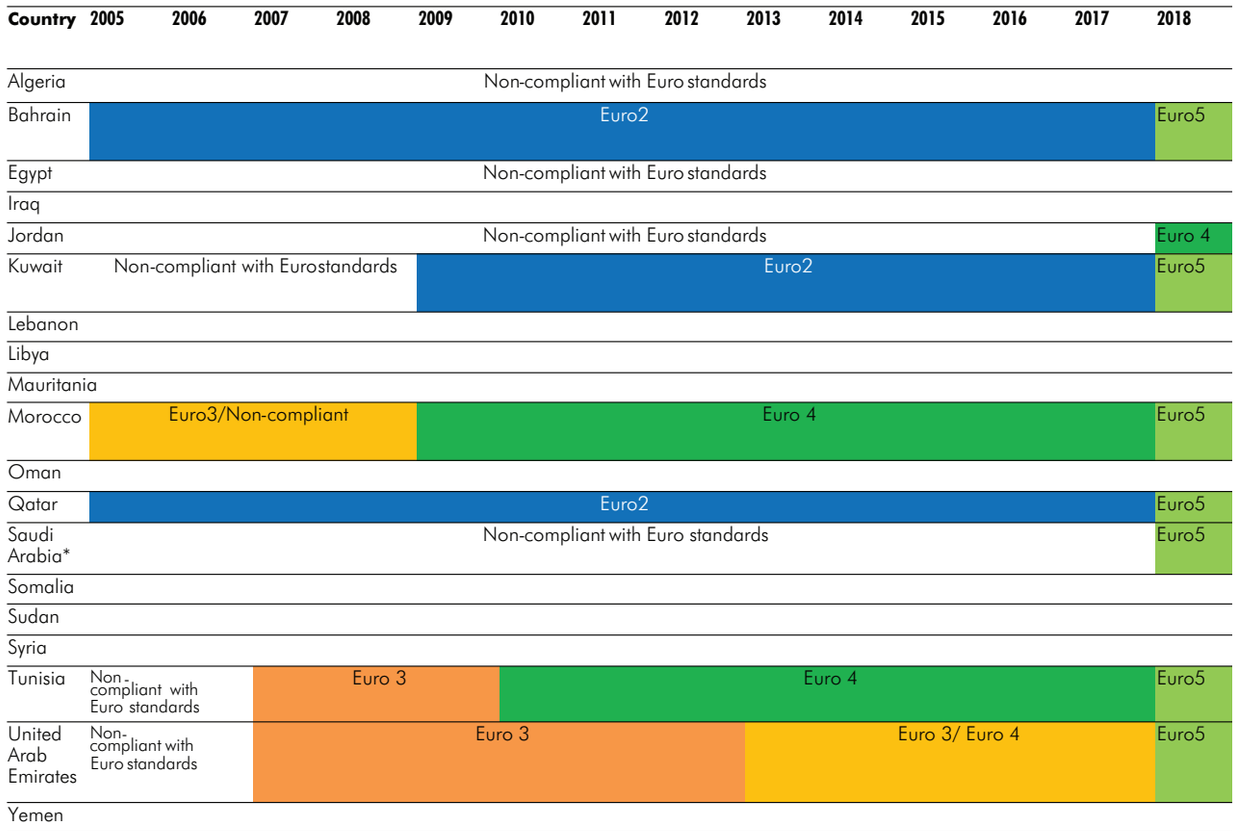
## *D. Policies of Water Resources*

The Arab region, characterized by severe water scarcity, has strived to pursue integrated water resources management to secure water supply, while reducing water demand and improving water quality in a changing climate. In 2010, the Arab Ministerial Water Council (AMWC) launched for the first time the "Arab Water Security Strategy 2010-2030". The strategy is developed to meet future water challenges for achieving sustainable development in the Arab world. At the sub-regional level, in 2016, the GCC countries launched their "GCC Unified Water Strategy and Implementation Plan 2016-2035". The strategy vision is to "establish a sustainable, efficient, equitable, and secure water resources management systems in every GCC country that would continue to contribute to their sustainable socio-economic development". However, heavy subsidies of water services have prevailed in the region for decades and have led to water inefficiency, overuse, and environmental degradation. While water pricing has been advocated for a long time, it is seldom enacted, except for some recent developments in water pricing announced by Saudi Arabia, the UAE, Bahrain, and Egypt.

According to the UNDP water governance report in the Arab Region, "water reforms are progressing unevenly. Some countries, such as Bahrain, Djibouti, Egypt, Jordan, Lebanon, Libya, the State of Palestine, Saudi Arabia, Syria, Tunisia and Yemen have national water policies, plans or strategies that incorporate many elements of IWRM" (p.55). But improved water management policies are not fully reaching their intended goals in most countries. The region's ineffective and fragmented water management structures have also affected water decisionmaking, and weak regulatory frameworks and enforcement have led to the degradation of water resources, public health risks and poor service coverage and delivery (UNDP, 2013).

Due to water scarcity, Arab countries face serious challenges in managing their variable water resources. Gulf countries, with rich hydrocarbon endowments, have adapted by relying on fossil-based desalination, with all its adverse environmental impacts. Egypt, Iraq and Syria have hastened to develop renewable, mostly transnational, water resources. Countries with limited renewable water resources and weak financial capability, such as Jordan, have pursued water reuse, water harvesting and demand management initiatives.

FIGURE 2 **FUEL STANDARDS IN THE ARAB REGION**




*There are announced plans for switching to Euro 5 standards by 2016. The study team has put back the date to 2018 in order to account for contingencies.

Source: CEDARE, 2015

## *E. Policies of Food Security*

Some of the most profound and direct impacts of climate change over the next few decades will be on agriculture and food systems. Quantitative assessments show that climate change will tremendously affect agriculture worldwide. Among the more drastic threats to food security in the Arab countries are increasing temperatures, declining and more unpredictable rainfall, more frequent extreme weather and a higher severity of pests and diseases. A particularly pressing concern for much of the Arab world is the high degree of aridity, water scarcity and the associated increased vulnerability of lands and water to climate change. As the productive capacities of the Arab agricultural lands are compromised by land degradation and as populations increase and economic growth cause per capita consumption rates to rise, the gap between production and consumption of food increases, and dependence on the importation of food grows.

To achieve food security, efforts in many Arab countries have been directed towards sustainable agricultural practices. This has included promoting efficiency in the use of water and energy and the use of renewable sources of both. With about 85 percent of the water used in the Arab region consumed by the agricultural sector, the sector in which water losses are the highest, most Arab efforts are focused on improving water efficiency in agriculture. These include improving irrigation efficiency, managing irrigation water demand, and adopting water-saving technologies and crops. Further, the biggest impact of climate change in the Arab region will be on its threat to food security, due

to the projected decrease in the available water resources and agricultural production. Some Arab countries have appropriately responded to the potential negative impacts of climate change by considering these potential impacts in their water resources planning and integrating the appropriate adaptation measures in their water programs.

Since the Arab world is the highest food-deficit and the highest food-importing region globally, and after the food crisis in 2008, many Arab countries put agriculture and food security on top of their national policy agenda. Further, the Arab Economic Summit in 2011 adopted the Kuwait Declaration, which underlines the importance of raising Arab living standards in three major areas, including food security. In line with that declaration, several GCC countries made considerable foreign investment in Sub-Saharan Africa and Central Asian countries to contribute to their national food security.

Table 3 exhibits policy options pursued by several Arab countries to respond to the 2008 food price shock. Those options are a combination of trade policies, wage increases, and safety-net programs. Many countries in the region rely heavily on food subsidies as the primary safety net, including Egypt, Jordan, Syria, and Morocco, among others. According to IFAD, Morocco maintained price controls on wheat and bread and reduced taxes on food grains. Egypt banned rice exports. Syria imposed export restrictions and reduced taxes on food grains. Djibouti eliminated consumption taxes on several food staples and provided limited food assistance to rural families through donor support. Tunisia reduced taxes on wheat, and Jordan maintained bread subsidies (WB, FAO, IFAD, 2014).

The AFED report in 2014 called to "strengthen regional cooperation among Arab countries, based on comparative advantage in agricultural and investable capital resources, coupled with coordination and harmonization of agricultural development strategies and programs" (p.11).

## *F. The Water-Energy-Food Nexus*

Adopting a nexus water, food, and energy approach is increasingly being considered in Arab countries to enhance synergies and complementarities between water, food, and energy policies. The resource scarcity challenges and other emerging development issues were well recognized in the Arab Strategic Framework for Sustainable Development (ASFSD) adopted by

TABLE 3 **POLICIES ADOPTED BY ARAB COUNTRIES TO RESPOND TO FOOD PRICE SHOCK**

| | Economy-wide policies | | | | Existing social protection programs | | | |
|---|---|---|---|---|---|---|---|---|
| **Country** | **Reduce taxes on foodgrains** | **Increase supply using foodgrain stocks** | **Export restrictions** | **Price controls/ Consumer subsidies** | **Cash transfer** | **Food for work** | **Food ration/ stamp** | **School feeding** |
| Egypt | | | ✓ | ✓ | ✓ | | ✓ | |
| Morocco | ✓ | ✓ | | ✓ | | | | ✓ |
| Tunisia | ✓ | ✓ | | ✓ | ✓ | | | |
| Yemen | | ✓ | ✓ | ✓ | ✓ | | | |
| Lebanon | ✓ | | | ✓ | | | | ✓ |
| Syria | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ |
| Jordan | ✓ | | | ✓ | ✓ | | | ✓ |
| Palestine | ✓ | | | | ✓ | | ✓ | ✓ |
| Iraq | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | |
| Djibouti | ✓ | | | ✓ | | ✓ | | ✓ |

Source: World Bank, 2008.

# ARAB ACTION IN THE ENVIRONMENTAL FIELD THROUGH THE LEAGUE OF ARAB STATES

## Fatma Al-Mallah

The Council of Arab Ministers Responsible for the Environment (CAMRE) is the regional mechanism within the League of Arab States (LAS) responsible for coordination and cooperation regarding the environment and sustainable development. The Council differs from other Arab ministerial councils in that environmental issues are not defined in specific sectors, but rather intersect with various social and economic areas. In addition, the bodies responsible for the environment in Arab countries vary in form, jurisdiction and the authority they yield. There is also a wide disparity among Arab countries in the depth of addressing environmental issues, in terms of regulations, procedures and legislations. The rapid and progressive developments on the global environmental scene and the development from the concept of conserving the environment to achieving sustainable development have had a profound impact on the evolution of CAMRE. The Council adapted its function and work plans to keep abreast of Arab and international developments. Its work over thirty years can be divided into a transitional phase from 1987-1991, two main phases from 1992-2001 and 2002-2015, and a third phase staring in 2015.

The transitional phase started in 1987 and continued until 1991. It kicked off in Tunisia with the first Arab Ministerial Conference on Environmental Considerations in Development. The conference concluded with the adoption of the Arab Declaration on Environment and Development, which included the main principles and directions for national action and international cooperation in the field of environment. One of the most important outcomes of the conference was the establishment of the Council of Arab Ministers Responsible for the Environment (CAMRE) in accordance with League of Arab States Council Resolution No. 4738.

At its founding meeting in 1987, CAMRE adopted a number of programs to translate the Arab Declaration on Environment and Development into areas of joint cooperation. Its activities focused on three issues that were given priority: combating desertification, combating industrial pollution and spreading environmental awareness. At that stage, work focused on collecting all available information that was scattered in several areas, as well as exchanging views and consulting on how best to deal with the information.

The first main phase lasted ten years, beginning with the United Nations Conference on Environment and Development (Rio de Janeiro, June 1992). In September 1991, the Council issued the "Arab Declaration on Environment, Development and Prospects for the Future", which outlined the Arab environmental action and charted visions and directions on the major environmental issues on the agenda of the Earth Summit. The Declaration took into account the right of Arab countries to utilize their natural resources to achieve sustainable development. The statement was reinforced in May 1992 with a document that included the Arab action plan and agenda for sustainable development, in line with Agenda 21.

During that phase, CAMRE highlighted two fundamental issues. The first was to strengthen and build Arab capability to deal with various environmental problems based on sustainability. The second was following up on the implementation of international agreements on the environment. The Council established mechanisms to enhance cooperation and coordination of Arab positions in international forums and to affirm the right of the Arab States and their sovereignty over their natural resources for the benefit of present and future generations. The Council also paid great attention to thwarting the attempts of some countries to exploit certain international agreements on the environment to achieve political and economic objectives against the interests of the Arab states.

CAMRE's success in implementing its priorities during this phase was due to three basic elements: first, effective coordination and cooperation with the United Nations Environment Programme (UNEP) and relevant Arab and international organizations; second, the establishment of appropriate institutional mechanisms; and third seeking the participation of all concerned parties, including civil society.

The second main phase started in mid-2001 and continued until 2015. Its first results emerged with the start of the

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Arab preparation for the World Summit on Sustainable Development (Johannesburg, September 2002) as a major turning point in cooperation between CAMRE, UNEP and the Economic and Social Commission for Western Asia (ESCWA). This coincided with the positive development in the interest of Arab and regional organizations in environmental issues, rationalization of the use of resources and the allocation of a large part of their programs, activities, material resources and technical expertise to address these issues. The Council had to reconsider its priorities in the light of the progressive development of its scope of work, to cover Arab cooperation in all areas of sustainable development. The LAS Council subsequently formalized this in March 2003, which amended CAMRE's mandate to cover issues of sustainable development within the LAS system.

CAMRE decided that its activities should focus on the formulation of policies and strategies in the context of the specificities of the Arab states, the prevailing patterns of behavior, values, available resources and the quality of prevailing environmental problems. That was further emphasized by the Abu Dhabi Declaration on the Future of Arab Environmental Action in 2001 and the Arab Ministerial Declaration on Sustainable Development 2001 and the Sustainable Development Initiative for the Arab Region, launched at the Johannesburg conference in 2002.

The 2004 Arab Summit in Tunisia adopted the Initiative for Sustainable Development in the Arab Region and the 2005 Summit in Algeria adopted its implementation plan. Since then, the Council has periodically presented many of its resolutions for adoption by Arab summits.

During that period, several important developments took place, including the expansion of CAMRE's activities to include natural disaster risk reduction and the development of environmental cooperation within the framework of bilateral and multilateral cooperation between the League of Arab States and South America, China, Japan, the Russian Federation, India, the African Union and the European Union. That period also witnessed the adoption of the Arab Strategy for the Reduction of Natural Disaster

Risk, the Arab Plan for Dealing with Climate Change, and the adoption of the Regulations of the Arab Environment Facility, the Arab Center for the Prevention of Seismic and Other Natural Disasters, and the Arab Union for Protected Areas. The environmental situation in Palestine, the Syrian Golan, Sudan, Somalia, Comoros, Djibouti, Libya, Syrian, Jordan, Lebanon and Yemen became a permanent item on CAMRE's agenda. CAMRE also led efforts to periodically convene the Arab Forum for Sustainable Development and the Arab Conference for Natural Disaster Risk Reduction, as well as presenting the experiences and success stories of Arab countries about green economy and to stimulate the shift towards sustainable production and consumption patterns and encourage cooperation between Arab countries. This phase witnessed the start of the adoption of national Arab universities as observer members in the Council and inviting them to contribute to the implementation of its activities.

This phase culminated in coordinating Arab preparation for the three global meetings for the post-2015 era. Those included the Third World Conference on Disaster Risk Reduction held in Japan, Sendai in March 2015, the United Nations Summit on Sustainable Development held in New York in September 2015, and the Paris Climate Summit, held between November and December 2015. CAMRE's active partners from Arab, regional and international organizations played an important role in developing the capacities of the Arab negotiators in climate change.

The third phase, beyond 2015, is still in its infancy, but it started with important developments. CAMRE took an important step towards cooperating with the other Arab Ministerial Councils by holding a joint meeting with the Council of Arab Ministers of Health to start cooperation in areas of mutual interest. Steps are also being taken to start forming a committee to study the modernization and development of the work of CAMRE. The Arab Strategy for Disaster Risk Reduction is also being updated to align with the Sendai framework and to revise and update the Arab Plan of Action to address climate change issues. The LAS Educational, Cultural and Scientific Organization, in collaboration with the Council and other relevant organizations, has also drafted the long-awaited plan of education for sustainable development in the Arab world. Coordination and cooperation between CAMRE, ESCWA and UNEP is currently under way to prepare an operational plan on the environmental dimension for the implementation of the 2030 Sustainable Development Agenda.

CAMRE's performance has been impeded by two major challenges, stemming from weak political support and lack of appropriate funding. The declared political support to CAMRE for the preservation of the environment and the achievement of sustainable development was ineffective. For almost 30 years, the annual symbolic contribution of USD 5,000 from each Arab state to CAMRE's programs not only has not changed, but has also not been paid by many countries. Even this minimal amount was taken away from CAMRE's jurisdiction, by resolution No. 7765 issued by the Council of the League of Arab States at the ministerial level on 9/3/2014, which stipulated the establishment of a unified account for specialized ministerial councils under LAS. This complicated further the disbursement procedures within CAMRE's Secretariat and limited the flexibility of following up on the implementation of the Council's decisions.

Lack of sufficient funding remains the major obstacle facing CAMRE. In order to enhance effectiveness and improve performance, a mechanism is needed to mobilize resources, and attract Arab and regional funding institutions as partners.

It is also noted that countries are slow to sign and ratify new institutional mechanisms. They are often afraid that new financial burdens will be imposed on them, despite the stipulations that these are voluntary commitments. For the same reason, we find that the plans are updated even before the bulk of their components has been implemented.

CAMRE has a leading role in coordinating environmental action in the Arab region, especially regarding an effective implementation of the environmental dimension in the Sustainable Development Agenda 2030. That is in addition to the need to consolidate and enhance the existing effective partnership with Arab, regional and international organizations as well as civil society and the private sector, and to cooperate with other regions. An overdue goal is to establish the Arab Environment Facility, an idea that was proposed in 2006 but never materialized. The formation of this regional body is hoped to attract resources from within the region, especially from non-traditional sources, which will act as an incentive to attract support from donor institutions and direct its resources to deal specifically with Arab environmental problems.

the League of Arab States in 2014. The ASFSD is promoting the nexus approach to water-energy-food sustainability in the Arab region, and encouraging the transition towards a low-carbon economy to address the interdependencies between water, energy and food to make the nexus work for the poor. Besides, the nexus approach will enhance system thinking and integration of sectoral policies and this in turn will help the Arab region achieve the targets of the SDGs (Abdel Gelil, 2015).

It is also remarkable that though the Arab SCP strategy identified energy, water, and food as regional priorities, the nexus concept was not matured enough at the time of its adoption in 2009. The strategy addresses the efficiency of those three resources independently. In most of the Arab countries, energy, water, and food policies are developed within each sector with little horizontal coordination. Additionally, climate change is still being addressed as an add-on policy issue rather than a core for development challenges in the region. Conventional policy and decision-making therefore needs to give way to an approach that reduces trade-offs and builds synergies across sectors. This new development has created unprecedented opportunities for fundamental policy changes in various economic, institutional, technological, and social systems. Thus, mainstreaming the nexus approach into development plans at the national level still needs to be seen.

## III. RESPONSE TO INTERNATIONAL AGREEMENTS: THE CASE OF CLIMATE CHANGE

Due to their geographic profile and to underlying economic factors, the Arab countries rank among the most vulnerable in the world to the impacts of climate change. Food security, water scarcity, public health and economic livelihoods are among the areas expected to be affected. This challenge comes on top of pre-existing development challenges ranging from poverty to high levels of unemployment, to already-low levels of renewable fresh water resources. Several Arab countries have acted to adapt to the changing climate and many have invested in energy efficiency and renewable energy. But regional policy dialogues and research indicate that there is much more work to be done.

To respond to this risk, the Arab Climate Resilience Initiative aims to promote integrated regional responses to climate change. It is assessing the impact of climate change on freshwater resources across the Arab region, and promoting integrating climate change measures into national policies and strategies, along with environmental and disaster risk reduction strategies (ESCWA and UNEP, 2015).

Further, the Arab Strategy for Disaster Risk Reduction was adopted by CAMRE in its 22nd session at the League of Arab States in 2010. This would complement existing and ongoing efforts in disaster risk reduction by national institutions and regional technical organizations. It calls for multi-sectoral approaches to considerably reduce emerging risks across the Arab region by 2020, in line with the global priorities outlined by the Hyogo Framework for Action and the Millennium Development Goals (LAS, 2010). This section will discuss the Arab involvement in the evolution of the climate policy regime since 2008 until the ratification of the Paris agreements in 2016.

The COP 14 in Poznan, Poland, was held in 2008, with a focus on international cooperation post-2012 period, when the Kyoto Protocol's (KP) first commitment period expired. The international political context for the Poznan conference was somewhat different than the negotiations that took place against the backdrop of a rapidly worsening global financial situation of 2008. Thus, as expected, the conference only concluded by what is known as the Poznan Strategic Program for Technology Transfer, which aims to enhance investments in technology transfers to developing countries.

In preparation for the COP 15 in Copenhagen, CAMRE announced an Arab position for the climate negotiations. It emphasized many of the region's typical positions regarding adaptation as the priority for the Arab region, the historical responsibilities of developed countries, the "common but differentiated responsibilities", and commitments of developed countries on finance, technology transfer, and capacity building (CAMRE, 2009).

In December 2009, the COP 15 convened in Copenhagen, Denmark, where an

unprecedented number of heads of state gathered. Despite the intense negotiations at the highest political level, no agreement was reached on emissions commitments beyond 2012. However, the heads of states of the US, and what is known as the BASIC group (Brazil, South Africa, India, and China) arrived at what is named the "Copenhagen Accord", which was rejected by countries including the Arab group. However, the Copenhagen Accord included some positive developments such as the creation of the Green Climate Fund (GCF) with a goal to mobilize 100 billion USD a year by 2020. Another major contribution of Copenhagen to the negotiation process is the recognition that the increase in global temperature above the pre-industrial level should not exceed two degrees Celsius. Another remarkable development in Copenhagen was the beginning of the dissolution of the group of G77 & China to different subgroups such as the BASIC group, the Association of Independent Latin American and Caribbean States (AILAC), and the "like-minded group" which includes Egypt, China, India, and other Arab countries (Abdel Gelil, 2014).

A year later, the COP 16 was convened in Cancun, Mexico, which imported the essential elements of the Copenhagen Accord into the UNFCCC formal process. It witnessed some concessions from developing countries including the Arab countries and the rest of G77 and China in terms of the final agreement on Nationally Appropriate Mitigation Actions (NAMAs), supported by technology and finance, aimed at achieving a reduction in emissions relative to 'business as usual' emissions in 2020. Though providing technology and finance are commitments of developed countries explicitly stipulated in Article 4 of the UNFCCC, the concept of NAMAs make it conditional of emission reductions by the respective developing country. Developing countries also conceded to the process of measurement, reporting and verification (MVR) (UNFCCC, 2010). This is a noticeable change in positions as for nearly two decades, the developing countries were reluctant to any form of verification of their mitigation efforts. However, none of the Arab countries have developed or submitted NAMAs yet.

It was a precedent that the climate change issue

TABLE 4 **STATUS OF ARAB COUNTRIES IN THE PARIS AGREEMENT**

| Country | Status | First NDC |
|---|---|---|
| Algeria | Signed & Ratified | Submitted |
| Bahrain | Signed & Ratified | Submitted |
| Comoros | Signed & Ratified | Submitted |
| Djibouti | Signed & Ratified | Submitted |
| Egypt | Signed & Ratified | Submitted |
| Jordan | Signed & Ratified | Submitted |
| Mauritania | Signed & Ratified | Submitted |
| Morocco | Signed & Ratified | Submitted |
| Palestine | Signed & Ratified | - |
| Qatar | Signed & Ratified | Submitted |
| Saudi Arabia | Signed & Ratified | Submitted |
| Somalia | Signed & Ratified | Submitted |
| Sudan | Signed & Ratified | - |
| Tunisia | Signed & Ratified | Submitted |
| United Arab Emirates | Signed & Ratified | Submitted |
| Iraq | Signed | - |
| Kuwait | Signed | - |
| Lebanon | Signed | - |
| Libya | Signed | - |
| Oman | Signed | - |
| Yemen | Signed | - |
| Syria | Unsigned | - |

Sources: INFCCC.int and Interim NDC registry (accessed 3 August 2017)

was first discussed during the Arab Summit that was held in Sirte, Libya in 2010, which adopted a summit's resolution that called upon the Arab countries to mainstream climate change in regional and national policies and plans, finalize the adoption of Arab Climate Change Action Plan (CCAP), adopt national plans to address climate change, and to speed up the ratification process of the Regional Center for Disaster Risk Reduction in Alexandria, Egypt. It is worth noting that the Arab CCAP was ready for adoption in June 2008, but was blocked by Saudi Arabia until October 2012, when it was adopted by CAMRE, indicating a shift of the position of the Saudi delegation. It is not clear whether the LAS has been monitoring the implementation of this action plan nor to what extent the Arab countries have been implementing it (Abdel Gelil, 2014).

In November 2011, COP 17 convened in Durban, South Africa. Parties agreed on a second commitment period of the Kyoto Protocol, to begin in 2013. They also agreed to launch a new process "to develop a protocol, another legal instrument or an agreed outcome with legal force under the Convention applicable to all Parties" (UNFCCC, 2011). Durban witnessed a major shift in positions within the negotiation process. For the first time in the history of the climate change negotiations all parties, including the Arab countries and the major emitters, agreed to begin a new round of negotiations that should lead to a legally binding instrument by 2015 and applicable to all. This process was completed in 2015 by the adoption of the Paris Agreement.

From 2011 to 2015, Parties of the UNFCCC met

in Doha, Warsaw, Lima, and Paris. They were elaborating the elements of the new proposed agreement, scheduled to be agreed in Paris in late 2015, while also agreeing the ground rules on how all countries can submit contributions to the new agreement through the Intended Nationally Determined Contributions (INDCs), which will form the foundation for climate action post-2020 when the new agreement is set to come into effect.

COP 21 was held in Paris and adopted the Paris Agreement. On 22 April 2016 (Earth Day), 174 countries signed the agreement in New York, and began adopting it within their own legal systems. All Arab countries signed the agreement except Syria. The Paris Agreement entered into force on 4 November 2016. Currently, 168 countries[3] including 15 Arab countries have ratified the agreement, and 147 countries including 13 Arab countries have submitted their first Nationally Determined Contribution "NDC" in accordance with Article 4 of the Paris Agreement (Table 4).

## IV. CONCLUSION AND RECOMMENDATIONS

Many changes have taken place in the Arab region and globally since the Rio Earth Summit of 1992 with respect to governance for sustainable development. This has been supported by a parallel development of the regimes of the multilateral environmental agreements (MEAs). At the regional level, the League of Arab States (LAS), supported by several regional UN organizations, play a central role in addressing sustainable development issues in the region. LAS adopted a regional strategy on sustainable development, in addition to several strategies on water, agriculture, education, climate change and others. The experience on implementation and monitoring of those regional strategies has proven to be ineffective, as they have not significantly influenced national efforts to achieve sustainable development. Several Arab countries created some form of national councils for sustainable development, which remain ad hoc in nature.

At the public policy front, Arab countries have been pursuing policy developments aiming at sustainable management of natural resources. A major shift in public policy has been the recent reforms in energy and water pricing across the region, including the major oil producing countries of the GCC. However, to achieve the global goals, LAS and other regional institutions need to move from rhetoric declarations to implementation on the ground, and Arab countries need to strengthen their legislative and institutional frameworks.

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## NOTES

1. MENA region here consists of the Arab countries, and Iran.

2. Percent increases are different for different consuming sectors.

3. As of October 17, 2017.

## IMPLEMENTATION OF GLOBAL ENVIRONMENTAL CONVENTIONS IN ARAB LEAGUE COUNTRIES

**Maria Ivanova and Natalia Escobar-Pemberthy**

Countries around the world have undertaken commitments to protect and preserve the environment. To safeguard species, ecosystems, and human health, governments have created international agreements that guide their national behavior to regulate pollution and manage conservation. The Stockholm Convention and the Basel Convention, for example, regulate the production of persistent organic pollutants and the transport of hazardous waste. In the conservation cluster, the Ramsar Convention sets out practices for the protection of wetlands, the Convention on International Trade of Endangered Species (CITES) manages such transactions, and the Word Heritage Convention (WHC) protects natural and cultural heritage sites.

Surprisingly, we don't know whether and to what extent countries have implemented their international obligations under these conventions. As a result, there is no baseline against which to assess performance, actions, or even expectations; and without empirical evidence, we risk erroneous conclusions. In the absence of measurement of implementation, it is impossible to determine whether the conventions solve the problems they were created to address. Moreover, without understanding what enables or prevents countries from implementing their obligations, no serious improvement can take place and risks persist and exacerbate.

The Center for Governance and Sustainability developed the Environmental Conventions Index, an empirical tool to measure implementation of the global environmental conventions that enables self-assessment and comparison with peers1. To create the Index, our research team collected reports submitted by state parties to the conventions over a 15-year period (between 2001 and 2015); identified implementation indicators for each convention; and created and applied scoring scales for each indicator. Based on the composite score derived from these indicators, we rank countries on progress toward the aims of the conventions using an ordinal scale from 0 to 5, with 5 denoting the highest level of implementation. A score of 0 is given when no information is provided. The indicators are not weighted. Weighting could take place at a later stage or users could do it once the database is available online in an interactive format. The Index establishes a foundation for a systematic assessment of countries' progress on their international environmental obligations. It also identifies trends across countries, within countries (across issues and over time), and across conventions.

Measuring the extent to which countries implement the conventions they have ratified helps us determine progress in creating the regulations, institutions, and strategies needed to achieve global environmental goals and to address challenges to fulfill obligations. We can then identify patterns and strategies that could be an effective tool to mobilize action and resources from governments, academia, civil society, and stakeholders. We can provide a report card to countries and conventions to measure progress and ensure accountability. In this short summary, we present results for the countries in the Arab League2 for five conventions: Basel and Stockholm in the pollution cluster, and CITES, Ramsar, and the World Heritage Convention in the conservation cluster. They illustrate membership in the conventions as well as reporting and implementation.

All 22 Arab League states are members of the Basel Convention, 21 are members of the Stockholm Convention and of CITES, and 18 are members of the Ramsar Convention. Palestine is only a member of the Basel Convention. In addition to Palestine, Qatar, Saudi Arabia, and Somalia are not members of the Ramsar Convention. Somalia is the only country in the Arab League that is not a member of the World Heritage Convention.

Reporting is a challenge in all conventions. As Figure 1 illustrates, the average reporting rates for all five conventions are lower than the world average. However, reporting to the Ramsar and the World Heritage Convention is significantly higher than for the other conventions. Indeed, 50 percent of the Ramsar Convention's members from the Arab League have reported 100 percent of the time they were obliged to do so. Nevertheless, the average reporting rate for the region is 70 percent while the world average is at 86 percent. The reporting cycle for the World

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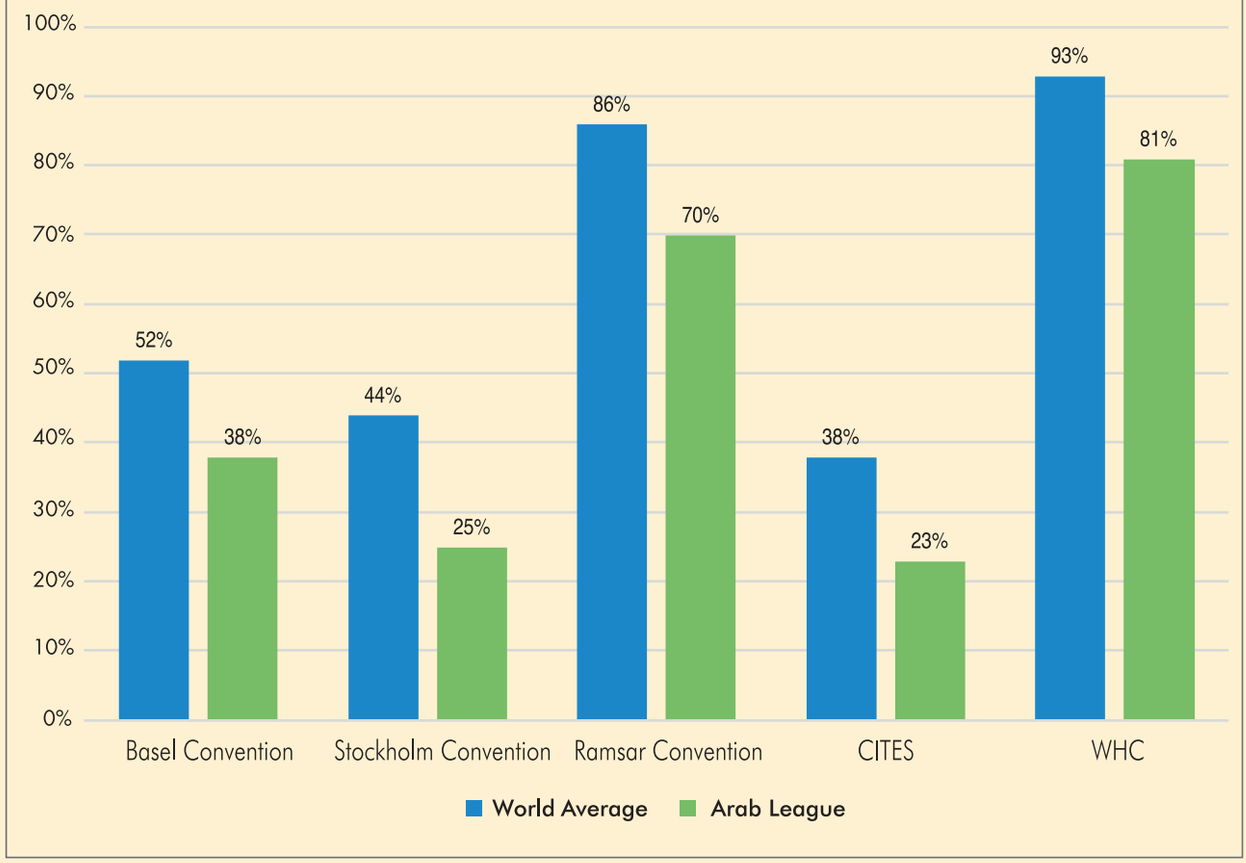
FIGURE 1 COMPARATIVE AVERAGE NATIONAL REPORTING RATE BY CONVENTION

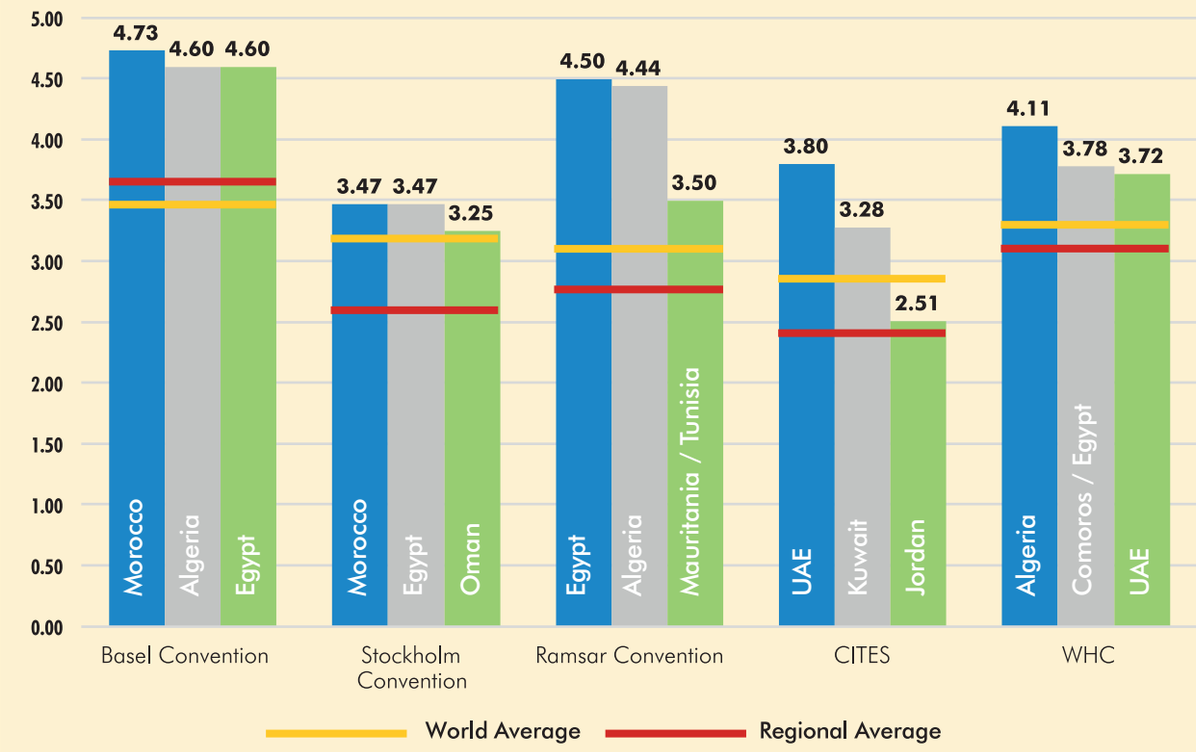



Heritage Convention is every five years and our analysis includes only the latest such cycle. Seventeen of the 21 members from the Arab League, or 81 percent, have reported in the last cycle for the World Heritage Convention.

- **Basel Convention:** Of the 22 Arab League members in the convention, 16 have reported at least once; 1 member state (Bahrain) has reported 100 percent of the time (15 reports), and 5 have never reported (Mauritania, Saudi Arabia, Somalia, Sudan, and Syria).
- **Stockholm Convention:** Of the 21 Arab League members in the convention, 10 have reported at least once; 10 have never reported; and no member has a 100 percent reporting rate.
- **CITES:** Of the 21 Arab League members in the convention, 6 have reported at least once; two (Qatar and UAE) have reported 100 percent of the time; and 14 have never reported.
- **Ramsar Convention:** Of the 18 Arab League members in the convention, 16 have reported at least once; 9 have reported 100 percent of the time (Algeria, Djibouti, Egypt, Iraq, Lebanon, Morocco, Oman, Tunisia, and UAE); and 2 (Kuwait and Syria) have never reported.
- **World Heritage Convention:** Of the 21 members, 4 have not submitted reports: Djibouti, Libya, Palestine, and Qatar.

Implementation across the conventions varies. No one country shows the same performance across all conventions. Nevertheless, the findings reveal some important dynamics that demand further research and analysis and could offer important case studies of best practices. Notably, several countries emerge as top performers not only in the region but also globally. For example, Morocco ranks 3rd worldwide in the implementation of the Basel Convention (out of 161 member states who have reported to the

FIGURE 2 **TOP PERFORMERS IN THE ARAB LEAGUE BY CONVENTION**




Note: The orange and red lines in each convention indicate the world average and the regional average (for the Arab League) respectively

convention) and is followed by Algeria and Egypt who both rank 16th out of 161 member states. Indeed, the average for the Arab League is higher than the world average for the Basel Convention, indicating solid performance across most countries. However, for all other conventions the regional average is lower than the world average.

Some countries perform better than the world average. The United Arab Emirates, for example, ranks 11th in CITES (out of 105 member states). Algeria ranks 12th in the Ramsar Convention (out of 166 member states) and is followed closely by Egypt, which ranks 15th. In the World Heritage Convention, Algeria leads the Arab League and ranks 24th (out of 177). It is followed by Comoros and Egypt who share second place and rank 56th, and by the United Arab Emirates ranking at 65. The Stockholm Convention presents greater implementation difficulties in the region; the top ranking Arab League country, Morocco, is fifty-seventh (out of 120) and is followed by Egypt which ranks 58th. The overview in Figure 2 presents the top three Arab League performers in each of the five conventions with their respective rankings worldwide and their rankings compared to the world average.

Egypt, Morocco, Algeria, and the UAE emerge as leaders in the Arab League. Across all five conventions they also perform above the world average. Egypt is among the top three performers in the region for four out of five conventions; Algeria is in the top three for three out of five conventions; and Morocco and the UAE for two out of five conventions. Importantly, Morocco is among the top five performers in the world for the Basel Convention and Algeria and Egypt are among the top 20. In CITES, the UAE is among the world's top 20 and in Ramsar, Algeria and Egypt rank among the top 20. The top three performers in the region across the five conventions are as follows:

- **Basel Convention:** Morocco (#3 of 161), Algeria (#16 of 161), Egypt (#16 of 161)

- **Stockholm Convention.** Morocco (#57 of 120), Egypt (#58 of 120), Oman (#69 of 120)
- **CITES.** United Arab Emirates (#11 of 105), Kuwait (#39 of 105), Jordan (#80 of 120)
- **Ramsar Convention.** Algeria (#12 of 166), Egypt (#15 of 166), Mauritania (#75 of 166) and Tunisia (#75 of 166)
- **World Heritage Convention:** Algeria (#24 of 177), Comoros (#56 of 177), Egypt (#56 of 177), and United Arab Emirates (#65 of 177)

Ultimately, we seek to measure, explain, and improve the level of implementation across global environmental conventions with the hope to improve their effectiveness in resolving the global risks they were designed to address. To this end, it will be critical for national governments to engage with these findings and commit to improving performance.

In 2016, we carried out a project sponsored by UN Environment Program on assessing the implementation of environmental conventions in ten countries around the world3. The project's results confirmed the relevance of the Index as an innovative assessment tool. They showed that the positive results of the Index correspond to the existence of governance instruments such as regulation and policy frameworks as well as specific initiatives. Relatedly, countries with lower scores face challenges with these same issues. Countries perform differently across the conventions, confirming that implementation is not static but is the result of a series of actions that change (and therefore can be improved) over time. Understanding how countries translate their global environmental obligations into national level policies can then serve as the foundation for creating policy space for the improvement of the performance of countries and their conventions. Such learning opportunities are created through the provision of information, the acquisition of knowledge, and sustained dialogue.

Through engagement with the Index, additional in-depth case studies that focus on the results that individual countries are achieving, and on how these results improve the state of the environment, can also be developed. Countries can then increase the salience of environmental issues in their foreign policy. Furthermore, in the context of the new Sustainable Development Agenda, the role and relevance of national results in global environmental conventions is critical to achieve the Sustainable Development Goals. Countries can identify best practices and chart a course for the implementation of commitments under the SDGs that builds on the institutions they have already established to ensure environmental protection under the global environmental conventions.

## NOTES

1. We group conventions in two categories – pollution and conservation. In Phase 1, we have analyzed two pollution conventions - the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal and the Stockholm Convention on Persistent Organic Pollutants – and four conservation conventions – the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Ramsar Convention on Wetlands of International Importance, and the World Heritage Convention. Phase 2 will include the Convention on Biological Diversity, the UN Convention to Combat Desertification, the UN Framework Convention on Climate Change, and the Vienna Convention for the Protection of the Ozone Layer. This analysis presents results for the five conventions from our Phase 1 work.

2. As of 2016, the Arab League comprises the following 22 member states: Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, United Arab Emirates, and Yemen.

3. The countries include Algeria, Argentina, Australia, Canada, Colombia, Czech Republic, Germany, Mozambique, the Republic of Korea, and Thailand.

## UN ENVIRONMENT: TEN YEARS IN WEST ASIA

### Iyad Abumoghli

The past ten years have witnessed a number of global events that will have profound transformational changes, not only on our environment and the way we deal with it, but also on future generations. The Rio +20 Conference, the adoption of the 2030 Agenda for Sustainable Development and the First Universal Council of the United Nations Environment Assembly are landmark events that have created new realities and will demand new actions and approaches to sustainability. The West Asia region has been at the core of these events, raising concerns over our changing environment at the highest levels. As UN Environment continues to position itself in the region to deliver on the 2030 Agenda, its focus is on enabling member states to achieve their visions for sustainable development and supporting them in meeting the ambitious Sustainable Development Goals (SDGs).

Recognizing the priorities of the region is imperative for the development of initiatives that respond directly to country needs. UN Environment's flagship series, the Global Environment Outlook (GEO), is part of a global initiative that aims to assess the state of the environment, review policies and options, and chart the outlook on priority environmental issues. The GEO-6 Regional Assessment for West Asia, published in 2016, involved various levels of consultations, starting with grassroots participation and ending with high-level government oversight. The assessment highlights the key issues affecting sustainable development in the region and the complexity of the interlinked challenges now confronting decision makers in West Asia.

The report reveals that the environment continues to be threatened by, and is a cause for, lack of peace and security and increasing levels of conflict. The war in Syria and the mass displacement of people across the region are having severe environmental impacts that are endangering the health of millions of people. In response, UN Environment, working with the international community, has been assisting the Jordanian government in the development of the Jordan Response Plan. With no formal mechanism in place to ensure proper integration of environmental aspects into response plan projects, UN Environment has been supporting Jordan in adopting a strategic approach towards integrating the environmental dimension in tackling the impacts of the refugee crisis.

Lack of regional cooperation on shared water resources and increased water demand and overexploitation of groundwater resources are also major threats to the region. Data sharing between countries is very limited. As a result, there is no common understanding of the state and development of water availability, use and trends. In addressing this, UN Environment has been working to support the strengthening of national data and indicator frameworks for monitoring and reporting on SDG6[1], including Target 6.5, which supports the equitable and efficient use of water resources. Through the Integrated Monitoring Initiative (GEMI), UN Environment is currently working to support Jordan's Ministry of Water and Irrigation to build on existing monitoring efforts and develop a coherent framework for national monitoring of SDG 6. UN Environment is also part of the Secretariat of the Arab Region Environmental Information Network. The initiative, called for by the Council of Arab Ministers Responsible for the Environment (CAMRE), acts as a clearinghouse to exchange and diffuse regional data and indicators to provide informational accessibility and facilitate knowledge transfer by encouraging the participation of all sectors of Arab society at large.

GEO-6 revealed that one of the top environmental risk factors for human health in the region is air pollution, which was estimated to be responsible for more than 70,000 premature deaths in 2010. Military operations during and after the Gulf War have also increased sand and dust storms multifold, resulting in not only threats to human health but also socio-economic challenges. In 2013, UN Environment worked with regional organizations and concerned countries to tackle this issue and develop a regional program to combat sand and dust storms. Through this initiative, a scientific mapping of hot spots has been made available to decision-makers and sources of sand and dust storms have been identified, whilst the importance of the issue has been up-scaled at the global level. A funding mechanism has also been developed, promoting cooperation between countries in the region, with scientific institutions working to address the issue and identify integrated approaches.

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UN Environment also supports countries in pursuing low-emission development pathways and boosting their adaptation and resilience capacities to the impacts of climate change. It helps countries in meeting their obligations under the UNFCCC and Paris Agreement through the preparation of national communications, helping to focus coordination at the national level and facilitate mainstreaming into policies and development plans. UN Environment has also been working to promote low emission technologies to reduce short-lived climate pollutants, such as methane and black carbon. In doing so, it is assisting countries in identifying their technology needs for adaptation and mitigation.

Maintaining nexus priorities was highlighted as an important challenge complicating environmental issues. Unsustainable consumption patterns threaten water, energy and food security, while high population and urban growth rates, together with current consumption patterns, compound pressure on the region's limited land and water resources. In response, UN Environment has been working to promote the concept of Sustainable Consumption and Production (SCP). Under the Marrakech Process, it supported the development of the Arab Strategy for Sustainable Consumption and Production, endorsed by CAMRE. The strategy, an opportunity for the region to deliver on Agenda 2030 and the SCP-related SDGs, encourages the use of products and services that ensure environmental protection and conserve natural resources, while contributing to sustainable lifestyles. UN Environment is also helping countries to implement Green Economy initiatives, as well as mainstreaming SCP into national development plans, such as its work through the EU-funded SwitchMed project to support Jordan, Lebanon and Palestine in the shift towards more sustainable lifestyles.

Continuous shrinkage of agricultural lands due to population growth, urbanization, land degradation and desertification will jeopardize food security in West Asia, especially in the Mashreq countries and Yemen. Most coastal ecosystems in the region have been classified as vulnerable, having lost significant portions of their original extent, and are in need of further representation in the protected area network. A flagship of UN Environment's work is Ecosystem Based Management. The Regional Office applied this approach when it supported Bahrain in the conservation of its oyster habitats through a first of its kind management project in 2012. The success of the project led to the Pearling Trail recently being listed by UNESCO as a World Heritage Site. UN Environment also worked with Iraq and partners in 2014 on a project to restore the Iraqi Marshlands. The project built the capacity of Iraqi authorities and communities and developed an integrated management plan that was instrumental in recognizing the Marshlands as a UNESCO World Heritage Site in 2016.

Waste management continues to be promoted through localized initiatives. Regional municipal solid waste generation is increasing at about 3 percent year. More than 50 percent of the municipal solid waste in the region comprises food waste. With the onset of the waste crisis in Lebanon in mid-2015, UN Environment engaged Lebanon in assessing the situation and helped prepare a roadmap for action to address the issue. At the core of its support was assisting in developing an overarching strategy for waste management in Lebanon, along with a comprehensive plan for resource mobilization.

Through its efforts to promote and enhance the management of chemicals and hazardous waste in the region, UN Environment, through stakeholder consultations with Multilateral Environmental Agreement Focal Points and concerned agencies of the region, helped to develop a regional strategy and action plan on harmful substances and hazardous waste. The strategy aimed at legislative and institutional reforms, enhancing institutional capacities and the promotion of national, regional and international cooperation. UN Environment has also been supporting countries achieve and sustain their compliance with the Montreal Protocol and Kigali Amendment. Part of this work involves bridging industries with future technologies, such as the promotion of low global warming potential refrigerants in the air-conditioning sectors through the PRAHA project. In collaboration with UNIDO, the project has helped put the air-conditioning industry in West Asia on the right research track in phasing out ozone depleting substances.

The achievements of UN Environment in the region in the past ten years have only been possible due to the support of member states and the active involvement of partners from the UN system, the League of Arab States and its subsidiary organs, the Gulf Cooperation Council, major groups and other partners. There are indeed great times before us that we need to pay attention to. We either go through a sustainable path towards the future we want, or we slip and disappoint the future generation that has entrusted us with a planet with limited resources but plenty of sustainable opportunities. We need to employ innovative approaches, strengthen partnerships and mobilize the potentials of the region and we can only do so with the support of our valued partners.

## NOTE

1. SDG 6 aims to ensure the availability and sustainable management of water and sanitation for all.

# INTEGRATED CLIMATE POLICY FRAMEWORK: THE CASE STUDY OF AMMAN

## Maha Al-Zu'bi

### Emergence of Urban Responses to Climate Change Impacts

Over the past 10 years, the importance of focusing mitigation action on the city scale has been recognized, and attention is now turning to adaptation action to build resilience and decrease vulnerability to the adverse effects of climate change. Further, increased attention to synergies between mitigation, adaptation, and socio-economic concerns and increased stakeholder engagement in policy development and implementation has emerged. Enhancing climate governance at the city scale matters, as the global climate change drivers of increasing temperature and changing precipitation are strongly interlinked with the urban cycle of water, energy, food, and related key pillars and urban services. Therefore, integrating the management of water, energy, food, and related services is essential to adapt and mitigate global climate change impacts at the local level. That led to a new water-energy-food nexus conceptual framework of transitions from silo to nexus. This framework aims to support coping with climate change at the global and national levels and to find a way at the local level to understand the dynamics of transitions from silo to nexus while considering the vertical relationships with different levels of governance, and by paying more attention to required coordination between related institutions and systems.

### Amman's Climate-related Challenges

Along with other Arab cities, the Greater Amman Municipality (GAM) has been trying to develop and improve its built environment, infrastructure, services, and institutional capacities to meet several challenges: (1) providing a larger urban population with access to basic services and vital resources; (2) sustaining continuous socio-economic development; (3) utilizing and managing resources (e.g. water, energy, food) within Jordan's limitations; and (4) addressing various environmental challenges, particularly climate change. Jordan's Third National Communication Report (2014) assessed vulnerability and adaptation in urban centers. The report revealed that Amman will be vulnerable to climate change impacts with a significant decrease in rainfall and an increase in its mean annual maximum temperature. With no dedicated urban climate policy, most of Amman's adaptive actions are reactive responses; once the problem has occurred adaptation takes place, mostly relying on the strong social ties and support systems of communities. These challenges mean that a comprehensive urban climate planning agenda is needed to increase resource use efficiency, allocate scarce resources, enhance security, reduce tradeoffs, and build synergies and improve governance across sectors to cope with climate change.

GAM is confronted by numerous issues that inhibit its ability to set and implement a climate-related agenda. Some of these factors are associated with institutional governance, the nature of vertical relationships and dynamics between GAM and the central government, while others are specific to GAM's decision-making environment and policy-making framework.

Despite these core issues, various assets exist that would advance GAM's climate policy coherence, such as the decentralization law, the green building incentives, and international urban networks (e.g. C40, 100 Resilience Cities, etc.). Owing to complex socio-economic and development interrelationships, climate change impacts cannot be addressed effectively in isolation. Therefore, national governments will not be able to meet their international commitments without localized climate-related action.

### Why Cities Matter

Despite its lack of control over the supply and management of resources within its jurisdiction, GAM has significant potential in contributing to resource demand management (e.g. infrastructure, awareness, policy interventions, and community engagement) and urban climate-related strategies (adaptation and mitigation). Furthermore, the sectors' interplay provides significant opportunities for synergies and nexuses between the sectors and key actors who are charged

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**GAM's Climate Policy Framework Components**

with planning and designing adaptation and mitigation responses. Also, there are significant and various sectoral interlinkages, urban synergies between adaptation and mitigation, and potential innovation areas and practical solutions to advance policy coherence and interventions within GAM. It is critically important for central government and GAM policy makers to understand these linkages and required coordination when devising sustainable urban adaptation and mitigation strategies.

## Amman's Integrated Climate Policy Framework

The city scale is increasingly being recognized for mitigation and adaptation actions. In the case of Amman, an integrated climate policy framework was seen as the best way to respond effectively to climate change by adopting an inter-sectoral approach that captures the multidimensional linkages between sectors and actors engaged in, or affected by, the management of natural resources and climate change, for the following reasons. First, GAM is the local jurisdiction where the related institutions exist, plan, and operate in silos. In addition, GAM's functions and operations (urban planning, land use planning, urban development, climate change urban-related responses, etc.) cannot be performed in isolation from the water, energy, food, and climate change institutions' plans, policies, and services. Second, there are many promising water, energy, food and climate change synergies in Amman that require coordination among all actors within the city's jurisdiction, such as energy-water efficiency technologies, demand management programs, wind power, solar panels, renewable energy for wastewater treatment and reuse in agriculture, and generation of energy from municipal waste and agriculture residues. The proposed integrated climate policy framework for Amman was designed to address policy, governance, and institutional challenges, among others. The following interlinked reforms were proposed to achieve GAM's integrated climate policy:

1. **Enhancing the legal framework:** Jordan's national government cannot effectively implement national climate strategies without working closely with local governments as agents of change. On the other hand, local governments cannot be effective alone and do not operate in isolation from other parts of the government. Further, local government authority to act in areas related to climate change is often nested in legal and institutional frameworks at higher levels. For instance, it is essential to clarify the legal jurisdictions over climate-related policy

areas (e.g., energy, land use, waste, water, food, transportation) and GAM's regulatory mandate (mitigation and adaptation) related to these areas, and identify public financing to leverage private investment locally.

2. **Establishing the Sustainability Office within GAM:** The degree to which local governments succeed in mainstreaming climate change planning depends on the institutional structures they create to drive forward this dialogue. The Sustainability Office will be responsible for a vision of urban sustainable development and climate change mitigation and adaptation, linking climate-related urban activities to other national policies, securing political commitments, developing a communications plan, and securing stakeholder and cross-sectoral support.

3. **Enhancing communication and policy coordination:** Enhanced communication and coordination is a two-way process. Therefore, GAM should achieve a better understanding of other sectors' policies and their direct and indirect links to the integrated climate policy, to establish links and means of communication with relevant ministries through Jordan's National Committee on Climate Change. Engaging stakeholders is increasingly critical in the design and implementation of climate action planning. Those involved in the research domain can contribute valuable expertise to the planning policy development process and act critically during evaluation, helping to ensure that it is transparent and verifiable.

4. **Enhancing awareness and maintaining urban climate change dialogue:** Local governments can play a major role by engaging the public in the climate change discussion. The needed changes will have real impacts on people's lives, but without public engagement no real action will be implemented. GAM could lead the process of awareness at the community level concerning better management practices and awareness about resource scarcity and efficiency.

5. **Empowering the community:** The existing governance structures demonstrate the lack of communication channels and coordination between the community and GAM officials. Establishing city-wide community-based organizations (CBOs) to work under the Sustainability Office as an umbrella organization responsible for related community activities would improve relationships among community members, develop vertical linkages with GAM officials, and enhance a platform for information exchange. Further, the office can simultaneously provide an avenue by which to disseminate information about climate change and potential community-based adaptation and mitigation activities that the CBOs could implement to improve local environment and living conditions.

6. **Securing financial resources:** It is essential to secure financial and technical assistance for climate change-related projects. GAM needs to coordinate with the Ministry of Environment, Ministry of Planning and International Cooperation, and the Ministry of Finance to mobilize internal resources. Further, through external resources it could insert climate change projects into multilateral and bilateral agreements, approaching international climate change funds and cities' networks like C40.

7. **Enhancing GAM's policy-making process:** As three governance levels exist (national, GAM, and districts) effective policy coordination should likewise exist. Within each level there are also internal networks that should be considered. The Sustainability Office can work as a focal point responsible for multiple governance coordination and integration to ensure horizontal and vertical policy coordination and integration and policy research, policy analysis, and monitoring and evaluation. By this engagement, policy implementation will be an interactive process involving policymakers, implementers from various levels of government, and other actors to strengthen the synergies in urban planning and the capacity for diagnosing inter-linkages among sectors and bringing them into planning decisions. This may help in the systemization of planning and decision-making at the local level to support urban climate-related dialogue by maximizing synergies and minimizing trade-offs in resource use, and enhancing policy coherence across the water, energy, food, and climate change sectors.

# GREEN ECONOMY AND GREEN FINANCE

Hussein Abaza

## I. INTRODUCTION

In 2008 the world witnessed the worst financial crisis and the start of the most severe recession since the Great Depression of the 1930s. In order to address the global financial and economic crisis, UNEP launched the Green Economy Initiative in 2008. UNEP defines a green economy as one that results in "improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities" (UNEP, 2010). The UN has further described green economy as a tool that can be used to achieve sustainable development and alleviate poverty.

It is estimated that every one percent fall in growth in developing economies will translate into an additional 20 million people consigned to poverty (World Bank, 2008). This happens at a time when economic inequality globally and within countries has been on the rise, increasing the gap between the rich and poor. Moreover, environmental deterioration continues unabated in spite of international and national efforts, negotiations, and a number of proposed environmental agreements aimed at address environmental problems. The current political situation, turmoil and unrest in several Arab countries and the continued occupation of the Palestinian territories have deterred efforts in these countries from transitioning to a green and more sustainable development path. However, since the launch of the UNEP Green Economy Initiative, several Arab countries have taken serious steps to adopt green and sustainable development strategies and direct investments towards green sectors.

## II. GREEN ECONOMY AT THE NATIONAL LEVEL

This section of the report provides relevant actions and initiatives made in the Arab world supporting the transition to a green economy, focusing on a selected set of countries.

***Algeria*** has initiated a number of reforms and initiatives intended, in particular, to diversify the economy, improve the business climate, enhance energy security, protect the environment, green its industries, and promote sustainable land use. These initiatives, however, need to be consolidated and articulated as part of a national strategy to promote the green economy, with an emphasis on promoting sustainable production and consumption, while contributing to wealth and job creation. Algeria considers green economy as a means of achieving the objectives of sustainable development, creating jobs, sustaining economic growth (diversifying the production base and increasing value-added), and strengthening innovation and reducing poverty.

Greening the economy in Algeria is reported to have provided about 450,000 jobs in 2012 and is projected to generate over 1.4 million jobs by 2025, especially in five sectors: renewable energy, energy efficiency, water management, waste treatment and recycling, environment-related services and management of green zones. Efforts in Algeria have also been devoted to the greening of cities. This included cities such as Boughezoul, where a pilot scheme in energy saving and renewable energy development (solar, photovoltaic and wind) has been introduced, combined with plans to develop green business areas and industries, such as agro-food processing and agricultural waste recovery, in the Wilaya of Tipasa (UNECA, 2015a). The country has also launched one of the largest solar projects with a capacity of 4,000 MW (UNECA, 2015a).

In February 2014 Algeria hosted a very successful High-Level African Conference on green economy in Oran, Algeria. The conference, which was very well attended, has resulted in a

declaration that encouraged African countries to develop strategies aimed at facilitating the transition to a green economy.

***Bahrain*** has placed sustainable development plans amongst its top priorities and has developed a package of programs aimed at raising the standard of living of its citizens. Emphasis is laid on education, healthcare and social welfare as a reflection of the country's vision that citizens constitute the center of any development process. A great deal of attention is given to environmental issues, including the protection and maintenance of flora and fauna and protecting the environment from harmful emissions. A series of measures were initiated to conserve wildlife through the protection of natural habitats. The Kingdom has also taken measures to ensure adequate monitoring and compliance with environmental laws (UNEP, 2012).

The National Committee for the implementation of the energy efficiency and renewable energy plan in Bahrain has recently initiated action aimed at achieving the SDGs, particularly goal number 7 related to renewable energy and energy efficiency. The plan includes some 22 initiatives including green buildings, green procurement, a public transport system, and enhancing energy efficiency in the different economic sectors. The plan aims to reach five percent of renewable energy in the total energy mix by 2025 and ten percent by 2035, as well as six percent energy efficiency by 2025 (NCIEERE, 2017).

In its efforts to conserve energy, Bahrain has taken measures to produce potable water using waste heat recovery produced during the production of aluminum. Waste heat, known also as secondary or low-grade heat, refers to heat produced by engines, equipment or industrial processes, which is usually lost and unutilized in industrial processes. This is especially the case in the aluminum industry due to the high temperature of the exhaust gas in furnaces, which can reach between 650-760°C. The waste heat recovery (WHR) technique was adopted at Aluminum Bahrain (ALBA) where the flue gas is used to operate waste heat boilers. The exhaust gas from waste heat boilers is then used to produce steam for seawater desalination (ESCWA, 2013).

In 2016 ***Egypt*** launched its Sustainable Development Strategy 2030, promoting the use of green economy as a tool to achieve sustainable development. Furthermore, the Ministry of Planning and Administrative Reform (MPAR) together with the Ministry of Environment has established a "Green Economy Working Group" covering the different economic sectors in Egypt. Egypt has also undertaken a number of studies on green economy, including "Transitioning to a Green Economy in Egypt, 2013", "Egypt Success Stories, 2013", "National Action Plan for Sustainable Consumption and Production, 2015", and "Integrating Environmental Considerations in Five Priority Sectors in Egypt, 2016".

Egypt has also initiated a green and sustainable cities program. This has been translated in the design and construction of mega cities projects: Al Sheikh Zayed City, south of Cairo, the New Administrative Capital, Al Alamein City in the North Coast, and El Galala project along the Red Sea.

Other green economy related projects include converting organic waste into biogas and agricultural residues (rice straw) into fodder and fertilizers. Wastewater recycling, reuse, and seawater desalination is another area given priority in Egypt in order to meet current and future water needs in the country.

Egypt also began utilizing compressed natural gas (CNG) in transportation through a small demonstration project managed by the Ministry of Petroleum in 1992, which involved two oil companies (PETROBEL and GUPCO) introducing vehicles using CNG to their fleets. The program started in 1992, but CNG was introduced in the Cairo Transport Authority and Greater Cairo Bus Company in 1996. In 2012, eight natural gas refueling stations were opened and four locations in Port Said were identified as centers for converting cars to CNG and for refueling CNG vehicles in Sinai, Bahariya Oasis, El Minya, Siwa, Dakhla, Fayoum, Wadi El Natrun, and Aswan (ESCWA, 2013).

Egypt is working to reach a level of electricity production of 85,000 megawatts by 2030 compared to the 31,600 MW produced currently. Renewable and new energies, including solar and wind energy and biogas, are important components of this target, set to make up 20 percent of all energy produced by 2022 and

35 percent by 2030. The size of investments in renewable energy in Egypt is one clear demonstration of the government's policy to transition to green economy. By the end of 2017, Egypt is set to achieve a target of 4,300 MW of solar and wind energy. The renewable energy program includes the building of a 2 GW power generation capacity and wind rotor blade factory by Siemens. Under the feed-in-tariff scheme, investment in renewable energy is estimated to generate between USD 6 to USD 7 billion of investments between 2017 and 2018.

The private sector is also quite active in Egypt, where private sector companies such as Mansour Manufacturing and Distribution Group, after joining the Global Compact, have invested in energy efficiency and water and are converting the fleet of over 900 vehicles to natural gas. SEKEM Holding in Egypt is another organization which has based its operational strategy on caring for the environment through investments in organic agriculture and community development (AFED, 2008).

In ***Lebanon*** following a sustainable development path has been mainly reflected in addressing climate change. Priorities such as clean and renewable energy, the greening of the economy and promoting resilience in the face of increasing climatic change have been some of the main concerns for decision-makers, civil society, businesses and the general public.

Recently, the Ministry of Environment launched three new initiatives that form a significant step forward in building a low carbon economy and greater national resilience in order to address climate change concerns. These include the "Lebanon Low Emission Capacity Building" project, the "National Action Program to Mainstream Climate Change into Lebanon's Development Agenda", and the "Third National Communication to the UNFCCC" (Third National Communication, 2016)

***Jordan*** has been taking steps in the last several years to transition into a green economy. With the support of UNEP, Jordan has implemented a project on greening the Jordanian economy in 2011. Jordan considers transitioning to a green economy as crucial for its current and future prosperity. It has developed its own green growth strategy (UNEP, 2011a), which underscores why green growth is an important concept for the country. UNEP, in its report "Towards a Green Economy – A Scoping Study", identifies six sectors as particularly important for Jordan's green economy – these are water, renewable energy and energy efficiency, transport, waste management, tourism and agriculture.

A great deal of progress has been achieved in recent years by the Jordanian government in achieving sustainable development, these include:

- Developing a Master Strategy for the energy sector, which includes generating 1,800 MW of renewable energy and reducing energy consumption by 20 percent by 2020.
- The adoption of the Renewable Energy and Energy Efficiency Law No. 13 in 2012, which introduces a regulatory and financial framework for renewable energy and provides incentives for energy efficiency.
- The development of the National Water Strategy 2008-2022, "Water for Life", which aims at improving water supply through investment in large water infrastructure projects, reduce the use of groundwater, and increase wastewater treatment and water efficiency.
- Promoting donor programs aimed at supporting the greening of the economy and improving access to finance, including through the Agence Française de Développement's renewable energy and energy efficiency credit line and the United States Agency for International Development's infrastructure and capacity building efforts to improve water efficiency (ASI, 2013).

Other initiatives launched in Jordan to green the economy included the launching of an eco-tourism initiative, which is part of the National Tourism Strategy for Jordan. Other initiatives included promoting energy efficiency and the use of renewable energy in the transport sector, and in converting waste from landfills into electricity through a non-profit company Al-Russaifah Biogas (ESCWA, 2013). Jordan has also launched an air conditioning initiative with solar energy for the Royal Cultural Centre. It has also recently signed off a contract for energy efficiency and renewable energy for 14 hotels

in the Petra area with a total cost of 3 million Jordanian Dinars (Government of Jordan, 2017).

Moreover, Jordan has recently launched a green economy strategy, and the Ministry of Environment announced in June 2017 a set of 24 projects to kick-off implementation of the strategy, covering energy, waste management, water, tourism, agriculture and transport.

***Morocco*** in 2008 launched the National Renewable Energy and Energy Efficiency Plan, with the aim of developing alternative energy to meet 15 percent of local energy needs and enhance energy saving measures in the country. The Solar Plan was then introduced in 2009 using concentrated solar technologies and photovoltaic systems with a total installed capacity of 2,000 MW by 2020. Morocco plans to achieve 42 percent of installed renewable energy capacity by 2020 (UNECA, 2016)

Morocco's green economy program includes renewable energy, energy efficiency, water economy, sustainable solid and liquid waste management, inclusive agriculture, aquaculture and ecotourism. Further efforts include the adaptation and enforcement of regulations, environmental taxation, costing of environmental goods and services, sustainable financing mechanisms, mobilizing knowledge and innovation, and monitoring and evaluation (UNECA, 2015b).

Morocco has also initiated an ambitious green and sustainable development program. One of the first initiatives under this program is the generation of electricity through a concentrated solar power (CSP) program. In November 2009, the government of Morocco announced a program for renewable energy called the "Integrated Solar Energy Generation Project". The aim of the program is to install a CSP system with a capacity of 2,000 megawatts (MW) by 2019. The program includes five sites/plants covering 10,000 hectares with three sites/plants generating up to 500 MW each, one site/plant generating 400 MW and the last site generating 100 MW, all for a cost of USD 9 billion.

In 2008, the country adopted the Green Morocco Plan on sustainable agriculture (2010-2020). The plan aims to support the agriculture sector, which represents 19 percent of the GNP and directly employs more than four million people. A major pillar of the plan is the principle of aggregating agricultural production for addressing financial, structural and technical obstacles facing the development of the sector. A multidisciplinary approach is adopted in order to support the green plan for agriculture, including: (a) Integrating climate change considerations in the plan; (b) Encouraging water conservation practices through various mechanisms (economic incentives, new technologies, management practices, etc.); (c) Encouraging organic farming practices by focusing on natural fertilizers and organic seeds; (d) Supporting renewable energy use in agricultural activities; and (e) Enhancing land management and conservation practices in agriculture.

In 2010, Morocco introduced a "green tax", as well as a tax on raw materials and semi-finished plastic products. The revenues generated by the tax are re-injected into the environmental sector through the National Environmental Fund to invest in recycling and the treatment of waste. In 2009, the Energy Development Fund was created with USD 1 billion to support these initiatives. Moreover, Morocco's Economic and Social Council has identified potential sectors for greening. For example, investments in solar and wind energy is estimated to reduce $CO_2$ emissions by 9.5 million tons and create 23,000 new jobs by 2020 (UNEP, GIZ, 2016).

Zenata in Casablanca is designed as a green city with 30 percent vegetation cover, rapid transit system, for 400,000 inhabitants creating about 130,000 jobs. Mehdya project close to Rabat with eight kilometers of beachfront is another green project comprising of 400 hectares, including residential, medical, commercial services and a convention center, is considered to be the biggest eco city in the region. The main source of energy is solar and wind energy, recycling and reuse will be promoted as well as zero net energy consumption of both passive and active systems, with 100 percent of water and waste to be recycled. It also plans to include an electrical power transportation system.

The continued occupation of ***Palestine*** constitutes a major deterrent for the state to take serious

## ARAMEX: SHIFTING TO A GREEN ECONOMY

**Raji Hattar**

Over the past ten years, we have seen a change in the way some corporates view sustainability across the Arab world. In the past, corporate activism was merely seen as a way to give back to the local community or support environmentally friendly initiatives. Organizing philanthropic activities, such as employee volunteering programs or donating to charities, broadly captured how these companies approached corporate activism. But with business dynamics changing, and some companies beginning to look for new ways to enhance performance, corporate activism is taking on a different role. Rather than being seen as only geared towards environmental and community development, corporate activism is starting to be viewed as a strategic investment for business development.

**What has facilitated this shift? There are four main drivers:**

First, staying in business. Regulations are raising the bar when it comes to environmental protection, and companies must find solutions to reduce their carbon footprint if they want to stay in business. In the UAE, Abu Dhabi introduced new laws in 2009 requiring all new building developments to adhere to green building codes. Dubai Municipality also introduced its green building regulations and specifications in 2011, which any new government building had to abide by. The government also recently announced its plans for a new federal environmental legislation, allowing the Ministry of Environment and Water to directly impose penalties on polluters and implement recycling and waste reforms. Corporates across the Arab world must become more environmentally friendly to continue to operate, and this trend will only grow as governments across the region introduce more environment-based laws.

Second, improving financial performance. Businesses increasingly realize the positive benefits corporate activism can have on their bottom line. A decade ago, running a successful business may have been broadly defined as 'output' - or what the company is capable of producing. An increase in share price, a newly acquired company, or expanding into a new market would all possibly contribute to stronger financial results. But what companies didn't always think about was that business growth could also come from cutting back. Minimizing operational efficiencies can significantly impact finances, and investing in initiatives that reduce water and electricity output can lead to an internal rate of return of up to 80 percent, according to consulting firm McKinsey. With more research and data in the public domain on this trend, companies quickly realize that half the battle in maintaining sustainable business growth is keeping operational costs low.

Third, maintaining and developing stakeholder relationships. Clients, employees, and investors are increasingly choosing to pursue relationships with firms that have active corporate activism programs. According to EY, many investors are finding companies' non-financial disclosures, such as their corporate activism activities, a prerequisite to making an informed decision about their future investments. Because of this growing trend, a lot of organizations are now required to include sustainability activities in their annual financial reports. There is no doubt that companies are seeing the value in robust corporate activism programs, as this has a direct impact on the decisions that existing and potential stakeholders make when it comes to pursuing a relationship with a business.

Fourth, becoming a market leader. Businesses are starting to see how corporate activism can raise industry standards and make them market leaders. Technology has played a major role in promoting this trend, with advancements over the past decade turning corporates on to the idea that they can outperform competitors if they have the right innovative, digitally based solutions in place. Some companies have been so successful in sourcing technology-based solutions that they have put competitors out of business, or significantly reduced their share in the market. So while corporate activism continues to support the environment and community, it now also has a material impact on the growth and success of businesses and their ability to lead in their sectors.

It is this holistic approach to corporate activism across the Arab world – one that focuses on the success of all aspects of a business - that will contribute to the development of the region's green economy in the future. We cannot go on managing businesses in ways that are inefficient or harmful to the communities where we operate. We also cannot go on only contributing to environmental and community initiatives, as this is just one piece of the bigger

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puzzle. Making our own businesses more lean and efficient is just as important as our ongoing dedication to the local environment and community-based initiatives. If we can get this balance right, I am confident that the region's economy will truly be green in the years ahead.

There is also a catalyst that companies can leverage to better and more quickly achieve this balance. As the Chief Sustainability Officer of Aramex, a company that is becoming technology-driven, I have seen first-hand the benefits digital solutions can bring to a business. We fully embrace this mindset when developing programs and activities for our corporate activism platform 'Delivering Good', putting technology at the heart of many of our programs. We currently have over 140 sustainability initiatives and projects in 97% of our locations around the world, and technology has been critical to ensuring that we truly can 'deliver good' in the markets where we operate.

For example, in recent years we have undertaken a number of technology-driven initiatives to achieve this balance between supporting the environment and community, while also making our operations more green and efficient. We are currently in the process of making all of our facilities entirely powered by solar technology. This has already been completed in Jordan, and we are in the final stages of obtaining the license to commence a similar project across Dubai. We continue to adopt global best practices in environment certifications and have Leadership in Environment and Energy Design (LEED) accreditations for our warehouses. We are also exploring options to make our Aramex fleet entirely electric. These technology-based initiatives have not only positively impacted the environment and communities where we operate, but have also made our business more sustainable.

When it comes to corporate activism, it's all about balance. We must deploy programs and initiatives that not only give back to the environment and communities where we operate, but that help us sustainably grow our own operations. Technology will also continue to play a fundamental role in how quickly we strike this balance and move towards a green economy. What is key is that we not only work hard to get there, but that we fully leverage technology in our everyday corporate activism practices moving forward. This will not only contribute to more efficient and successful business operations, but will also fuel the development of our future green economy.

measures for developing and implementing green and sustainable development policies. During the Israeli attack of December 2008-January 2009, more than 15 percent of available residential housing in Gaza was destroyed or partially damaged, and about 12,000 refugees lost their homes. Unemployment in Gaza continues to be a challenge and contributes to the overall impoverished situation of the population, placing Gaza among the poorest areas in the world (about 70 percent of the inhabitants live on less than $1 per day). However, this situation led the ILO, in collaboration with the United Nations Relief and Works Agency and the Cooperative Housing Fund, to develop a project to address immediate housing needs while at the same time increasing the possibility of generating job opportunities in Gaza. The new houses followed a green approach for construction, using compressed earth blocks instead of cement and other standard materials. The basis of this approach is grounded in the reuse and recycling of raw materials, eliminating steel reinforcement bars or concrete materials, saving energy and water and reducing waste and pollution.

***Saudi Arabia*** has recently launched its 2030 Development Plan, where sustainable development has been streamlined in the management of the country's resources. This has been translated in the following main priority objectives:

- Promote a sustainable petroleum industry within an environmental framework that ensures a healthy living environment and a balance between the consumption of natural resources and the achievement of development objectives without denying future generations access to these resources.
- The use of renewable sources of energy for the production of electricity and seawater desalination.
- Protection of non-renewable water resources and promote efficiency in the use of water.
- Promote the use of treated water for agriculture.
- Minimization of waste, recycling and safe disposal.
- Reduction of waste from factories and vehicles.
- Conservation of natural resources and natural reserves, including land, coastal areas, and biological diversity (Ministry of Economics and Planning, Kingdom of Saudi Arabia, the 10th Development Plan and its Priorities, 2016).

Investment in renewable energy is one of the main components of the plan, with the initial

target of generating 9.5 GW of renewable energy. It is also planned to localize a significant portion of the renewable energy value chain in the Saudi economy, including research and development, and manufacturing (2030 Vision, 2017). Saudi Arabia plans to invest between USD 30 to USD 50 billion in renewable energy by 2023. It also plans to achieve 4 percent contribution of renewable energy of total energy supply, amounting to 3,450 MW by 2020 (Ministry of Energy, Industrial and Mineral Resources, Kingdom of Saudi Arabia, 2017). Furthermore, The Ministry of Energy has recently announced the launch of its ambitious National Renewable Energy Program (NREP) (MOE, 2017). It is planned to generate 50 percent of the demand for electricity from non-fossil fuels by 2032 (SASIA, SAWIA, 2017).

***Tunisia*** has taken serious steps towards transitioning to a green and sustainable economy. The National Strategy for Sustainable Development of Tunisia estimates that green investments will reach 2 percent of GDP and is expected to create between 227,000 to 307,000 jobs, which is 7-9.5 percent of the total population. The government has also developed a national solar energy plan with the objective of increasing the percentage of renewable energy sources from 1 percent to 4.3 percent in 2014. The plan includes the use of solar photovoltaic, solar water heating and solar concentrated power units for electricity generation (UNECA, 2016). Moreover, the Tunisian Government has recently announced its plans to invest USD 1 billion towards the installation of 1,000 MW of renewable energy in 2017, 650 MW derived from photovoltaic power and 350 from wind (UNEP, 2017).

Moreover, Tunisia has recently launched a Green Economy Strategy with the following main objectives:

- Promoting sustainable agriculture
- Providing safe drinking water and sanitation for all citizens
- Promoting integrated waste management and recycling and reducing GHGs
- Reducing dependency on fossil fuel
- Enhancing the industrial sector through the use of clean technologies
- Improving mass transit system
- Promoting energy efficiency and eco buildings
- Promoting ecotourism (Green Economy Strategy, 2017).

Tunisia has had a successful wastewater treatment program since 1960. The number of wastewater treatment plants has gradually risen in the last decade. The largest wastewater treatment plant is situated in Choutrana with a daily performance of 120,000 $m^3$ (Bahri, 2002).The government plans to build four seawater desalination plants in Djerba, Kerkennah, Zaarat near Gabès and Sfax. The total installed capacity of the plants is 381,000 $m^3$ per day (GWI, 2014).

Plans are underway to produce solar water heaters (SWH) through the Biome Solar Industry (BSI) company for households, hotels, hospitals and the local stadium, with a capital investment of 400,000 Tunisian dinars (USD 50,000). The firm is classified as private, though it was established through strategic partnerships between public and private entities, including the National Agency for Energy Conservation, the Electricity and Gas Company of Tunisia, and the Professional Association of Renewable Energy, and with international partnerships (KBB/Germany and CEDRIS/France). BSI produces SWH according to international standards, which has facilitated its access to international markets. Market opportunities for SWH in Tunisia are enhanced through a subsidy system and through soft loans from commercial banks. Other drivers for industrial development include the year-round sunny climate in Tunisia and the high electricity and gas prices. BSI began producing SWH in 2007 and by 2011 its market share had reached 17 percent of the local market. The company expanded its operations by exporting to Morocco and France (ESCWA, 2013). Furthermore, the government plans to invest USD 15 billion in the energy sector with half of it in renewable energy with the aim of achieving self-sufficiency in energy by 2030. The World Bank, the European Investment Bank, and the African Bank for Development, as well as other organization in France, Belgium and Spain have expressed interest in investing in the energy sector in Tunisia, (RCREEE, 2016) with plans to generate 30 percent of electricity from renewable energy by 2030 (UNEP, 2017).

***Qatar*** has launched its Green Economy Roadmap and Energy and Environment Commission in 2014, which was led by the International Chamber of Commerce Qatar (ICC Qatar). The Roadmap aims at supporting the Qatar National Vision 2030 (ICC Qatar, 2014).

Qatar has created a Green Building Council in 2009 to promote the development of efficient and environment-friendly building practices. Since then Qatar has built several green structures and is now ranked the fifth highest Leadership in Energy and Environmental Design (LEED) registered and certified buildings outside the USA. Moreover, Qatar National Convention Center located in Doha is accredited for its approach to environmental stress mitigation. It is considered one of the world's most energy efficient convention centers in the world (Suresh, 2016).

In February 2006, through the Qatar General Electricity and Water Corporation (KAHRAMAA) and ESCWA, the country signed a cooperation agreement to develop an energy efficiency program for the Qatari electricity sector, which is expected to run until 2020. The aim of the program is to improve energy efficiency and increase the contribution of the energy sector in achieving sustainable development. In order to achieve this end, KAHRAMAA prepared detailed implementation plans for several energy efficiency projects such as: phasing out inefficient lamps in residential areas; setting new power factor limits in order to reduce losses during distribution, particularly for bulk electricity consumers; and improve energy efficient labelling for air conditioning units. In addition, KAHRAMAA started to organize a national conservation campaign (Tarsheed), which is now annually recognized on international Earth Day. This campaign aims to raise awareness on: 1) Increasing efficiency in the electricity and water sectors; 2) Decreasing per-capita electricity consumption by 20 percent and water consumption by 35 percent; and 3) Eliminating waste and reducing consumption (ESCWA, 2013).

Moreover, Qatar plans to build the largest 200 MW solar power project in the country. It will be constructed as a joint venture between the Qatar Electricity and Water Company and Qatar Petroleum. It is expected that the project will become operational by 2020. The project can be expanded to a capacity of 500 MW. It also plans to set up 1,800 MW of solar power capacity by 2020, which is expected to contribute up to 16 percent of total power generation, and plans to set up 10 gigawatts of solar capacity by 2030 (Mahapatra, 2017).

***The United Arab Emirates (UAE)*** was one of the first Arab countries to develop a Green Economy Strategy. The country's Green Economy approach was one of the key pillars for sustainable development, following the launch of the country's Green Growth Strategy almost a decade ago. The approach is part of the UAE Vision 2021 inspired by the National Work Program of the President His Highness Sheikh Khalifa bin Zayed Al Nahyan. This has been translated into action on the ground, which included undertaking major investments in renewable sources of energy and the introduction of energy saving measures in the building sector. Other measure included the introduction of an environmental friendly mass transport system. The UAE has also initiated a number of projects related to water recycling. Serious consideration is also being given to the use of solar energy in seawater desalination. The second edition of the UAE State of Green Economy Report was recently released by the Minister of Environment and Water.

Dubai encouraged green buildings by introducing in 2011 Green Building Regulations and Specifications, which is considered to be one of the most important legislations adopted by the government. Its main objectives are to protect its natural resources and the environment, as well as to ensure human health and welfare. Initially, the Dubai municipality only made the regulations and specifications mandatory for governmental buildings. The regulation was then made mandatory for all new buildings in Dubai. More than 44 green governmental buildings have been constructed so far (Government of Dubai, 2017).

The UAE's first World Green Economy Organization (WGEO) based in Dubai was launched in 2016 to promote a culture of green economy in the country, the region and around the world. The organization provides consultations and technical, financial and moral

support in the field of green economy. It also aims to be a primary reference for green sector parties undertaking research related to clean energy, the environment and human protection. The WGEO has been established through the support of the Dubai government in partnership with UNDP. The UAE has also created a new council in 2016 for Climate Change and Environment.

Masdar City is one of the main projects translating the green economy concept into a reality on the ground. Located in Abu Dhabi, the 6km$^2$ eco city project started in 2006. Its main source of electricity is solar and treated wastewater produced by the city's treatment plant is used for irrigating green public space. It is a car free city with space for walking and cycling. Other projects include renewable energy projects, the introduction of the Green Building Code in 2008, and the launch of a recycling program "Bee'Ah".

Moreover, in the field of tourism, Al Maha Resort is a world-class retreat where ecology has been put to work for tourism (AFED, 2008).

## III. FINANCING GREEN ECONOMY FOR SUSTAINABLE DEVELOPMENT

As far as financing of a green economy and sustainable development is concerned, it has been estimated that the financial requirements needed to transition to a green economy and implement sustainable development activities worldwide are in the range of USD 1.05-2.59 trillion annually. This figure is less than one tenth of the total annual global investment (measured by global Gross Capital Formation). In order to allocate an annual level of funding of USD 1.3 trillion, 2 percent of global GDP will be required to finance sustainable development (UNEP, 2011b). Applying the same percentage of 2 percent for Arab countries to support sustainable development activities, USD 57.38 billion (GDP USD 2.869 trillion – 2014) would need to be allocated annually for greening the Arab economies (AFED, 2016).

However, according to ESCWA, the financing gap in Arab countries is estimated between USD 80 to USD 85 billion per annum in 2015 and 2016. This estimate, which results in a higher estimate than the one based on 2 percent of GDP

as referred to above, is calculated using a balance of payment forecasts of the International Monetary Fund (IMF) and the Economist Intelligence Unit (EIU). These forecasts do not necessarily take into account additional and changed spending patterns geared to sustainable development, nor possible synergies between various sustainable development goals.

The financing gap was estimated on the basis of two scenarios, as reflected in Table 1. Scenario I depends on the latest forecasts provided by the World Economic Outlook Database and published by the IMF in October 2014. It includes projections for the current account balance and gross domestic product for most Arab countries, except Palestine and Syria. Scenario II is based on the forecasts of the Economist Intelligence Unit forecasts as of December 2014 and January 2015, and therefore reflects more accurately the impact of the recent drop in oil prices (ESCWA, 2015a).

The Arab region has supported international environmental programs through contributions to the Environment Fund of UNEP. Kuwait continues to be the largest Arab contributor to the Fund of UNEP, with USD 1.8 million during the period between 2008-2016, followed by the Kingdom of Saudi Arabia with USD 531,757 during the period between 2011-2015; UAE: USD 200,000 (2012-2016); Egypt USD 120,000 between 2008-2013; Morocco USD 87,599 between 2010-2015; Algeria USD 50,000 between 2008-2014; Jordan, USD 41,000 between 2012-2015; Lebanon USD 34,000 between 2008-2015; and Tunisia USD 32,400 between 2008-2015 (UNEP, 2017).

## TEN YEARS OF ACWA POWER AND CORPORATE RESPONSIBILITY

**Paddy Padmanathan**

Since 2007 the Arab region has undergone a number of changes because of economic cycles, movement of people and changes in attitudes to climate change and renewable energy. As a major regional producer of electricity and desalinated water, ACWA Power sits at the nexus of the water-energy-green economy. The challenges faced by this tripartite relationship have been discussed at many of AFED's conventions and meetings, and will be adopted as the structure for this look back.

It has long been recognized that the cornerstone of any green economy strategy needs to address the significant portion of locally produced hydrocarbons that are consumed to meet local demand. As such, the region has embarked on an aggressive strategy to wean itself from hydrocarbons by embracing energy efficiency, demand-side management, and most importantly by deploying renewable energy. In parallel, over the past decade the cost of photovoltaic panels has dropped by more than 80 percent, which has led to regional initiatives embracing utility scale projects and some of the largest renewable power plants in the world. This year, the Kingdom of Saudi Arabia sought bids from companies to build wind and solar plants with a total capacity of 700 MW as a start to meeting their goal of generating at least 9.5 GW of renewable energy by 2030. The government of Jordan has entered into multiple agreements for solar projects with a total capacity of 1000 MW to be operational by 2018. Last November saw the award of a 176 MWp photovoltaic (PV) plant in Morocco – a new phase in the NOOR Solar program that aims to develop a total solar capacity of 2 GW by 2020. Already 165MW of electricity generated from solar energy is powering thousands of homes during the day and for three hours in the night in Morocco.

In the early part of 2017 almost every Gulf Cooperation Council (GCC) member and regional state utility (service provider in the GCC region) have announced ambitious plans for photovoltaic and concentrated solar power projects. ACWA Power is proud to have been part of kick-starting this renewable renaissance with our, at that stage, lowest ever worldwide tariff of US 5.86 cents for the Mohammed bin Rashid Phase II 200 MW photovoltaic plant. The plant was successfully commissioned two weeks ahead of schedule in March 2017 and is now supplying

electricity to 50,000 homes in Dubai and reducing carbon emissions by 214,000 tons per year. Subsequent bids for utility scale photovoltaics have dropped still further which, coupled with the speed of installation as compared to fossil fuel power plants, makes the technology very viable and attractive.

The coming years will see a large-scale rollout of renewable power plants that will be supplying power around the clock using thermal and battery storage, making them base load plants. Battery technology, for the storage of electricity produced during the day and for delivery at night, is reaching an inflection point with its cost dropping and capacity increasing. ACWA Power is including the option for battery storage into current and future utility scale photovoltaic project proposals. In addition, desalination of water will be increasingly supplied using renewable power and hybrid technologies. The combination of both cheaper renewables and cheaper storage combined with the region's abundant solar potential (the majority of days per year are cloud free with high solar insolence in combination with available land in close proximity to existing transmission networks) is enabling a reduction on the dependence on fossil fuels as a base load.

The benefits of harnessing renewable energy to soften the water-power-development entanglement is now a foregone conclusion. These material changes in the affordability, maturation and demonstration of renewables' central role in providing energy and water to the region are the greatest paradigm shift since 2007.

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ACWA Power has been a strong advocate for consumers paying the full cost, or as close to it as possible, for the power and water they use without the support of subsidies. Over the past decade, all regional governments and state utilities have implemented pricing structures that have incentivized users, via slab pricing, to avoid excessive consumption. These policies have avoided rampant wastage of precious non-renewable resources, contributed to moderating investments and the need for new infrastructure and so reduced the carbon intensity of national economies. The strategic importance of demand-side management is now engrained into growth strategies. In parallel with these successful economic instruments, the region's growth and demand for power and water is still strong and growing rapidly to keep up with social economic development.

Finding funding for major developmental projects has been a bumpy road over the past decade, with some periods seeing liquidity and availability of financing while others have seen dramatic and acute reductions and increased risk aversion by funders. At the same time, local and international funding has increasingly embraced the Equator Principles as a benchmark for environmentally and social responsible lending. Nearly 80 financial institutions that have arranged around 80 percent of global project finance lending have adopted the Equator Principles. The principles set standards for environmental and social sustainability to ensure environmental and socials risks of any project are assessed and managed. ACWA Power has always ensured that the company's projects and assets comply with the World Bank and International Finance Corporation's Environmental and Social Performance Standards. These standards set by the global financial institutions are pushing the region and the supply chain to meet common international standards through financing projects. In addition, in recent years these standards have been included as a minimum requirement in requests for proposals from national utilities. This gradual maturation of environmental and social performance is another notable change that is welcomed as it has win-win benefits for all parties and stakeholders.

The final significant change has been the rise in the maturation of environmental and social reporting by public and private organizations. This change has been spurred by a combination of factors including organizations' strategies to become the "best in class" environmentally and socially, subtle pressure from central governments and the support

and encouragement of regional non-governmental organizations (NGOs). NGOs such as AFED continually emphasize the benefits of corporate social responsibility while simultaneously developing grassroots support and understanding. In parallel, there are several regional award schemes focusing on corporate social sustainability reporting and performance, which have become highly sought-after. The Global Reporting Initiative (GRI) standard for corporate reporting is commonly accepted as the good practice whereas in the past it was considered the standard. Reviewing international databases of regional corporate social reports demonstrates the evolution of corporate reporting which could only have come about by changes in corporate strategies and leadership. Sustainability reports of the sector's leaders now routinely include independent assurance statements as is common in Europe, which supports local and international stakeholders' requests for transparency. Overall, the development both in technical depth and breadth of adoption of corporate social reporting is an area to be watched for the future.

Looking back, it seems hard to believe that ten years have passed so quickly as ACWA Power and the region have both grown and changed tremendously. The continued reduction in the carbon intensity of power supply coupled with the increases in efficiency of consumption and a focus on responsible corporate behavior all bode well for a sustainable and successful regional green economy. Looking to the future I would expect the successes achieved by the sector's leaders and by multinational corporations to be adopted by the next tier and wave of entrepreneurs in order to take us even further, and to push the leaders to stay at the forefront of development.

TABLE 1 **Financing Gap Based on Two Scenarios (Billions of United States dollars)**

| Classification | Country | Scenario I* | | Scenario II** | |
|---|---|---|---|---|---|
| | | Financing gap/surplus 2015 | Financing gap/surplus 2016 | Financing gap/surplus 2015 | Financing gap/surplus 2016 |
| UMI | Algeria | -9.98 | -12.12 | -15.88 | -17.50 |
| HI | Bahrain | 2.86 | 2.57 | 1.35 | 0.77 |
| LDC | Comoros | -0.11 | -0.12 | -0.11 | -0.12 |
| LDC | Djibouti | -0.76 | -0.92 | -0.76 | -0.92 |
| LMI | Egypt | -17.57 | -21.72 | -11.45 | -13.64 |
| UMI | Iraq | 3.14 | 0.40 | 0.66 | 3.18 |
| UMI | Jordan | -6.34 | -5.06 | -4.60 | -5.26 |
| HI | Kuwait | 82.28 | 82.51 | 59.27 | 56.10 |
| UMI | Lebanon | -9.91 | -10.45 | -12.67 | -12.49 |
| UMI | Libya | -12.45 | -5.08 | -2.49 | -3.05 |
| LDC | Mauritania | -3.14 | -2.76 | -3.14 | -2.76 |
| LMI | Morocco | -9.09 | -8.92 | -6.80 | -7.30 |
| HI | Oman | 5.23 | 3.05 | -0.05 | 0.65 |
| LMI | Palestine | NA | NA | NA | NA |
| HI | Qatar | 58.73 | 50.82 | 17.07 | 17.58 |
| HI | Saudi Arabia | 73.73 | 63.70 | -5.73 | 0.26 |
| LDC | Somalia | NA | NA | NA | NA |
| LDC | Sudan | -6.22 | -6.29 | -6.22 | -6.29 |
| LMI | Syria | -4.51 | -4.20 | -4.51 | -4.20 |
| UMI | Tunisia | -4.79 | -4.39 | -5.70 | -5.74 |
| HI | United Arab Emirates | 51.79 | 50.17 | 28.36 | 19.27 |
| LDC | Yemen | -0.44 | -0.64 | -0.44 | -0.64 |
| **Number of Arab countries with financing gap** | | **13** | **13** | **15** | **13** |
| **Total financing gap (USD bn)** | | **85.32** | **82.69** | **80.19** | **79.92** |

*Mainly using IMF forecasts dated October 2014 for current account balances and GDP except for the Syrian Arab Republic where EIU forecasts were used due to the unavailability of forecasts by IMF. Principal repayments and disbursements of private debt were estimated in view of historical average levels. Net investment and portfolio flows were estimated as per the historical average to GDP.

**Mainly using EIU forecasts dated December 2014 and January 2015 for current account balances and GDP except for Comoros, Djibouti, Mauritania, South Sudan, the Sudan and Yemen, where IMF forecasts were used due to the unavailability of forecasts by EIU. Principal repayments and disbursements of private debt and net private investment and portfolio flows are estimated in a similar manner to Scenario I.

Source: ESCWA, 2015b

Total cumulative financing to Arab countries by the Coordination Group (CG) institutions[1], comprising major development funds operating in the Arab region, amounted to about USD 164 billion over a period of 40 years up to December 2015. Out of this, USD 90 billion, or 55 percent, was spent over the last ten years. This represents a sharp increase in financing development projects mainly related to infrastructure and environment, including renewable energy, wastewater treatment, food production, health and housing.

Moreover, the CG institutions committed about US dollars 107 billion over 2006-2016 to finance development operations in various sectors in Arab and other developing countries, with a share of about 48 percent for Arab countries.

With respect to Arab countries, the CG institutions supported 1,396 development operations, including renewable energy, wastewater treatment, agricultural and livestock products, education, health, and housing, which not only contributed to improving living standards, but also addressed environmental concerns through the implementation of renewable energy, wastewater treatment and other projects which contributed to protection of the environment (AFESD, 2017).

However, given that funding allocated covers environmental activities as well as other economic sectors, it would be rather difficult to precisely estimate the amount of financial resources allocated to green economy and sustainable development programs in the Arab region, as it should cover investments in green and sustainable agriculture, eco-tourism, green industries, sustainable cities and green buildings, mass transit systems, and integrated waste management systems.

Given that there is increasing recognition to the need and importance of adopting a green and sustainable development path, there is an incremental increase in green investments in Arab countries over the last decade and the trend is expected to increase in the coming years, particularly as Arab countries are bent on achieving the SDGs.

It should be pointed out though that countries adopting green and sustainable development strategies implies the gradual greening of national budgets and that the bulk of future investments should eventually be largely directed to fund green investments.

## IV. CONCLUSION AND RECOMMENDATIONS

It would be fair to conclude that apart from the lack of real progress in several Arab countries in the region facing political unrest and instability, other countries in the region have made strides towards shifting onto a more sustainable path, with major financial resources directed towards investments in environmental infrastructure. In several instances, the shift towards a green and sustainable economy was sparked by the sheer need to address critical problems and shortages in resources such as water, food, and energy. For example, major investments in energy efficiency and in renewable energy has been prompted by an increased demand for energy as a result of population increase, changes in consumption patterns, and increased rate of urbanization and economic activities. Investing in solar and wind energy represented cheaper, faster, and cleaner solutions to shortages in energy supply in several countries in the region. Water shortages in Arab countries have also led to investments in water efficiency and in renewable sources of water, including wastewater recycling, reuse and seawater desalination projects in many Arab countries.

In order to achieve food security, efforts in many Arab countries have been directed towards sustainable agricultural practices. This has included promoting efficiency in the use of water and energy and renewable sources of both. Moreover, adopting a nexus water, food, and energy approach is increasingly being considered in Arab countries in order to enhance synergies and complementarities between water, food, and energy policies in the region.

It should be emphasized that transitioning to a green economy as a tool to achieve sustainable development provides an opportunity for Arab countries to address main economic, social, and environmental challenges facing countries in the region. More efforts are therefore needed by Arab countries to develop and implement policies that contribute towards achieving sustainable

development. Providing the necessary finance is essential to fund a transition to a green economy and a sustainable development path.

The following are key recommendations for achieving this end:

### *National Level*

- Promote political stability and security in Arab countries as a necessary requirement for the formulation and implementation of long term strategic sustainable development plans.
- Promote a stable macroeconomic environment through predictable fiscal policies, regulations and market incentives.
- Raise awareness to the benefits of adopting a green economy approach by communicating to decision makers and different stakeholders, including the finance and private sector, and highlighting the financial, social and developmental gains of transitioning into a green and sustainable economy.
- Promote the adoption of an integrated approach in order to ensure the integration of social, economic and environmental considerations in policy and decision making and close coordination and inter linkages between sectoral policies.
- Design a package of coherent regulations and incentive measures that facilitates the transition to a green and sustainable economy.
- Encourage domestic and foreign investment by the finance sector in green infrastructure projects through a package of regulatory and incentive measures.
- Allocate sufficient financial resources for R&D and innovation and the development of green technologies.
- Further develop and strengthen local capacities needed to support green and sustainable development projects through formal education and vocational training.
- Designate a national institution to ensure the development and implementation of integrated sustainable development policies, plans, and programs, as well monitoring and evaluation.
- Promote green public procurement to include green consumable products, services, and fixed assets.

### *Regional Level*

- Enhance regional cooperation to end the state of occupation of Palestinian territories, hostilities and wars in the region.
- Promote the exchange of experience, knowledge, good practices and policies in the field of green economy and sustainable development, including the exchange of expertise.
- Promote regional cooperation among Arab countries in the field of innovation, research, and capacity development.
- Undertake joint regional projects in the field of sustainable agriculture, water, and energy.
- Promote market access and trade between Arab countries in green and environmentally friendly products.
- Create a regional university in the field of green economy and sustainable development in order to provide the necessary calibers needed to support the development and implementation of green and sustainable development strategies, plans and programs.
- Develop a regional plan for refugees in the Arab region to promote their integration in the economies of the host countries and contribution in the national sustainable development plans of those countries.
- Create an Arab Green Fund to finance green and sustainable projects in the Arab region, and consider the use of green bonds as a means to promote investments in this area.
- Convene an annual Arab conference on Green Economy and Sustainable Development in order to promote cooperation, exchange experience and knowledge in the field of green economy and sustainable development.

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## NOTE

1. The CG comprises of the Islamic Development Bank, Abu Dhabi Fund for Development, OPEC Fund for International Development, Saudi Fund for Development, Arab Fund for Economic and Social Development, Kuwait Fund for Arab Economic Development, Arab Bank for Economic Development in Africa, Arab Gulf Programme for Development, Arab Monetary Fund and Qatar Development Fund.

# WATER TRENDS

Waleed K. Al-Zubari and Alaa A. El-Sadek

## I. INTRODUCTION

The availability of water in the Arab region is scarce due to limited natural renewability of surface and groundwater resources, low water efficiency in both the supply and demand sides in the consuming sectors, and the continuous degradation and decline of supplies due to increasing pollution. During the past few decades, sustainable water provision to the various development activities has grown to be one of the most challenging tasks faced by the majority of the Arab countries. This is due to limited natural water resources and constrained financial resources on one hand, and the escalating sectoral water demands resulting from fast-paced socio-economic development activities on the other. Currently, the Arab countries are experiencing an alarming future of increasing water scarcity and growing costs of water supply, with implications not only for the future development of the Arab countries, but also for the sustainability of their economic and social achievements. Fortunately, all Arab countries have realized that efficient development and management of water resources requires water policy reforms emphasizing demand management and water efficiency, improvement of the legal and institutional provisions, and enhancement of stakeholder participation and the role of the private sector, with many countries taking major steps in this direction. Such trends needs to be encouraged and strengthened to enable the water sector to continue serving the socio-economic development of the Arab countries.

## II. WATER AVAILABILITY AND VARIABILITY

Water scarcity threatens development in the Arab region. Rainfall is low and variable, evaporation rates are high and droughts are frequent, which all contribute to low water resource reliability and availability. Arab countries cover 10 percent of the world's area but receive only 2.1 percent of its average annual precipitation. The region's annual internal renewable water resources amount to only 6 percent of its average annual precipitation, against a world average of 38 percent. Most of the region is classified as arid or semi-arid, receiving less than 250 millimeters of rainfall annually. Only southern Sudan, the southwestern Arabian Peninsula and the Atlantic and Mediterranean coastlines receive a high rainfall (UNDP, 2013). Moreover, the region experiences frequent drought cycles, which have been intensifying in recent years (Box 1).

Rapid population growth, since the mid-1970s, has caused a dramatic reduction in per capita renewable freshwater resources, currently reaching an alarming level below the water poverty line of 1,000 $m^3$/capita/year. During the period 2005 to 2015, annual per capita freshwater availability in the region dropped by about 20 percent, from about 990 to 800 $m^3$. The world average of 7,525 $m^3$/capita/year was about ten times more. In 2015, 16 of the 22 Arab countries fell below the water poverty line, and 13 are among the world's 19 most water-scarce nations (AFED, 2015). Per capita water availability in nine countries is already below 200 $m^3$, much less than the amount designated as absolute water scarcity of 500 $m^3$/capita/year (Figure 1). This means that about 40 percent of the Arab population is already living in conditions of absolute water scarcity (ESCWA and UNEP, 2015). These trends in the reduction of per capita water availability are expected to continue as population growth continues, and it is projected that by 2030, Iraq, Comoros, Mauritania and possibly Sudan could be the only Arab countries with an average above 1,000 $m^3$/capita/year.

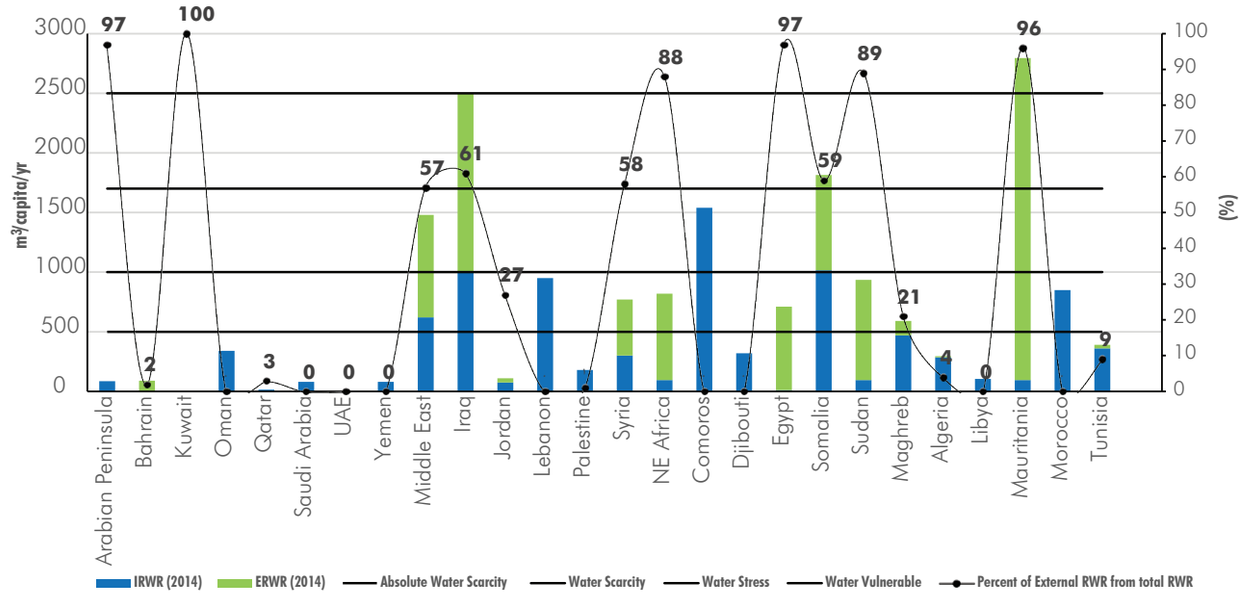
**BOX 1**

### INTENSIFICATION OF DROUGHT CYCLES

In Morocco, the drought cycle has accelerated from one year in every five-year period in the 1990s to one every two years, with droughts in 2012 and 2014. Extended drought in northeast Syria from 2006 to 2009 drove an estimated one million people out of their homes and farms to seek refuge in cities, and thereby reportedly contributed to the popular uprisings in that country (ESCWA, 2012). The Horn of Africa is experiencing one of the worst droughts in decades, which in Somalia has caused widespread resource-based conflicts between communities, population migration and recurrent famine .

(ESCWA and UNEP, 2015)

FIGURE 1 **INTERNAL AND EXTERNAL RENEWABLE WATER RESOURCES IN THE ARAB REGION**




Source: Mohtar et al ., 2017

However, it is estimated that by 2030, the effects of climate change will have reduced renewable water resources by another 20 percent (UNDP, 2013).

The current water situation is exacerbated by the fact that more than half of total renewable water resources in the Arab region (about 174 billion $m^3$/yr of a total of 315 billion $m^3$/year) originates from outside the region (water dependency ratio of 55 percent), with two thirds crossing at least one international border (ESCWA and UNEP, 2015). Thus, water availability and security in the Arab region has a political dimension, as it is largely dependent on the effective management of transboundary water resource between Arab states and between Arab and non-Arab states. Furthermore, some Arab countries are deprived of their water resources by occupying powers (Box 2), which is another major issue in the region and is constraining the development of the population of these countries.

Almost every Arab country depends for its water supply on rivers or aquifers shared with neighboring countries (UNDP, 2013). These include major rivers such as the Nile, Senegal, Tigris and Euphrates. Many smaller rivers are also shared between Arab countries, including the Medjerda and Orontes. Moreover, most large aquifer systems in the Arab region cross at least one international border, with many shared among Arab countries. Most of these aquifers contain non-renewable groundwater resources and lie deep below the Sahara Desert and the Arabian Peninsula (ESCWA and UNEP, 2015). Almost in all cases, riparian countries have not signed conventions and agreements on the equitable sharing and management of these water resources, which threatens the region's stability and food security, and complicates national water resources management and planning (AFED, 2016).

**BOX 2**

## ARAB WATER UNDER OCCUPATION

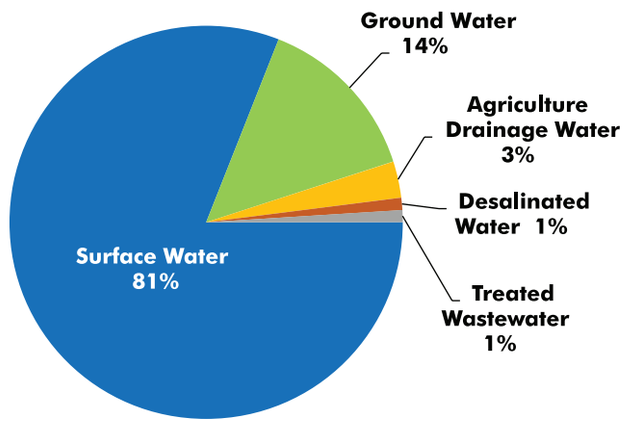
The fact that several water basins are shared with Israel further hampers constructive dialogue on shared water resources. Five riparian countries (Israel, Jordan, Lebanon, Palestine and the Syrian Arab Republic) share the Jordan River Basin, for instance, and control over its water adds to existing regional tensions. The impact of power asymmetry is clear: Israel is the largest user of water from the Jordan River Basin, and the only user of water from Lake Tiberias.

(ESCWA and UNEP, 2015)

## III. WATER RESOURCES, USES, AND CHALLENGES

To meet escalating demand, Arab countries rely on both conventional water resources (surface water and groundwater) and nonconventional (desalinated water, treated wastewater, irrigation drainage water, and water harvesting). Egypt, Iraq and Sudan depend primarily on surface water, while Jordan, Morocco and Syria depend more heavily on groundwater. All Arab countries are using more treated wastewater, and the desalinated water share is rising in the water budgets in Gulf Cooperation Council countries. Reuse of agricultural drainage water is practiced mainly in Egypt and Syria and at smaller rates in Saudi Arabia. The overall contribution of each water source in meeting the region's water requirements in 2016 is illustrated in Figure 2. The overall percentage contribution of these sources has not significantly changed since 2006, with a very small increase in desalinated water input, which is masked by the large volumes used from surface water and groundwater. However, at the sub-regional level, the contribution of desalination has been increasing dramatically in the GCC countries in their overall water budget, particularly in meeting municipal water sector requirements. The contribution of desalination to the total water budget in the GCC countries increased from about 7 percent in mid-2005 (fulfilling 56 percent of municipal water demands) to more than 20 percent in 2016 (fulfilling 75 percent of municipal water demands).

FIGURE 2 WATER RESOURCES IN THE ARAB REGION




Source: UNDP, 2013

The majority of water resources in the region are being used for agriculture (85 percent), while the municipal and the industrial sectors consume about 8 percent and 7 percent of the total water use, respectively (Figure 3). In the past ten years, a clear trend of sectoral water competition is observed. The region's overall sectoral water utilization percentages have been shifting from the agricultural sector towards the municipal and industrial sectors, where the agricultural sector used to utilize 88 percent of the total water consumption, followed by the municipal sector at 7 percent and then by the industrial sector at 5 percent. The trend reflects rapid urbanization and industrialization trends in the region, and is expected to continue in the future.

### *A. Water Resources*

#### *i. Surface Water Resources*

The Arab region contains 23 major watersheds with either perennial rivers or ephemeral streams, or wadis. The few medium-size rivers, mainly in Algeria, Lebanon, Morocco, Sudan, Syria and Tunisia, originate and flow within a single country's national boundaries. Some major rivers, such as the Euphrates, Nile, Senegal and Tigris, originate outside the region, while some others are shared among Jordan, Lebanon and Syria. Some Arab countries in the Arabian Peninsula also share a few wadis.

Several Arab countries with highly variable rainfall and transboundary waters have invested heavily in water storage and conveyance networks. These networks preserve water sustainability, ensure water availability despite erratic rainfall and reduce the risk of water-related disasters. Other countries, especially in hyper-arid areas, have built dams to recharge groundwater. The Arab region's dam capacity amounts to about 356 $km^3$ (World Bank 2007). More than 86 percent of this capacity is located in four countries with large, agriculture-dependent populations (Table 1): Egypt, Iraq, Syria, and Morocco. Large fluctuations in rainfall can impede dam functioning. Dams, constructed on the basis of past rainfall patterns, might not have enough water to meet customer demand when rainfall is lower than expected. The fill rate of Jordan's dams, for example, sank from 46 percent in 2010 to 33 percent in 2011, while that

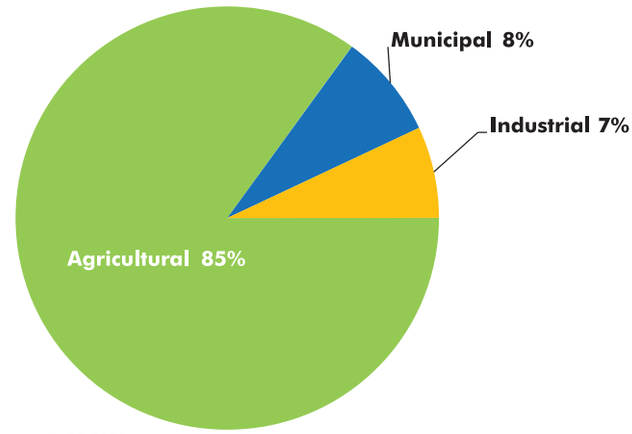
of Morocco's dams fluctuated considerably from 75 percent to 20 percent over the period 1986–2004 (UNDP, 2013).

### *ii. Groundwater Resources*

The Arab region's second major conventional water resource is groundwater. Shallow and deep groundwater resources, within or across national boundaries, are recharged by precipitation and by rivers. In the Arabian Peninsula groundwater contributes to more than 80 percent of total water withdrawals; in Jordan, Lebanon, and Tunisia it contributes to more than 50 percent. Even countries fairly rich in surface water are relying more on groundwater to meet steadily rising demand. Vast areas, spanning many Arab countries, contain non-renewable groundwater resources, or fossil aquifers. These resources are used mainly for agricultural expansion and development and with few exceptions without integrated planning. As surface water quality deteriorates, groundwater could become the main water resource for domestic use (UNDP, 2013).

Major geological structures and sedimentation processes control groundwater movement, exploitation and quality in both shallow and deep aquifers. Extensive, deep sedimentary formations in northern Africa and the Arabian Peninsula contain major non-renewable fossil aquifers, with very limited recent recharge (most recharge

FIGURE 3 WATER USES IN THE ARAB REGION




Source: UNDP, 2013

TABLE 1 TOTAL AND PER CAPITA DAM CAPACITY AND SHARE OF INDIVIDUAL COUNTRIES IN THE ARAB REGION

| Country | Estimated total dam capacity (cubic kilometers) | Share of total dam capacity in the Arab region (%) | Per capita dam capacity (cubic meters per inhabitant) |
|---|---|---|---|
| Algeria | 5.68 | 1.56 | 157.80 |
| Egypt | 168.20 | 46.30 | 2038.00 |
| Iraq | 151.80 | 41.79 | 4647.00 |
| Jordan | 0.27 | 0.07 | 43.43 |
| Lebanon | 0.23 | 0.06 | 53.53 |
| Libya | 0.40 | 0.11 | 59.89 |
| Morocco | 16.90 | 4.65 | 523.70 |
| Oman | 0.09 | 0.02 | 31.06 |
| Saudi Arabia | 1.00 | 0.28 | 35.75 |
| Syria | 15.90 | 4.38 | 893.00 |
| Tunisia | 2.50 | 0.69 | 237.10 |
| UAE | 0.06 | 0.02 | 7.74 |
| Yemen | 0.20 | 0.06 | 10.00 |
| **Total dam capacity** | 363.27 | 100 | 672.1541 (average) |

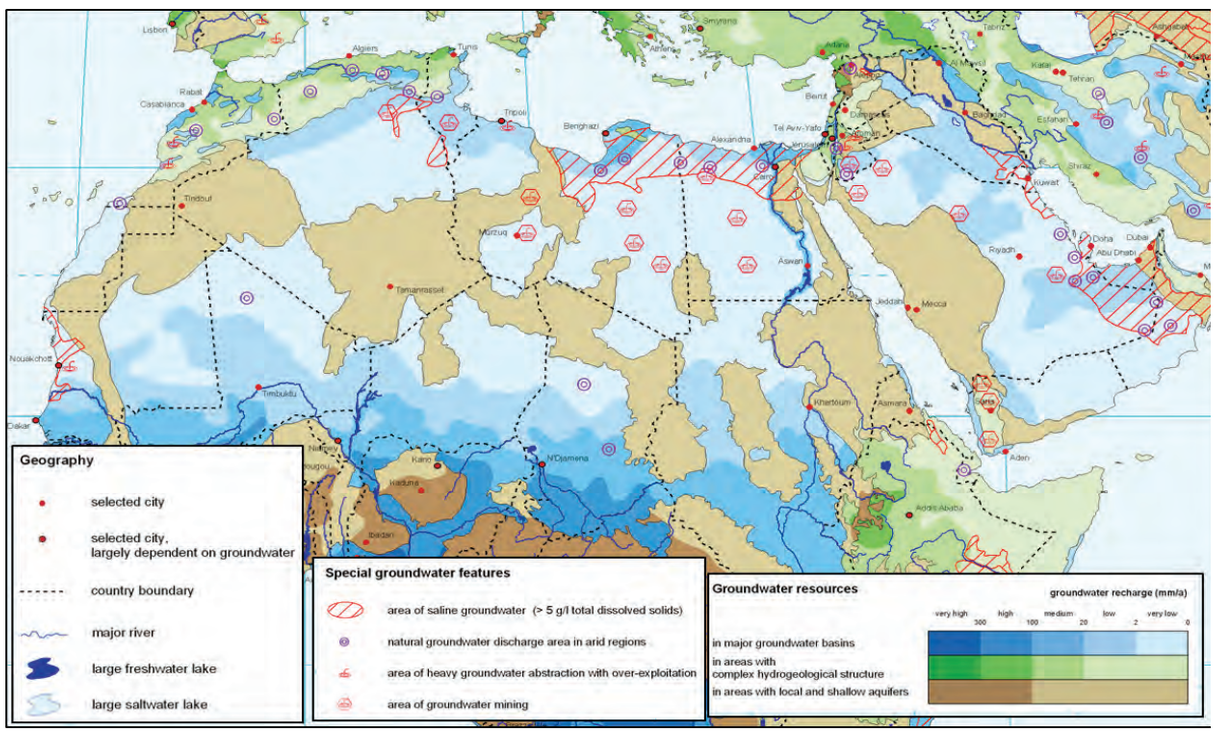
Note: Countries not listed have no dams.
Source: FAO 2013; World Bank 2007

occurred during wet periods 15,000–25,000 years ago). Unconsolidated deposits, mainly sand and gravel from the Neogene and Quaternary periods, form the shallow renewable aquifers under riverbeds, flood plains, deltas, wadi beds, major depressions and the interior coastal plains. Water quality varies widely, with a salinity range of 200–20,000 mg/L. The aquifers of the Tigris-Euphrates and the Nile and its delta, the intermountain valleys in North Africa and the wadis in the Arabian Peninsula store adequate reserves, with good water quality, and are frequently recharged from river flow and floods. These aquifers are used extensively for domestic water consumption and irrigation. Iraq, Jordan, the Arabian Peninsula and North Africa share many of the deep aquifers (Figure 4).

Most Arab countries, especially in the Arabian Peninsula[1] and the Maghreb region, draw heavily on groundwater resources (renewable and non-renewable) to meet their rising demand for water, particularly for irrigation and domestic consumption. Non-renewable groundwater resources are used in planned ways (for example, the Sarir basin in Libya and Al-Sharqiyah Sand and Al-Massarat basin in Oman) and unplanned ways (for example, Saq Aquifer, Disi Aquifer, Tawilah Aquifer and Sana'a basin in Yemen and the Palaeogene aquifer in the Arabian Peninsula), with unplanned use far more common (LAS, UNEP and CEDARE, 2010). Using groundwater resources beyond their natural replenishment rates has resulted in rapid depletion of aquifer reserves and salinization and deterioration in water quality due to seawater intrusion. In addition to overexploitation and quality deterioration, groundwater resources in most Arab countries are threatened by pollution from agricultural, industrial and domestic activities (UNDP, 2013).

Groundwater depletion and quality deterioration do not only lead to increasing scarcity but also have severe environmental impacts such as drying of natural springs and the degradation and destruction of their surrounding habitats and

FIGURE 4 **GROUNDWATER BASINS DISTRIBUTIONS IN THE ARAB REGION**




Source: BGR & UNESCO, 2008

ecosystems, as well as diminishing these areas' historical and cultural value and their investment opportunities (e.g., springs in the Syrian Palmyra oasis, south Algerian oases, natural springs in Bahrain, most of the oases of the Egyptian Western Desert, the Al Kufrah oasis in Libya, the Al Ahsa oasis in Saudi Arabia and the natural springs used to irrigate Tozeur and Kébili in southern Tunisia).

Overexploitation of groundwater also depletes national assets. While economic activities based on extracted water boost GDP in the short term, groundwater overexploitation, especially mining fossil water resources, erodes a country's natural capital and threatens irrigated areas in the long term. The value of national wealth consumed by overexploiting groundwater is estimated to have stayed over the last decade at as much as 2 percent of the GDP in four Arab countries (Figure 5; Ruta, 2005).

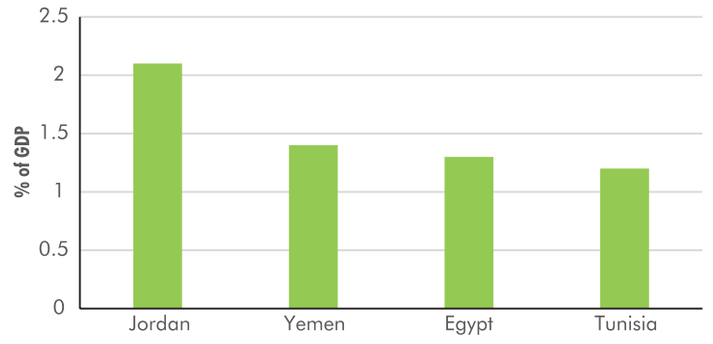
Therefore, it is vital to manage groundwater resources in the Arab countries as public goods by observing their natural recharge rates in order to have them continue to contribute to sustainable socio-economic development. On the other hand, sustainability for non-renewable resources must be clearly defined in socio-economic and physical contexts that fully account for the immediate benefits as well as the longer-term negative consequences. Groundwater reserves must be used with maximum hydraulic efficiency and economic productivity. The management goal would be to use aquifer reserves responsibly, in accordance with expected benefits and predicted impacts over a specified time frame.

With demand rising and supplies dwindling, Arab countries have drawn heavily on nonconventional water sources, including desalinated water, treated wastewater and other sources such as rainwater harvesting, cloud seeding and recycling of irrigation drainage water. The following is a brief of the three most important sources: desalination, treated wastewater, and agricultural drainage water.

### *iii. Desalination*

The Arab region leads the world in desalination, possessing more than half the world's desalination capacity (Jagannathan, et al. 2009). Although desalinated water contributes to only a very small share of Arab countries' total water supply (1.8 percent), it accounts for nearly all the water supply for many Arab cities, especially in the GCC countries. Growth in desalination capacity is expected to remain high for the next decade to meet escalating domestic water demand, and the overall share is expected to grow to reach about 8.5 percent of the region's total water supply by 2025 as a result of industrialization, accelerated urbanization, population growth and depletion of conventional water resources. This is consistent with global trends; the capacity of desalination plants increased by nearly 60 percent between 2008 and 2013 (IDA 2014).

FIGURE 5 **VALUE OF GROUNDWATER DEPLETION IN SELECTED ARAB COUNTRIES**

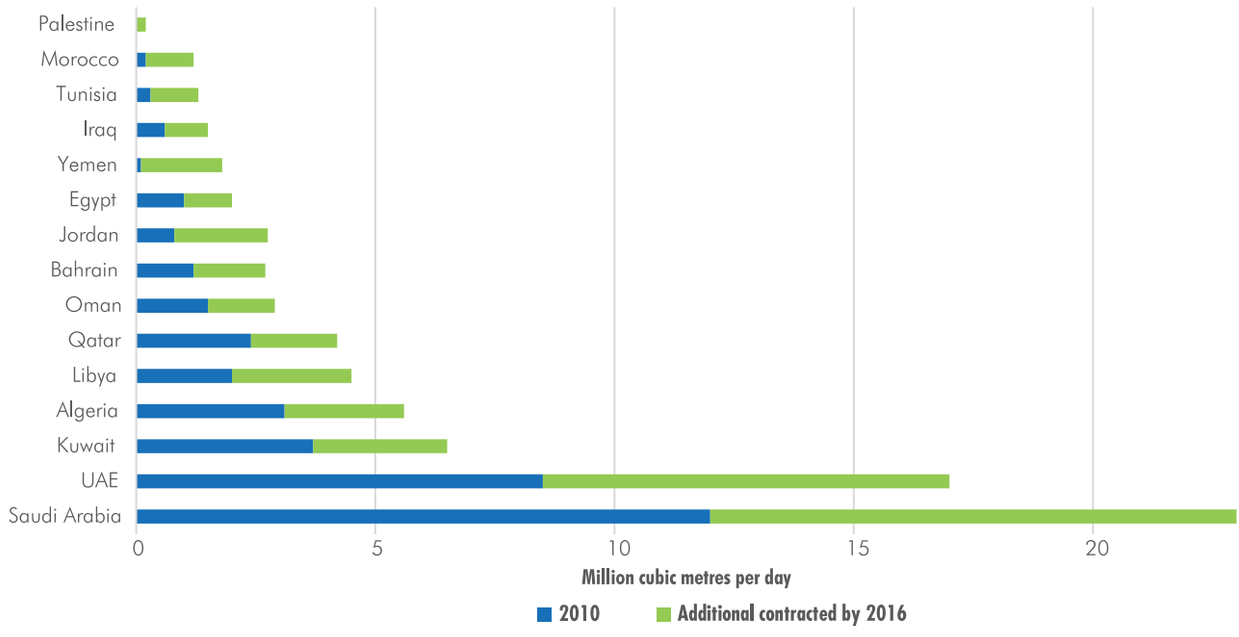



Source: Ruta, 2005

The total cumulative desalination capacity in the region is about 24 million $m^3$/day. The highest desalination capacity is in the GCC countries (81 percent), Algeria (8.3 percent), Libya (4 percent) and Egypt (1.8 percent). Most of the anticipated increase in capacity will be concentrated in the region's hyper-arid, high-income, energy-exporting countries, such as the Gulf countries (Figure 6), where it will be used to supply water to cities and industry (Al-Jammal and Schifffler, 2009). More than 74 percent of the water supplied to cities in the Gulf countries comes from desalinated water, used directly or blended with groundwater (GCC SG, 2016). This share is expected to rise as groundwater resources continue to deteriorate.

Desalination is an energy- and capital-intensive process, with costs depending on

FIGURE 6 ACCUMULATED DESALINATED WATER IN SELECTED ARAB COUNTRIES IN 2010 AND 2016




Source: GWI, 2010

energy requirements, water production costs, technology growth trends, and environmental impact. A generally observed trend in the past decade is that with improvements in desalination technologies, production costs are dropping. New technologies, such as reverse osmosis, electro-dialysis and hybrids, are more energy efficient and better suited to different types of water. These advances drove down global prices for multistage flash technology to drop from about USD 9 in the 1950s to about USD 0.80–0.50 in the mid-2000s (Zhou and Tol, 2005). The downward trend in the cost of desalinated water indicates that desalination technology might be becoming more viable for poorer countries.

Desalination raises energy security concerns and energy consumption creates a larger carbon footprint, although in GCC countries it takes place mostly in thermal-powered co-generation stations that produce both water and electric power, thereby improving energy efficiency and cost effectiveness (IEA-ESTAP and IRENA, 2012). The GCC countries are also increasingly concerned about the threat to marine life and ecosystems posed by water discharged from desalination plants (World Bank, 2012).

Despite having half the world's desalination capacity, Arab countries devote little research and development (R&D) to these technologies, which are all imported. In addition, the desalination industry contributes only a limited added value in fabricating equipment, refurbishing plants, localizing operations and maintenance, manufacturing key spare parts and training local labor (Bushnak, 2010 in AFED 2010).

The large anticipated expansion in desalination plants requires a review of policies and practices, including ways to increase capacity, knowledge and value added to the local economy. In the Arab region, local capacity and knowledge focuses on operations and maintenance, ignoring plant design, manufacturing and construction, even in countries that depend heavily on desalination to meet domestic water demand. The current local talent is not adequate to meet the enormous demand for technicians and engineers. By designing incentives for local businesses, governments can attract local investments

in manufacturing key desalination plant components and cultivating local innovations to attain economic sustainability (Bushnak, 2010).

### *iv. Treated Wastewater*

In general, generated, treated, and reused wastewater volumes have been increasing in the Arab region; however, these volumes are not increasing at the same rates, where treated and reused wastewater volumes far lag behind volumes of water generated. The spread of water reuse has been uneven and generally slow across the Arab region, despite its ranking as the most arid and water-scarce in the world. Wastewater reuse potential has not been harnessed yet in the region. Currently, Arab countries produce an estimated 10.8 billion $m^3$ per year of wastewater[2]. Around 60 percent of collected wastewater but only 20 percent of generated wastewater is treated (2.17 billion $m^3$/year), which is considered as major lost opportunity under the prevailing scarcity conditions of the region. The rest of wastewater is being discharged to open water channels, the sea or ground reservoirs, raising concerns for public health and the environment (ESCWA and UNEP, 2015). If all municipal wastewater were properly treated and reused, it could support water demand in some sectors, such as agriculture and industry, while avoiding many health and environmental problems (UNDP, 2013).

Treated wastewater is reused in agriculture, landscape irrigation, industrial cooling, and groundwater recharge. Egypt, Saudi Arabia, Syria and the UAE account for more than 75 percent of total reused wastewater in the Arab region (ESCWA and UNEP, 2015). The reuse of treated municipal wastewater has been increasing to meet escalating water demands. Water scarcity, financial capacity and agricultural sector importance shape wastewater treatment and reuse. While most of the region has programs for reusing treated wastewater in irrigation (fodder crops, cereals, alfalfa, and olive and fruit trees are irrigated mostly with treated water), few countries have institutional guidelines for regulating treated wastewater (AFED, 2010). Concerted efforts, supported by regional and international organizations, will be needed to overcome economic, institutional, health and environmental obstacles in order to increase the volume of treated wastewater that is reused.

The reuse of treated wastewater in the Arab region targets agriculture predominantly (e.g., Tunisia, Syria, Jordan), with irrigation for landscaping and golf courses and parks also on the rise in many countries (e.g., GCC), which seems to be more economical (Box 3). Moreover, the potential for treated wastewater reuse in the industrial sector is also large, especially in the non-food and beverages industries. The main

**BOX 3**

#### POTENTIAL WASTEWATER REUSE IN THE INDUSTRIAL SECTOR

Foulath Holding is located in the Hidd industrial area in Bahrain. It consists of three companies: Bahrain Steel producing high quality Direct Reduction grade iron oxide pellets; SULB producing steel beams and sections as finished products; and United Stainless Steel which produces stainless steel cold rolled sheets. The three companies use about 2.7 million $m^3$ per year (7,250 $m^3$/day) in processing, cooling, and landscaping. These volumes are withdrawn from the municipal water supply network owned and operated by the Electricity and Water Authority (EWA). EWA tariff for industrial uses are set to achieve operation and maintenance cost recovery at about USD 2/$m^3$, leading to high water costs estimated at more than USD 5 million/yr. On the other hand, a tertiary treated wastewater plant located in the same area (Hidd) is producing about 27 $Mm^3$/year (75,000 $m^3$/day) of tertiary treated wastewater, and due to the lack of conveyance infrastructure it is currently discharging it into the sea. On the long run, it might be more feasible economically for the company to use this tertiary treated wastewater in its non-potable uses than continue with the potable water supplied by EWA.

Similar infrastructure problems exist in many Arab countries where wastewater is generated at urban centers that are far from the agricultural lands. For example, in Saudi Arabia and Kuwait large amounts of treated wastewater are available at major urban areas, which are located at relatively far distances from the agricultural areas, posing the problem of transportation of this water and the economic costs of the conveyance infrastructure.

constraints for treated wastewater reuse in the Arab region are: 1) high cost of wastewater treatment and conveyance infrastructure; 2) insufficient economic analysis on wastewater treatment infrastructure projects; 3) technical and social issues affecting the demand for reclaimed water; 4) low pricing of irrigation water that does not adequately reflect its cost; 5) difficulty in creating financial incentives allowing safe and efficient reuse (World Bank, et al. 2011).

### *v. Agricultural Drainage Water*

Some Arab countries draw heavily on reused irrigation drainage waters. Egypt and Syria use the most nonconventional irrigation water: Egypt reuses agricultural drainage water amounting to about 7.5 billion $m^3$ annually and Syria reuses about 2.3 billion $m^3$. Despite the benefits, reusing drainage water damages the Nile's water quality; salts, pesticides and industrial and municipal effluents in the water harm human health and the environment. A long-term policy and a comprehensive monitoring program are needed to improve the efficiency of drainage water reuse and limit its polluting impact. Egypt has operational guidelines for reusing drainage water as a part of its horizontal land expansion program, including evaluating water availability, assessing water quality and examining the socio-economic aspects for landholders.

## *B. Water Uses*

### *i. Municipal Sector*

In almost all Arab countries, rapid urbanization challenges efforts to meet rising domestic water demand, especially in countries with tight budget constraints. During the period 2005-2015, urbanization increased from 67 percent of the Arab population to about 70 percent, and it is expected to continue to increase by the same rate in the next ten years to reach 73 percent by the year 2025 (UN Urbanization Prospects, 2014). Along with this relatively rapid urbanization rate, domestic water consumption has increased from about 14 billion $m^3$ in the early 2000s to about 20.4 billion $m^3$ in 2011 (UNDP, 2013). It is expected that the municipal water demand is to escalate in the future to match the rapid urbanization rate, and it is expected to increase to about 30 billion $m^3$ in 2025 (Hamoda, 2004), constituting more than a 50 percent increase over a ten-year period.

In addition to population growth and urbanization, the rapid increase in urban water demands in the region can be explained by several factors, including a rise in per capita consumption, large losses in the supply network, and the absence of recycling programs within the sector. Municipal and domestic water demands have been exaggerated by the level of per capita consumption in many countries in the Arab region. Average per capita domestic water consumption in the Arab region is about 200 liters/day, but varies considerably, both among and within countries, reaching more than 500 liters/day in some GCC countries (Figure 7). There is generally a clear relation between per capita municipal water consumption and the income levels of the countries (Figure 7); domestic water consumption can significantly increase with the rise of living standards if water use efficiency and demand management policies and interventions are not put into place. However, recently in 2016, there has been a change in the municipal water tariff to encourage conservation and enhance cost recovery in Saudi Arabia, the UAE and Bahrain (see section VI on Water Pricing Reforms).

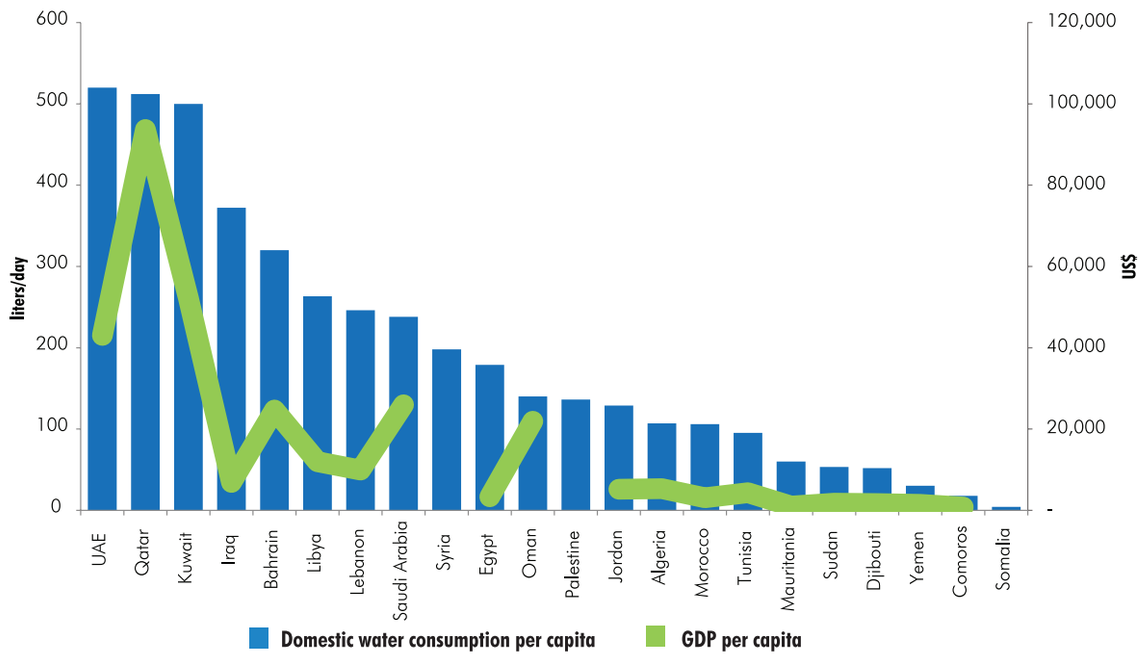
The other major factor in exaggerating the municipal water supply is the high percentage of physical losses in the distribution network. There are no exact figures on the physical leakage in the municipal distribution network in many Arab countries. However, non-revenue water (NRW[3]) can be taken as an indicator for the real physical losses, as they typically represent the major component of NRW. In many Arab cities, NRW can reach more than 60 percent in poorly maintained distribution networks, and is generally high in both the financially capable and incapable countries. Reducing such high losses by efficiency measures can often obviate or delay the need for physical infrastructure investments, reducing burden on current financial and energy resources and providing real gain to society.

Many Arab countries have given the losses in the municipal distribution network (both real losses and apparent losses) their adequate attention and have made programs to minimize these to the acceptable international norms. A very good example is KAHRAMAA in Qatar. This successful program has succeeded in reducing NRW from 59.1 percent in 2007 (real losses = 33.6 percent and apparent losses = 17.7 percent) to 19.6 percent in 2012 (real losses = 6.8 percent and apparent 12.7 percent). Similarly, in the UAE, DEWA in Abu Dhabi has reduced the total physical losses from its distribution network from 42 percent in 1990 to 11 percent in 2012, which is very close to the acceptable norms in developed countries such as the United States (10-15 percent). In Syria, an eight-year project on reducing physical leakage in Damascus has led to a decrease from 36 to 20 percent.

### *ii. Agricultural Sector*

Although urban demand for water has been rising steadily, agriculture continues to consume most of the water in the Arab region. Agricultural water use rose from about 165 billion $m^3$ in 1995 (ACSAD, 1997) to more than 218 billion $m^3$ in 2012/2013 (UNDP, 2013) – an increase of about 32 percent in 15 years. However, despite this increase, agricultural performance and food production failed to advance in many Arab countries (Dabour, 2006; AFED, 2014). Over the last three decades, the Arab region has experienced a development boom with rapid population growth. To meet the accompanying

FIGURE 7 **PER CAPITA DOMESTIC WATER CONSUMPTION IN THE ARAB COUNTRIES IN 2011 AND GDP PER CAPITA IN 2010-2014.**




Source: World Development Indicators: http://data.worldbank.org/indicator

rising demand for food, many countries have prioritized food security and socio-economic development through policies to expand agricultural land and irrigated cultivation. Despite this, they have failed to consider water's limited availability and the need for water use efficiency, conservation and demand management (LAS, UNEP, and CEDARE, 2010).

While agricultural water consumption is being driven by national agricultural development and food policies, the consumption sector is exaggerated by a number of factors that are related directly to water use efficiency. The most important of these factors are: 1) the predominance of traditional irrigation methods (flood irrigation); 2) unrestricted surface water and groundwater abstraction; 3) absence of water tariff for water use in agriculture which does not provide any incentive for water conservation; and 4) cultivating high water consuming crops. In the Arab region, about half of irrigation water is wasted because of inefficient irrigation methods (Abu-Zeid and Hamdy, 2004).

Surface irrigation is the most widely used method in the region and is practiced on about 85 percent of the irrigated area, followed by sprinkler irrigation, which is practiced on about 12 percent of the area. The more efficient micro-irrigation is practiced on only 3 percent of irrigated area (FAO 2011; LAS, UNEP, and CEDARE 2010). Some studies estimate that irrigation efficiency in the Arab region is as low as 30-40 percent (AFED, 2010). Such waste leads to weak agricultural performance and, more dangerously, salinization and water level decline due to overuse. Agricultural practices are also contributing to increased soil and water salinity, toxic pollution from agrochemicals, the loss of biodiversity through wetlands destruction and the construction of new dams (AFED, 2010; LAS, UNEP, and CEDARE 2010).

With about 85 percent of water used in the Arab region consumed by the agricultural sector, the sector in which water losses are the highest, it becomes imperative for Arab countries to focus their efforts on improving the water efficiency in agriculture. The prospect to save water is notably higher here than in other sector. For instance, in the Arab countries in North Africa, which allocate more than 80 percent of their water resources to agriculture, reducing conveyance losses by 50 percent and improving irrigation efficiency from 40-50 percent to 80 percent could save nearly 52 BCM a year, or more than 40 percent of the region's water losses, and thus provide an additional supply of nearly 20 percent. Possible untapped savings in irrigation constitute more

than 70 percent of water savings (Mehmet and Biçak, 2002).

### *iii. Industrial Sector Water Use*

As in the municipal and agricultural sectors, water consumption in the industrial sector in the Arab region has been increasing with time. In the mid-1990s the total water consumption of the industrial sector was about 10.1 Billion $m^3$ (ACSAD, 1997) and represented about 5.5 percent of the total water consumption. In 2011, the industrial sector was reported at 17.1 Billion $m^3$ (UNDP, 2013) with a share of 7 percent of the total water consumption. The main sources of supply of the industrial sector are surface and groundwater, with relatively smaller amounts of desalinated water.

The main driving force for the increase of water consumption in the industrial sector is the implementation of economic diversification policies towards industrialization in many countries (e.g., manufacturing, mining, cement factories, food industry, and many others). For example, since the early 1990s the GCC countries have implemented policies of economic diversification to other non-oil and gas industries and manufacturing in order to lower their vulnerability to oil price fluctuations. The total water consumption in the industrial sector in the GCC countries increased from about 321 million $m^3$ in the mid-1990s (1.3 percent of total water consumption) to about 1.3 billion $m^3$ in 2012 (5.3 percent of total water consumption) (AFED, 2015).

Undoubtedly, the current increasing industrialization trends in the Arab countries will be associated with increasing water demands as well as with industrial wastewater generation. These trends are expected to continue in the future, and will have impacts on the overall water management system, not only in terms of the amounts of water utilization by the sector, but also in terms of the potential pollution resulting from the sector. The latter issue will require major attention and measures to mitigate the negative impacts resulting from industrial effluents (air, liquid and solid) by providing legislation and economic incentives and disincentives for the use of appropriate technology, imposing appropriate fees for the discharge of industrial wastewater and other industrial wastes (i.e., applying the "polluters pay" principle), and establishing and enacting legislation on treatment and reuse of wastewater in the industrial sector (AFFD, 2015). Moreover, alternative water sources such as treated wastewater can provide a source of low-grade water for many industries (Box 3) that do not need high-grade water (e.g., construction industry, chemical plants, metal working facilities, oil industry and enhanced oil recovery). However, pre-treatment might be necessary to meet the required quality for some industries. In either case, there is a need to audit and account for the industrial water use and its supply sources within the national water budget of Arab countries. In addition, it is important to identify the nature of water use and required associated quality in the various industrial subsectors, and to forecast the sector's future water demands and its impact on the overall water consumption as well as its wastewater discharge. The absence of this information limits the effective water management in the sector and hinders opportunities for sustainable consumption and production.

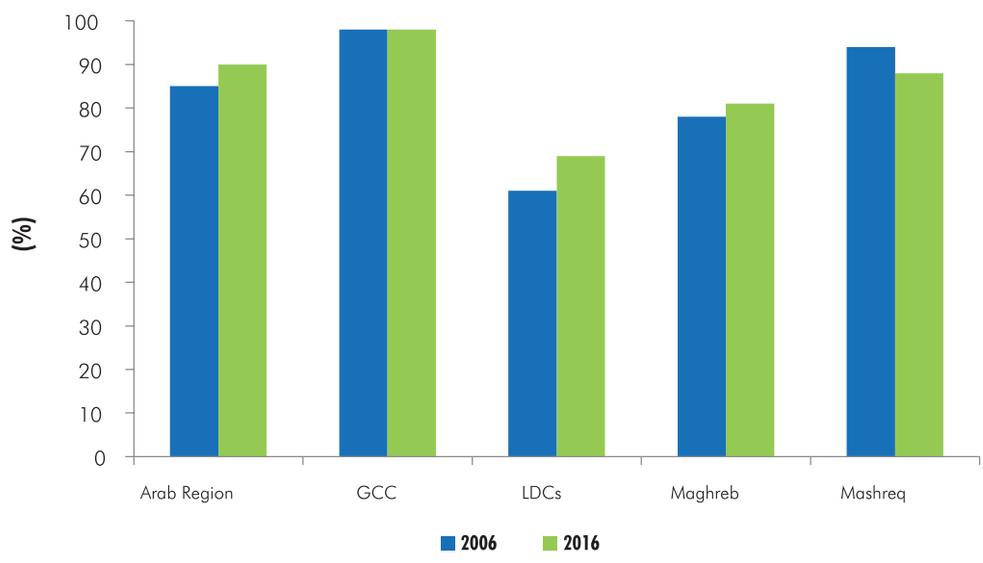
## IV. MOVING FROM WATER MDGs TO WATER SDGs

Across the region, the proportion of the population with access to safe drinking water has improved between 2006 and 2016 (Figure 7), rising from 85 percent to 90 percent, which is almost equal to the global average of about 91 percent in 2016. In absolute figures, millions of people have been provided with access to drinking water since 2006. The progress in access to safe drinking water was made in most of the region, except in the Mashreq where the proportion of the population with access to safe drinking water has deteriorated between 2006 and 2016 (Figure 8), decreasing from 94 percent to 88 percent. New challenges in these countries are attributed to occupation, conflicts and instability, water shortages, inadequate water management, lack of financial resources and insufficient investments (AFED, 2016). Access to water, as well as sanitation, generally deteriorates in conflict and post-conflict contexts, where infrastructures may be destroyed and investments in improvements delayed (UN and LAS, undated).

However, it should be noted that in many Arab countries with access to improved water sources, water is received only intermittently and may not be suitable for drinking. Furthermore, there is a large disparity in access between the urban and rural population in many Arab countries, indicating the wide urban-rural divide (Figure 9); the percentage of the urban population with access to improved water sources (89 percent and 90 percent in 2006 and 2016, respectively) is higher than in rural areas (77 percent and 85 percent in 2006 and 2016, respectively). It is worth mentioning that in 2016 that the percentage of the rural population of the Arab region with access to improved water sources (85 percent) was slightly higher than the world average (84 percent) (The World Bank, DataBank World Development Indicators, 2016).

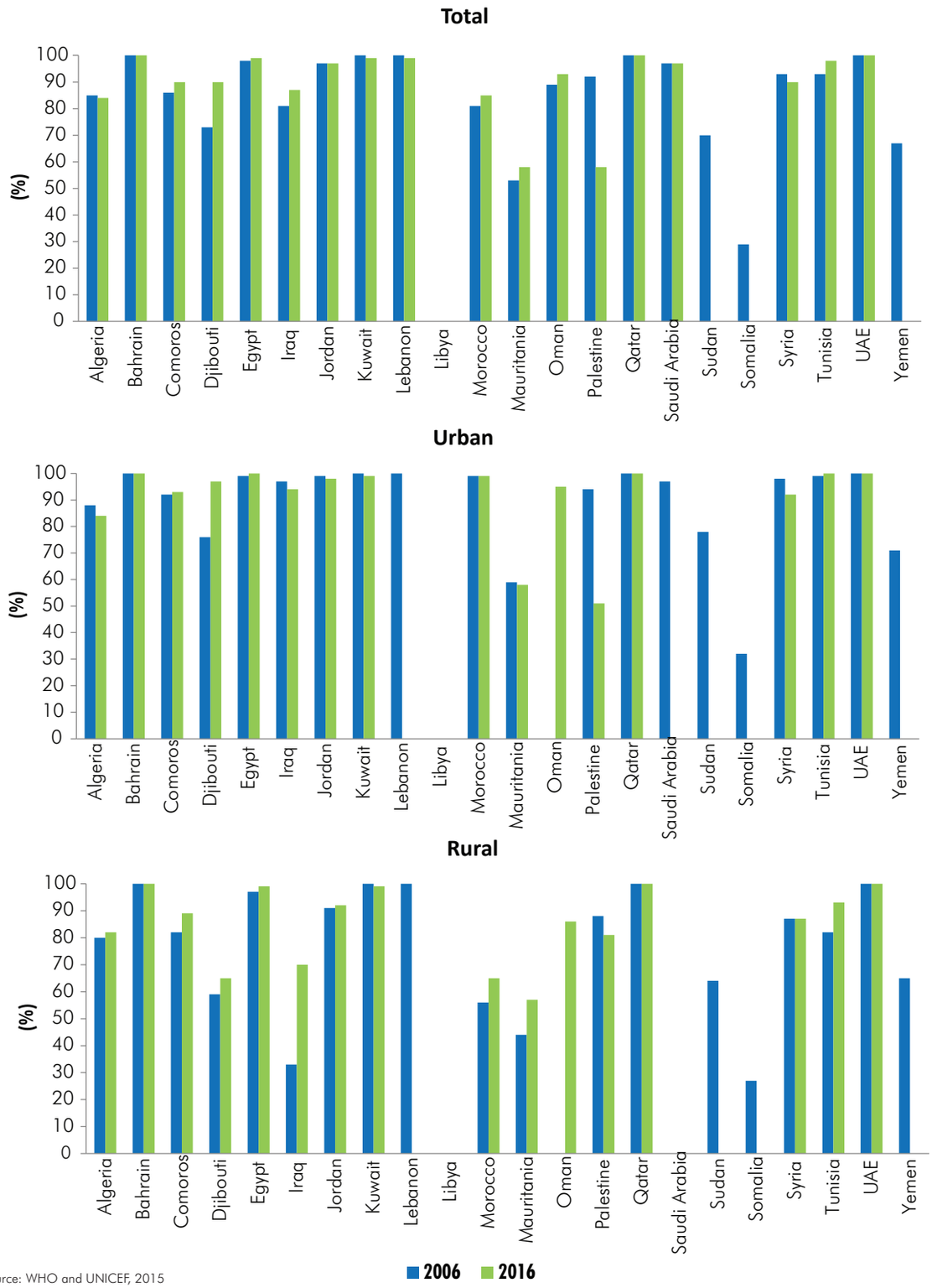
In terms of access to improved sanitation facilities, there has been considerable progress in the Arab region. Between 2006 and 2016, access to improved sanitation facilities increased in the entire Arab region, reaching 85 percent of the population (Figure 10), well above the global average of 67.5 percent in 2016. However, despite this progress there are still about 66 million people in the Arab region who do not have such access (ESCWA, 2015). Moreover, the disparity between urban and rural areas is greater for access to improved sanitation facilities than in

FIGURE 8 **PERCENTAGE OF POPULATION WITH ACCESS TO AN IMPROVED WATER SOURCE, 2006 AND 2016**




Source: The World Bank, DataBank, World Development Indicators, 2016

FIGURE 9 **PERCENTAGE OF TOTAL, URBAN AND RURAL POPULATIONS WITH ACCESS TO AN IMPROVED WATER SOURCE IN 2006 AND 2016**




Source: WHO and UNICEF, 2015

the case of access to an improved water source. The greatest disparities are observed in the least developed countries (LDCs) (Figure 11).

It is clear that the challenges faced by many Arab countries in achieving their water-related MDGs will continue in the future in their efforts to meet the water-related SDGs (Box 5). In fact, these challenges might be even more pressing due to many factors, the most important of which is limited financial resources in the face of increasing population, being compounded by other driving forces including conflict and instability, low cost recovery, and the impacts of climate change.

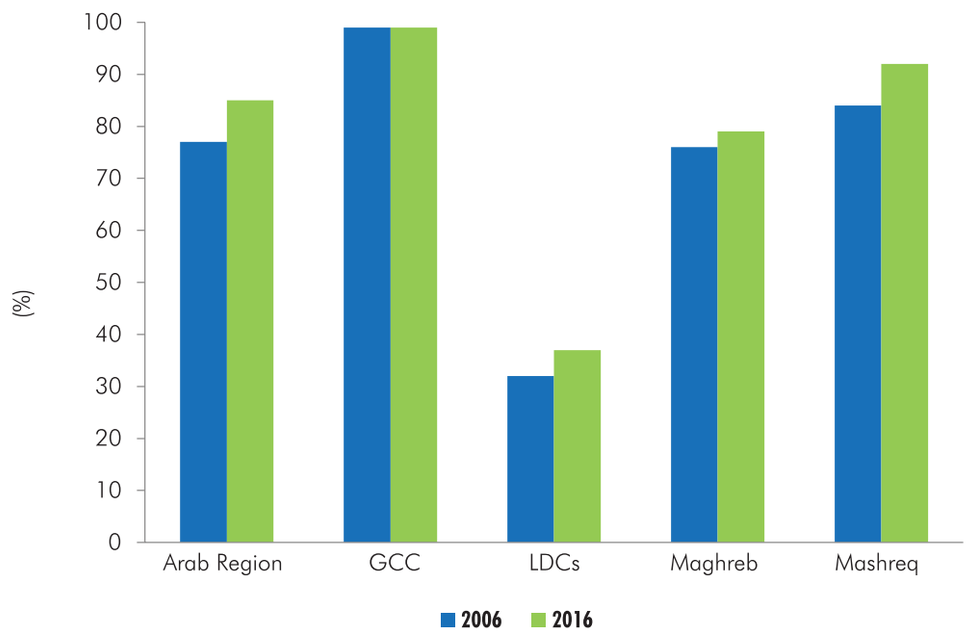
Achieving the water-related SDGs will require large investments and improved water technology across the region. Many Arab countries rely mainly on imported water-technology, such as desalination and water treatment, while the domestic private sector role is still limited in the majority of the Arab countries. Most water utilities in the region are caught in a vicious cycle of poor services, low tariffs because of subsidies, and low consumer expectations about services, leading to consumer resistance to price increase (UNDP, 2013).

In almost every Arab city, insufficient revenue is collected to cover water supply and operation and maintenance cost, let alone depreciation of assets. Socio-economic policies on water pricing prevent cost recovery, discourage maintenance spending, lower service quality and threaten financial sustainability of utilities. Water users should pay the full cost of the services they use. Full cost recovery could create the incentives needed to improve water services. This should be made under carefully and transparently targeted subsidies to ensure that poor people have access to water services and to avoid any negative social equity impacts (World Bank, 2007).

## V. REGIONAL ARAB INITIATIVES AND COORDINATION

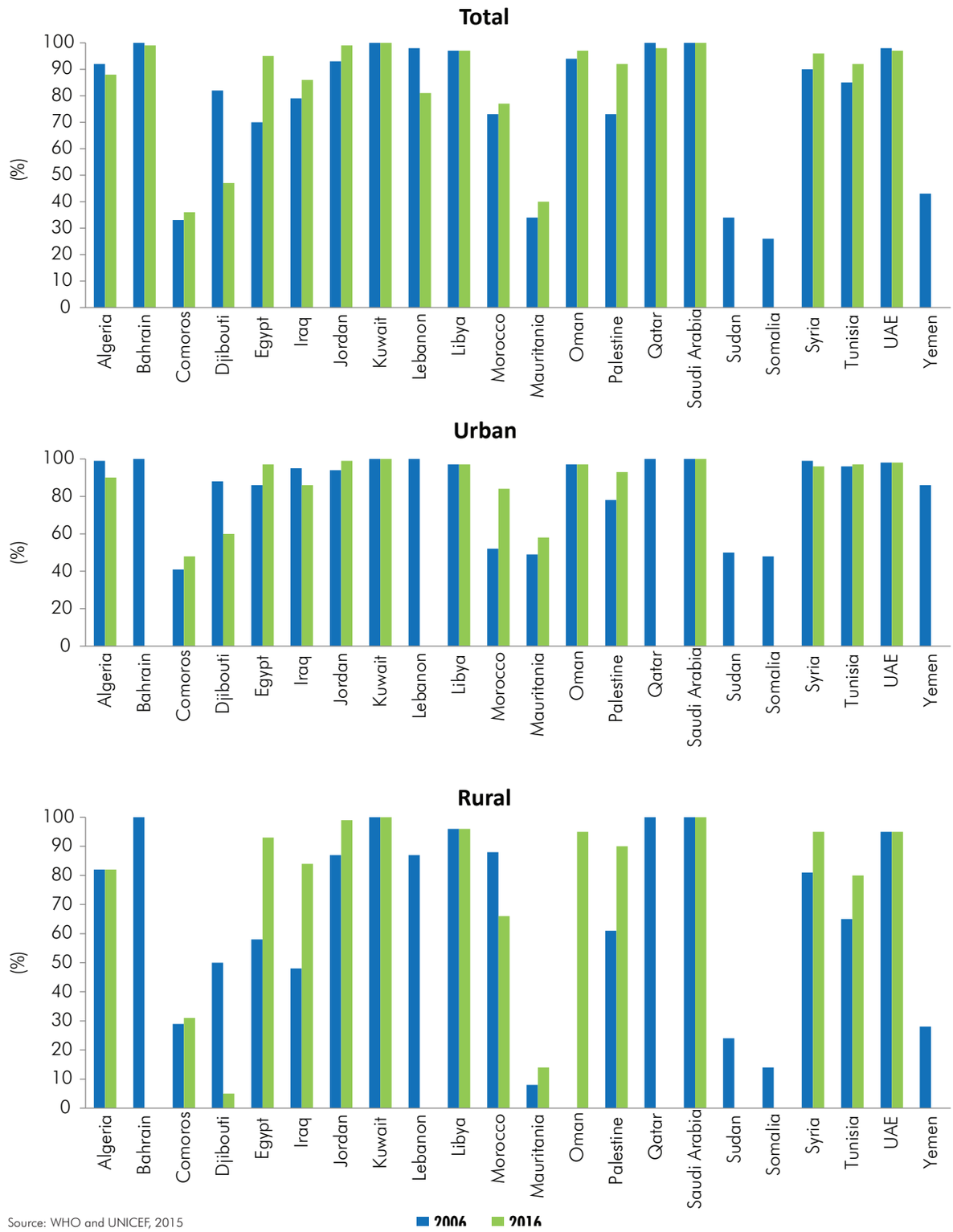
Arab countries, in cooperation with neighboring countries, must adopt a strategic approach to translate their socio-cultural solidarity into a unified political position supporting the rights of all riparian countries to fair, just and equitable shares in international water resources[4]. The 2008 establishment of the Arab Ministerial Water Council (AMWC) by the League of Arab

FIGURE 10 **PERCENTAGE OF POPULATION WITH ACCESS TO IMPROVED SANITATION FACILITIES, 2006 AND 2016**




Source: WHO and UNICEF, 2015; the World Bank, DataBank, World Development Indicators, 2016

FIGURE 11 **PERCENTAGE OF TOTAL, URBAN AND RURAL POPULATIONS WITH ACCESS TO AN IMPROVED SANITATION IN 2006 AND 2016**




Source: WHO and UNICEF, 2015

States, an important step in this direction, reflects a regional political will to elevate water issues from the traditional technical level to the more influential political level (Box 4).

Moreover, in 2010 the AMWC launched the "Arab Water Security Strategy 2010-2030". The strategy is developed to meet future challenges and requirements for sustainable development in the Arab world. It identifies the joint Arab aspiration towards achieving sustainable development, and represents a long-term program and a practical mechanism to overcome future challenges in water resources development and management. The strategy aims primarily at achieving sustainable development that responds to future requirement, thereby achieving major goals in three strategic pillars:

1) **Developmental and economical,** related to providing water services for drinking, agriculture, and sanitation, including financing, investments, technology transfer and the application of integrated management of water resources and the development of non-conventional water resources;
2) **Political,** especially related to the protection of Arab rights in the occupied territories and shared waters with regional neighbors and strengthening cooperation between Arab states to manage their shared water resources, in addition to the implementation of the Arab countries commitment to achieving the MDGs.
3) **Institutional,** the human and technical capacity development in addition to the development of societal awareness on water problems in the region, including scientific research, and promotion of civil society participation in decision making.

In this line and at the sub-regional level, the GCC countries launched their "GCC Unified Water Strategy and Implementation Plan 2016-2035" in 2016. The strategy is a translation of the GCC supreme council directive in their 31st summit (December 2010) in which was stated: "Serious and speedy steps should be taken and endorsed by the GCC Supreme Council towards a long-term comprehensive Gulf water strategy". The strategy vision is to "establish a sustainable, efficient, equitable, and secure water resources management systems in every GCC country that would continue to contribute to their sustainable socio-economic development". The strategy stated mission is "to align GCC states' national water strategies and master plans with a unified GCC water management strategy that foster joint initiatives and strengthen the capacities of each country in achieving a rational, integrated, efficient, and sustainable management of their water resources". The strategy is founded on five strategic themes which constitute its pillars and reflect its vision and mission statements:

1) Development and sustainability of water resources
2) Efficient and equitable water resources utilization
3) Enhanced municipal water supply security
4) Effective water governance and awareness
5) Economic efficiency and financial sustainability

The first three pillars are related to resource sustainability under normal and emergency conditions and their efficient utilization. They represent development, enhancement, and improvement themes, while the last two are related to establishing an enabling environment for the sustainable and effective management of the water sector in the GCC countries and representing governance, control, and incremental uplift. Another four themes have been considered as crosscutting themes,

BOX 4

## ARAB MINISTERIAL WATER COUNCIL (AMWC)

The League of Arab States established the Arab Ministerial Water Council in 2008, reflecting a unified regional political will to promote discussion on water issues from the technical to the political level. The council's aim was to boost cooperation efforts within a joint Arab strategy to combat water challenges and bolster water security. Its main objectives were managing water demand, developing and preserving water quality and quantity, managing water resources, protecting Arab water rights and improving regional governance under the League of Arab States.

wherever applicable, and are related to capacity development and training, research and development, environmental and ecological aspects, and the impacts of climate change.

## VI. WATER PRICING REFORMS

Several Arab countries have started to make a more effective shift in their water policies from supply augmentation towards demand management and conservation. Economic tools (incentives/disincentives) have been increasingly used to materialize this shift. These tools, manifested in reducing subsidies and tariff reforms from general to targeted, are meant to serve two objectives: enhancing water use efficiency and increasing cost recovery. For example, in the agricultural sector, Morocco and Tunisia have introduced volumetric pricing for public irrigation, charging farmers by the amount of water they use rather than by hectares under cultivation. Irrigation charges almost completely cover operation and maintenance costs in Tunisia and are approaching full coverage in Morocco (IFAD, 2009; AFED 2015). In Bahrain, groundwater from one of the principal aquifers used by the industrial sector is charged since November 2016 to enhance the water use efficiency in the industrial sector and to conserve groundwater. Moreover, in the municipal sector, many GCC countries (Saudi Arabia, UAE, Bahrain, and Kuwait) have made pricing reforms. General subsidies in the municipal water tariff have been revised to differentiate between household and non-household uses and to encourage water saving. In addition, some countries (Oman and Saudi Arabia) have introduced a wastewater treatment tariff, taken as a percentage of the municipal water consumption. Such policy shifts are expected to complement and enforce other demand management tools such as social (e.g., education and awareness) and structural (e.g., building codes legislations) tools.

## VII. CONCLUSION AND RECOMMENDATIONS

Water policies in Arab countries have allowed for the unrestricted use of scarce water resources. While the importance of the supply side cannot be overstated, the effectiveness of demand management is now universally accepted, particularly where water is scarce and unnecessarily wasted. Ensuring the efficient use of available supply may yield significant benefits and proves to be more cost-effective than traditional supply-side measures.

A key motive for water policy reform is the intensifying competition among domestic, agricultural, and industrial uses. These concerns are worthy of careful examination by Arab decision-makers, who should articulate appropriate policy frameworks to guide a forward looking water reform process. National strategic goals for the water sector should be articulated, including making shifts in water allocation among sectors, introducing new pricing policies, drafting new rules and regulations to address groundwater abstraction, and designing plans to clean public waterways from industrial waste and pollution.

Low water tariffs have compromised the financial situation and physical conditions of urban and rural water supply networks. Artificially low prices and heavy subsidies to water services are at the root of inefficiency, overuse, excessive pollution, and environmental degradation. While pricing is being looked at as the most effective method to foster conservation, a major governance issue is how to provide the public with adequate and inexpensive water from a human rights perspective. An answer lies in imposing progressive tariffs for drinking water and rationing water in agriculture, while demanding water pricing at the actual cost in commercial activities and industry. A progressive water tariff ensures that basic human needs for fresh water are met at a low, subsidized price, while excessive use is priced at a tariff that reflects actual cost.

With about 85 percent of the water used in the Arab region consumed by the agricultural sector, the sector in which water losses are the highest, it becomes imperative for Arab countries to focus their efforts on improving the water efficiency in that sector. The prospect to save water is notably higher here than in other sectors. Incentives are needed to improve irrigation efficiency. Managing irrigation water demand, including adopting water-saving technologies and crops, is essential. Economic and financial mechanisms include permits, rebates, tax incentives, targeted subsidies, price controls and water rights. Relevant R&D must also be promoted and properly targeted. Moreover, there is an urgent need for changing the mindset, attitude and practices in

Arab societies through raising water awareness and the application of appropriate social change instruments and incentives, resulting in a widespread culture where water resources are not wasted, polluted or overused.

Water governance in Arab countries should be strengthened by building partnerships with beneficiaries and the private sector. Governments should encourage joint investment by the private sector and the community of beneficiaries in modern, well monitored and metered water delivery services. Increased decentralization and empowering water user associations should be promoted in order to devolve responsibilities to manage and operate local services to user communities. Arab countries should recognize the important goal of reaching the poor and expanding water services to all communities, particularly in rural areas. Priority should be given to expanding water services to vulnerable communities and encouraging local initiatives in building and managing such services.

Much work has been done at the regional level to build resilience to climate-related hazards (UN-ESCWA, 2015). The Arab Climate Resilience Initiative aims to promote integrated regional responses to climate change. RICCAR is assessing the impact of climate change on freshwater resources across the Arab region. It would be beneficial for Arab governments to integrate climate change measures into national policies and strategies, along with mainstreaming environmental and disaster risk reduction. To be effective, resilience and adaption strategies need to be supported by improved education, awareness raising and building human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.

The development of both the Arab Water Security Strategy and the GCC Unified Water Strategy represents a major milestone for the long and intricate path for coping with the water scarcity in the arid Arab countries. Both strategies aim at establishing a sustainable water sector management system in the Arab countries by securing long-term water supplies while meeting strict criteria for socio-economic, financial and environmental sustainability and public health requirements. The Arab region's implementation of the strategic objectives and policies set in these strategies would result in a multitude of successive benefits and would contribute directly to the developmental goals of the Arab countries, would help ensure reliable water supplies today and for future generations, and enhance the overall level of water security. Such conditions will enable the water sector to continue serving the needs of their socio-economic development. However, failure to achieve the set targets of the strategy would result in the deterioration of both the quantity and quality of water supplies and increase the sector's associated financial, economic and environmental costs, which might eventually impact Arab countries' efforts in achieving their socio-economic development goals.

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## NOTES

1. Tawila Aquifer in Sana'a Basin in Yemen (ACSAD and BGR, 2005); Dammam aquifer in Bahrain (Al-Zubari,2001) and Kuwait (Sayid and Al-Ruwaih 1995; Al-Murad 1994); Umm Er Radhuma aquifer in Saudi Arabia (Al-Mahmoud, 1987); Al-Dhaid, Hatta, Al-Ain and Liwa areas in the United Arab Emirates (Rizk, Alsharhan, and Shindu, 1997); Al-Batinah coastal plain aquifer and Al-Khawd fan in Oman (Macumber and others 1997).

2. Data on wastewater produced, treated and reused are lacking or very old for many Arab countries.

3. NRW components: Real losses, apparent losses (administrative errors, metering errors, theft), and unbilled authorized consumption.

4. Because of the high dependency on shared water resources, regional cooperation in water governance is essential. The Arab region lacks comprehensive agreements on the major international river basins. The second best alternative is an international binding legal instrument that sets the duties and responsibilities of riparian countries and establishes guiding principles for coordinating, managing and allocating shared water resources. The international community widely recognizes the Convention on the Law of the Non-Navigational Uses of International Watercourses, published by the International Law Commission of the United Nations in 1997, as a candidate. Turkey, the upstream riparian country of the Euphrates and Tigris rivers, and Burundi, one of the upstream riparian countries of the Nile River, voted against the convention. Only nine Arab countries signed the convention (Jordan, Syria, Tunisia and Yemen with initial signatories and Iraq, Lebanon, Libya, Morocco and Qatar with accession), while three countries (Jordan, Tunisia and Syria) ratified it.

# FOOD SECURITY IN A CHANGING ARAB ENVIRONMENT

Mahmoud El Solh, Majd Jamal, Kamel Shideed, Ahmed Mazid, and Chandrashekhar Biradar

## I. INTRODUCTION

The Arab region has the largest food deficit in the world, due to the strained natural resource base and vulnerabilities to climate change implications, which put tremendous pressure on achieving food security. During the last ten years a number of Arab countries have been facing challenges in environmental changes and political instability in the region. These changes and developments include high rate of population growth; natural resource degradation; serious climate change implications; wars and civil strife; and migration.

These developments negatively impact sustainable agricultural growth and food security. The Arab world is the only region in the world that is currently experiencing an increase in hunger (FAO, 2015). The number of hungry people in the region has doubled from 16.5 million people between 1990 and 1992, to 33 million people between 2014 and 2016. The proportion of undernourished people has also increased from 6.6 to 7.5 percent during this same period, and the number of stunted children is high in countries like Egypt, Iraq, Sudan and Yemen. In the region as a whole, anemia affects one third of the population, particularly children, pregnant women and women of childbearing age. The rate of obesity in Kuwait and Egypt is among the highest in the world.

Considering their diversity in economic terms and in agro-ecologies, the Arab countries have different adaptive capacity to cope with various challenges to enhance sustainable agricultural development and food security (World Bank, 2014). Despite this diversity, the Arab world has substantial potential to enhance food security at the regional level and to considerably reduce the growing gap between food production and consumption through the exploitation of agricultural potential and regional collaboration.

## II. CHANGES IN POPULATION GROWTH

The total population of the Arab world was estimated at 391 million in 2014 compared to 316.8 million in 2005, with a significant variation in the size of the population among the Arab countries (AOAD, 2015). In 2016, Arab population would have surpassed 400 million. The increase in the population during this period was 23.4 percent (about 2.3 percent annually). The population increase rate in the Arab world is higher than the world average, where the average rate of developed countries is around 0.8 percent, and 1.9 percent in developing countries. This high population growth is the result of sustained high fertility rates, successful efforts in improving public health and lowering mortality rates combined

TABLE 1 **TOTAL RURAL AND URBAN POPULATION IN ALL THE ARAB COUNTRIES FROM 2005 TO 2014**

| Year | Total Population (in thousands) | Rural Population (in thousands) | Urban Population (in thousands) | % of Rural Population | % of Urban Population |
|---|---|---|---|---|---|
| 2005 | 316,789 | 142,486 | 174,304 | 45.0 | 55.0 |
| 2006 | 324,826 | 145,592 | 179,234 | 44.8 | 55.2 |
| 2007 | 333,179 | 146,184 | 186,995 | 43.9 | 56.1 |
| 2008 | 345,604 | 151,906 | 193,698 | 44.0 | 56.0 |
| 2009 | 352,801 | 154,087 | 198,714 | 43.7 | 56.3 |
| 2010 | 360,880 | 156,878 | 204,002 | 43.5 | 56.5 |
| 2011 | 362,163 | 156,173 | 205,990 | 43.1 | 56.9 |
| 2012 | 371,035 | 156,740 | 214,295 | 42.2 | 57.8 |
| 2013 | 381,646 | 158,033 | 223,613 | 41.4 | 58.6 |
| 2014 | 391,042 | 159,220 | 231,823 | 40.7 | 59.3 |

Source: AOAD, 2016

with young communities. However, this increase has produced problems such as food insecurity, unemployment, migration, and a decline in the level of education.

The rural population in Arab countries in 2014 was estimated by the Arab Organization for Agricultural Development (AOAD) in 2016 to be 159.2 million, representing 40.7 percent of the total population, compared to 45 percent in 2005 (Table 1). During the period 2005-2014, the rural population increased by 16.7 million and the urban population increased by 57.5 million. This decline in the rural population is due to the continuing migration from rural to urban areas and due to the weak economic structure in rural areas, inadequate infrastructure, adverse climate change impacts on agriculture and unemployment and inequality per capita income of the agricultural sector compared to those in other sectors. Migration from rural to urban areas has negative implications on achieving sustainable agricultural development and food security.

## III. ENVIRONMENTAL CHANGES SINCE 2006

### *A. Changes in Natural Resources and the Implications of Climate Change*

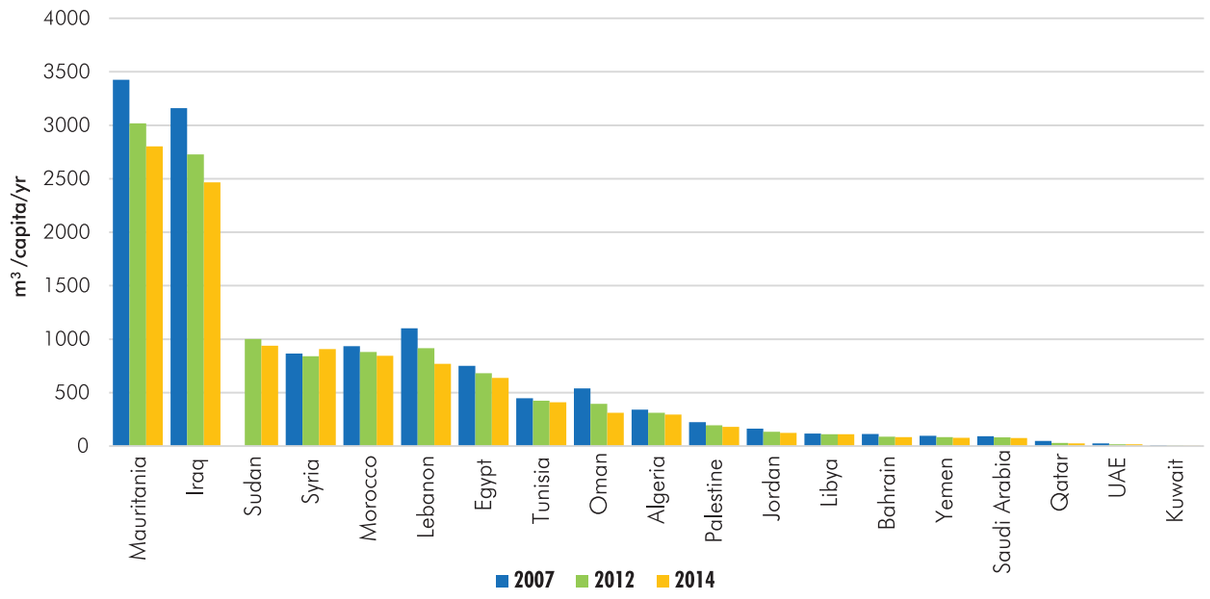
#### *i. Changes in Water Resources*

The Arab countries account for more than 5 percent of the world's population, but less than 1 percent of global water resources. Arab countries face serious challenges in managing their scarce water resources. The extremely arid Gulf countries have adapted by relying on desalination. Egypt, Iraq and Syria have hastened to develop renewable, mostly transnational, water resources. Countries with limited renewable water resources and weak financial capability, such as Jordan, have pursued water reuse, water harvesting and demand management initiatives (UNDP, 2013).

Several countries now draw heavily on non-renewable fossil aquifers to offset the negative water balance. Most Arab countries have already exhausted their water supply development potential. The per capita availability of renewable water resources in 13 Arab countries is less than 500 $m^3$ per year, which is far below the water poverty level of 1000 $m^3$ and the world average of 7000 $m^3$.

Arab countries rely on both conventional water resources (surface water and groundwater) and nonconventional (desalinated water, treated wastewater, irrigation drainage water, water harvesting and cloud seeding). All Arab countries are using more treated wastewater, and desalinated water is a rising share of water budgets in Gulf Cooperation Council (GCC) countries. Renewable water resources per capita have been decreasing considerably between 2007 and 2014 (Figure 1) and it is expected that this decreasing trend will continue until 2017 and beyond, considering the poor water management and the serious implications of climate change in the Middle East and North Africa (UNDP, 2013). In the last ten years, water scarcity threatened development in the Arab region, coupled by the serious climate change implications.

FIGURE 1 **TOTAL RENEWABLE WATER RESOUCES PER CAPITA (2007-2014) IN ARAB COUNTRIES**



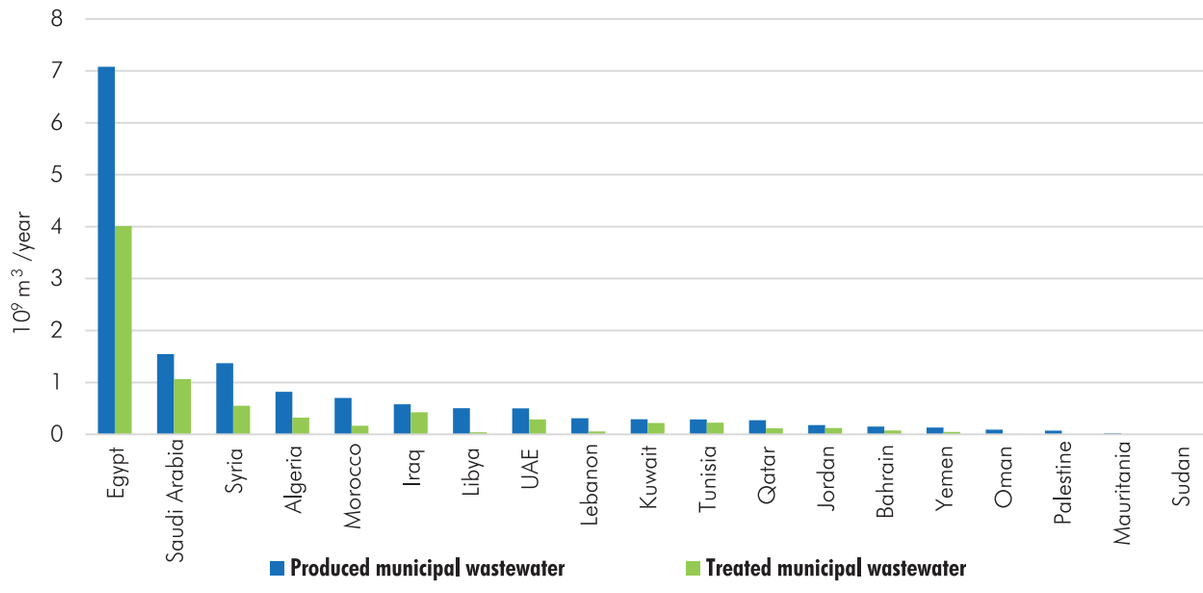

Source: Aquastat, 2017

Most of the agricultural area in the Arab countries is rainfed, and a large portion of the region's agricultural production is based on dryland farming systems, with a variable annual rainfall in the range of 200 to 600 millimeters (Solh, 2016). Most of the region is classified as arid or semi-arid (desert), receiving less than 250 millimeters of rainfall annually. Higher rainfall is only received in southern Sudan, the Atlantic and Mediterranean coastlines and the southwestern Arabian Peninsula (Jagannathan et al. 2009).

The rainfall trend in the last ten years, between 2006 and 2016, can be assessed meaningfully at the sub-regional level as indicated based on similar agro-ecologies: North Africa or Maghreb countries; West Asia or Mashreq countries and the Gulf countries. In West Asia drought prevailed from the 2005/06 to the 2013/14 seasons (Biradar et al., 2016; NASA, 2016). In North Africa drought became much more frequent and Morocco has experienced the worst drought in the 2015/16 season (Biradar et al., 2016).

a. **Groundwater resources** is the Arab region's second major conventional water resource. Shallow and deep groundwater resources, within or across national boundaries, are recharged by precipitation and by rivers. In Bahrain, Jordan, Lebanon, Oman, Tunisia, United Arab Emirates and Yemen, groundwater contributes to more than 50 percent of total water withdrawals. In the Arabian Peninsula, it accounts for 84 percent. Even countries fairly rich in surface water are relying more on groundwater to meet steadily rising demand. There is no systematic quantitative data on the loss of groundwater resources in the last ten years. However, there is clear overexploitation of groundwater resources in almost all Arab countries, especially in the Arabian Peninsula and the Maghreb region. In the last ten years, the levels of groundwater are decreasing by one to two meters annually, depending on rainfall. Groundwater overexploitation and depletion mostly used for agriculture have also had severe environmental impacts due to the deterioration of water quality. Water salinization has dried natural springs and degraded or destroyed their surrounding habitats and ecosystems as well as negatively affecting food security. Taking

FIGURE 2 PRODUCED AND TREATED MUNICIPAL WASTEWATER (2009-2013)




into consideration the serious implications of excessive exploitation of non-renewable water resources, Saudi Arabia passed a policy decision in 2008 to phase out intensive wheat production using non-renewable water resources by 2016, and has since moved from being a large wheat exporter to a large wheat importer.

With demand for water rising and supplies dwindling, Arab countries have relied heavily in the last ten years on nonconventional water sources, including desalinated water, treated wastewater and other sources such as rainwater harvesting, cloud seeding and use of irrigation drainage water.

b. **Desalinized water** is becoming very important in Arab countries, particularly the Gulf countries, with more than half the world's desalination capacity. The Arab region leads the world in desalination, although desalinated water contributes to only 1.8 percent of the total water supply. Desalination plants in Arab countries have a cumulative capacity of about 24 million cubic meters a day. Growth is expected to remain high for the next decade to meet escalating domestic water demand. Desalinated water will expand from comprising 1.8 percent of the region's total water supply to an estimated 8.5 percent by 2025. Most of the anticipated increase in capacity will be concentrated in the region's high-income, energy-exporting countries, such as the Gulf countries. More recently solar energy is being tapped to provide a good part of the energy required for desalinization.

c. **Brackish water and biosaline agriculture** is given more emphasis particularly in the Gulf countries where almost all the underground water resources have a good level of salinity. Research on bio-saline agriculture is led by the International Center for Biosaline Agriculture (ICBA) and good results were demonstrated in Arab countries on the use of brackish water in agricultural production particularly in forage production.

d. **Treated wastewater:** Arab countries produce about 14.9 billion cubic meters of wastewater a year and treated about 52

percent of it in 2014, which is an increase from previous figures of 40 percent in 2007 (AQUASTA, 2017). Thus in the last ten years, Arab countries are using more treated municipal wastewater to meet escalating water demand in urban areas. Treated wastewater is estimated at 4.7 billion cubic meters a year and is rising further. Figure 2 presents the volumes of produced and treated wastewater in some Arab countries in 2010. While most of the region has programs for reusing treated wastewater in irrigation (fodder crops, cereals, alfalfa, and olive and fruit trees are irrigated mostly with treated water), few countries have institutional guidelines for regulating the use of treated wastewater. Many factors prevent the expansion of treated wastewater reuse, such as social barriers, technical obstacles and institutional and political constraints. Nevertheless, these factors are expected to be resolved with advanced technology and more efforts in public awareness.

e. **Use of drainage water:** The Arab region also draws heavily on reused irrigation drainage water. Among Arab countries, Egypt and Syria use the most nonconventional irrigation water: Egypt uses about 7.5 billion cubic meters a year of reused agricultural drainage water, and Syria uses 2.3 billion. Egypt adopted a national policy for drainage reuse in 1975 to enhance water use efficiency and increase cultivated area. The amount of drainage water reused for irrigation is expected to reach 8.7 billion cubic meters a year by 2017.

### *ii.Changes in Land Degradation/ Desertification*

Land studies on land degradation refer to the UN Convention to Combat Desertification (UNCCD, 1994), which defines desertification as land degradation affecting drylands. This process includes a change in soil properties, vegetation, or/and climate (D'Odorico et al. 2013). Desertification transforms a dryland ecosystem into a non-productive ecosystem with loss of vegetation cover, soil erosion, dust storms, salinization, and a decrease in soil productivity, loss of biodiversity, poverty, reduced human wellbeing, and migration (Bayram and Öztürk 2014; D'Odorico et al., 2013). Desertification

TABLE 2 **DESERTIFICATION AREA AND THE AREA THREATENED BY DESERTIFICATION AS ASSESSED IN 2012**

| Country | Total Area (Thousand km²) | Desertified Area in 2012 (Thousand km²) | Percentage of Total Area (%) | Area threatened by desertification in 2012 | |
|---|---|---|---|---|---|
| | | | | Thousand km² | Percentage % |
| Mauritania | 1031 | 636 | 62 | 343 | 33.3 |
| Morocco | 711 | 455 | 64 | 195 | 27.4 |
| Algeria | 2382 | 1970 | 83 | 230 | 9.7 |
| Tunisia | 164 | - | - | 105 | 64.0 |
| Libya | 1807 | 1589 | 88 | 381 | 21.1 |
| Sudan | 2506 | 725 | 29 | 650 | 25.9 |
| Yemen | 566 | 405 | 72 | 90 | 15.9 |
| Kuwait | 18 | 5 | 28 | 4 | 22.2 |
| Qatar | 11 | 11 | 100 | - | - |
| Saudi Arabia | 2150 | 1182 | 55 | 860 | 40.0 |
| **Total** | **11346** | **6978** | **62** | **2858** | **25.2** |

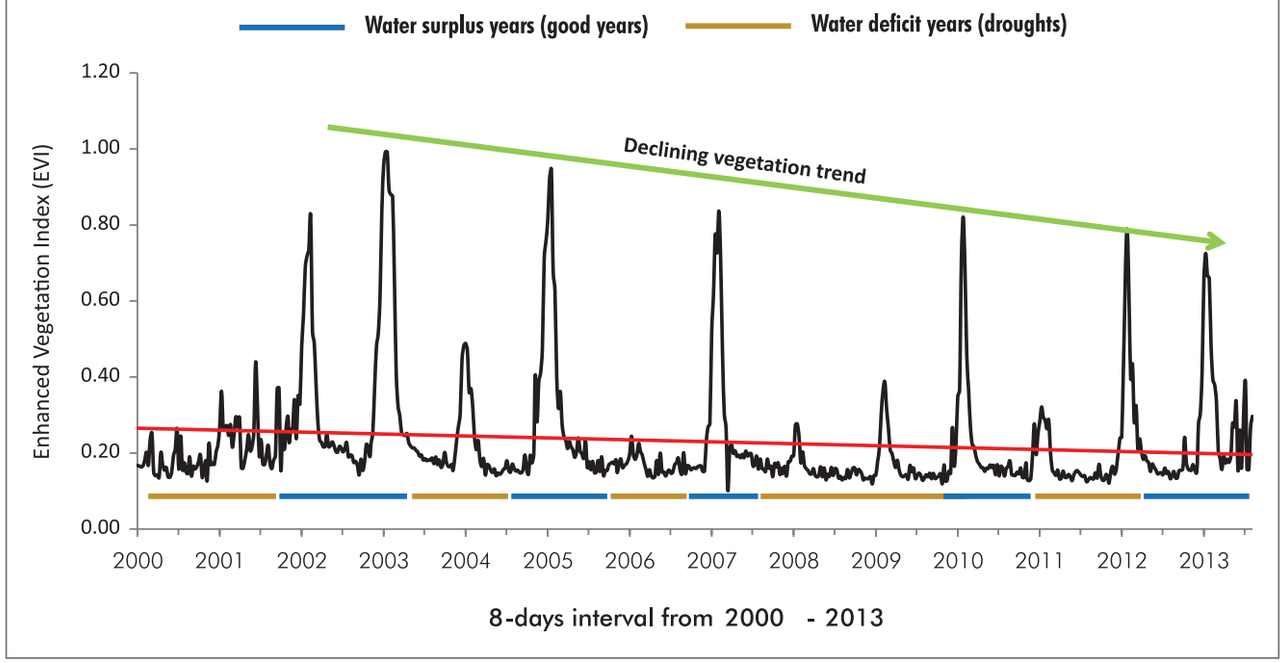
Source: Unified Arab Economic Report, 2016 (Arab Monetary Fund)

or land degradation is caused by variations in climate and natural disasters (e.g. climate change, drought, soil erosion by wind and water, diseases and insect pests' epidemics such as desert locust and dust storms) and human activities including overgrazing, deforestation, non-sustainable intensification of agricultural production systems, salinization, pollution, inadequate policies to protect natural resources and conflict.

When we assess these factors in the last ten years we can clearly conclude that land degradation or desertification is on the increase in Arab countries. According to the Joint Arab Economic Report 2016 (AMF, 2016), the area threatened by desertification ranges from 9.7 percent in Algeria to 64 percent in Tunisia based on the assessment made in 2012 in ten Arab countries (Table 2). Urbanization of rural areas, besides the problem of salinization, is eating up the highly fertile Egyptian Delta. Overgrazing by high livestock stocking rate has been seriously affecting rangelands in all Arab countries, particularly in Jordan, Syria and Iraq. Rangelands used to provide 80 to 85 percent of the sources of feed for livestock in marginal land but as a result of overgrazing, they now provide only 15 to 20 percent of the sources of feed. Conflicts in Syria, Iraq, Libya and Yemen that started in 2011 are contributing greatly to land degradation since the agricultural sector has declined in many rural areas. All these factors have been contributing to the current widening gap in food insecurity in Arab countries.

Salinization is a serious problem that contributes to land degradation or desertification in Arab countries. There is no quantitative data about the land affected by salinity in the last ten years. However, salinization, which is caused by several factors mostly related to poor water management, is becoming a serious problem in almost all Arab countries. Currently 50 percent of irrigated areas in Iraq are affected by salinity due to faulty irrigation by high-salt drainage water coming from the Euphrates and Tigris. A similar situation can be found in the Jordan River and in the Nile (World Bank, 2014). Faulty irrigation is caused by lack of consideration of salt-leaching requirement in the amount of irrigation water applied and the required drainage. In coastal areas, the intensive extraction of groundwater leads to

FIGURE 3 MODIS TIME SERIES SPECTRAL PROFILES OF RANGELANDS IN MUWAQQAR, JORDAN FROM 2000 TO 2013 USING THE VEGETATION INDEX (EVI)




seawater intrusion into the aquifers, causing severe salinization. This process is accelerated by climate-change-induced sea-level rise (Carneiro et al., 2009). The Nile Delta, which is home to more than 35 million people and provides 63 percent of the agricultural production of Egypt, is seriously affected by salinity and is especially vulnerable to salinization under changing climate conditions due to seawater intrusion as a result of higher sea level (Hereher, 2010).

### *iii. Changes in Biodiversity*

The highest density of biodiversity in the MENA region is in the Fertile Crescent, which extends over Palestine, Lebanon, Northern Syria, southern Turkey and northern Iraq. Other high-density areas of biodiversity are found in northern parts of Morocco, Algeria and Tunisia. However, biodiversity losses in these countries are caused by many factors, presented in their order of importance: grazing pressure of rangelands, drought, new varieties and species replacing landraces, overuse, land reclamation, urbanization, wars and civil strife.

The eco-geographic/botanic surveys since 2000 show increasing trends in the loss of biodiversity (data taken from 73 sites in Jordan, Lebanon, Palestine, Syria) with grazing pressure followed by land reclamation for agricultural and urbanization purposes and recurrent droughts being major threats to range and forest biodiversity. The use of remote sensing time series spectral profiles in Muwaqqar rangeland areas in Jordan confirms the decreasing trend of biodiversity over the last ten years, due mainly to overgrazing and droughts (Figure 3). As mentioned earlier, biodiversity loss in rangelands is most serious since it was the major source of feed of sheep, goats and camels in Arab countries. Considering that sheep and goats are important for food security and better livelihoods in marginal lands or rangelands, it is apparent that loss of biodiversity due to overgrazing has a direct serious negative effect on food security in the vast marginal lands in the Arab world.

## *B. Implications of Climate Change*

It is apparent that changes in the climate of the MENA region have several implications that

influenced sustainable agricultural production in the last ten years as indicated below:

- Changes towards less precipitation in both total quantity and distribution, and more frequent and higher intensity droughts;
- More extreme temperatures with higher temperatures in spring and summer and much lower temperature in winter with higher mean temperature on average;
- Changes in length of growing season, mostly shorter growing season by about two weeks in the Eastern Mediterranean region;
- Changes in agro-climatic zones;
- Newly emerging diseases and insect pests that threaten food production stability and quality;
- Rise in sea levels and salt-water intrusion in coastal areas.

The impact of climate change on water resources with respect to less rainfall and more frequent drought has been already covered in the previous section on Natural Resources. Other implications of climate change include the following:

### *i. Change in Temperature Extremes*

According to the World Bank (2014), the region recorded a 0.2°C temperature increase per decade between 1960 and 1990 and later on the rate of increase in average temperature was the highest recorded in the last ten years. In 2010, temperatures in winter were higher by 3 to 4°C in West Asia, and as a result new virulent races of diseases and insect pests emerged. Furthermore, the increase in temperature is geographically projected to be the highest in the Mediterranean coast compared to other coastal areas in various parts of the world. Inland temperature is projected to increase by 3°C in Algeria, Libya and large parts of Egypt with a world average temperature increase scenario of 2°C (World Bank, 2014). According to the World Bank studies (2016), with a scenario of world average temperature increase of 4°C, summer temperatures are expected to increase by 8°C inlands by the end of the century in Algeria, Saudi Arabia and Iraq.

Global warming will have serious implications on agricultural productivity in the MENA region. According to the World Bank (2014), crop yields are expected to drop by 30 percent with a 1.5 to 2.5°C increase in temperature and by 60 percent with a 3-4°C increase, with geographical variation and without considering adaptation (World Bank, 2014).

### *ii. Changes in Agro-Climatic Zones and the Length of Growing Season*

Reduced precipitation and warmer temperatures have resulted in a shift of agro-climatic zones in the MENA region towards drier areas. In Syria, the consecutive droughts from 2005 to 2014 resulted in moving rainfall stability zones towards drier, less stable rainfall zones. According to the World Bank (2014), at a scenario of a 4°C increase in temperature the lower rainfall and warmer drier climate will shift vegetation and agricultural zones northward by 75 kilometers by the end of the century. This will shorten the growing period in large parts of the region by two weeks by the middle of the century. The growing season has become shorter by about two weeks in the eastern part of the Mediterranean region as a result of the shift in agro-climatic zones to drier climate, terminal droughts and increase in temperature.

### *iii. Emergence of Diseases and Insect Pests as a Result of Climate Change*

Higher temperatures caused by climate change already led to the emergence and spread of new diseases and insect pests that affect both crop and livestock production and consequently food security. This will raise the possibility of diseases and insect pest epidemics that could cause drastic losses in food production. For example, West Asia has experienced a stripe or yellow rust disease epidemic in wheat in the 2009/10 season, causing widespread damage to wheat crop – the staple food crop – although the prevailing improved wheat varieties were resistant to stripe rust. Some wheat farmers in northern Syria experienced 40-80 percent wheat yield losses due to the emergence of a more aggressive new wheat rust disease race that has broken the resistant genes that were prevailing in wheat varieties. This development was due to the increase of 3-4°C in the

temperature of the winter of 2010. Another example on the impact of the increase in the winter temperature due to climate change is the large-scale infestations in 2008/09 of the barley stem gall midge, which caused serious economic losses in barley, the main source of livestock feed. The barley stem gall midge was a minor insect pest on barley with no economic loses in barley in the past.

### *iv. Rise in Sea Levels and Salt-Water Intrusion in Coastal Areas*

The level of the Mediterranean Sea rose an average of 1.1 to 1.3 mm per year in the 20th century, which is lower than the world average of 1.8 mm (World Bank, 2014). However, the variation in the raise in the Mediterranean Sea was apparent and with slow and gradual rise from 1960 to 1990, and with a rise above average thereafter in the last ten years. This resulted in seawater intrusion, which is becoming a serious challenge in the coastlines of several Arab countries. Projections show that Egypt, Tunisia, Morocco and Libya have been identified as the most exposed African countries in terms of total population that will be affected by sea level rise (World Bank, 2014). The Delta of Egypt, as mentioned earlier, provides 63 percent of agriculture in the country. 35 percent of the population is already seriously affected and highly vulnerable to salinization as a result of the rise in the Mediterranean Sea and the absence of the annual Nile River flood since the Aswan High Dam was built. Assuming no protection or adaptation to the seawater rise in Egypt, annual damages have been projected in the range of USD 5 billion by 2100 for a 1.26 meter sea level rise (Hinkel et al., 2012).

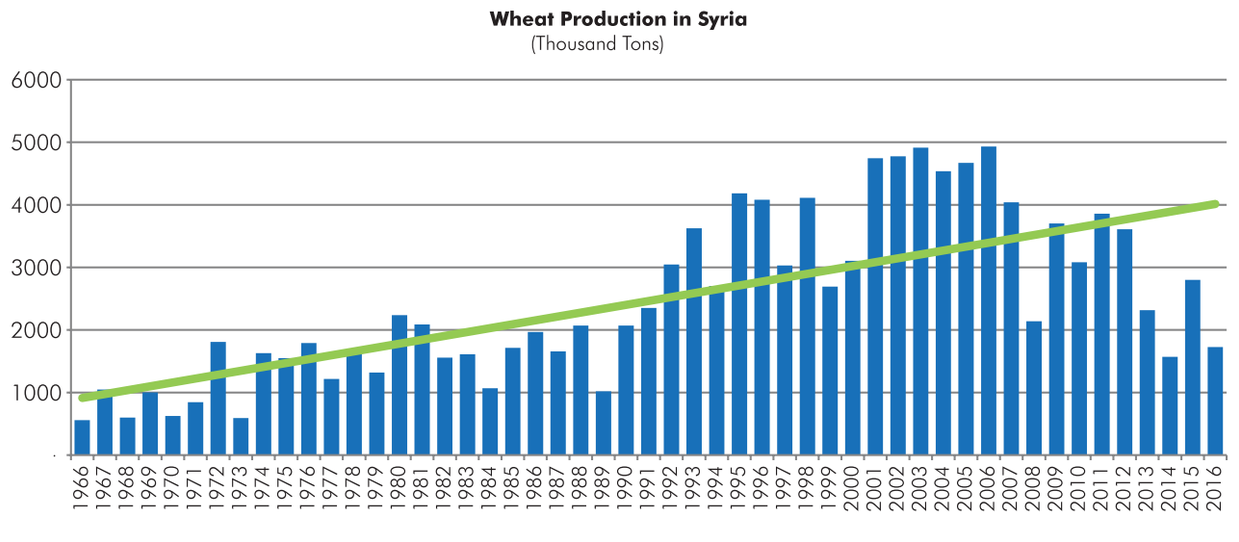
## *C. Changes in the Geo-Political and Security Situation*

The MENA region is geopolitically a volatile region affected by political instability. The Iraqi war in 2003 and the revolutions and civil conflicts flamed by external intervention that started in 2010 have seriously affected development in Iraq, Tunisia, Egypt, Libya, Syria and Yemen. Although most Arab countries were previously on track towards achieving the Millennium Development Goals (MDGs) by the 2015 deadline, the wars and conflicts reversed progress in achieving the MDGs (IFPRI, 2016). The least developed countries (LDCs) in the region (in particular Comoros, Djibouti, Mauritania, Somalia, Sudan, and Yemen) were not expected to achieve most of the MDGs on schedule. As the International Food Policy Research Institute (IFPRI) indicated in its 2016 annual report, the intensified conflicts in Iraq, Libya, Syria, and Yemen have and continue to have spillover effects in Egypt, Jordan, Lebanon, and Tunisia while the Gaza Strip has not yet recovered from the destruction of its infrastructure in July 2014. The rest of the region was also affected by the unrest mobilized by various reasons; and thus the security concerns became the top priority at the expense of sustainable development, including enhancing food security.

The above developments affected mostly the achievement of MDG 1 and 2 on reducing poverty, hunger, and malnutrition (IFPRI, 2016). MENA is the only region in the world where poverty increased between 2011 and 2016; and poverty is projected to increase further by 2030 (World Bank, 2014). In 2016, the number of food-insecure people who needed urgent action was 14.1 million in Yemen, 7 million in Syria, 1.5 million in Iraq and 1.1 in Somalia (FSIN, 2017). An estimated 50 million people are still undernourished and the region is far behind on meeting the target of halving undernourishment according to the MDGs (IFPRI, 2016). The outlook for 2017 for countries that are at risk for famine include Yemen (17 million) and Somalia (2.9 million) as indicated by the Global Report on Food Crises (FSIN, 2017).

The report of the Crop and Food Security Assessment Mission (CFSAM, 2016) conducted in Syria by FAO and WFP found that many farmers have lost the ability to cope with the difficulties created by five years of conflict. Serious consecutive droughts in Syria and West Asia between 2006 and 2014 aggravated the situation further. As a result, wheat was grown on 900,000 hectares in the 2015/16 cropping season compared to an average of 1.5 million hectares before the Syrian crisis. As shown in Figure 4, wheat production declined from an average of 3.4 million tons, which meets Syrian domestic

FIGURE 4 CHANGES IN WHEAT PRODUCTION IN SYRIA FROM 1966 TO 2016




consumption needs, to 1.5 million tons. Syria was the only self-sufficient Arab country in major staple food crops. In good rainy years before drought and civil war, Syria produced about 4.8 million tons of wheat and exported about one million tons. The key findings of the recent FAO report "Counting the Cost: Agriculture after six years of crisis" (FAO 2017), are presented in Box 1.

Similarly, Iraq is another Arab country with high agriculture potential that achieved a high level of food security before the 2003 war started despite the embargo because of relatively better political stability. However, after the 2003 war, civil conflicts and violence caused massive population displacement and migration as well as serious deterioration in food and nutritional security.

## *D. Rural to Urban and Overseas Migration*

According to the World Bank (2014), there are several interrelated drivers to migration including **political drivers** such as discrimination/persecution, corruption and injustice, poor governance and political instability; **environmental and physical drivers** including climate change implications such drought, resource depletion and exposure to risk; **economic drivers** including poverty and loss of livelihoods; **social drivers** including poverty, marginalization and lack of education opportunities; and demographic pressure.

Globally in 2015 there were about 65.3 million forcibly displaced people, 21.3 million refugees and 10 million stateless, according the 2016 statistics of UNHCR. According to the same source, 53 percent of the global refugees come from three countries; namely Syria (4.9 million), Afghanistan (2.7 million) and Somalia (1.1 million). The number of displaced people in 2016 in Syria is 4.8 million, in Yemen 3.2 million, 3.1 million in Iraq and 2.1 million in Somalia.

The civil strife, insecurity, serious consecutive droughts, food insecurity and the high level of unemployment contributed to the massive displacement of populations, rural to urban, and overseas migration. The economies and the pressure on services affected several Arab countries like Lebanon, Jordan and Egypt by the large number of refugees hosted from the Arab countries where civil strife escalated.

## *E. Policy and Institutional Changes Relevant to Agriculture*

After the food crisis in 2008, the Arab

BOX 1

## SUMMARY OF FAO REPORT
## "COUNTING THE COST: AGRICULTURE IN SYRIA AFTER SIX YEARS OF CRISIS"

Agriculture in Syria is by far the most important sector of the economy. In 2001, agriculture made up as much as 27 percent of the GDP, and despite falling to 19 percent of GDP in 2011, it still made up more than twice the share of manufacturing. In the same year, the rural population of was just under 50 percent and agriculture employed 26 percent of the economically active population. To date, a clear picture of the impact of the six-year crisis on agriculture has been lacking. The latest study, which was conducted by FAO mission in 2017, could be summarized as follows:

1- The most striking impact of the crisis is the internal displacement of a third of the population – over six million people – in 2016.

2- There has been a very significant decrease in net income in the rural community due to higher production and marketing costs, and very constrained purchasing power as the index of food consumer prices increased by 800 percent between 2010 and 2016.

3- Vast areas of agricultural land with orchards or crops have been destroyed and farmers are facing shortages of agricultural inputs (seeds, fertilizers, fuel to power irrigation pumps, etc.) or are unable to afford them due to soaring prices. The livestock subsector accounted for the highest proportion of damage (value of livestock deaths) followed by perennial crops (value of destroyed trees).

4- The overall financial cost of damage and loss in the agriculture sector over the 2011–2016 period is estimated to be at least USD 16 billion, which is equivalent to just under one third of Syria's GDP in 2016.

5- More than 25 percent of households overall reported lacking seeds, and more than 50 percent lack access to fertilizers, while 35 percent do not use fertilizers at all. Pesticides are now mainly sourced from informal markets, resulting in the use of poor quality and sometimes dangerous products. Pests and diseases were reported as being of particular concern for perennial crop production.

6- The cost of damage in different sectors is estimated:

Irrigation systems and other kinds of agricultural infrastructure, such as buildings, are estimated at USD 3.2 billion.

a. Loss for perennial crops is estimated at about USD 1.5 billion
b. The livestock sector suffered high damage and loss amounting to USD 5.5 billion.
c. The total damage to agricultural infrastructure and assets is estimated at USD 3.2 billion, accounting for almost half of the total damage to the agriculture sector.

7- The FAO study assessment estimates that the costs of meeting the agricultural recovery over a three-year period would be of the order of USD 11 billion at 2016 prices. Due to an assumed partial return of rural migrants from urban areas and abroad, this total increases to USD 14.9 billion under a "partial return to peace" scenario, and to USD 17.1 billion under a "transition to peace" scenario.

8- An important consideration for recovery of the agriculture sector is the question of production incentives, and the linked issues of irrigation and climate smart agriculture, and to tackle this effectively, the water management approach will need to include the following elements:

- Adaptation of crop selection patterns to maintain economic profitability – this could mean a movement away from high water intensity crops to more water-efficient or drought-tolerant crops such as vegetables, pulses and spices;
- Adoption of conservation agriculture methods to reduce needs in water and fertilizers, including landscape-based approaches.
- Improved efficiency of irrigation systems.

countries focused much more on agricultural policies as one of the most important tools for the development of the agricultural sector and sectors affecting performance in agricultural development, in order to deal with the food deficit and achieve Arab food security on a sound economic basis. When the sudden jump in food prices in 2008 further culminated in 2011, many Arab countries put agriculture and food security at the top of their national agenda. This was driven particularly by the high food import bills paid by Arab countries since the Arab world is the largest food-deficit region in the world as well as the largest food-importing region globally. The fact that several factors were behind the increase in food prices, it was apparent that prices of major food commodities would never go back to the levels prior to the 2008 food crisis.

During the food crisis several major food-exporting countries put embargo on exports of major food commodities like rice, preventing food-deficit countries that have financial resources from buying certain food commodities from the global market. To cope with this situation, policy makers of Arab countries at the highest level adopted the Kuwait Declaration in 2011. Entitled "Elevating the Standard of Living for Arab Citizens" and declared at the Arab Economic Summit in Kuwait in 2011, it underlines the importance of raising living standards in Arab countries in three major areas including food security:

- The Arab leaders called for launching an emergency Arab food security program.
- On water security, they tasked the Council of Arab Water Ministers with preparing a strategy for water security in the Arab region to face challenges and requirements for sustainable development.
- As for poverty, they called for implementing the Arab program for combating poverty and financing its programs for four years, while inviting Arab finance institutions to contribute to financing them.

In line with the Kuwait Declaration, several Arab countries invested more in sustainable agricultural development to enhance food security and a number of countries formed national food security programs. Besides investment in the national agricultural sector, a number of countries, particularly those in the Gulf with very limited agriculture potential, made considerable foreign investment in Sub-Saharan Africa and Central Asian countries to contribute to their national food security. The Arab African Economic Forum in Kuwait in early November 2013 developed the "Third Africa-Arab Summit: Kuwait Declaration", which adopted a recommendation to: "Strengthen cooperation on issues concerning Rural Development, Agricultural Development and Food Security".

The Gulf countries in particular made good use of these recommendations and made considerable investments in agricultural projects in Sub-Saharan Africa (SSA) to enhance their food security. However, Arab countries still have a very long way to realize the underutilized agricultural potential in the Arab world that could enhance food security at both national and regional levels. It is essential for Arab countries to enhance regional cooperation to promote agricultural production based on complementarities and their comparative advantages to achieve regional food security and reduce the unwarranted food import bills.

Due to the ongoing conflicts, violence and insecurity over the last five years, most countries of the region were distracted from implementing policies for critical sustainable development priorities. Egypt, however, was an exception to this trend. According to IFPRI (2014/2016), the Egyptian government continued its effort to reform subsidies on major food items and fuel which are environmentally and socially detrimental. Steps were taken towards national economic and distributional gains (Breisinger, et.al., 2014). Furthermore, Saudi Arabia and the United Arab Emirates started reforms by lifting subsidies on important commodities, water resources and services.

## IV. TRENDS AND CHANGES IN NATIONAL AGRICULTURAL RESEARCH SYSTEMS

Egypt ranked highest in agricultural R&D spending and Morocco ranked second. Total agricultural R&D in the ten countries grew by

TABLE 3 **TOTAL AGRICULTURAL R&D SPENDING IN ARAB COUNTRIES, 2009 AND 2012**

| Country | Total spending, 2009 (in million 2005 PPP dollars) | Total spending, 2012 (in million 2005 PPM dollars) | Spending as a share of Ag GDP (%), 2012 |
|---|---|---|---|
| Algeria | 68.6 | 81.7 | 0.21 |
| Egypt | 379.3 | 471.0 | 0.44 |
| Jordan | 34.0 | 32.3 | 1.84 |
| Lebanon | 21.7 | 34.1 | 0.95 |
| Mauritania | 11.2 | 8.9 | 0.80 |
| Morocco | 127.4 | 131.2 | 0.49 |
| Oman | 81.4 | 97.0 | 6.51 |
| Sudan | 52.4 | 30.0 | 0.19 |
| Tunisia | 49.4 | 55.9 | 0.64 |
| Yemen | 47.6 | 34.5 | 0.56 |

Source: Stads, 2015

8 percent between 2009 and 2012. Lebanon had the highest increase (more than 50 percent) in investments in infrastructure and equipment. Algeria and Egypt also had largely increased their agricultural R&D spending, driven by salary-related increases. The Omani government promoted a considerable increase in public funding to support agricultural R&D. On the other contrary, Sudan and Yemen experienced a sharp decline in their agricultural R&D spending levels between 2009 and 2012 (Stads, 2015).

Table 3 presents the total agricultural R&D spending between 2009 and 2012 in a number of Arab countries. One main observation is that, despite their great agricultural potential, Algeria and Sudan seriously underinvest in agricultural R&D, each spending only 0.2 percent of their GDP on agricultural research, which is insufficient given the importance of agriculture in national economics. In contrast, Oman's intensity ratio reached 6.5 percent in 2012, which is one of the highest shares in the world.

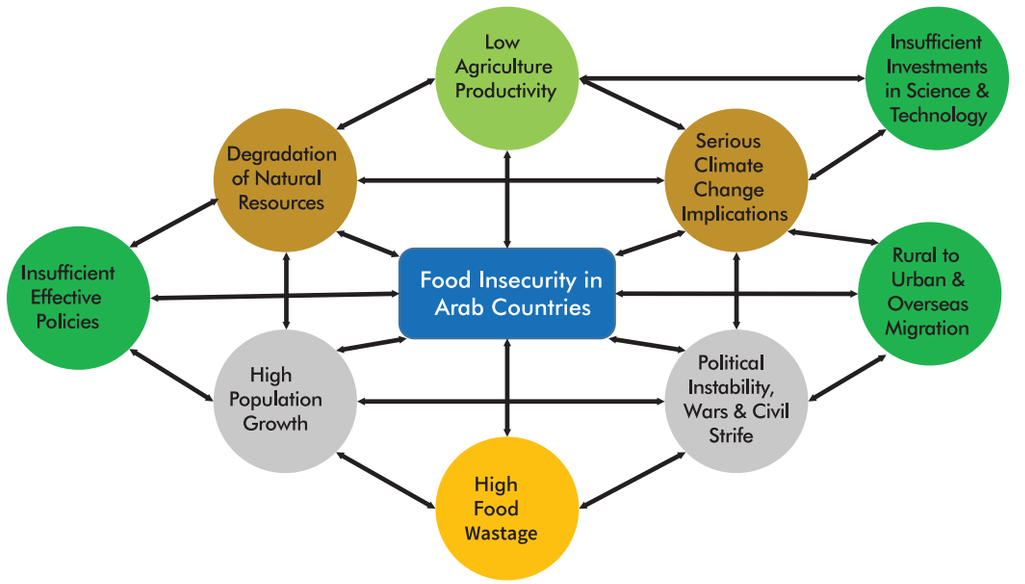
Research focus in Arab countries is predominantly commodity-oriented, in favor of crops, fisheries and livestock. National Agricultural Research Systems allocate their resources priorities and commodities of national significance following underlying national thematic priorities. Roughly half of the time of the researchers in Egypt, Jordan, Oman and Yemen was allocated for crops, mainly wheat, fruits, vegetables, and olives. Livestock research accounted for 10-30 percent of full time equivalent (FTE) researchers in Algeria, Egypt, Jordan, Lebanon, Mauritania, Morocco, Oman, Sudan, Tunisia, and Yemen (Stads, 2015). Fisheries research is given high priority in Mauritania, Morocco and Oman.

Given chronic water scarcity in the region and the fact that the agricultural sector consumes more than 80 percent of the scarce water resources, improving water-use efficiency in agriculture should be a major research priority in the region, although current resources allocation for water research does not necessarily reflect this priority. Only 7-10 percent of researchers are allocated for research on natural resources (Stads, 2015).

The number of agricultural researchers increased in Arab countries between 2009 and 2012, either modestly as in both Jordan and Sudan or considerably as in Egypt and Lebanon. Egypt's agricultural R&D system increased its researchers from 6,490 to 8,420 between 2009 and 2012. Egypt's agricultural R&D system is among the world's largest in terms of human resource capacity. With the exception of Jordan, the number of PhD-qualified researchers increased during 2009-2012 in all countries (Stads, 2015).

As a result of scientific research, many improved technologies were locally developed, and some found their way to the hands of farmers and

FIGURE 5 **FACTORS CONTRIBUTING TO FOOD AND NUTRITIONAL INSECURITY IN THE LAST TEN YEARS IN THE ARAB WORLD**




made substantial impact. However, many more technologies were restricted to laboratories, which requires more investment in technology transfer and strengthening the extension systems.

## V. CHANGES IN FOOD SECURITY IN ARAB COUNTRIES SINCE 2006

According to the World Food Summit held in Rome in 1996, "food security exists when all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food which meets their dietary needs and food preferences for an active and healthy life".

To achieve food and nutritional security, the following four dimensions must be considered:

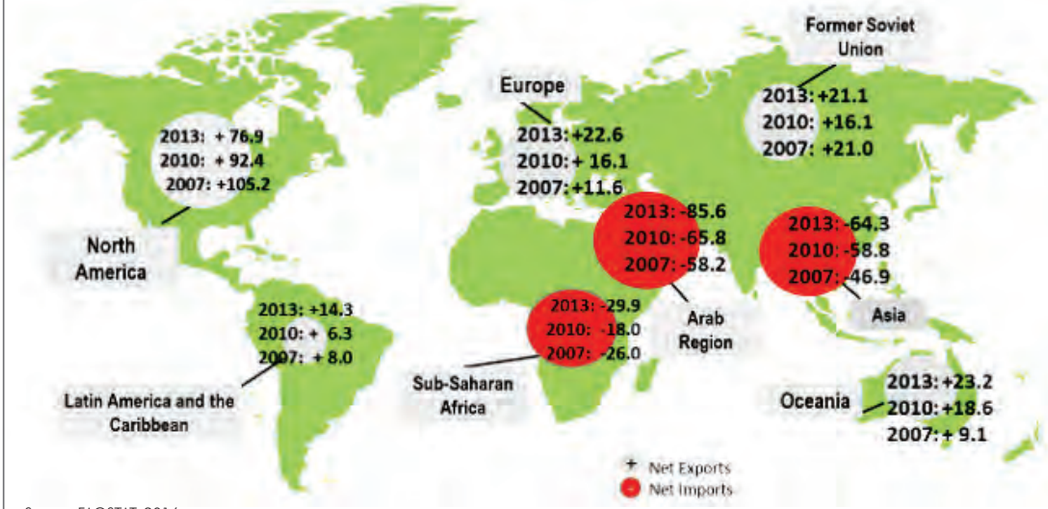
- Food availability, related to domestic production & market availability;
- Food access, related to affordability to people as food producers and/or consumers;
- Stability, no or minimum fluctuation in production and in market prices related to affordability;
- Utilization, food nutritional quality and food safety.

Agricultural productivity in all Arab countries except Egypt is already way below the global average because of insufficient enabling policy environment, insufficient investment in agricultural research and development and the lack of improved technologies in the hands of farmers. Thus, in most countries advanced agricultural technologies were not available to farmers, particularly the resource-poor farmers that contribute to more than 80 percent of national agricultural production in these countries. However, ICARDA, based on ground-field experience over the last 40 years, has demonstrated that agricultural productivity in all Arab countries can be increased substantially despite the limitation in natural resources (El Solh, 2014). It is essential to upscale successful case studies to ensure large impact towards food security.

### *A. The Gap Between Consumption and Production is Growing Wider*

In the last ten years, from 2006 to 2016, the food and nutritional security has deteriorated further in several Arab countries despite bright spots in certain countries. Based on the earlier sections of this chapter, there are several factors that affected food and nutritional security in Arab countries as indicated in Figure 5.

FIGURE 6 **GLOBAL CEREAL TRADE: CEREAL IMPORTS AND EXPORTS (IN MILLION MT) IN DIFFERENT PARTS OF THE WORLD IN 2007, 2010 AND 2013**




Source: FAOSTAT, 2016

The gap between food production and consumption has been growing over the years in Arab countries. Cereals imports in Arab region, which are already the highest in the world, have grown from 58.2 million tons in 2007 to 65.8 million tons in 2010 to 85.6 million tons in 2013 (Figure 6).

In monetary terms the total Arab food gap has increased to very high values: from USD 18 billion in 2005 to about USD 29 billion in 2010, and to about USD 34 billion in 2014. The average annual increase in the gap was 7.3 percent during the period 2005-2014, as shown in Table 4. This is a clear indicator of the inefficiency of the implementation of Arab agricultural development plans to reduce the food gap. It is apparent that the deficit is widening in all food commodities with gap increases of 6.5 to 12.5 percent between 2005 and 2014 except in the case of vegetables and fruits recording a surplus of 13 percent, 8 percent and 2 percent, respectively (Table 5). There is an improvement in the production of milk and dairy products where the deficit has been reduced by 7 percent.

The food gap differs greatly among the Arab countries based on their populations, levels of income and patterns of consumer habits, in addition to the availability of natural and agricultural resources and the efficiency of their use. This is in addition to the difference in their investment and agricultural research, development and technology transfer to farmers. However, five Arab countries (Saudi Arabia, Egypt, UAE, Algeria, and Kuwait) represented about 67.9 percent of the total value of Arab food gap in 2014 (AOAD, 2015).

Self-sufficiency rates continue to be at low levels for the staple food commodities as shown in Table 5 for the same reasons stated in food shortage. Table 3 shows sufficiency ratios for three groups at regional level as follows:

- The first group includes commodities where surplus or close to self-sufficiency ratio have been achieved and this includes vegetables, fruits, potatoes and fish.
- The second group includes food commodities in which moderate sufficiency has been achieved. These include dairy products, meat, legumes, and rice.
- The third group includes food-deficit goods, which include cereal, flour, wheat, sugar, and vegetable oils.

Food self-sufficiency at the country and sub-regional levels vary widely in the Arab world. At country level, it ranged between about 10 percent in Qatar and 87 percent

TABLE 4 THE FOOD SECURITY GAP (IN MILLION USD) IN THE ARAB WORLD FOR THE GROUPS OF MAIN COMMODITIES

| | Food security gap (in million USD) | | | % change in food gap value | % of food Self-sufficiency | | |
|---|---|---|---|---|---|---|---|
| **Year** | **2005** | **2010** | **2014** | **2005-2014** | **2005** | **2010** | **2014** |
| **Total** | 18060 | 29409 | 34183 | 7.3 | | | |
| **Cereals and flours** | 9661 | 17479 | 22441 | 9.8 | 49.7 | 44.6 | 52.6 |
| Wheat and flours | 4497 | 7981 | 9429 | 8.6 | 49.9 | 42.8 | 51.5 |
| Barley | 1400 | 2299 | 4039 | 12.5 | 32.4 | 40.7 | 40.6 |
| Rice | 1470 | 3095 | 3996 | 11.7 | 70.6 | 55.9 | 62.5 |
| Maize | 2098 | 3643 | 4841 | 9.7 | 36.2 | 30.9 | 30.8 |
| **Potatoes** | 104 | -22 | -170 | surplus | 100.6 | 101.2 | 105.4 |
| **Sugar** | 1359 | 2989 | 2430 | 6.7 | 38.5 | 33.4 | 35.7 |
| **Legumes** | 414 | 507 | 730 | 6.5 | 56.2 | 55.5 | 65.2 |
| **Oils** | 1960 | 3987 | 4469 | 9.6 | 28.1 | 36.8 | 35.1 |
| **Vegetables** | -66 | -2007 | -2892 | surplus | 100.1 | 102.7 | 113.1 |
| **Fruits** | 448 | -1136 | -1160 | surplus | 95.9 | 97.5 | 107.9 |
| **Meat** | 2610 | 6018 | 7429 | 12.3 | 80.9 | 75.5 | 77.5 |
| **Milk and its product** | 2856 | 2088 | 1471 | -7.1 | 71.4 | 77.7 | 82.2 |
| **Eggs** | 57 | 5 | 94 | 5.7 | 95.9 | 95.6 | 97.5 |
| **Fish** | -1343 | -499 | -659 | -7.6 | 103.1 | 100.7 | 102.2 |

Source: Arab Monetary Fund; Unified Arab Economic Report for 2016 based on AOAD publication on situation of Arabian food security.

in Sudan, and at the sub-regional level, the ratio ranged between 30 percent in the Gulf Cooperation Council (GCC) countries and 81 percent in the Nile Valley countries in 2011 (Table 5).

## *B. Classification of Food Security Risk in Arab Countries*

A conceptual framework links food security to economic and social development to base the overall food insecurity risk in Arab countries (Breisinger, et.al. 2014). Following this concept, the countries are categorized by assessing two major indicators: a macro-economic level and a micro-household nutritional and health status level as measures of food insecurity (Breisinger, et.al. 2014). The macro-level indicator is defined according to Breisinger et.al. (2014) as the share of food imports divided by total exports plus net remittance inflows (food imports / [total exports + net remittance inflows]). This definition reflects the ability of a country to finance food imports through exports of goods and the revenues from services and the remittances received. The micro-level indicator classifies Arab countries based on the prevalence of child undernutrition (expressed as a percentage) and is used as a micro-level food-insecurity indicator.

Combining both indicators, macro and micro food security measures of economic growth and malnutrition reflected in the number of stunted children, Figure 7 shows that the food insecurity risk is extremely alarming in Yemen, Comoros, Sudan, and Mauritania. This risk is serious in Algeria, Egypt, Morocco, Jordan, Lebanon and Syria. It is moderate in Libya and Tunisia while it is low in the Gulf countries.

However, all these assessments do not take into consideration the agricultural potential of Arab countries. This potential should be well explored to increase domestic food production

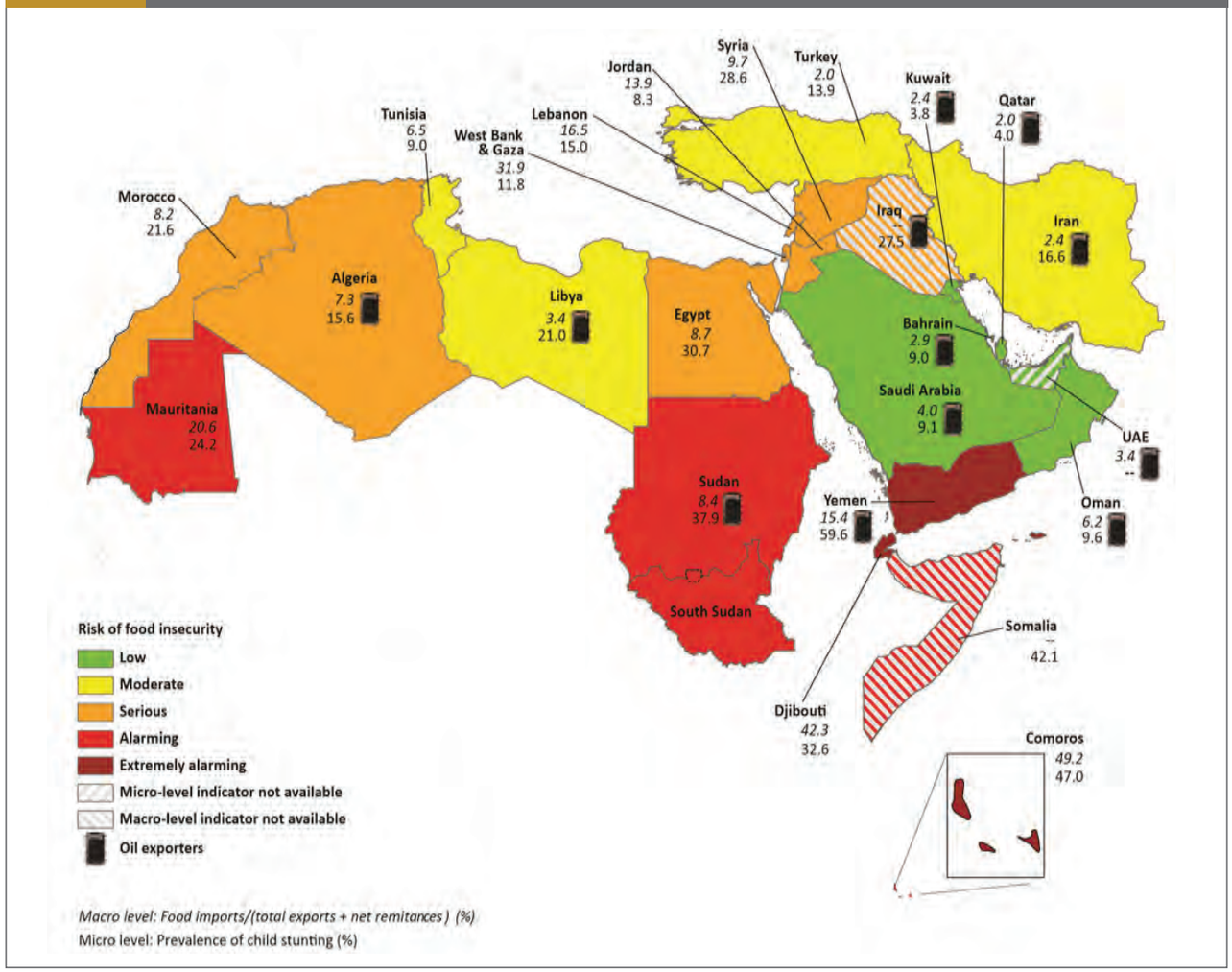
TABLE 5 **SELF-SUFFICIENCY RATIO IN TOTAL FOOD COMMODITIES AND CEREALS IN VARIOUS ARAB COUNTRIES**

| | Food Self-Sufficiency Ratio (%) | | | | | |
|---|---|---|---|---|---|---|
| **Country/Sub-Region** | **Total Food** | | | **Cereals** | | |
| | 2005 | 2011 | 2014* | 2005 | 2011 | 2014** |
| Bahrain | 12.96 | 12.81 | 19.0 | 0 | 0 | 0 |
| Kuwait | 28.38 | 21.68 | 25.0 | 3.88 | 2.56 | 3.84 |
| Oman | 45.21 | 34.52 | 49.4 | 1.17 | 9.22 | 2.30 |
| Qatar | 12.18 | 9.90 | 15.8 | 3.12 | 0.37 | 0.42 |
| Saudi Arabia | 44.52 | 34.49 | 32.7 | 26.75 | 11.15 | 4.58 |
| United Arab Emirates | 21.13 | 18.66 | 21.3 | 0.85 | 1.06 | 2.05 |
| **GCC** | 37.40 | 29.45 | 29.9 | 20.25 | 9.12 | 3.97 |
| Yemen | 51.53 | 31.45 | 63.2 | 22.59 | 10.92 | 17.45 |
| **Arabian Peninsula** | 39.74 | 29.74 | 34.4 | 20.54 | 9.46 | 6.46 |
| Iraq | 75.34 | 82.84 | 90.5 | 55.51 | 95.42 | 97.20 |
| Jordan | 56.26 | 53.09 | 66.6 | 5.05 | 3.66 | 3.70 |
| Lebanon | 73.23 | 61.03 | 74.7 | 18.05 | 10.96 | 13.80 |
| Syria | 85.23 | 80.62 | 84.3 | 74.00 | 57.98 | 47.86 |
| Palestine | 81.55 | 72.26 | 79.3 | 19.69 | 10.00 | 9.48 |
| **West Asia** | 77.20 | 75.52 | 82.6 | 54.86 | 56.48 | 56.08 |
| Egypt | 83.68 | 78.96 | 88.0 | 69.63 | 56.30 | 66.04 |
| Sudan | 91.15 | 86.84 | 94.4 | 75.74 | 70.59 | 60.72 |
| **Nile Valley** | 85.51 | 80.8 | 86.4 | 70.74 | 59.09 | 65.42 |
| Algeria | 53.48 | 70.04 | 75.2 | 29.88 | 31.96 | 21.65 |
| Libya | 44.95 | 43.09 | 38.3 | 10.79 | 7.06 | 9.49 |
| Mauritania | 68.49 | 70.03 | 88.0 | 19.17 | 36.04 | 47.86 |
| Morocco | 89.60 | 80.40 | 100.0 | 46.09 | 58.91 | 68.00 |
| Tunisia | 71.78 | 68.49 | 89.5 | 47.82 | 46.79 | 42.42 |
| **North Africa** | 66.87 | 71.58 | 88.6 | 35.75 | 43.19 | 30.35 |
| Comoros | - | - | | - | - | |
| Djibouti | 4.04 | 2.00 | 10.1 | 0 | 0 | 0 |
| Somalia | 69.17 | 74.26 | 96.0 | 32.89 | 33.00 | 31.23 |
| **African Horn** | 64.80 | 63.52 | 90.7 | 28.46 | 26.70 | 25.42 |
| **Arab Countries** | 70.48 | 71.69 | 84.4 | 49.74 | 45.55 | 45.16 |

Source: Abdul-Karim Sadik. 2014. The State of Food Security and Agricultural Resources. AFED
* Compiled by the authors based on data in AOAD, 2015.
** AOAD. 2015. Arab Agricultural Statistics Yearbook, Vol 35.

and reduce food imports. ICARDA's 40 years of field experience in agricultural research for development demonstrates that food security can be enhanced in most Arab countries through modernization of agriculture production systems and the transfer of improved technologies to farmers. This has already been done by bridging the yield gap

FIGURE 7 COMBINED MACRO AND MICRO FOOD INSECURITY RISK BASED ON 2011 ASSESSMENT




between actual farmers' production and the potential production, which can be up to 147 percent (El Solh, 2016).

Arab countries differ in their agricultural potential to enhance food security. Table 6 shows the cultivated areas which include the arable and permanent cropland and total renewal water resources, irrigated area and the area that potentially can be put under irrigation. All these factors provide important elements for agricultural potential, which could be exploited to enhance food security. However, except for Sudan, Arab countries have limited horizontal potential to expand agriculture. Nevertheless, there is great potential to increase agricultural productivity vertically considering that agricultural productivity in most Arab countries is way below the global average.

A project by ICARDA titled Enhancing Food Security in Arab Countries provided an important example on realizing the agricultural potential by bridging the yield gap in wheat. In an average of six seasons (2010/2011-2015/2016) targeting whole provinces in nine Arab countries, wheat productivity yield gap was increased by up to 124 percent under irrigated conditions in Sudan, up to 96 percent under supplemental irrigation in Yemen and up to 84 percent under rainfed conditions in Syria (Table 7). At the national level, there are clear examples that both Syria and Iraq were the only Arab countries that managed to achieve self-

TABLE 6 **ARAB COUNTRIES' POTENTIAL FOR EXPANSION IN AGRICULTURE CLASSIFIED ON THE COMBINATION OF CULTIVATED AREA AVAILABLE AND AVAILABILITY OF RENEWABLE WATER RESOURCES (AQUASTAT 1999-2014)**

| Country | Total area of the country (1000 ha) | Arable land area (1000 ha) | Cultivated area (arable land + permanent crops) (1000 ha) | Total renewable water resources ($10^9$ $m^3$/year) | Area equipped for irrigation: actually irrigated (1000 ha) | Irrigation potential (1000 ha) |
|---|---|---|---|---|---|---|
| Sudan | 187,936 | 19,823 | 19,991 | 37.80 | | |
| Morocco | 44,655 | 8,130 | 9,592 | 29.00 | 1448 | 1664 |
| Algeria | 238,174 | 7,469 | 8,439 | 11.67 | 1065 | 1300 |
| Syria | 18,518 | 4,662 | 5,733 | 16.80 | 1210 | |
| Iraq | 43,505 | 5,034 | 5,269 | 89.86 | | 5554 |
| Egypt | 100,145 | 2,670 | 3,745 | 58.30 | 3422 | 4420 |
| Tunisia | 16,361 | 2900 | 5,232 | 4.62 | 405 | 560 |
| Saudi Arabia | 214,969 | 3,502 | 3,647 | 2.40 | 1191 | |
| Yemen | 52,797 | 1,248 | 1,546 | 2.10 | | |
| Mauritania | 103,070 | 450 | 461 | 11.40 | 23 | 250 |
| Libya | 175,954 | 1,720 | 2,050 | 0.70 | 316 | 40 |
| Jordan | 8,932 | 238 | 322 | 0.94 | 76 | 85 |
| Lebanon | 1,045 | 132 | 258 | 4.50 | 90 | 178 |
| Palestine | 602 | 64 | 148 | 0.84 | | |
| UAE | 8,360 | 38 | 773 | 0.15 | 76 | |
| Oman | 30,950 | 38 | 69 | 1.40 | | |
| Kuwait | 1,782 | 10 | 16 | 0.02 | 10 | 25 |
| Qatar | 1,161 | 13 | 16 | 0.06 | 6 | 52 |
| Bahrain | 77 | 2 | 5 | 0.12 | 4 | 4 |

**High Potential** **Medium Potential** **Limited Potential** **Extremely Limited Potential**

sufficiency in staple food crops before the wars and civil strife started in these countries. Food security deteriorated drastically after the war in Iraq in 2003 and after the disturbances in Syria in 2011. So there is no reason why Arab countries could not exploit their agricultural potential to enhance food security.

Based on their potential, Arab countries can be categorized into four groups to enhance food security both horizontally and vertically (Figure 8):

- **Group A, High Potential Countries:** Algeria, Egypt, Iraq, Morocco, Sudan and Syria.
- **Group B, Medium Potential Countries:** Mauritania, Saudi Arabia, Tunisia and Yemen.
- **Group C, Limited Potential Countries:** Jordan, Lebanon and Libya.
- **Group D, Extremely Low Potential Countries:** Bahrain, Kuwait, Oman, Qatar, United Arab Emirates.

Despite the high arable area in Libya, it was characterized as a limited potential country because of very limited renewal water resources. Data is not available for Comoros Islands, Djibouti and Somalia.

Considering the different potentials for enhancing food security in Arab countries, it is apparent that regional collaboration can enhance agricultural productivity, both horizontally and

TABLE 7 **GRAIN WHEAT YIELD (T/HA) AS AN AVERAGE OF SIX SEASONS (2010/2011-2015/2016) IN THE FARMERS' DEMONSTRATION FIELDS VERSUS FARMERS' TRADITIONAL FIELDS**

| Country | Egypt | Iraq **** | Jordan * | Morocco | | Palestine *** | Sudan | Syria | | Tunisia | | Yemen ** | Overall mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Production system* ***** | I | I | R | R | SI | R | I | R | SI | R | SI | SI | |
| Participating Farmers | 8.51 | 5.50 | 2.52 | 3.63 | 6.56 | 2.48 | 3.89 | 2.33 | 5.40 | 3.14 | 5.35 | 3.36 | 4.39 |
| Non-Participating Farmers | 6.87 | 4.30 | 2.03 | 3.17 | 5.20 | 2.09 | 2.44 | 1.75 | 4.84 | 2.49 | 4.11 | 2.31 | 3.47 |
| Average increase (%) | 24 | 28 | 24 | 15 | 26 | 19 | 59 | 33 | 12 | 26 | 30 | 45 | 28 |
| Maximum yield | 10.29 | 6.20 | 3.64 | 5.15 | 7.98 | 2.97 | 5.48 | 3.23 | 7.39 | 4.40 | 7.39 | 4.53 | 5.72 |
| Potential max increase % | 50 | 44 | 79 | 63 | 53 | 42 | 124 | 84 | 53 | 76 | 80 | 96 | 70 |

* Av of 2012-2016 seasons; ** Av of 2013-2016 seasons; *** Av of 2014-2016 seasons; **** Av of 2016 season; *****
R: Rainfed, SI: Supplemental Irrigation, I: Full irrigation

Source: Enhancing Food Security in the Arab Countries, ICARDA/National Programs Project (2011 to present) Unpublished data provided by the courtesy of Dr. Habib Halila, ICARDA Project Manager.

vertically, to achieve food security at the regional level. This collaboration should be based on the complementarities and comparative advantages between Arab countries.

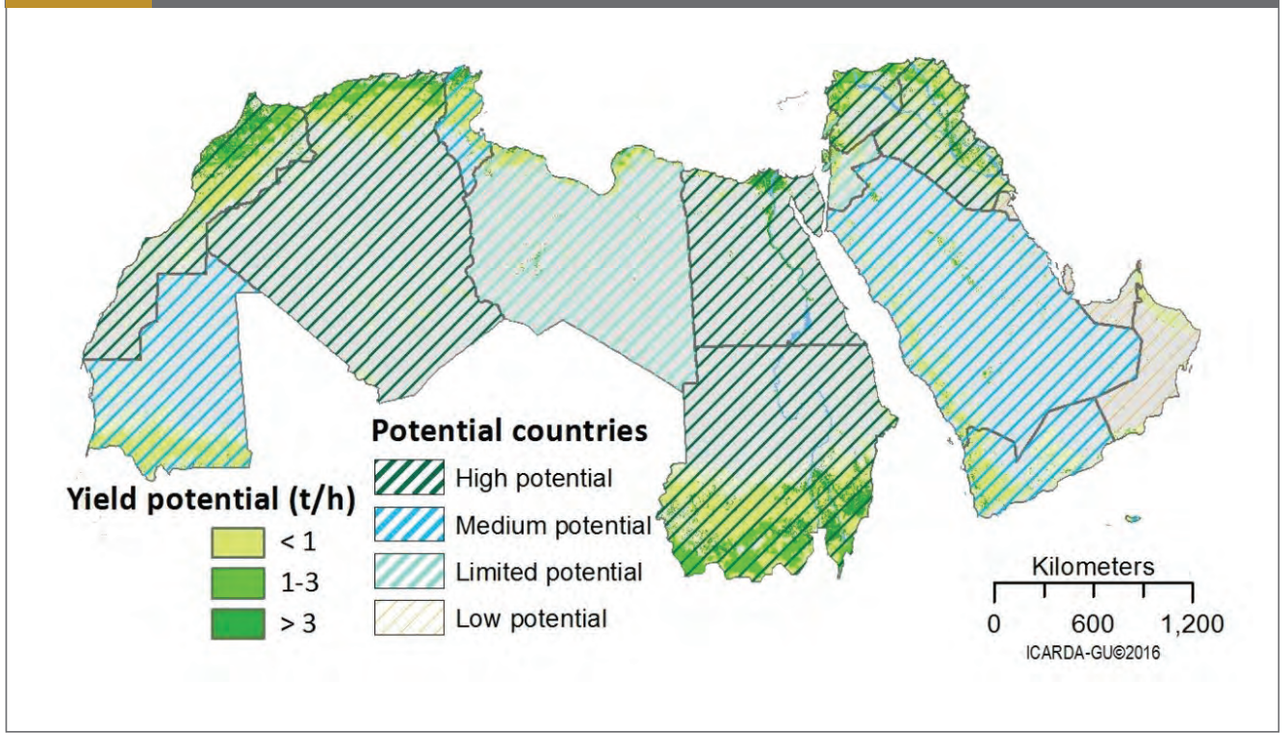
## VI. CONCLUSION AND RECOMMENDATIONS

Before the upheavals that started late in 2010 in Arab countries, most Arab countries were making good progress to achieve the Millennium Development Goals (MDGs) including MDGs 1 and 2 on poverty and hunger. However, after the upheavals, which are still escalating in several countries including Iraq, Syria, Libya and Yemen, this progress has been halted and even reversed not only in these countries but in almost all Arab countries because of the spillover effects of violence. Thus sustainable development, including enhancing food security, slipped down as a first priority in most Arab countries. What added to these developments is the 50 percent drop in oil prices in 2015, which also negatively affected the development plans in the oil rich countries, including the Gulf countries and Algeria. Of the countries that were affected by the upheavals, Egypt was the exception since the Egyptian government continued its effort to reform subsidies, including cutting environmentally and socially detrimental fuel subsidies (IFPRI, 2016).

In the last ten years, the gap between food production and consumption has widened further in the Arab world, due to several factors including high population growth, the degradations of natural resources (water resources, land and biodiversity), serious implication of climate change and low investment in science and technology. These factors added to higher risks for food insecurity, on top of the recent upheavals in a number of countries with high agricultural potential. With respect to their vulnerability to food insecurity, Arab countries were classified using three indicators: macro-economic, micro-household nutritional and health and agricultural potential indicators. Arab countries should work together to exploit their agricultural potential based on their complementarities and comparative advantages to achieve food and nutritional security.

Considering the changes in the region over the last ten years, the following three areas are high priorities for policy intervention to improve food and nutrition security in Arab countries:

FIGURE 8 **POTENTIAL OF ARAB COUNTRIES TO ENHANCE FOOD SECURITY BASED ON AGRICULTURAL POTENTIAL**




- In conflict areas, peace-building through investment in sustainable development including reducing poverty and enhancing food and nutritional security activities at local and national levels.
- Outside conflict areas, strengthen education and adopt subsidy reforms to improve food and nutritional security.
- Attention is essential in enhancing both macro and micro food security as well as the utilizing the agricultural potential of Arab countries to enhance food and nutritional security through science and technology.

Considering the potential of various Arab countries for enhancing food security, regional collaboration is essential to utilize agriculture potential effectively, both horizontally and vertically, to achieve food security at the regional level. This collaboration should be based on the complementarities and comparative advantages of each of the Arab countries and the following are important considerations:

- Based on agricultural potential, increasing food production vertically by bridging yield gaps in staple crops and whenever possible expanding production horizontally;
- Building food reserves and stocks;
- Reducing food losses at all stages of the food chain including at the consumption stage;
- Promoting financial mechanisms to absorb shocks against food price fluctuations;
- Ensure long-term procurement sources of cereals as the staple food for protection against the sudden banning of food exports in case of a global food crisis.

In order to insure the aforementioned consideration there is an urgent need for effective policies and mechanisms to enhance regional cooperation to ensure national and regional food and nutritional security.

More investment is needed in scientific innovation is to make a difference to bridge the growing gap between production and consumption.

Innovative research outputs and advanced technologies can help both farmers and pastoralists to overcome or minimize the negative impacts of climate change implications on agriculture.

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# SUSTAINABLE ENERGY PATHWAY FOR THE ARAB REGION

Radia Sedaoui

## I.INTRODUCTION

Global energy markets have undergone substantial changes in recent years. Oil prices have declined, creating a growing source of concern, and downside economic risks still threaten the energy sector as investments continue to decrease, not only in the oil industry but also in the gas and power sectors in general. As explained by Naim (2016), "Hydraulic fracturing and related technologies have also created new ways of producing hydrocarbons. In addition to solar panels and batteries, wind turbines, biomass gasification and tidal energy, among other technological innovations, are changing the face of the energy industry, as we know it".

Today, high rates of population growth, increasing rates of urbanization, economic and industrial expansion, and rising living standards are all expected to contribute to the progressive shift in the global geography of energy consumption towards industrializing and urbanizing regions in South East Asia and parts of Africa, Latin America and the Middle East (IEA, 2016).

With a historically small domestic energy market, the Arab region has long been perceived as a marginal energy consumer, with limited priorities set on policies and regulations such as energy efficiency, increasing the share of renewable energy, and the move away from fossil fuels.

Within this context, it is time for the Arab region's socio-economic development to move toward a sustainable energy future. Fossil fuels and their synergies with renewable energy and the modernization and diversification of the Arab economies have to be assessed in a strategic and forward-looking manner to ensure a better management of the Arab countries' natural assets and resources and to improve quality of life, health and education for all.

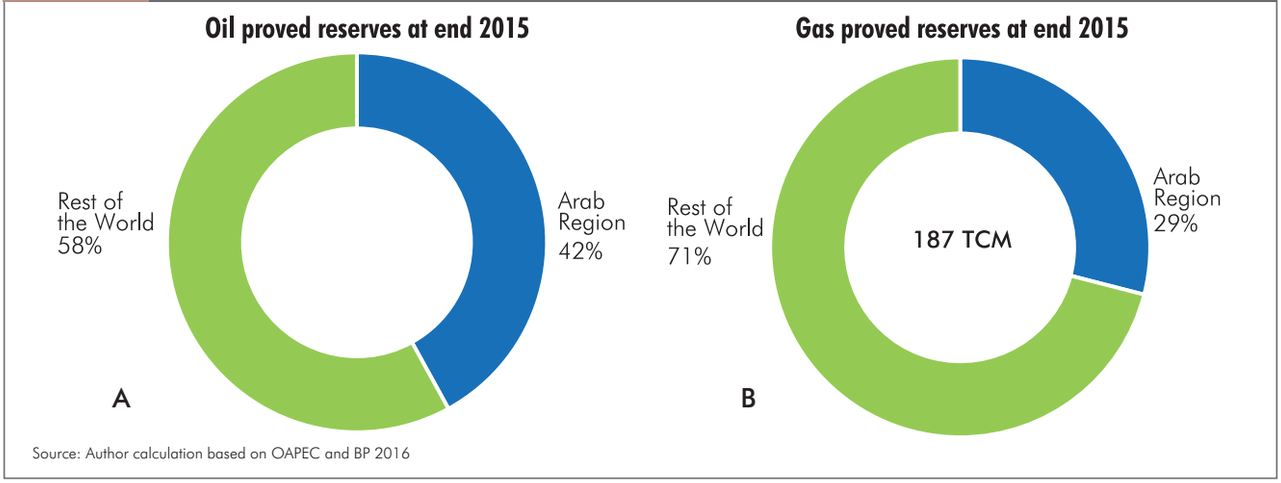
## II. ARAB COUNTRIES' RELIANCE ON FOSSIL FUELS

The Arab region's rapidly growing domestic energy demand challenges the region's traditional energy policy. In 2014, the region accounted for 5.1 percent of the world's total primary energy supply, 7.8 percent of its carbon dioxide emissions, and 5.6 percent of its gross domestic product (GDP) (2011 PPP USD), much of it generated in the Gulf Cooperation Council (GCC) (World Bank, 2017a).

Fossil fuels form an integral part of the Arab region's socio-economic development trajectory, reflecting the region's large oil and natural gas resources that have defined the region's status as a key supplier of oil to world markets.

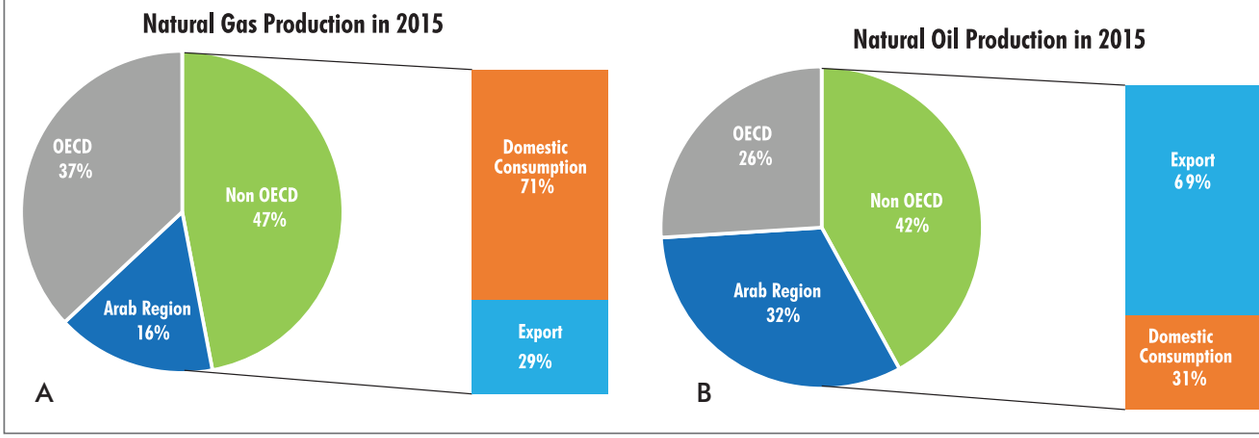
Arab economies account for over 40 percent of the world's proven crude oil and around a third of global natural gas reserves, and are major net exporters of energy to international markets. The Arab region also accounts for some 30

FIGURE 1 A- OIL AND B- GAS RESERVES IN THE WORLD AND ARAB REGION AT END 2015




Source: Author calculation based on OAPEC and BP 2016

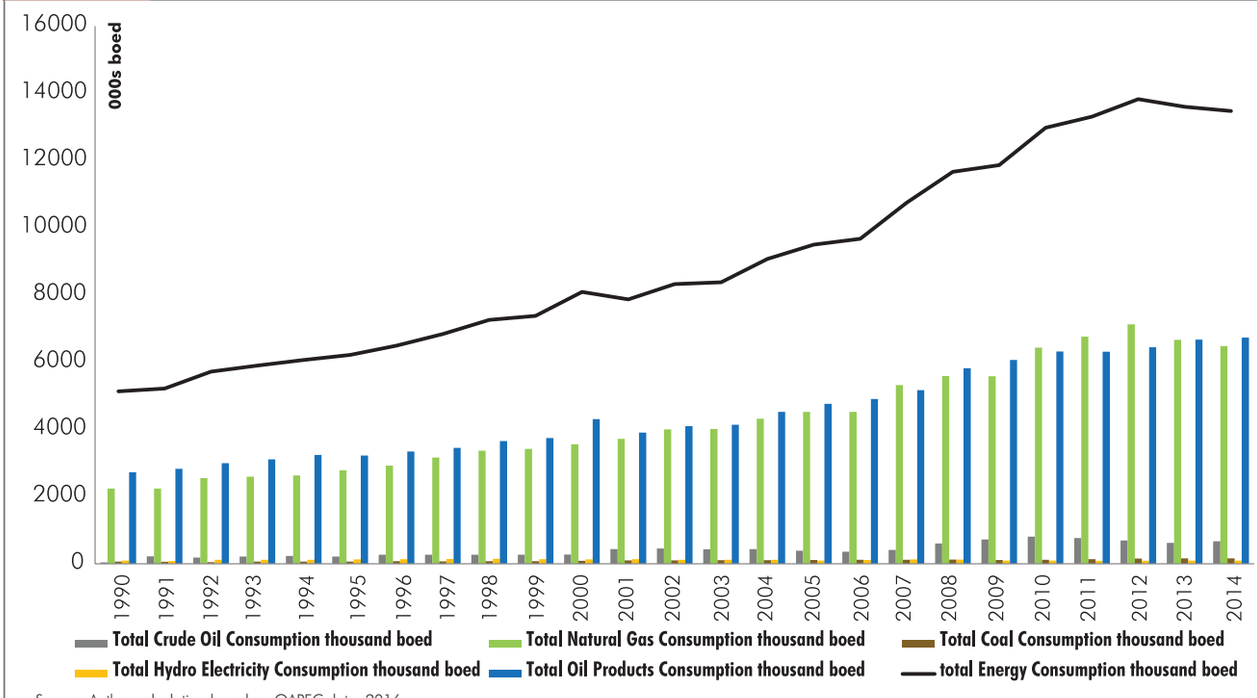
FIGURE 2 A- GAS AND B- OIL PRODUCTION AND EXPORTS IN THE ARAB REGION AT END 2015




percent of the world's oil and around 16 percent of global natural gas production, holding some of the world's largest regional reserves in crude oil and natural gas. Some three-quarters of the region's oil production is exported and traded on international markets, reflecting the region's historically small domestic energy demand relative to the size of its energy resources, and the vast role played by oil industries in many Arab oil-producing economies.

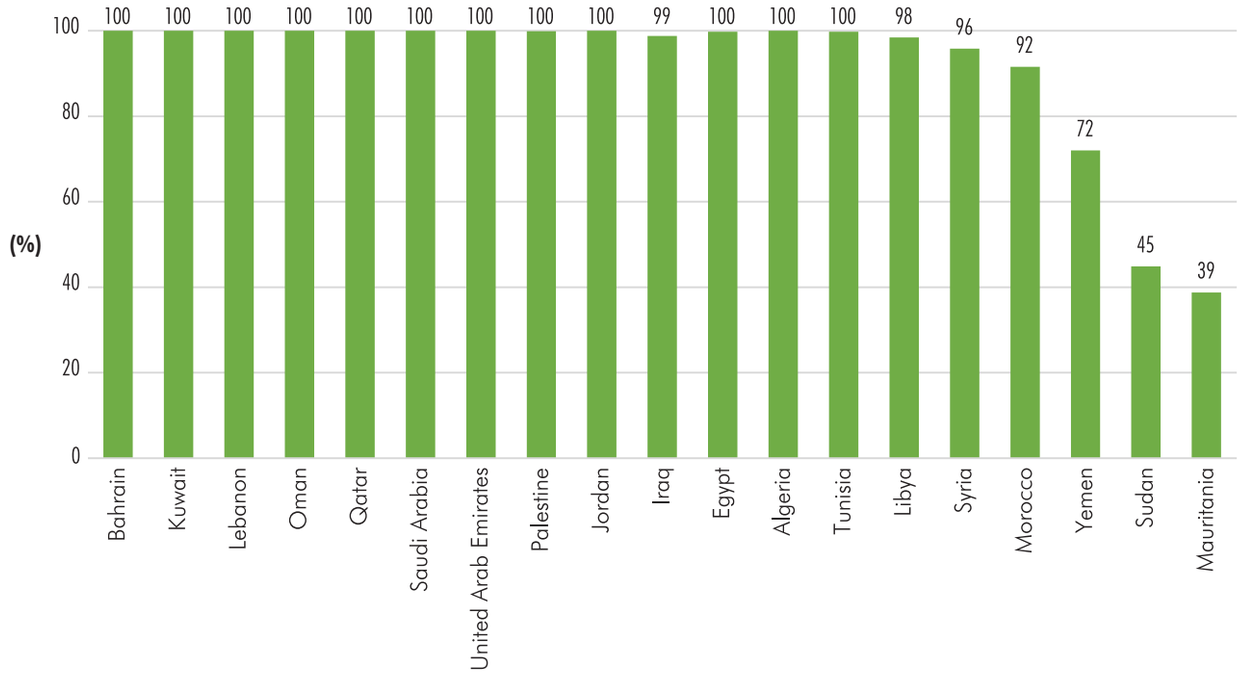
Fossil fuels also dominate the region's domestic energy mix, with oil and natural gas accounting for around 95 percent of the region's own energy needs. A transition away from using fossil fuels will not happen smoothly or evenly.

FIGURE 3 ENERGY CONSUMPTION BY FUEL IN THE ARAB REGION: 1990-2014




Source: Author calculation based on OAPEC data, 2016

FIGURE 4 **PERCENTAGE OF POPULATION WITH ACCESS TO ELECTRICITY BY COUNTRY**




Source: GTF, 2017

## III. PATHWAY TOWARD UNIVERSAL ENERGY ACCESS

Previous policy priorities in the field of energy were essentially placed on energy access, the result of which has been the high rate of modern energy access in the Arab region. Indeed, according to the latest release of the Global Tracking Framework Report (2017), the Arab region ranked third globally and was assessed as approaching universal access to electricity. Figure 5 shows the percentage of the Arab population that had access to electricity by the end of 2014.

As of 2014, over 35 million people in the Arab region lack electricity access, where the highest deficits are in the least developed countries (LDCs) including Mauritania, Sudan and Yemen. The percentage of the population in these countries that has access to electricity reaches as low as 39 percent in Mauritania and 45 percent in Sudan.

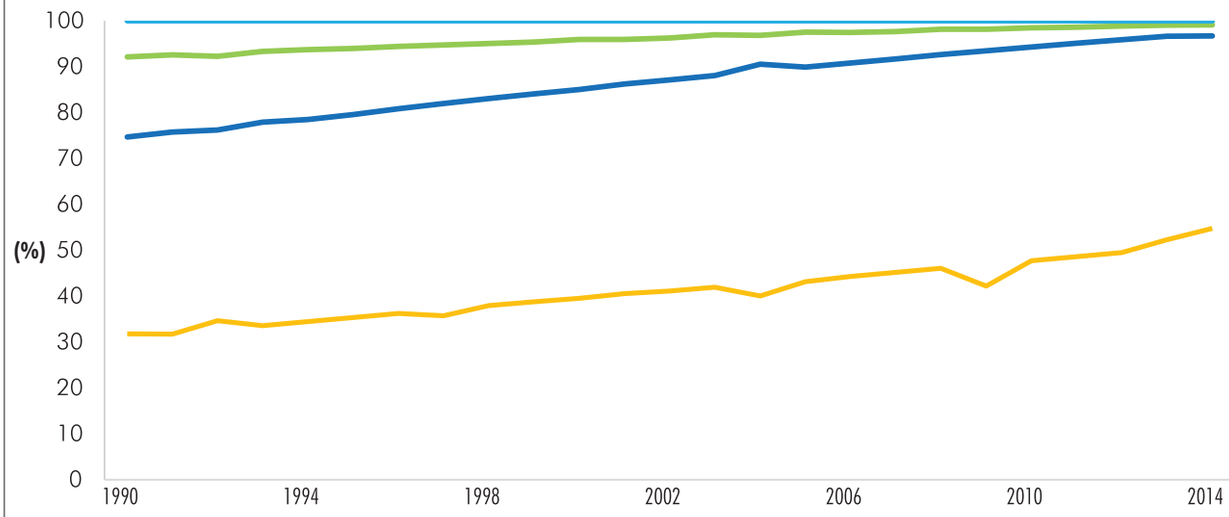
Most people in the Arab countries that lack access to electricity are in rural areas, which requires urging local authorities to find appropriate solutions such as diesel generators and renewable energy sources.

### A. Urbanization is Driving Arab Demand for Energy

In the Arab region, urbanization rates are growing, owing to greater socio-economic opportunities in cities. The urban population in Arab countries grew fourfold from 1970 to 2010 and will more than double again between 2010 and 2050. 57 percent of the Arab region's population already lives in cities and the UN projects that by 2050, this proportion will increase to over 68 percent (UN ESCWA, 2015). While in the past poverty was largely associated with rural areas, increased urbanization has led to poverty also being present in urban areas in countries such as Jordan and Tunisia (Santos and Ceccacci, 2015).

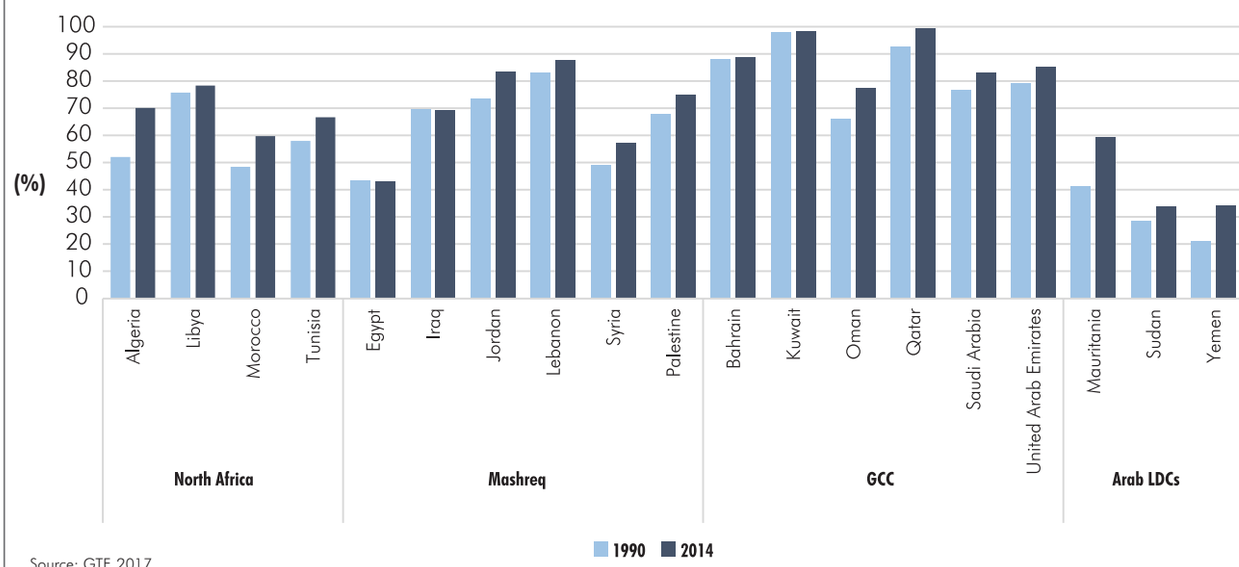
The rate of urbanization is accelerating and is also made more complex due to war, political instability, and consequent displacement and migration, particularly in low and lower middle-income countries (UN ESCWA, 2015).

FIGURE 5 SHARE OF POPULATION WITH ACCESS TO ELECTRICITY (%)




Source: GTF, 2017

FIGURE 6 URBAN POPULATION IN THE ARAB REGION (% OF TOTAL)




Source: GTF, 2017

## IV. MARGINAL ROLE OF RENEWABLE ENERGY IN THE ARAB REGION'S ENERGY SUPPLY

Over the past decades, the Arab region has on the global scale displayed the smallest role in developing renewable energy, reflecting the Arab region's globally unparalleled reliance on non-renewable sources of energy. The reasons for this particular development pattern lie less in the resource base for renewables – as the Arab region has access to prolific renewable energy resources such as solar and wind power – but rather in the region's own development model that has tied a relatively high degree of socio-economic development to the availability of abundant, low-

cost fossil fuel-based energy resources. Energy pricing practices, including the widespread practice of energy subsidies to supply energy to domestic markets, have historically reduced the commercial playing field for renewables in the Arab region.

As seen in Figure 7, Sudan, Egypt and Morocco account for two-thirds of total RE consumption, where Sudan alone consumes almost half of the region's renewable energy resources. Biomass and hydropower are the largest consumed RE sectors in the Arab countries today.

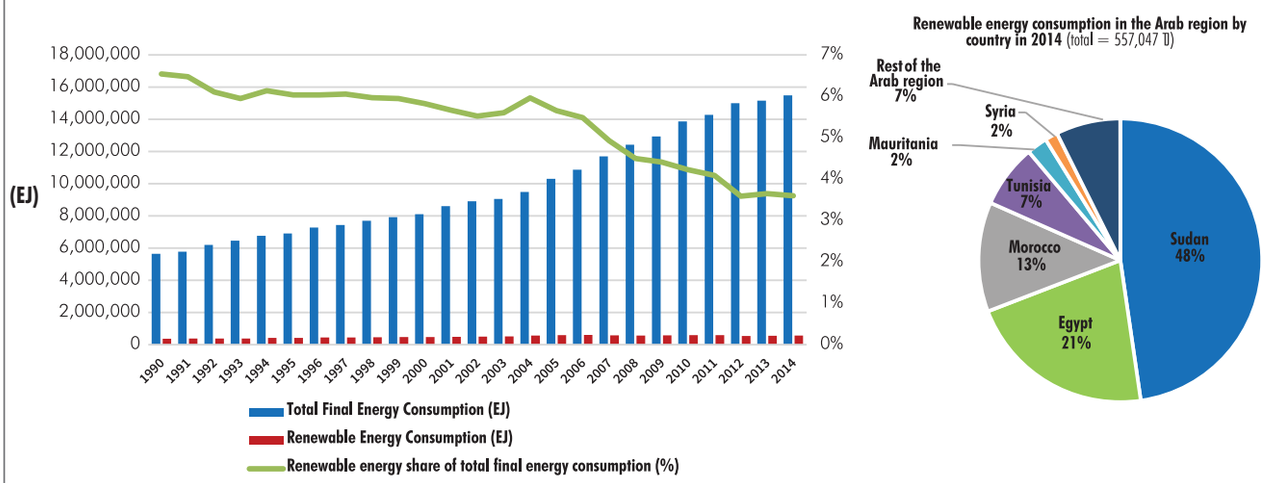
## A. Emerging Roles For Solar and Wind Power

The trend in new renewable energy consumption in the Arab region nevertheless moves away from biomass, towards modern renewable technologies. Where renewable energy consumption has grown over the past few years, it has done so primarily based on technologies such as solar and wind power, and to a lesser extent hydropower (Figure 8). The single largest increments in renewable energy consumption over the past 25 years were recorded in wind power, consumption of which rose by nearly 1,000 percent between 2000 and 2010, particularly in North Africa with the installation of large wind farms in Morocco and in the Mashreq countries during the 1990s and 2000s. Solar power consumption increased strongly as well – albeit from very low rates to start with – up 55 percent across the region during the 2000s, and most recently in the GCC economies. In the Arab LDCs, the largest single increment in renewables consumption came from hydropower.

Arab LDCs have in the past acknowledged the potential for RE to play a greater role in electrifying rural off-grid areas. In Mauritania, for instance, the scattered nature of many rural settlements away from existing infrastructure and transport makes grid expansion inherently difficult – 60 percent of the rural population lives in villages with less than 1,500 inhabitants (GRET, 2016). The country's Master Plan for the Production and Transport of Electricity considers connecting villages outside a radius of 120 km from the last grid-point to local off- and mini-grids powered by solar hybrid/diesel power (IRENA/UNEP, 2015; Mauritania Renewables Readiness Assessment, 2016; UNDP et al., 2016). In Sudan, a 2011 assessment of national GHG mitigation options by the Higher Council for Environment and Natural Resources specifically identified PV for rural electrification as one of six priority PV applications (UNDP et al. 2016).

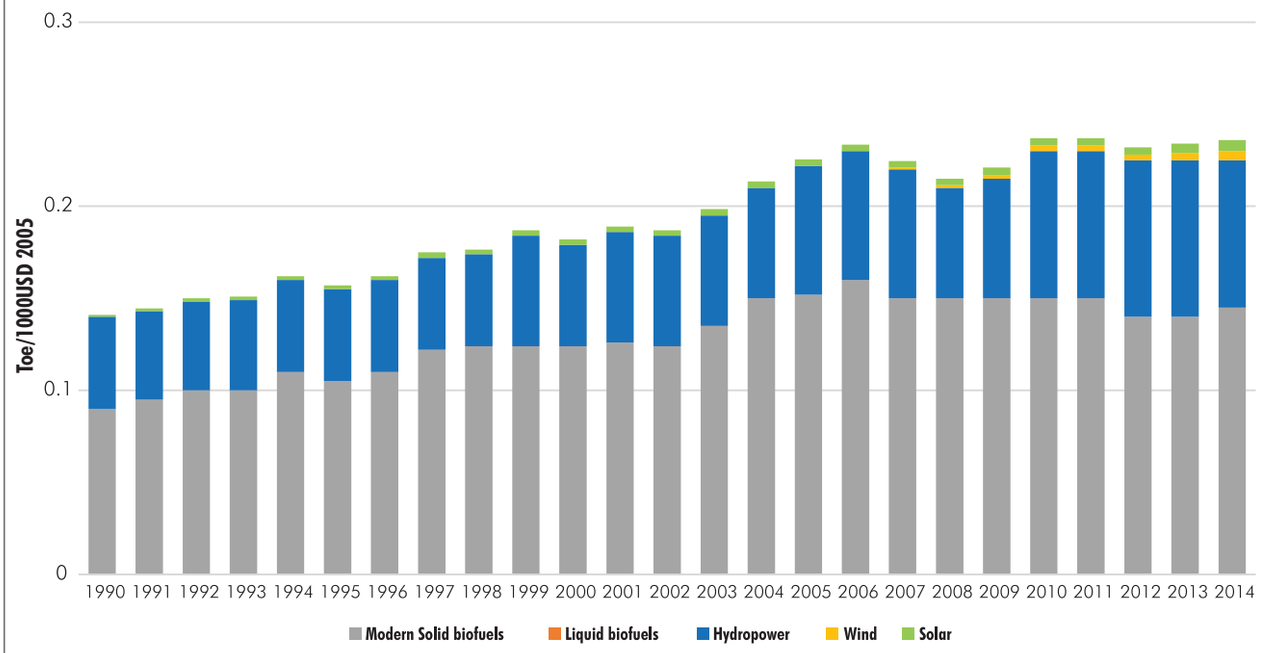
The outlook for wind and solar power in the Arab region is generally positive, provided further policy reform continues to incentivize investment in new sources of energy. The International Energy Agency

FIGURE 7 SHARE OF RENEWABLE ENERGY IN TFEC IN THE ARAB COUNTRIES




Source: Author's calculation based on WB and IEA Data

FIGURE 8 CONSUMPTION OF MODERN RE SECTORS IN THE ARAB REGION DOMINATED BY BIOMASS AND HYDROPOWER




Source: IEA, 2014

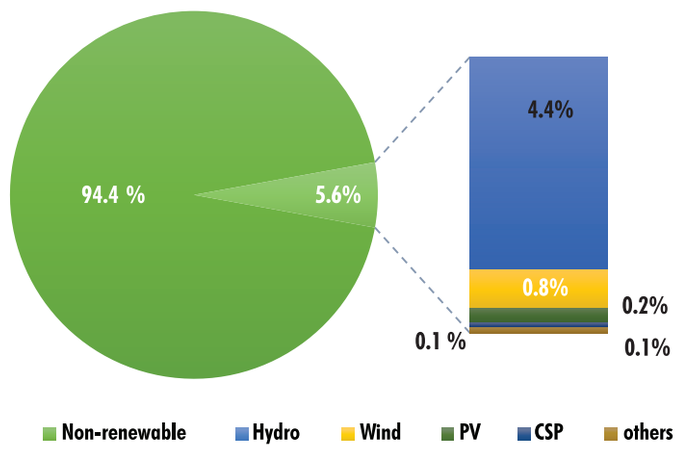
(IEA) projects that renewable energy generation in the Middle East (including Iran) is expected to double in size between 2013 and 2020, while it could also emerge as the world's largest deployment market for new solar thermal electricity (STE) capacity by 2020 provided conductive policies are in place, with the newest developments occurring in Saudi Arabia (IEA, 2014).

## B. Renewable Energy Installed Capacities

By the end of 2015 many Arab countries developed different renewable energy projects, with Morocco taking the lead. Morocco has increased its solar installed capacity to 198 MW from only 35 MW in 2014. In addition, the country has seen an increase in wind capacity from 787 MW in 2014 to 797 MW by the beginning of 2016. In addition, Egypt has kept its lead in the region in wind energy with a current total wind installed capacity of 810 MW and with an increase in PV installed capacity, reaching 90 MW (IRENA, 2016).

Furthermore, the UAE has also kept its leading position in solar energy (in particular CSP technology) with a current installed capacity of 100 MW. More so, Jordan has also made a big leap by increasing its total installed capacity in wind and solar technology to reach 210 MW. Table 1 shows the most recent data for the current installed capacities divided by sector and Arab countries (IRENA, 2014, 2016).

FIGURE 9 RE SHARE FROM TOTAL INSTALLED CAPACITIES IN THE ARAB REGION

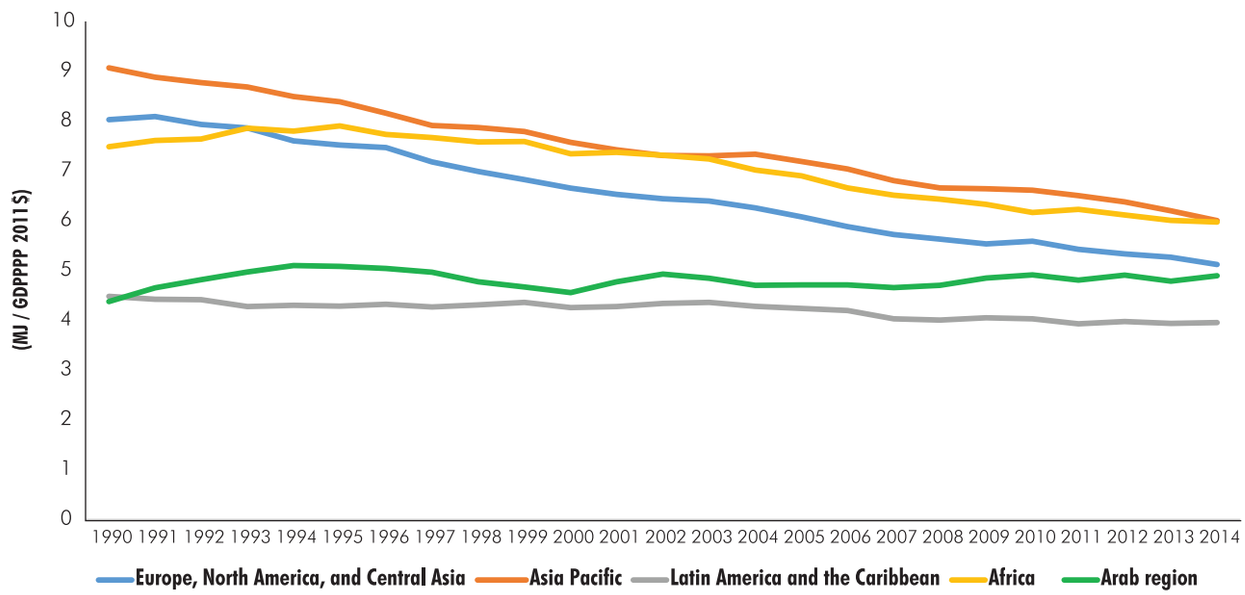



IRENA, 2015, 2016

TABLE 1 **RE INSTALLED CAPACITIES BY SECTOR IN THE ARAB COUNTRIES (MW)**

| Countries | PV | CSP | Wind | Hydro | Others (Biomass & waste) | Total RE |
|---|---|---|---|---|---|---|
| Jordan | 15 | | 197 | 12 | 3.5 | 227.5 |
| UAE | 33 | 100 | 0.9 | | 1 | 134.9 |
| Bahrain | 10 | | 0.7 | | | 10.7 |
| Tunisia | 20 | | 245 | 66 | | 331 |
| Algeria | 270 | 25 | 10 | 228 | 150 | 683 |
| Saudi Arabia | 25 | | | | | 25 |
| Sudan | 0.5 | | | 1,593 | 191 | 1,784.5 |
| Syria | 2 | | 0.6 | 1,571 | | 1,573.6 |
| Iraq | 3.5 | | | 2,513 | | 2,516.5 |
| Oman | 0.7 | 7 | | | | 7.7 |
| Palestine | 12 | | 0.7 | | | 12.7 |
| Qatar | 3.2 | | | | 25 | 28.2 |
| Kuwait | 1.8 | | | | | 1.8 |
| Lebanon | 20 | | 1 | 282 | 2 | 305 |
| Libya | 5 | | | | | 5 |
| Egypt | 90 | 20 | 810 | 2,800 | | 3,720 |
| Morocco | 183 | 15 | 797 | 1,770 | | 2,765 |
| Yemen | 3 | | | | | 3 |
| Mauritania | 18 | | 35 | 51 | | 104 |
| **Total** | **715.7** | **167** | **2,097.9** | **10,886** | **372.5** | **14,239.1** |

FIGURE 10 **ENERGY INTENSITY TRENDS BY REGION (MJ/2011 PPP $)**

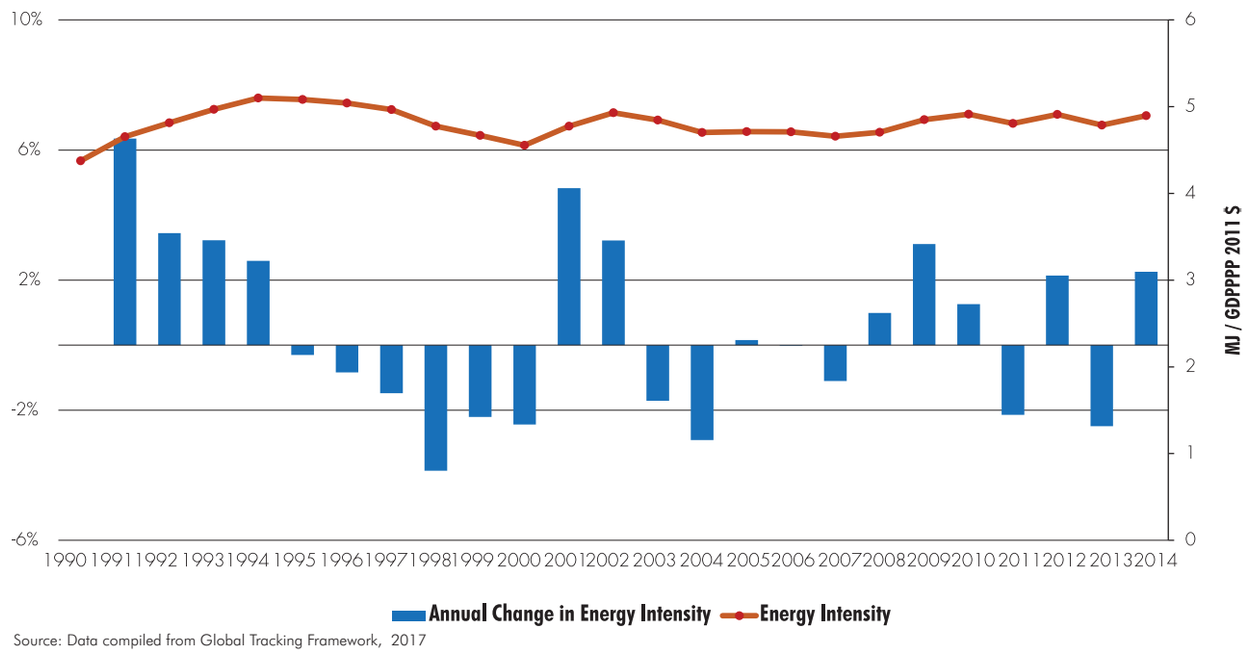



Source: Global Tracking Framework, 2017

## V. INCREASING THE EFFICIENCY OF ENERGY USE

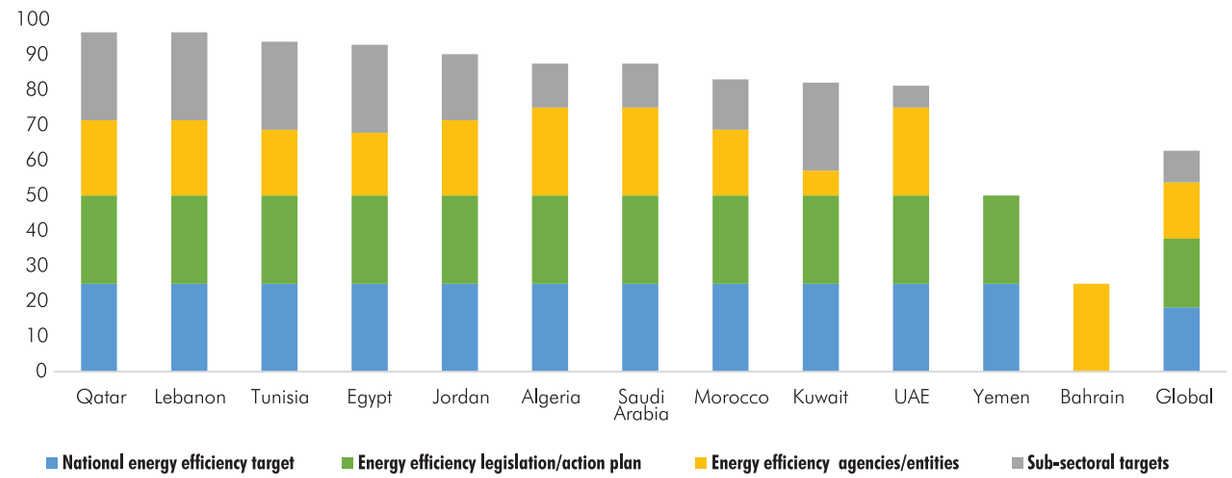
Over the long-term, the Arab region's energy intensity has been rising with some variation, from around 4.4 MJ/2011 USD PPP in 1990 to 4.9 MJ/2011 USD PPP by 2014, a regional net increase of 12 percent, which contrasts a trend in falling energy intensity rates everywhere else in the world. In 2012, Arab countries used almost twice the amount of energy used worldwide to produce the same GDP, at 0.40 toe/1000 USD

FIGURE 11 **ENERGY INTENSITY IN THE ARAB COUNTRIES: 1990-2014**




Source: Data compiled from Global Tracking Framework, 2017

FIGURE 12 **RISE ENERGY EFFICIENCY (EE) INDICATORS FOR THE ARAB COUNTRIES**




Source: World Bank, 2017a

2005 in Arab countries, compared with 0.24 toe/1000 USD 2005 for the world, and 0.13 toe/1000 USD 2005 in OECD countries (UN ESCWA, 2015a).

While the Arab region has historically not been one of the most energy-intensive regions in the world, it has been the only world region to achieve no fall in its energy intensity over the past 25 years, implying more energy is needed today than 25 years ago to produce a unit of economic output. Today's average energy intensity rate in the Arab region is close to the rate of North America and Central Asia – countries that have over the past 25 years reduced their own energy intensity rates by more than a third. Indeed, in 2014 the Arab region was the second-least energy-intensive region after the Latin America and the Caribbean region. It was also the only one presenting rising energy intensity trends in the period 1990-2014.

Within the Arab region, there has been no significant shift from energy-intensive activities such as mining and manufacturing, towards less energy-intensive services activities; in fact, output from both has grown. Some of the world's lowest prices of energy for domestic consumers, combined with the lack of other regulatory initiatives, have meant energy consumption in the GCC and some other regional oil and gas producers has skyrocketed in recent decades, with no domestic market incentives to conserve energy and to invest in more energy efficient technology.

### *A. Regulatory and Policy Frameworks Key to Energy Efficiency in the Arab Region*

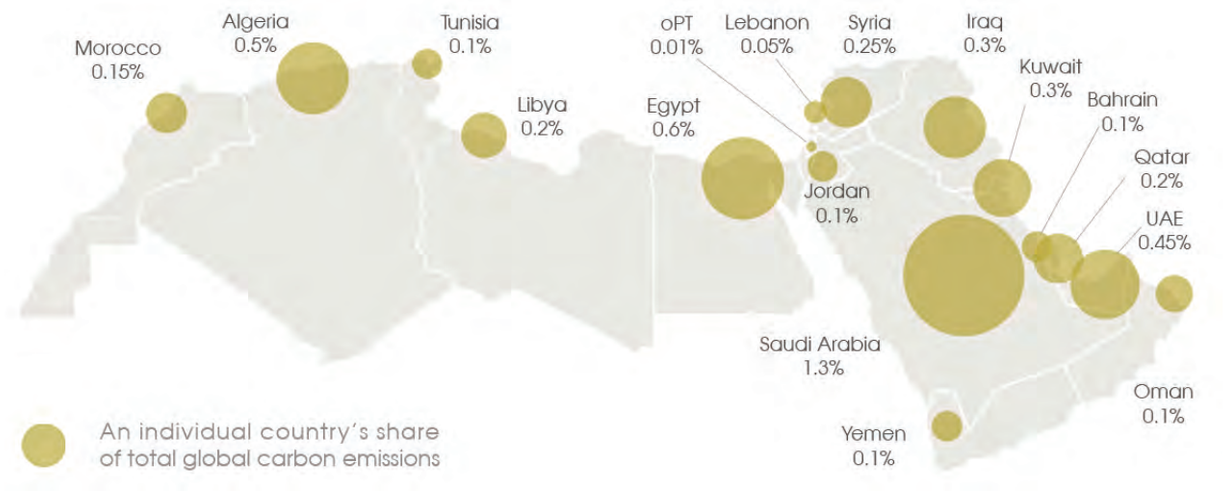
A closer look at survey results from the Arab region as part of the World Bank's Regulatory Indicators for Sustainable Energy (RISE) provides some insight into the state of regional energy efficiency procedures. The indicators chosen have been shown to be effective in many countries in enabling investments in energy efficiency, and can hence provide an idea of where countries stand relative to each other.

Improvement could be made in energy efficiency and energy use within Arab countries during the current period of low oil prices. Examples include direct policies aimed at long-term energy efficiency savings, and through policies targeting those barriers that have obstructed progress in energy efficiency in the region for the past few decades, including a weak market and energy pricing incentives.

## VI. INCREASING EFFECT OF POLITICAL CONFLICT

Since 2010, conflict and political instability have further affected the Arab region's energy sector,

FIGURE 13 **ARAB COUNTRIES' SHARE OF TOTAL GLOBAL CARBON EMISSIONS (%)**




Source: Elgendi, 2017

particularly in parts of the Mashreq and Arab LDCs (UN ESCWA 2015c). Infrastructure and power generation capacity have been severely destructed in countries such as Syria, Libya and Yemen, and data collection capabilities have been undermined (UN ESCWA 2015c; UN ESCWA 2016b). Conflict and political instability has lifted energy intensity across a number of countries.

Falling oil prices are likely to further reduce government budgets, with a lagging effect on the ability of a number of Arab countries to invest systematically in energy efficiency and renewable energy over the coming years. The influx of large numbers of refugees into neighbouring Arab countries, particularly Jordan and Lebanon, means that also countries that remain stable have seen rising energy consumption levels (due to a higher population) relative to GDP, and hence a spike in overall energy intensity.

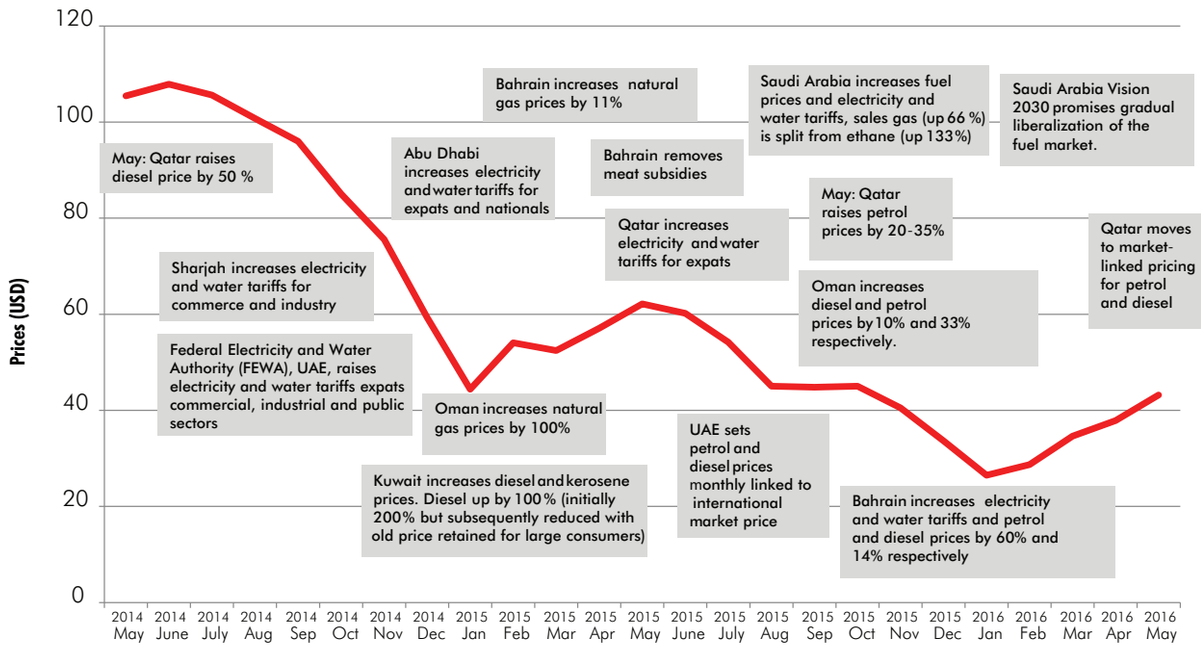
## VII. RECONCILING THE TIGHT EMISSIONS PATHWAY WITH SUSTAINABLE DEVELOPMENT ASPIRATIONS

Historically, the Arab region has had a low rate of energy use and carbon emissions – the region constitutes 5 percent of the world's population and emits just under 5 percent of global carbon emissions. While climate change has never played a significant role in Arab countries' discourse on energy use, the Arab region itself is one of the most vulnerable regions to climate change given that water shortages and hazards to food security posed by climate change jeopardize the livelihoods of large segments of the population (FAO, 2014.) The Arabian Peninsula is already one of the most water-stressed regions in the world, making its long-term water and food security highly vulnerable to climate change (Odhiambo, 2016). Agriculture in North Africa, the Mashreq and the Arab LDCs is likely to suffer major losses due to high temperature, droughts, floods and soil degradation, and extreme weather events. FAO estimates that in Egypt alone, climate change could decrease the national production of rice by 11 percent and soybeans by 28 percent by 2050, compared with their production under current conditions (FAO, 2014). This calls for better management of Arab countries' natural resources where energy conservation, renewable energy, energy efficiency and the use of clean technologies would support the move towards a sustainable energy future.

## VIII. HOW RECENT DECLINE IN OIL PRICES IMPACTED THE ARAB REGION

The oil prices dropped by around 70 percent between mid-2014 and mid-2016, reaching USD

FIGURE 14 **GCC DOMESTIC PRICE REFORMS IN THE CONTEXT OF FALLING INTERNATIONAL OIL PRICES**




Source: Chatham House, 2016

30 per barrel by February 2016 before floating around the USD 50 mark. Although changes in supply and demand expectations played a key role, other events had their effect on the prices as well including a significant shift in OPEC's policy objectives, less-than expected spillovers from geopolitical risks, and a significant appreciation of the US dollar.

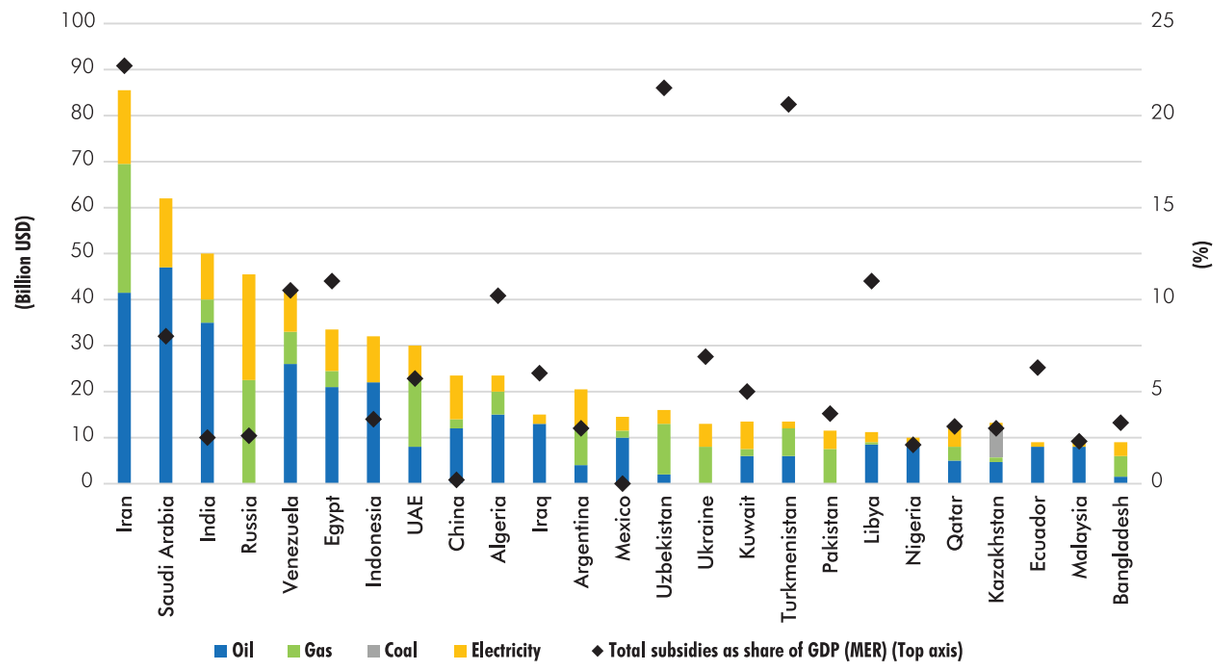
Oil and gas export revenues are the principal source of export income in the GCC, accounting for over 90 percent of total export revenues in countries such as Qatar and Kuwait, and well above 85 percent in Saudi Arabia. With no income or corporate tax in these countries, oil and gas export revenue supply well over 90 percent of total government revenues. The GCC countries lost USD 157 billion in oil revenues in 2015 and governments in the region are taking measures long considered impossible such as imposing taxes, eliminating fuel subsidies, and reducing public sector jobs and salaries. Fiscal balances in MENA oil exporters swung from a surplus of USD 128 billion in 2013 to a deficit of USD 264 billion in 2016 (World Bank, 2016).

### *A. Towards a Structural Shift of the Arab Economies*

The large decline in oil prices witnessed since June 2014 was an alarming signal to Arab oil and gas exporting countries and heavily affected their revenues and economy. Indeed, this has pushed the Arab countries to announce various economic reforms, focusing mainly on waiving energy subsides and diversifying their economies away from oil.

In April 2016, for example, Saudi Arabia unveiled an ambitious new strategy to build a more diversified economy and reduce its reliance on oil revenues, called "Vision 2030". Plans exist to privatize up to 5 percent of Saudi Aramco (the state oil company) and create the world's largest sovereign wealth fund with the remaining shares. There are also aims to restructure the extensive subsidies for energy that have been available to both industry and consumers. Figure 14 provides the major reforms initiated by the GCC countries since the sharp decline in oil prices.

FIGURE 15 **INTERNATIONAL FOSSIL FUEL SUBSIDIES IN 2013**




Source: IEA, 2014

### *B. Growing Domestic Energy Demand Challenges Subsidy Reforms*

Many Arab countries that for many decades priced fossil fuels at around the cost of domestic production – in countries such as the Gulf typically, a fraction of international market prices since the 1980s – incentives for fuel users such as utility companies and private households to switch to other energy technologies were virtually non-existent.

A number of countries started adopting subsidy reforms of fuel and electricity between 2012 and 2014, a trend that has further spread since mid-2014 with the fall in global oil and commodity prices. Pushed by the escalating cost of fuel subsidies since the mid-2000s when oil prices on international markets set on to rise to previously unknown heights, net-importers of energy in North Africa and the Mashreq have been among those countries that have been active in adjusting domestic pricing. Morocco eliminated all subsidies for gasoline and industrial fuel in January 2014, now reviewing its fuel prices twice a month on the basis of international market price movements. Jordan introduced a five-year plan to reform electricity prices in June 2013 and plans to increase rates annually until 2017, protecting the most vulnerable user groups from price increases. Since November 2012, Jordan has removed subsidies for all domestic oil products, and prices track international market trends through a monthly review. Tunisia launched a reform program in January 2014 aiming to eliminate all remaining electricity subsidies by 2021 (RCREEE, 2015).

In the MENA region, generalized price subsidies have for many years been part of the "social compact" and are still common, especially on food and fuels. Yet, generalized price subsidies are neither well targeted nor cost-effective as a social protection tool. Though subsidies may reach the poor and vulnerable to some extent, they benefit mostly the better off, who consume more subsidized goods, particularly energy products. For example, in Egypt in 2008, the poorest 40 percent of the population received only 3 percent of gasoline subsidies (IMF, 2016).

## IX. CONCLUSION AND RECOMMENDATIONS

Fast-growing energy demand in the Arab region, coupled with prospects of the Middle East becoming a global economic center by 2030 alongside the Asia-Pacific region, drives the need to diversify energy sources and to move to a more sustainable energy sector.

The lower oil price has already sent a clear message that energy systems must be hastened and economic diversification and policy reforms can play an important role to ease the tension between the climate goals and a sustainable exit strategy for the Arab countries.

Supporting a sustainable energy transition is particularly difficult if current market incentives are being considered, given the various imperfections of energy markets in and outside the Arab world. These include distortion of price signals to producers and consumers, the lack of regulatory environments, missing information for consumers and the problem of pricing long-term sustainability of resources into today's energy prices.

Indeed, for many energy markets in and outside the Arab region, economic incentives are at the core of the opportunity for, but also barriers towards, the adoption of more efficient energy technologies and renewable energy. Disincentives to invest in more sustainable production techniques, and to change long-established consumption patterns also affect progress in other areas of sustainable development, such as the protection of water resources and food security.

With this in mind, new solutions and a new mix of energy sources with a high focus on sustainability need to be developed. The common expression for all of these aspects is that the world is in the midst of an important energy transition. In this energy transition, it is mandatory for the Arab nations to tackle the regulatory and institutional frameworks, taking into consideration fiscal policies and frameworks, governance and transparency efforts. This would help improve the business environment, encourage the growth of the private sector, provide economic incentives and access to finance. Such measures would allow the uptake of more sustainable energy technologies in line with the development agenda and national priorities, capabilities, and circumstances.

## RENEWABLE ENERGY GROWTH IN JORDAN

**Shada El-Sharif**

In contrast with its oil-rich neighbors, Jordan's key assets have always been the human capital, cultural heritage, and the ingenuity of its economic development with scarce natural resources. Not only is Jordan the second most water-poor nation in the world, it has also been importing over 95 percent of its energy. Jordan has long recognized its strategic location on the global solar and wind maps – the south of Jordan enjoys some of the highest insolation levels in the world at 4-7 kWh/m2 and wind speeds of 7-11 m/s. Since the 1970's, penetration of solar water heater (SWH) technology in Jordan was among the highest in the region (reaching 20 percent of homes in the early 1990's). Due in part to subpar products flooding the market, public confidence in SWH technology decreased, which has led to a decline in uptake over subsequent decades. However, many initiatives are in place today to encourage a wider adoption of this safe and effective technology.

Ten years ago, Jordan issued its Master Strategy of the Energy Sector for the period 2007-2020. With an initial target of 10 percent renewable energy (RE) by 2020, Jordan is set to achieve – and quite possibly surpass – its RE contribution to the national energy mix with mega projects already on the ground. The turning point for rapid growth of the clean energy sector in Jordan was in 2012, when the Ministry of Energy and Mineral Resources (MEMR) issued the landmark Renewable Energy and Energy Efficiency Law (REEEL) – the first of its kind in the region. This legislation, and ensuing regulations, effectively laid the legal framework to enable

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investment in centralized/utility-scale projects, implementation of distributed systems, and incentivizing local economic growth.

Stepping into Ma'an Development Area (MDA) in the south of Jordan, you are instantly taken by the sea of photovoltaic panels glistening against the desert landscape. This is the site of most of Jordan's 12 large-scale PV projects, implemented under Round One of MEMR's Direct Proposals Process for Renewable Energy with a total capacity of 200 megawatts (MW). The project has attracted over USD 500 million in investments by local, regional and international developers alike, enabled by some of the region's first RE power purchase agreements (PPAs). The site enjoyed a royal launch by His Majesty King Abdullah II in May 2017, reinforcing Jordan's status as a clean energy pioneer in the region. According to the Regional Center for Renewable Energy and Energy Efficiency's (RCREEE) Arab Future Energy Index (AFEX) findings of 2015, Jordan ranked at a close second in creating a favorable environment for RE growth after Morocco. A discussion of Jordan's impressive RE projects would not be complete without a reference to the Jordan Wind Power Project Company (JWPC); the country's largest wind project with 117 MW turbines injecting clean power into the grid from the mountains of Tafila.

What characterizes the growth of the renewable energy sector in Jordan is not only the fast-paced development of utility scale solar projects (at the time of writing, Round Two solar projects with an additional 200 MW capacity are under construction in Mafraq, and Round Three project development is also under way), but also the successful implementation of small-to-medium scale projects by homes, industries and small and medium-sized enterprises (SMEs). The REEEL paved the way for net-metering regulations that have made it possible to install rooftop or carpark systems for onsite generation, as well as wheeling regulations that allow entities to generate solar energy offsite for the purposes of electricity savings. Over 80 MWs of such systems have been implemented across Jordan's three distribution networks managed by power companies in the north, center and south (IDECO, JEPCO and EDCO, respectively) with many more in the pipeline. Given their favorable payback periods (ranging from 3-5 years), these projects help Jordan achieve its National Green Growth Plan and climate mitigation targets set by its Nationally Determined Contributions (NDCs) announced at COP21 (14 percent $CO_2$ reduction by 2030). Moreover, these energy saving projects are also having a direct positive impact on the bottom line of businesses faced with a difficult economic climate.

In addition to a strong regulatory framework, another key factor in Jordan's RE success story is the availability of diverse forms of finance. The Central Bank of Jordan has provided low interest financing for clean energy projects, which has enabled many local banks to finance small to medium scale projects. Under the REEEL, the Jordan Renewable Energy and Energy Efficiency Fund (JREEEF) was also established, which has collaborated with a number of local finance institutions to provide even further incentives for renewable energy and energy efficiency. The JREEEF is also helping to implement the school heating initiative; a prime example of how clean energy can have positive social impact by improving the learning environment and well-being of students.

The opportunities brought about by Jordan's clean energy are countless; not only is the sector creating thousands of jobs locally, it is also helping Jordan in its path towards energy security. This is of particular significance today, as Jordan continues to host a growing refugee population, and thus must improve the resilience of its infrastructure systems despite natural resource scarcity. Some of Jordan's brightest minds are competing on the global stage with their homegrown clean technology innovations, such as the award-winning panel cleaning system showcased in Silicon Valley last year. Jordan's ancient monuments continue to tell stories of human feats of civilizations past, but the future is looking just as bright.

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# AIR QUALITY

FARID B. CHAABAN

## I. INTRODUCTION

The impact of fuel combustion in various anthropogenic activities in most economic sectors is proven to have detrimental effects on air quality, and is regarded as one of the most serious environmental risks. Several studies conducted over the past two decades have analyzed the regional and global impacts of excessive effluents. The overall annual cost of air quality degradation could sum up to around 2 percent of GDP in developed countries and around 5 percent in developing countries. These costs include mortality, chronic illness, hospital admissions, lower worker and agricultural productivity, IQ loss, and reduction of visibility (Abdallah, 2006). The 2008 AFED report has presented a detailed analysis of air pollution in the Arab countries, and especially in major cities where local transport sectors contribute drastically to air quality degradation in major cities and urbanized areas (AFED, 2008). Thermal power plants and energy- intensive industries have also had negative impacts on air quality and have emitted high quantities of greenhouse gases (GHG). Air quality management measures that were suggested include establishing a reliable database, improving fuel quality, and setting air quality standards for various effluents (AFED, 2008). The aim of this chapter is to present an update tracking changes in air quality in the region in ten years, including overall energy consumption trends and developments mainly in the energy and transport sectors.

## II. GLOBAL VIEW

According to a recent report of the Organization for Economic Co-operation and Development (OECD) on the consequences of air pollution, the global costs of air pollution related to premature deaths are projected to increase from USD 3 trillion in 2015 to USD 18-25 trillion in 2060. Moreover, the cost associated with suffering and illness, including restricted activity and hospital admissions, will increase from USD 300 billion in 2015 up to around USD 2.2 trillion in 2060 (OECD, 2016), and the number of hospital admissions due to these illnesses is expected to increase from 3.6 million in 2010 up to around 11 million in 2060. Emissions of oxides of nitrogen and ammonia will increase substantially due to an increase in demand for agricultural products, food, and energy. Sulfur dioxide ($SO_2$) emissions are expected to drop due to policies forcing filtering technologies (FGD) in many countries, but will rise again after 2030 due to an increase in demand. Transport-related emissions such as VOC, soot and carbon monoxide are also expected to increase in smaller increments due to the growth in the size of transport sectors in most countries and major cities.

Table 1 shows the global variations in $CO_2$ and particulates ($PM_{2.5}$) emissions over the past two decades, as reported by the World Bank (World Bank, 2016). These figures indicate that the per capita $CO_2$ emissions rate has increased by around 10 percent between 2005 and 2013, whereas the $PM_{2.5}$ remained almost the same. The population exposure to particulates has dropped by almost 2.5 percent.

$PM_{2.5}$ is a particulate matter with a diameter smaller than 2.5 microns (μm) and is found in soot, smoke, and dust. $PM_{2.5}$ is especially dangerous because it can get lodged in the lungs and cause long-term health problems like asthma

TABLE 1 GLOBAL EMISSIONS DATA RELATED TO $CO_2$ AND $PM_{2.5}$

| Year | $CO_2$ [metric tons/capita] | Population exposed to $PM_{2.5}$ levels exceeding WHO guidelines [%] | Average $PM_{2.5}$ Exposure [$\mu g/m^3$] |
|---|---|---|---|
| 1995 | 4.08 | 95.8 | 37.96 |
| 2000 | 4.03 | 95.28 | 38.89 |
| 2005 | 4.5 | 94.57 | 40.20 |
| 2010 | 4.84 | 91.69 | 40.20 |
| 2013 | 5 | 92.19 | 42.27 |

and chronic lung disease. $PM_{2.5}$ starts to become a major health problem when its concentration exceeds 35.5 µg/m$^3$, according to the US Environmental Protection Agency. It should be noted, though, that around 80 percent of pollution-related deaths are caused by cardiovascular rather than respiratory effects, such as heart attacks and strokes.

## III. REGIONAL ENERGY TRENDS OVER THE PAST DECADE

The above-mentioned OECD study also states that annual premature deaths from exposure to particulate matter in the Arab region is around 300 per one million inhabitants, and could rise to 500-600 per million by 2060. In the past decade several Arab countries have witnessed major political, social and economic turmoil accompanied by major shifts and changes in the energy production and consumption patterns (ESCWA, 2015). The anticipated change in energy consumption patterns will eventually lead to similar changes in GHG emissions and local air pollution.

The same period has also witnessed a significant shift towards the deployment of renewable energy, mainly photovoltaic technologies (PV), and in adopting cleaner and more energy efficient devices on a lesser scale. Several countries started considering renewable energy as a measure to meet the rising demand for energy, to mitigate emissions, and to diversify their energy mix. It is estimated that the total projected annual primary energy supply for the region in 2030 can be 75 percent less than its projected value in a conservative 'low policy intensity' scenario, and 50 percent less of its projected value if more aggressive 'technical potential' scenarios are pursued (Hormann et al., 2012).

Global $CO_2$ emissions data as reported by the International Energy Agency (IEA) show that the electricity and heating sector has the highest contribution with 42 percent of the total emissions, followed by transport, 23 percent, and the industrial sector with 19 percent (IEA, 2015). The per capita $CO_2$ emissions in the region have increased from around 4 tons/capita in 1990 to around 7.5 tons/capita in 2013. It should be noted that these figures exceed the World Bank figure of 5t/capita in 2013 (World Bank, 2016).

TABLE 2 PER CAPITA $CO_2$ EMISSIONS [METRIC TONS/YEAR]

| Country | 2007 | 2013 | % Change |
|---|---|---|---|
| Algeria | 3.2 | 3.5 | 9.4 |
| Bahrain | 23.7 | 26 | 9.7 |
| Djibouti | 0.6 | 0.7 | 16.7 |
| Egypt | 2.4 | 2.4 | 0.0 |
| Iraq | 2.2 | 4.9 | 122.7 |
| Jordan | 3.8 | 3.4 | -10.5 |
| Kuwait | 29.6 | 27.3 | -7.8 |
| Lebanon | 3.3 | 4.3 | 30.3 |
| Libya | 8.3 | 8.1 | -2.4 |
| Mauritania | 0.6 | 0.7 | 16.7 |
| Morocco | 1.6 | 1.8 | 12.5 |
| Oman | 16.8 | 15.7 | -6.5 |
| Qatar | 53.7 | 40.5 | -24.6 |
| Saudi Arabia | 14.9 | 17.9 | 20.1 |
| Somalia | 0.1 | 0.1 | 0.0 |
| Sudan | 0.3 | 0.3 | 0.0 |
| Syria | 3.4 | 1.9 | -44.1 |
| Tunisia | 2.4 | 2.5 | 4.2 |
| United Arab Emirates | 22.6 | 18.7 | -17.3 |
| Yemen | 1.0 | 1.0 | 0.0 |
| **Regional Average** | **9.73** | **9.09** | **-6.6** |
| **World Average** | **4.66** | **5.00** | **7.3** |

Table 2 shows the changes in the $CO_2$ per capita rates over the past decade, specifically between 2007 and 2013, as reported by the World Bank in 2017. According to these figures, several countries such as Jordan, Kuwait, Oman, Syria, and the UAE have managed to reverse the trend and to reduce the per capita rate. The most significant drop is recorded in Syria, followed by Qatar. However, Qatar still has the highest emission rate amongst all regional countries. As for Syria, the drop in the consumption and emissions figures could be attributed to the current situation where the government has lost control of most oil fields, the damage and destruction of the energy infrastructure including power plants and transmission lines, and to the scarcity of reliable sources that can provide one figure for the whole country (Al-Najjar, 2017). The rest of the Arab countries are still witnessing an increase in the

emission rate. Iraq has the highest rise, followed by Lebanon.

The regional per capita $CO_2$ emissions has dropped by around 6.6 percent between years 2007 and 2013, whereas the world average has increased by 7.3 percent.

## IV. THE POWER SECTOR

Electricity consumption has risen sharply in the region during the last 40 years (OAPEC, 2016). According to OAPEC reports, around 94 percent of electricity generation has largely relied on oil and gas, and in 2013 over 42 percent of primary energy supply devoted to energy use was consumed for electric power generation. The use of other sources, especially hydropower and other renewable sources was quite limited and represented only 5.7 percent, mostly hydro (ESCWA, 2015). Various power strategies, short medium and long terms, have been successfully implemented in many countries in the region to improve the energy access. In Saudi Arabia, the percentage of the population connected to the grid increased from around 41 percent in 1980 to 99.5 percent in 2012. Morocco and Tunisia went, respectively, from 45 percent and 56 percent in 1980 to 99 percent and 99.5 percent in 2012. It should be noted that, in

TABLE 3 ELECTRICITY GENERATION AND CORRESPONDING EMISSIONS OVER THE PAST DECADE

| Country | Electricity Generated [$10^6$ kWh] | | $CO_2$ emitted [$10^6$ tons] | | Percentage Change |
|---|---|---|---|---|---|
| | 2006 | 2015 | 2006 | 2015 | |
| Algeria | 35.2 | 64.66 | 24.6 | 45.3 | 83.7 |
| Bahrain | 9.76 | 17.29 | 6.8 | 12.1 | 77.2 |
| Egypt | 108.69 | 174.87 | 76.1 | 122.4 | 60.9 |
| Iraq | 35.00 | 91.41 | 24.5 | 64.0 | 161.2 |
| Jordan | 11.63 | 19.01 | 8.1 | 13.3 | 63.5 |
| Kuwait | 41.28 | 67.92 | 28.9 | 47.5 | 64.5 |
| Lebanon | 9.29 | 11.97 | 6.5 | 8.4 | 28.8 |
| Libya | 18.20 | 37.49 | 12.7 | 26.2 | 106.0 |
| Mauritania | 0.62 | 0.85 | 0.4 | 0.6 | 37.1 |
| Morocco | 19.92 | 29.92 | 13.9 | 20.9 | 50.2 |
| Oman | 12.06 | 29.13 | 8.4 | 20.4 | 141.5 |
| Qatar | 14.03 | 38.83 | 9.8 | 27.2 | 176.8 |
| Saudi Arabia | 181.43 | 338.33 | 127.0 | 236.8 | 86.5 |
| Somalia | 0.30 | 0.35 | 0.2 | 0.2 | 16.7 |
| Sudan | 4.50 | 13.05 | 3.2 | 9.1 | 190.0 |
| Syria | 37.73 | 19.87 | 26.4 | 13.9 | -47.3 |
| Tunisia | 12.27 | 18.21 | 8.6 | 12.7 | 48.4 |
| UAE | 66.77 | 116.53 | 46.7 | 81.6 | 74.5 |
| Yemen | 5.11 | 5.35 | 3.6 | 3.7 | 4.7 |
| **Total** | **623.79** | **1,095.04** | **436.65** | **766.53** | |
| **Average Increase in $CO_2$ Emissions** | | | **75.5%** | | |

TABLE 4 REGIONAL POPULATION AND TRANSPORT STATISTICS

| Country | Population in 2007 | Number of Vehicles per 1000 inhabitants in 2007 | Population in 2014 | Number of Vehicles per 1000 inhabitants 2014 | 2014 Ownership Ranking [out of 191 Countries] |
|---|---|---|---|---|---|
| Algeria | 33,857,913 | 87 | 39,666,52 | 114 | 100 |
| Bahrain | 752,647 | 322 | 1,377,240 | 537 | 27 |
| Egypt | 75,497,914 | 30 | 91,508,080 | 45 | 131 |
| Iraq | 28,993,376 | 50 | 36,423,390 | 50 | 130 |
| Jordan | 5,924,247 | 47 | 7,594,550 | 165 | 83 |
| Kuwait | 2,851,144 | 357 | 3,892,110 | 527 | 32 |
| Lebanon | 4,099,114 | 434 | 5,850,740 | 434 | 41 |
| Libya | 6,160,481 | 234 | 6,278,440 | 290 | 59 |
| Morocco | 31,224,136 | 53 | 34,377,510 | 70 | 121 |
| Oman | 2,595,132 | 150 | 4,490,540 | 215 | 67 |
| Qatar | 840,634 | 378 | 2,235,360 | 532 | 29 |
| KSA | 24,734,532 | 336 | 31,540,370 | 336 | 51 |
| Somalia | n/a | n/a | 10,787,100 | 3 | 186 |
| Sudan | n/a | n/a | 40,234,880 | 27 | 147 |
| Syria | 19,928,518 | 50 | 18,502,410 | 73 | 116 |
| Tunisia | 10,327,285 | 71 | 11,107,800 | 125 | 97 |
| UAE | 4,380,439 | 193 | 9,156,960 | 313 | 55 |
| Yemen | 22,389,172 | 47 | 26,832,220 | 35 | 138 |

many countries, being connected to the grid is no longer a guaranty of getting undisrupted electrical supply (ESCWA, 2015).

Table 3 shows the electricity consumption variation in the region between 2006 and 2015 as recorded by relevant OAPEC reports (OAPEC, 2016). It is evident from the listed figures that electricity consumption has increased in all countries by different rates. Saudi Arabia currently has the highest electricity consumption rate of all Arab countries, followed by Egypt (Table 5). When considering the highest growth rate in electricity consumption, Sudan is ranked first followed by Qatar, Iraq and Oman. The total sum of electricity consumed in the whole Arab region has increased by 75.5 percent, from around 624 million kWh in 2006 up to 1095 million kWh in 2015 (OAPEC, 2016).

According to the Environment Protection Agency (EPA) in the USA (USEPA, 2017), an average of 700 grams of $CO_2$ is emitted for every kWh generated from thermal power plants that utilize fossil fuels. Adopting this emission rate for the OAPEC statistics (OAPEC, 2016) will lead to a total amount of 766.5 million tons of $CO_2$ being emitted from generated power in the Arab region in 2015, compared to 436.6 in 2006, i.e. an increase in $CO_2$ emissions of around 75 percent.

## V. THE TRANSPORT SECTOR

Impacts of emissions from the transport sector are more substantial compared to the power sector because they are emitted at ground level and in highly populated cities and provinces. As mentioned earlier, the transport sector is the second largest contributor to $CO_2$ emissions with

a share of 23 percent. In addition to $CO_2$ and other GHG emissions, the sector is the main source of carbon monoxide emissions and VOC effluents. Lead emissions are not accounted for anymore since most countries in the region have successfully shifted to the use of unleaded fuels, in line with a worldwide trend.

Table 4 compares the population densities of each Arab country and the number of vehicles allocated to every 1000 inhabitants, i.e. the car ownership rate, for the years 2007 and 2014. According to these statistics, all countries have witnessed a high increase in population at rates that vary from one country to another. This increase has been paralleled with a substantial increase in car ownership and consequently in the sector size in most countries. The Table also presents the ranking amongst 191 countries in number of vehicles per 1000 inhabitants (Nationmaster, 2017; Worldometers 2017; World Bank 2017; UNSD, 2007; Wikipedia, 2017).

Table 5 presents a comprehensive summary of gasoline consumption over the past decade (the main transport fuel in the region). The corresponding amounts of $CO_2$ emissions over the same period can be estimated using the IEA average conversion figure of 317kg of $CO_2$ being emitted from burning one barrel of gasoline (Gulf Insider, 2014).

TABLE 5 GASOLINE CONSUMPTION TRENDS OVER THE PAST DECADE

| | Gasoline consumption [$10^3$ barrels/day] | | |
|---|---|---|---|
| **Country** | **2006** | **2010** | **2015** |
| Algeria | 67.5 | 88.6 | 103 |
| Bahrain | 11.6 | 13.8 | 18 |
| Egypt | 72.6 | 98.1 | 153 |
| Iraq | 100 | 102.8 | 105 |
| Jordan | 17.3 | 21 | 31 |
| Kuwait | 51.8 | 58.9 | 71 |
| Lebanon | 36.5 | 38.8 | 41 |
| Libya | 57.1 | 68.2 | 87 |
| Mauritania | n/a | 0.5 | 0.5 |
| Morocco | n/a | 13 | 14.1 |
| Oman | 23.4 | 27.9 | 62 |
| Qatar | 17.9 | 28 | 37 |
| Saudi Arabia | 293.6 | 373.8 | 559 |
| Somalia | n/a | 0.8 | 0.8 |
| Sudan | n/a | 18.1 | 21.4 |
| Syria | 31.8 | 39.8 | 27 |
| Tunisia | 10.3 | 11.1 | 14 |
| United Arab Emirates | 79 | 92 | 181 |
| Yemen | 27.8 | 34.1 | 30 |
| **Total Arab Countries** | **898** | **1096.9** | **1554.8** |

## VI. AIR POLLUTION LEVELS IN SOME ARAB COUNTRIES

According to the World Health Organization (WHO), air pollution has globally risen by 8 percent in the past five years, and it is estimated that this will lead to around 3 million premature deaths a year. Most large cities in the developing countries suffer from high levels of air pollution that exceed global guidelines. Air quality has short- and long-term health effects. Up to 80 percent of pollution-related mortalities are caused by cardiovascular rather than respiratory effects. Accordingly, pollution concentration limits are set for various intervals and for different pollutants, as shown in the WHO guidelines in Table 6.

Urban air quality data, collected between 2011 and 2015, reveals that 98 percent of cities with over 100,000 inhabitants in low- and middle-income countries do not meet WHO air quality guidelines.

The MENA region and Southeast Asia were the regions that performed worst overall according to the WHO database. Urban air pollution has risen by 5 percent over the past five years in more than two-thirds of cities. Recorded annual mean levels of air pollution in these cities often exceeded the WHO limits by five to ten times. On the other hand, the data also showed that more than half of the monitored cities in high-income countries and more than one-third in low and middle-income countries reduced their air pollution levels by more than 5 percent in these five years (Shirley, 2016).

Reports from air pollution studies and estimates from 3,000 cities indicated that several major Arab cities are amongst the 20 most polluted cities in the world. Riyadh in KSA with $PM_{10}$ concentrations of around 368ug/m3 ranked 7th, whereas Al Jubail ranked 8th with levels reaching 359. Hamad Town in Bahrain ranked 11th with 318, Dammam 15th with 286, and Maameer 19th with 267 (WHO, 2016).

Another WHO report of 2015 ranked the world's most polluted cities according to their perspective $PM_{2.5}$ annual averages. From the Arab cities, Doha ranked 12th with 93 µg/m³ (Chainey, 2015). Table 7 shows the particulates, both $PM_{10}$ and $PM_{2.5}$, concentrations in major Arab cities.

### A. Bahrain

The transport sector is the main source of pollution in Bahrain, with a share of 49 percent, according to air quality tests (DT news of Bahrain, 2016; Sami and Khonji, 2006). Air monitoring equipment set up in each of Bahrain's five governorates in July has revealed a significant increase in pollutants associated with vehicle emissions over the past ten years, particularly nitrogen oxides and ozone gas. It is the result of vehicle exhaust and industrial emissions, petrol vapors and chemical solvents – as well as natural sources – emitting $NO_x$ and volatile organic compounds, which form ozone.

Sulfur dioxide, which is emitted by industries such as petroleum refineries, cement manufacturers and metal processing facilities, have been relatively stable in Bahrain at under 5ppb over the last ten years. There were spikes upwards to 10ppb in 1998 and 9ppb in 2002, but the figure currently stands at 7ppb. $SO_2$ also contributes to respiratory illness and acid rain.

### B. Egypt

Measurements inside urban areas and close to industrial complexes have recorded pollution levels sometimes 6 to 8 times higher than the limits set by the country's environmental law, Law Number 4. With a population of around 78 million in 2010, Egypt fell below the global average for quality of urban air, with an average of almost 5 out of 10,000 people dying due to air pollution (MadaMasr, 2015). In Cairo, however, the pollution impacts are much more drastic. WHO estimated $PM_{10}$ concentrations at around 179 µg/m³, which is considered as extremely high compared to their annual limit of 20 µg/m³. Also, $PM_{2.5}$ levels at around 76ug/m³ are extremely high considering a WHO annual limit of 10 µg/m³. With 6,000 premature deaths linked to outdoor air pollution in 2010, Cairo ranked 7th among the world's deadliest cities for air pollution.

TABLE 6 **WHO POLLUTANTS GUIDELINES [µg/m₃]**

| Pollutant | $PM_{10}$ | $PM_{2.5}$ | Ozone | $NO_2$ | $SO_2$ |
|---|---|---|---|---|---|
| Annual mean | 20 | 10 | | 40 | |
| 24- hour mean | 50 | 25 | | | 20 |
| 8- hour mean | | | 100 | | |
| 1- hour mean | | | | 200 | |
| 10-minute mean | | | | | 500 |

### C. Saudi Arabia

Riyadh has been ranked as one of the most polluted cities in the world, according to a report released by WHO in 2016 (Ramsey, 2016). The list also included Lahore, New Delhi, Cairo,

TABLE 7 PM LEVELS IN SELECTED ARAB CITIES (WHO, 2016)

| Country | City | $PM_{10}$ [$\mu g/m^3$] | $PM_{2.5}$ [$\mu g/m^3$] | Year Recorded |
|---|---|---|---|---|
| Bahrain | Ras Hayan | 250 | 44 | 2014 |
| Egypt | Cairo | 179 | 76 | 2013 |
| Iraq | Baghdad | 208 | 88 | 2015 |
| Jordan | Amman | 68 | 36 | 2015 |
| Kuwait | Al Ahmadi | 168 | 64 | 2014 |
| Lebanon | Beirut | 41 | 32 | 2014 |
| Morocco | Marrakesh | 58 | 24 | 2012 |
| Oman | Muscat | 82 | 35 | 2009 |
| Qatar | Doha | 168 | 93 | 2012 |
| KSA | Jeddah | 161 | 68 | 2014 |
| Tunisia | Tunis | 90 | 38 | 2010 |
| UAE | Abu Dhabi | 132 | 56 | 2013 |

Dhaka, Moscow, Mexico City and Beijing. The WHO report attributed the inclusion of Riyadh in the list to the occurrence of sandstorms, as well as pollutants emerging from the transport sector and industrial waste. Riyadh has recorded annual $PM_{2.5}$ levels that are 15 times higher than the standards set by WHO. The recorded high $SO_2$ concentrations are attributed to the industrial activities inside, and in the vicinity of, the city (Taha, 2014).

### *D. Lebanon*

The power sector of Lebanon is regarded as the main source of air pollution in nearby areas, where levels of particulates and oxides of sulfur were found to be several times higher than international standards. The power demand, estimated at around 15,000GWh exceeds the installed capacity of around 11,000GWh. To make up for the deficiency, small and medium

BOX 1

## BLACK DUST OVER CAIRO

**by Katherine Leitzell**

September 22, 2011

Cairo still suffers from high air pollution levels resulting from a transport sector of two million cars, a number of thermal power plants, and a thousand factories emit their smoke into the atmosphere (Chainey, 2015). To make things worse, farmers in Greater Cairo Area burn leftover rice husks at the end of the growing season, in September or October, adding smoke to an already heavily polluted air. A so-called "black cloud" settles over the city, forming a black-brown haze. In 2004, authorities banned rice husk burning, but the annual cloud continued to occur because farmers started burning it at night and early in the morning. The smoke reaches Cairo after sunset, which is just when the temperature inversion starts to form, and as a result, the black cloud settles down at low ground levels, with a maximum altitude of 500 meters. Moreover, farmers shifted towards using gas stoves for cooking rather than burning rice husks for fuel, which meant they had more leftover plant material to get rid of all at once. https://earthdata.nasa.gov/user-resources/sensing-our-planet/a-black-cloud-over-cairo

private generators are scattered in all cities and urban areas of the country. These diesel-run generators are causing drastic deterioration to air quality because they are run without any control on their performance and the quality of the fuel. Moreover, emissions from these units are emitted almost at ground level without any measures for filtering or even proper air circulation. Medical reports warned that the number of cases of asthma-related diseases have been rising significantly over the past decade (Saliba, 2011).

### *E. Qatar*

A World Health Organization (WHO) report showed that Qatar ranked the second-most polluted country in the world in 2014 after Pakistan (Gulf Insider, 2014). Other countries appearing on the report among the top ten countries were Egypt, ranking sixth, UAE ranking eighth, and Bahrain ranking tenth. Deterioration of air quality can be related to the expanding manufacturing industry and construction projects in Qatar, in addition to the growing road congestion as the country's population increases, according to official statistics.

The rise of Qatar's airport's traffic is another contributing factor to the pollution emergency. The traffic at Qatar's Doha Hamad International Airport (HIA) rose by 11.4 percent in 2014, in comparison to traffic at the old Doha International Airport in July 2013, according to the Center for Asia Pacific Aviation (CAPA).

### *F. United Arab Emirates*

The rapid pace of urbanization and motorization has resulted in the UAE having the highest per capita carbon dioxide emission rates in the world. The UAE is currently the most polluted country when looking at the volume of small particulate matter in the air, according to the latest report compiled by the World Bank in 2016. UAE had the world's highest exposure to $PM_{2.5}$ emissions, estimated at around 80 $\mu g/m^3$, more than China (73 $\mu g/m^3$) and India (32 $\mu g/m^3$).

## VII. SULFUR CONTENT IN DIESEL FUEL

Many areas in the world, including most Arab countries, rely on older technology diesel generators for electricity because the electrical grid is unreliable. Transport vehicles, mainly medium and heavy-duty trucks and buses, are old and do not use the latest generation of clean diesel technology because they lack access to the

TABLE 8 DIESEL SULFUR MATRIX IN THE REGION (UNEP, 2006; UNEP, 2011)

| COUNTRY | Diesel Sulfur Content in 2006 (ppm) | Diesel Sulfur Content in 2011 (ppm) | COMMENT |
|---|---|---|---|
| Algeria | 900 | 900 | No plans to process crude further |
| Bahrain | 5,000 (500) | 500/10 | Up to 10 ppm for export, 500 ppm for local use |
| Egypt | 5,000 | 5,000 | No plans to reduce levels |
| Iraq | 10,000 | 10,000 | Actual (existing) standard is 25,000 ppm |
| Jordan | 9,000 | 7,000-10,000 | Actual standard is 350 ppm, to be reduced to 50 ppm after refinery expansion |
| Kuwait | 3,500 | 2000 | 50 ppm diesel imported from EU, plans to further drop to 10 ppm |
| Lebanon | 6500 (350) | Industrial: 5000 Transport: 500 | 2 grades marketed, green and red diesel |
| Libya | 1,000 | 1,000 | Standards are about 1,500 ppm |
| Morocco | 10,000 (350) | 50 | Since 2009 (not 2006) |
| Oman | 5,500 | 50 | Since 2008 (not 2006) |
| Palestine | 10,000 | 10,000 | Gets fuel from Jordan which is at 10,000 ppm |
| Qatar | 5,000 | 500 | Road map to drop to 10 ppm by 2012 |
| Saudi Arabia | 5,000 | 500 | Gradual drop from 10,000 ppm Effective since 2014 |
| Syria | 6,500 | 6,500 | Actual Standards 7,000 ppm Imported 50ppm for selected cities |
| Tunisia | 10,000 | 50 | since 2009 (not 2006) |
| UAE | 5,000 | 500 | Plans to go to 50 ppm, implemented only in Dubai |
| Yemen | 10,000 | 10,000 | No current standards. Plans to build a refinery to drop the level |

cleaner diesel fuel. Cleaner diesel fuel, advanced generators and vehicle engines, coupled with effective emissions control would make up a new generation of diesel. It all starts with the cleaner diesel fuel. Table 8 shows the changes in the status of diesel fuel in a number of Arab countries between 2006 and 2011, and a brief of future plans as declared in 2011. Evidently, most Arab countries have taken initiatives to shift towards using diesel fuel with much lower sulfur content.

Several European countries, including the United Kingdom, have moved to almost sulfur-free transport fuels, with sulfur content not exceeding 10 ppm. Sulfur reduction is achieved by using lower-sulfur crude oil from which sulfur is removed. This requires substantial investment in hydro de-sulfurization plants at refineries. Moreover, the removal of sulfur is energy consuming and thus increases the refinery operating costs (Tucker, 2012).

## VIII. AIR POLLUTION DROP

A team of researchers from institutions in Germany and Saudi Arabia has found in 2015 that pollution levels over several major cities in the Middle East are dropping due to economic and political unrest and war (Yirka, 2015; The Guardian, 2015). They stated that under normal circumstances, and as countries advance, the amount of pollutants they emit increases. However, as political unrest started around 2010, the chaos became predominant and this led to a lowering of economic standards in many cities, which meant less fuel was burnt by motor vehicles or used in electric power generation. Some cities have witnessed declines of 20 to 50 percent, though in some cases, the declines are due to legislation enforced to reduce pollution. The power sector condition drastically deteriorated and people opted for distributed small-scale diesel generators to be used during the power cut-off intervals, as discussed in the case of Lebanon.

Cities witnessing the most substantial change were in areas of severe unrests such as Iraq, Libya, and Syria, where civil war and insurgencies have driven down economic output. A substantial decrease in nitrogen dioxide ($NO_2$) concentrations was reported in Baghdad and central Iraq since 2013. A similar drop was recorded in Egypt around the time of the political unrest in 2011. In Syria, $NO_2$ concentrations over Damascus and Aleppo has decreased by 40-50 percent since 2011. In sharp contrast, the report found a 20-30 percent increase in $NO_2$ levels in Lebanon in 2014, which is linked to over 1.5 million Syrian refugees that have moved into the country, where they make up at least one-fifth of the population.

The report, on the other hand, attributes drops in pollution levels in other parts of the region, such as Saudi Arabia, Kuwait and the UAE, to the introduction of air quality control systems and devices. The Middle East air pollution control equipment market that stood at USD 103.4 million in 2009 reached around USD 155 million by 2014.

## IX. MITIGATION OPTIONS

Studies have shown that if air pollution concentration is reduced to recommended WHO levels, the number of asthma cases would fall by 70 percent and bronchitis cases would decrease by half. There are no common measures that can be suggested to all countries alike to reduce air pollution due to the differences amongst these countries in terms of types and sources of pollutants, in addition to the socioeconomic conditions that characterize each country. Solutions to the air quality degradation problems and excessive GHG emissions might consider a mixture of political leadership, regulations, technology and lifestyle changes. Although implementing mitigation measures to reduce emissions at the source is needed, setting adaptation strategies to the problems of air pollution, such as air quality warnings systems and air sampling should also be considered. In what follows is a brief analysis of applicable options in both the energy and transport sectors of the region.

i. **In the power sector:** The wide-spread use of low-emissions fuels and renewable combustion-free power sources (like solar, wind or hydropower) provides an economically feasible solution. The rapid demographic growth and the rising need for economic development call for additional, stable energy sources that can satisfy demand while providing diversification and protecting the environment (IRENA, 2016). Accordingly, there is a considerable potential for wide-scale deployment of renewable energy technologies region, stimulated by the rapid drop in their prices, mainly of PV cells. Since 2014, renewable energy has gained momentum in most Arab countries, especially wind and solar power. Most regional countries including Egypt, Jordan, Mauritania, Morocco, and the UAE are developing a viable market for renewable energy investments. Between 2012 and 2015, total renewable installed capacity witnessed a 150 percent increase, exceeding 3GW, excluding hydropower, compared to 1.2GW in 2012 (IRENA, 2016). In 2015, renewable power production (including hydropower) contributed to around 6 percent of the total generation capacity. Also, the shift towards more efficient technologies that reduce the consumption of electricity, and hence combustion fuels, is also a viable solution. This should result in a drop in fuel combustion and GHG emissions by the same rate – 6 percent. Despite difficulties faced by regional economies and energy sectors, the Arab world is taking bold steps to advance renewables and play a significant role in the global energy transition. Other options include fitting flue gas desulfurization systems to existing thermal diesel and fuel oil power plants, shifting to the use of natural gas for power generation, co-generation of heat and power, and distributed energy generation (i.e. mini-grids). Finally, it should be emphasized that removing subsidies would lead to a more rational consumption of electric energy, and hence a reduction in fuels burnt and emissions.

ii. **In the transport sector:** There have been efforts in the Arab world, as well as the rest of the world, focused at reducing GHG emissions targeting fuel standards, vehicle inspection, and public transit. Most sustainable transportation strategies fall into one of three categories: vehicle/fuel technology changes, road/vehicle operations improvements and demand management. The implementation of fuel standards and vehicle inspection measures can be found in most Arab nations, though they are not strictly implemented. The implementation of formal, mass transport systems can only be found in countries such as Egypt,

Algeria, Tunisia, and the UAE (Kaysi and Chaaban, 2015). The implementation of these measures have not been very successful in many countries, mainly due to the lack of proper enforcement, lack of funding, and a lack of technical expertise. Petrol engines generally emit less harmful emissions compared to diesel, thus tightening the standards related to petrol quality will lead to substantial emissions reduction.

iii. **Other sectors:** In the industrial sector, measures could include: clean technologies that reduce industrial smokestack emissions and an improved management of urban and agricultural waste, including the capture of methane gas emitted from waste sites as an alternative to incineration (for use as biogas). At the urban planning stages, options include improving the energy efficiency of buildings (green buildings) and making cities more compact and thus more energy efficient. In the municipal and agricultural waste management strategies for waste reduction, waste separation, recycling and reuse or waste reprocessing could be implemented.

## X. CONCLUSION AND RECOMMENDATIONS

The status of air quality in the Arab region over the past decade has been assessed. The amounts and types of combustion-related emissions are influenced by two contradicting factors. On one side, mitigation measures such as adopting cleaner fuels for transport and integrating renewable and cleaner fuels technologies in the power sector have led to a drop in emissions from these sectors. On the other hand, the demographic and economic growth witnessed in most countries has led to an increase in demand for power and motor vehicles. According to relevant data, there is an overall increase in fuel combustion and hence GHG emissions in most countries, meaning there is an urgent need to solve pollution problems. Adopting renewable energy resources for power generation at a much wider scale is a very viable option for further reduction in emissions. In the transport sector, most sustainable strategies fall into one of three categories: vehicle/fuel technology improvements, road/vehicle operations improvements and better sector management.

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## HYBRID AND ELECTRIC CARS IN JORDAN

Almost half of the cars currently registered in Jordan are either fully electric or hybrid, running on both battery and fuel. This development, unique in the Arab region, was the result of tax policies to encourage the transition to cleaner cars. Rapid success has resulted in savings in fuel and has improved air quality, especially in the country's capital Amman.

Since the introduction of the law in 2009, more than 100,000 hybrid cars have been registered. Among these are more than 33,000 cars in 2016, up from 5,000 in 2009. The number of registered electric vehicles increased from 336 vehicles in 2015, the first year of exemption for this type, to 885 in 2016. Of the 43,100 vehicles registered in Jordan in 2016, 44 percent were hybrid and electric cars. The percentage is expected to reach 50 percent in 2017.

The Jordanian cabinet decided in 2009 to exempt hybrid cars from import taxes, followed by a decision in 2015 to exempt electric cars from the full tax and registration fees, as part of a plan to save fuel and reduce emissions. The law passed in 2009 exempted hybrid cars from all tariffs, regardless of the size of their engine. This led to the registration of around 12,000 hybrid cars in 2009 and 2010 – about 9 percent of the cars that entered the market during this period. Because the exemption law did not put limits to the size of the engine, a large number of luxury cars with hybrid engines operating on eight cylinders or more, and with a capacity exceeding six liters, were imported. This was contrary to the goal of the exemption, as hybrid cars with large engines emit more pollutants than small and medium-powered vehicles that run on fuel.

Instead of revising the law by putting controls on the capacity of hybrid engines to prevent it from being exploited in order not to pay taxes on some large luxury vehicles, the exemption was completely discontinued in 2011. This resulted in a significant drop in the number of imported hybrid cars, from 6360 in 2010 to 558 in 2011. In 2012 and 2013, the government approved new regulations for exemptions on hybrid cars, with limitations on the size of the engine, and introduced for the first time a new regulation fully exempting electric vehicles from taxes and road fees. This led to a rapid rise in the number of hybrids and electric cars, reaching about half of the cars registered in 2016. However, percentage of electric cars remained lower, due to time needed to put in place reliable infrastructure for charging the batteries and the delay by dealers to start importing and servicing them. As a sign of commitment, the government provided Tesla electric cars as official vehicle to all ministers. Otherwise, most electrical cars in the Jordanian market are currently imported as second-hand, mainly from the United States. The total number of registered electric and hybrid cars in Jordan between 2009 and 2016 can be found in Table 1.

The case of cars in Jordan proves that significant changes in environmental protection are linked to tax measures involving incentives and sanctions, leading to the promotion of cleaner practices and limiting polluting cars by imposing higher fees on them.

The trend is gaining a snow-ball effect. Dubai has announced in September 2017 an innovative scheme to provide free charging, free-parking and toll-free driving for electric cars. The Dubai Electricity and Water Authority (DEWA) will offer free electricity until end 2019 for electric vehicles at its 100 Green Charging Stations, to be expanded to 200 stations in one year. The move is expected to bring 32,000 electric cars to local roads by 2020 and over 42,000 by 2030.

TABLE 1 **NUMBER OF ELECTRIC AND HYBRID CARS SOLD IN JORDAN BETWEEN 2009 AND 2016**

| Year | Electric Cars | Hybrid Cars | Regular Cars | Total | Percentage of hybrid and electrical cars from total |
|---|---|---|---|---|---|
| 2009 | 0 | 5350 | 63966 | 69316 | 8 |
| 2010 | 0 | 6360 | 58278 | 64638 | 10 |
| 2011 | 0 | 558 | 61359 | 61917 | 1 |
| 2012 | 0 | 2662 | 55207 | 57869 | 5 |
| 2013 | 0 | 14620 | 24018 | 38638 | 38 |
| 2014 | 9 | 17500 | 20709 | 38218 | 46 |
| 2015 | 336 | 23500 | 50700 | 74536 | 32 |
| 2016 | 885 | 33400 | 43100 | 77385 | 44 |

# ENVIRONMENTAL RESEARCH IN THE ARAB WORLD: A BIBLIOGRAPHIC REVIEW

Ahmed Gaber, Mohamed Lotaief and Djihan Hassan

## I. INTRODUCTION

The Arab world consists of the 22 sovereign nations of the Arab League and occupies a large expanse of Northern Africa and Western Asia (the Middle East), comprising a total area of around 11.2 million km$^2$, and a population of nearly 320 million people (United Nations Department of Economic and Social Affairs, 2015). Such a large expanse of land and people with diverse environments and population densities face many environmental challenges such as the need to efficiently process natural resources, manage water shortages and address the effects of pollution and climate change. By learning from the collective world's experiences, approaches and tools, the achievement of satisfactory and successful solutions can be realized according to the Arab world's needs.

The natural distribution of resources across the Arab world allows for a representation of diverse issues. Egypt and Sudan are significant in terms of water resources, agriculture and biological diversity while Iraq and Saudi Arabia and other Gulf states in terms of oil extraction and production[1]. Further, mining for different minerals is abundant in Saudi Arabia, Egypt, Iraq and the Maghreb (Morocco, Algeria, and Tunisia). The Arab world is also rich with ecological and living resources, such as Lebanon's forests, the Nile valley and its abundant flora and fauna, the many desert oases, fresh water and marine habitats, national protectorates and others scattered across the Arab world, which are all under threat from human expansion and development. Nonetheless, due to anthropogenic activities, the welfare and health of nation states has developed into an ongoing struggle due to soil, water and air pollution and limited waste management practices. In this, the Arab world shares many common problems, in addition to a diverse range of very specific individual problems and requirements that warrant special attention.

In 2008, Gaber detailed in Chapter 16 of the Arab Forum for Environment and Development (AFED) report the Arab world's state of research in the field of environmental science. This chapter presents an update of that review by highlighting and identifying the contribution and impact of Arab scholars by analyzing bibliometric data and providing recommendations to help improve research within the field. Additionally, research collaborations at regional and local levels are addressed as well as the influence of Arab journals in environmental research.

## II. FRAMEWORK AND APPROACH

In this section, a definition of environmental science is presented. A framework of its subdivisions and associations is provided together with error factors and limitations undertaken in this study. Methods used to extract the data are presented in Section 3.

### *A. Definition of Environmental Research and Its Value*

Environmental research is inherently multidisciplinary, pooling upon research in several of the basic sciences as well as in the engineering and industrial sectors. For example, soil heavy metal pollution involves the fields of chemistry, botany, geology, engineering, agriculture, irrigation, public health, economy and law. Environmental research employs a practical approach to problem solving by addressing real life issues, and often utilizes methodologies originally developed under other disciplines. It aims to predict impacts of human activity on the natural environment and to indicate the socio-economic and/or health impacts of any ongoing environmental pressures on human, animal and plant populations.

In the Arab world, environmental research is carried out in most research centers and

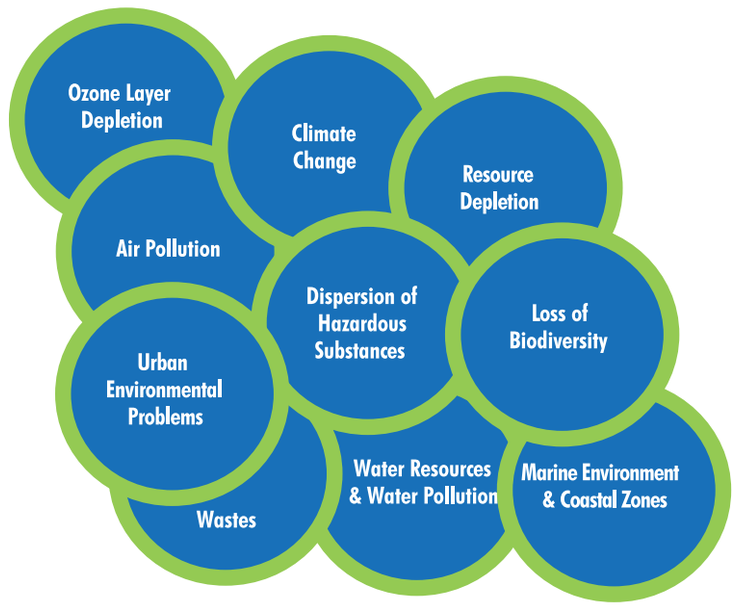
universities; however, it is usually classified under different disciplines. As such, it is a main concern for a number of specialized researchers in many different fields. The value of research can be measured by how much of it is applied, its impact in the form of patents, the implementation of technologies and their effectiveness in solving specific problems, or what impact the research has upon the GDP or intellectual capital of a nation.

### *B. Classification of Environmental Research Disciplines*

Given the diverse nature of environmental research, it is important to outline disciplines falling within its domain. Many attempts have been made to standardize the environmental science domain as a way to simplify policymaking and investigations with clear and defined objectives in mind. Gaber (2008) previously used the EUROSTAT framework, which is used in this chapter, to define environmental pressures as main disciplines for research (Europäische Gemeinschaften, 1999). Linking these environmental pressures to research disciplines allows for a more focused evaluation of research, excluding basic studies that do not contribute directly to environmental solutions, or that may hinder policy makers from converging on the relevant points. EUROSTAT defines ten environmental pressures that link and overlap but can be considered separate research areas, as shown in Figure 1.

A bibliographic review of each of these disciplines is presented in order to assess the scope of research within Arab countries. Bibliographic engines such as the Scopus-powered SCImago Journal & Country Rank portal vary widely in their categorizations of environmental science. These categorizations, and the EUROSTAT classification are described and used here as separate disciplines (that necessarily overlap) within environmental science research. Several journals are categorized under a single Scopus category, and given the diversity of journals and their respective collective disciplines, it is problematic to narrow down the categorizations further. Several categories may overlap, allowing research to be published under a variety of sources. Acceptance in one journal necessitates no republication in another journal, and that the article adheres to the specialty of said journal.

FIGURE 1 **ENVIRONMENTAL RESEARCH AREAS AND THEIR OVERLAP**




Source: Europäische Gemeinschaften, 1999

This chapter uses the Scopus categorization for environmental research. Moreover, Scopus and EUROSTAT categorizations have been equated, grouping broader research disciplines for convenience as shown in Table 1. This allows for using these categorizations to describe the state of the environment in the Arab world with reference to European sustainable development indicators, which can give stakeholders better options for decisive actions with regards to their environmental and development needs. All bibliographic data presented in this chapter has been retrieved from the SCImago Journal & Country Rank portal run by Elsevier unless explicitly stated otherwise.

## C. Research Samples, Accuracy Margins and Limitations

As an update to Gaber's chapter in the AFED's 2008 annual report, "Arab environment, Future Challenges", this study uses a method of bibliographics in a manner that was previously unavailable. The limitations of these methods are discussed together with a short update of the current situation in the Arab world, which subsequently impacts its research output and trend. The use of indices such as citation rates is explained to give the reader a better view on how to assess the data presented in Section 3.

### i. Error factors, and limitations of this study

This study only takes into account peer reviewed research that can be found readily through online search engines. Another limitation of this study is the abundance of paper (or physical) and private studies that have not been officially digitized, are not in the correct repositories and are unavailable for analysis. Many environmental consultancy firms also do not publish their studies, due to data ownership and other proprietorial issues. Furthermore, there remain studies that are too small or localized to allow for peer review, studies that are ignored or postponed due to lack of funding, and the lack of accessibility to PhD theses.

The reader is requested to exercise caution while interpreting the indices and data described so as not to reach any misleading conclusions. The indicators analyzed in this chapter are used for comparative purposes and are not finite indicators of a nations' scientific productivity.

Selecting nations as indicators or representatives of the Arab world has in itself a relative bias. Consequently, care should be taken while selecting representative samples for the

TABLE 1 LINKAGE BETWEEN ENVIRONMENTAL RESEARCH DISCIPLINE CLASSIFICATION

| Broad Discipline | EUROSTAT classification | Scopus |
|---|---|---|
| Biodiversity-related disciplines | Marine environment and coastal zones | Ecological modeling |
| | Loss of biodiversity | Ecology |
| | | Nature and landscape conservation |
| Global and planetary change | Ozone layer depletion | Global and planetary change |
| | Climate change | |
| | Resource depletion | |
| Health and pollution | Dispersion of hazardous substances | Health toxicology and mutagenesis |
| | Air pollution | Environmental chemistry |
| | | Pollution |
| Policy and Law | Urban environmental problems | Management monitoring policy and law |
| Water science | Water resources and pollution | Water science and technology |
| Waste management | Wastes | Waste management and disposal |
| General | General | Environmental engineering |
| | | Environmental science miscellaneous |

TABLE 2 **EXAMPLES OF INDICES USED IN BIBLIOMETRIC ANALYSIS**

| Index | Description |
|---|---|
| Citation rate | The frequency and pattern by which a publication is cited in other publications. Citation rates are calculated by article, author, editor or journal, and are based upon online data mining and indexing of metadata within articles. Examples of online citation indexers are Google Scholar, Web of Science, and Crossref). |
| Journal impact factor | Measures the average number of citations of articles published in a journal in the preceding two years of the reference year they are measured in. Articles with high citation frequencies skew a journal's impact factor. Statistically, this means that journal impact factor is a measure of journal performance rather than article performance, and consequently more research needing publication will be submitted to that journal. Such journals are not only responsible for scientific impact, but also for delivering the research to a wider audience. |
| Hirsch index (h-index) | An author level index measuring both citation impact of researchers as well as the individual research paper published (Jones, Huggett, & Kamalski, 2011). It takes into account the number of times a researcher and their research has been referred to. |
| Research productivity | The number of publications per author (Abramo & D'Angelo, 2014). It is used as a measure of output. |

economic, social and geographical diversity of the Arab world while taking into consideration the problem of information availability and political circumstances. Previously, Egypt and Syria were selected as representatives of agricultural-and industrial-scale research; yet, since then several international agricultural trade agreements were lost to Morocco. Syria was considered a leader in research and development, but since the civil war began in 2011, increasing loss of both cultural and academic prowess has taken place. Saudi Arabia and Arab Gulf states, although relatively calmer, have also experienced political unrest. Hence an accurate comparative study with representatives of Arab nations for different research, industrial, or environmental sectors is not possible, and only general indications can be expressed.

### *D. Bibliometric Analysis*

Research popularity and impact can be defined via several indices, according to the framework described above. Bibliometric analysis is defined as a statistical analysis of published scientific literature such as books and journals. It is often also referred to as scientometrics and provides quantitative analyses of academic literature that can be used to evaluate monetary funding in different disciplines. The indices used in such analysis are summarized in Table 2.

## II. CURRENT STATE OF RESEARCH IN THE ARAB WORLD

According to the 2015 UNESCO Science Report, the Arab world has suffered negatively from the world's financial crisis in 2007-2008 and the Arab spring in 2011-2015 (UNESCO, Moneef R. Zou'bi, Samia Mohamed-Nour, Jauad El-Kharraz, & Nazar Hassan, 2015). UNESCO reports a relative disparity between economies of countries of the Mashreq and Maghreb, with economies of the Maghreb boasting healthy growth rates as opposed to Mashreq countries (including Egypt and Sudan) who witnessed the Arab spring or had pre-existing conflicts.

General scientific research between 1996 and 2015 showed that the total document input of the 22 nations of the Arab world was about 6.3 percent of that of the United States of America (USA is the world's ranking number one) for the same period. Global figures indicate that the Arab world in its entirety only contributed about 1.4 percent of articles, compared to North America's 25.7 percent and European countries' 18.6 percent[2] of global citable documents. The h-index and citation number data (Table 3 and Table 4) indicate that for general science research, Arab world scholars do not benefit from a high amount of citations, and consequently do not get as much circulation for their research as other nations. This is an indication

TABLE 3 **ARAB COUNTRY RANKS FOR GENERAL SCIENTIFIC RESEARCH***

| | | | Category (Arab rank) [International category rank] | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Country** | **World Rank** | **Arab Rank** | **Documents** | **Citable documents** | **Citations** | **Self-citations** | **Citations per document** | **H index** |
| Egypt | 42 | 1 | 137,350 (1) | 133,147 (1) | 1,009,954 (1) | 198,941 (1) | 7.35 (7) | 184 (2) [51] |
| Saudi Arabia | 44 | 2 | 111,117 (2) | 106,187 (2) | 748,069 (2) | 122,715 (2) | 6.73 (12) | 195 (1) [43] |
| Tunisia | 53 | 3 | 58,769 (3) | 55,904 (3) | 342,429 (3) | 73,636 (3) | 5.83 (17) | 123 (6) [75] |
| Algeria | 55 | 4 | 42,456 (4) | 41,544 (4) | 215,922 (5) | 43,297 (5) | 5.09 (20) | 106 (9) [85] |
| Morocco | 56 | 5 | 40,737 (5) | 38,371 (5) | 279,731 (4) | 51,031 (4) | 6.87 (9) | 129 (5) [71] |
| United Arab Emirates | 61 | 6 | 31,366 (6) | 29,259 (6) | 210,873 (6) | 21,957 (7) | 6.72 (14) | 130 (4) [70] |
| Jordan | 66 | 7 | 28,234 (7) | 27,369 (7) | 201,400 (7) | 24,913 (6) | 7.13 (8) | 112 (7) [81] |
| Lebanon | 68 | 8 | 20,815 (8) | 19,040 (8) | 186,558 (8) | 18,136 (8) | 8.96 (3) | 138 (3) [63] |
| Kuwait | 70 | 9 | 18,468 (9) | 17,687 (9) | 157,888 (9) | 18,112 (9) | 8.55 (5) | 108 (8) [84] |
| Qatar | 77 | 10 | 13,438 (10) | 12,524 (10) | 71,382 (11) | 8,900 (11) | 5.31 (19) | 86 (11) [98] |
| Oman | 80 | 11 | 12,846 (11) | 11,919 (11) | 87,333 (10) | 10,379 (10) | 6.8 (11) | 91 (10) [95] |
| Iraq | 85 | 12 | 11,605 (12) | 11,042 (12) | 39,145 (14) | 5,022 (14) | 3.37 (22) | 59 (15) [131] |
| Sudan | 99 | 13 | 6,099 (13) | 5,792 (13) | 50,784 (13) | 5,797 (13) | 8.33 (6) | 70 (13) [120] |
| Syria | 101 | 14 | 5,744 (14) | 5,459 (14) | 53,601 (12) | 5,900 (12) | 9.33 (2) | 81 (12) [101] |
| Bahrain | 110 | 15 | 4,657 (15) | 4,225 (15) | 24,769 (16) | 2,346 (16) | 5.32 (18) | 55 (16) [138] |
| Palestine | 111 | 16 | 4,506 (16) | 4,224 (16) | 30,338 (15) | 3,884 (15) | 6.73 (12) | 60 (14) [129] |
| Libya | 113 | 17 | 4,160 (17) | 4,020 (17) | 18,971 (17) | 1,158 (18) | 4.56 (21) | 51 (17) [145] |
| Yemen | 121 | 18 | 2,776 (18) | 2,698 (18) | 18,951 (18) | 2,154 (17) | 6.83 (10) | 50 (18) [149] |
| Mauritania | 173 | 19 | 482 (19) | 456 (19) | 4,762 (19) | 300 (19) | 9.88 (1) | 32 (19) [175] |
| Djibouti | 195 | 20 | 190 (20) | 178 (20) | 1,206 (20) | 94 (20) | 6.35 (15) | 18 (20) [203] |
| Somalia | 203 | 21 | 115 (21) | 97 (21) | 685 (22) | 33 (22) | 5.96 (16) | 15 (21) [207] |
| Comoros | 208 | 22 | 96 (22) | 89 (22) | 839 (21) | 52 (21) | 8.74 (4) | 13 (22) [211] |

*Numbers indicate the quantity of the category in question followed by the country's rank within the Arab world between brackets. Square brackets in the H-index indicate the international rank of the index.

of the exponentially large gap in the amount and rate of research produced by the Arab nations in comparison to the remainder of the world. There also seems to be a lack of publishers willing to publish in Arabic digitally. It may be the case that due to the scarcity of Arab publishers and the lack of researchers' publishing expertise, research goals that are only relevant to Arab countries do not get as much attention within the Arab world as they would have in research-oriented nations with more prolific publishing capabilities.

Arab countries' research ranking shows that Egypt, Saudi Arabia, and Tunisia rank at the top, with some Gulf states occupying the final slots of the top ten (as shown in Table 3). H-index data suggests stronger citation impacts for Saudi Arabian scholars over Egyptian scholars; given their relative world h-index ranks, and the relative size of faculties and research force (data shown in full online version), this would indicate better reception of Saudi Arabian scholarly articles for the current sample of Arab scholars.

## *A. Environmental Research in the Arab World*

Arab nations contributed 1.7 percent to the world's

TABLE 4 **BIBLIOGRAPHIC DATA FOR THE TOP TEN RANKED COUNTRIES AND OTHER COUNTRIES OF INTEREST UNDERTAKING ENVIRONMENTAL RESEARCH WORLDWIDE**

| Country | Rank | Documents | Citable documents | Citations | Self-citations | Citations per document | H index (International rank) |
|---|---|---|---|---|---|---|---|
| **Top 10 countries worldwide** | | | | | | | |
| United States | 1 | 433,231 | 417,603 | 8,164,911 | 3,916,606 | 18.85 | 487 (1) |
| China | 2 | 185,217 | 182,794 | 1,618,324 | 930,727 | 8.74 | 215 (10) |
| United Kingdom | 3 | 121,873 | 117,137 | 2,538,532 | 683,448 | 20.83 | 332 (2) |
| Germany | 4 | 97,290 | 94,084 | 1,607,020 | 399,956 | 16.52 | 287 (3) |
| Canada | 5 | 82,331 | 79,795 | 1,549,382 | 398,587 | 18.82 | 271 (4) |
| India | 6 | 71,218 | 69,517 | 637,503 | 223,794 | 8.95 | 190 (15) |
| Japan | 7 | 68,095 | 66,730 | 876,287 | 220,043 | 12.87 | 196 (13) |
| France | 8 | 66,642 | 65,119 | 1,244,511 | 305,037 | 18.67 | 257 (5) |
| Australia | 9 | 65,779 | 63,561 | 1,175,082 | 362,102 | 17.86 | 246 (7) |
| Spain | 10 | 56,817 | 55,732 | 1,023,631 | 294,917 | 18.02 | 214 (11) |
| **Totals** | | **1,248,493** | **1,212,072** | **20,435,183** | **773,5217** | **160.13** | |
| **Other countries of interest** | | | | | | | |
| Brazil | 13 | 34,276 | 33,564 | 387,858 | 138,220 | 11.32 | 157 (20) |
| Turkey | 18 | 23,203 | 22,763 | 281,462 | 73,500 | 12.13 | 147 (24) |
| Russian Federation | 19 | 22,652 | 22,372 | 170,192 | 40,402 | 7.51 | 120 (33) |
| South Africa | 30 | 14,442 | 14,099 | 199,722 | 53,028 | 13.83 | 132 (27) |
| Israel | 37 | 8,366 | 8,177 | 151,228 | 25,757 | 18.08 | 123 (31) |
| Iran | 21 | 19,557 | 19,135 | 141,643 | 50,001 | 7.24 | 103 (38) |
| **Totals** | | **122,496** | **120,110** | **1,332,105** | **380,908** | **70.11** | |

citable documents on environmental research compared to North America with 26 percent and European countries' with 17.5 percent[3] for 2015 alone. Similar to general scientific research, the quantity of Arab nations' research is equal to 8 percent of that of the US, and about 60 percent of that of Spain (world rank 10th).

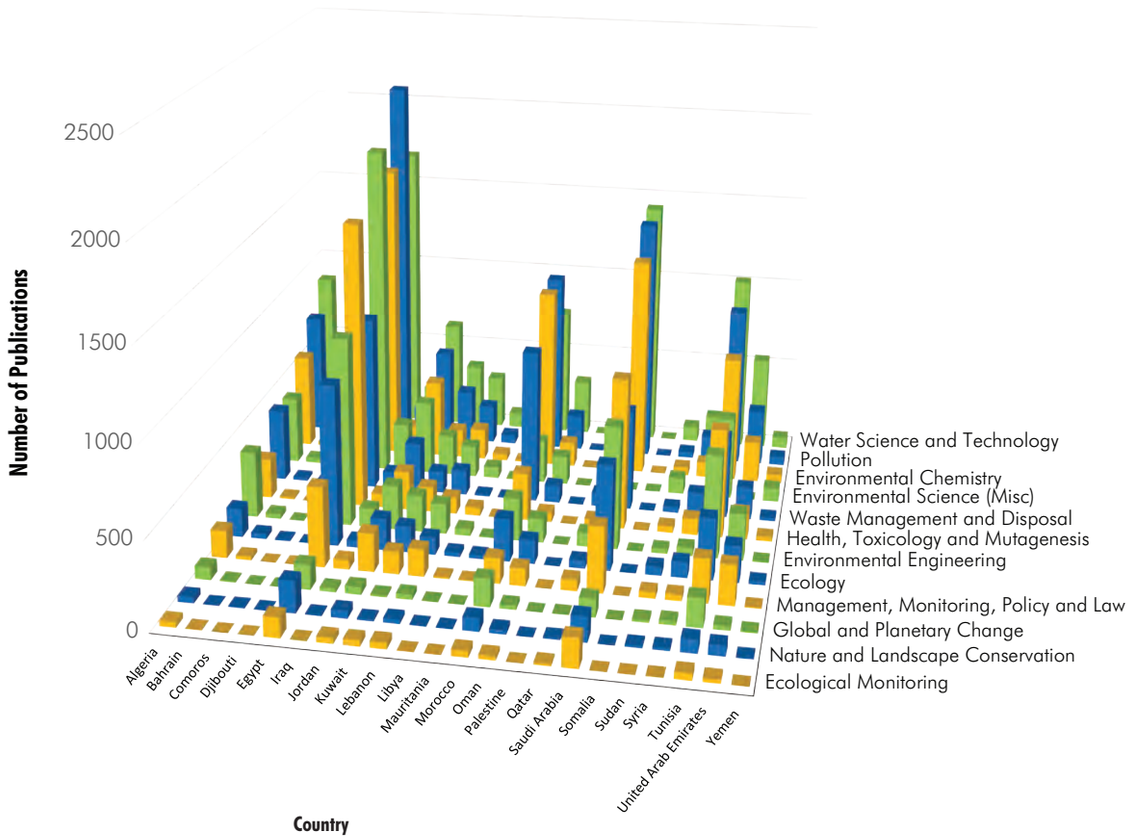
Ranking within the Arab world indicates that Egypt and Saudi Arabia occupy top ranks with a combined 14,246 published documents (43 percent of Arab scholarly articles) with moderate citation rates per document. Maghreb countries Tunisia, Morocco and Algeria are not only active, but also more widely cited, with relatively higher citation rates, and higher h-indices as detailed in Table 5.

## *B. National Research Impacts by Discipline Popularity*

Table 6 illustrates the general ranking of Arab nations according to research discipline within environmental science as compared to the world. In broad terms, Arab nations have published more research on health and pollution issues (nearly 40 percent of research), than any other group of disciplines. 20 percent of published research was on general environmental research, followed by 17 percent of publications for water science and technology. Remaining broad disciplines occupied minor percentages.

Figures for discipline popularity can be seen in Table 7 and Table 8. These figures serve as an indication

FIGURE 2 **THE NUMBER OF PUBLICATIONS PRODUCED IN EACH PREDEFINED ENVIRONMENTAL SCIENCE DISCIPLINE BY THE 22 ARAB COUNTRIES**




of which nations are publishing the most popular disciplines and their percentage contribution to overall Arab research in that discipline. Table 7 indicates the quantity of articles produced and percentages for the top three publishing nations, while Table 8 indicates the most popularly cited disciplines (by number of citations) for the top three cited nations within each discipline. The least number of articles published is on ecological modeling, where Saudi Arabian scholars published 28 percent of articles. Table 7 indicates that the Arab world's most popular cited discipline is water science and technology. Of the 84,585 citations that are recorded, about 18 percent are citations for research by Egyptian scholars, 14 percent for research by Saudi Arabian scholars, and 10 percent for research by Jordanian scholars. The least cited subject is global and planetary change, indicating a small number of researchers, or few research articles with little citation impact. Within

TABLE 5 **ARAB COUNTRY RANKS FOR GENERAL ENVIRONMENTAL RESEARCH***

| Country | Overall Rank | Documents | Citable documents | Citations | Self-citations | Citations per document | H-index |
|---|---|---|---|---|---|---|---|
| Egypt | 36 (1) | 8,397 (1) | 8,212 (1) | 72,131 (1) | 12,470 (1) | 8.59 (13) | 83 (1) [42] |
| Saudi Arabia | 43 (2) | 5,849 (2) | 5,718 (2) | 45,445 (2) | 7,446 (2) | 7.77 (15) | 69 (2) [55] |
| Tunisia | 52 (3) | 3,412 (3) | 3,343 (3) | 35,249 (3) | 7,431 (3) | 10.33 (6) | 65 (3) [56] |
| Morocco | 56 (4) | 2,714 (4) | 2,679 (4) | 25,160 (4) | 4,298 (4) | 9.27 (11) | 61 (5) [63] |
| Algeria | 59 (5) | 2,460 (5) | 2,427 (5) | 22,367 (5) | 3,215 (5) | 9.09 (12) | 62 (4) [60] |
| Jordan | 62 (6) | 2,011 (6) | 1,984 (6) | 22,259 (6) | 2,735 (6) | 11.07 (4) | 60 (6) [65] |
| United Arab Emirates | 65 (7) | 1,784 (7) | 1,733 (7) | 16,725 (7) | 1,801 (8) | 9.38 (10) | 51 (7) [74] |
| Kuwait | 71 (8) | 1,282 (8) | 1,261 (8) | 12,360 (8) | 1,908 (7) | 9.64 (9) | 45 (8) [82] |
| Lebanon | 76 (9) | 1,013 (9) | 995 (9) | 10,408 (9) | 1,183 (9) | 10.27 (7) | 44 (9) [85] |
| Oman | 80 (10) | 946 (10) | 925 (10) | 9,564 (10) | 1,152 (10) | 10.11 (8) | 42 (10) [89] |
| Iraq | 86 (11) | 826 (11) | 799 (11) | 2,834 (13) | 396 (13) | 3.43 (22) | 22 (16) [137] |
| Syria | 91 (12) | 613 (12) | 605 (12) | 6,852 (11) | 705 (11) | 11.18 (3) | 36 (11) [96] |
| Qatar | 96 (13) | 493 (13) | 486 (13) | 2,730 (14) | 286 (14) | 5.54 (18) | 26 (13) [122] |
| Palestine | 97 (14) | 477 (14) | 469 (14) | 3,712 (12) | 469 (12) | 7.78 (14) | 31 (12) [106] |
| Sudan | 107 (15) | 363 (15) | 357 (15) | 2,473 (15) | 195 (15) | 6.81 (17) | 25 (14) [125] |
| Libya | 118 (16) | 296 (16) | 295 (16) | 1,403 (18) | 81 (18) | 4.74 (19) | 17 (18) [151] |
| Bahrain | 121 (17) | 270 (17) | 261 (17) | 1,940 (17) | 171 (16) | 7.19 (16) | 22 (16) [137] |
| Yemen | 126 (18) | 230 (18) | 221 (18) | 2,412 (16) | 169 (17) | 10.49 (5) | 23 (15) [133] |
| Mauritania | 162 (19) | 61 (19) | 61 (19) | 901 (19) | 46 (19) | 14.77 (2) | 17 (18) [151] |
| Djibouti | 203 (20) | 14 (20) | 14 (20) | 62 (21) | 6 (20) | 4.43 (20) | 4 (21) [208] |
| Comoros | 207 (21) | 11 (21) | 11 (21) | 209 (20) | 4 (21) | 19 (1) | 6 (20) [199] |
| Somalia | 211 (22) | 6 (22) | 5 (22) | 25 (22) | 1 (22) | 4.17 (21) | 3 (22) [212] |

* Numbers indicate the quantity of the category in question followed by the country's rank within the Arab world between brackets. Square brackets in the h-index Indicate the international rank of the index.

the discipline of global and planetary change, Morocco and Tunisia dominate the top two places with 49 percent of citations (27 percent and 22 percent respectively) going to their shared research efforts.

Egypt and Saudi Arabia dominate most disciplines in terms of both research published as well as their citation impact. Egypt's influence is not as effective in terms of citation impact compared to Saudi Arabia, but the sheer quantity of research published, together with its moderate citation rate (and h-index) allows for Egyptian scholars' dominance in the majority of disciplines. Also of note is the Maghreb's contribution to disciplines that appear to be deficient in the majority of Arab scholars' publications.

Each nation publishes different research on different subjects. Figure 2 presents a comparison of discipline prioritization in the Arab world (as defined by research productivity per discipline per nation). The most active countries are shown with the highest amount of research across many disciplines (highest bars in Figure 2). Figure 2 shows the relative percentage of research within each discipline for the 22 Arab nations.

Of the least active Arab nations, Comoros appears to be most concerned with the broad discipline of biodiversity and conservation, amounting to 80 percent of its research articles. Arab nations with the exception of Comoros, Iraq, Mauritania, Morocco, Somalia and Yemen, publish the majority of their environmental research in the

TABLE 6 **ARAB COUNTRY RANKS PER DISCIPLINE WITHIN ENVIRONMENTAL RESEARCH***

| Country | Science General (1996-2015) | Total Environmental Research | Ecological Modelling | Ecology | Nature & Landscape Conservation | Global & Planetary Change |
|---|---|---|---|---|---|---|
| Egypt | 1 (42) | 1 (36) | 2 (43) | 1 (46) | 1 (53) | 3 (46) |
| Saudi Arabia | 2 (44) | 2 (43) | 1 (38) | 2 (51) | 2 (65) | 4 (55) |
| Tunisia | 3 (53) | 3 (52) | 3 (60) | 3 (68) | 3 (79) | 1 (42) |
| Morocco | 5 (56) | 4 (56) | 4 (61) | 4 (77) | 4 (81) | 2 (43) |
| Algeria | 4 (55) | 5 (59) | 8 (68) | 7 (90) | 7 (102) | 5 (65) |
| Jordan | 7 (66) | 6 (62) | 7 (67) | 6 (86) | 6 (97) | 6 (76) |
| United Arab Emirates | 6 (61) | 7 (65) | 10 (76) | 5 (83) | 5 (87) | 8 (88) |
| Kuwait | 9 (70) | 8 (71) | 6 (65) | 8 (93) | 12 (144) | 13 (122) |
| Lebanon | 8 (68) | 9 (76) | 5 (62) | 10 (103) | 8 (114) | 7 (85) |
| Oman | 11 (80) | 10 (80) | 9 (72) | 9 (95) | 9 (116) | 9 (90) |
| Iraq | 12 (85) | 11 (86) | 15 (122) | 14 (135) | 15 (158) | 11 (95) |
| Syria | 14 (101) | 12 (91) | 14 (115) | 11 (105) | 10 (133) | 10 (94) |
| Qatar | 10 (77) | 13 (96) | 11 (86) | 13 (130) | 13 (147) | 18 (154) |
| Palestine | 16 (111) | 14 (97) | 12 (91) | 15 (139) | 21 (206) | 14 (123) |
| Sudan | 13 (99) | 15 (107) | 17 (147) | 12 (128) | 11 (136) | 12 (105) |
| Libya | 17 (113) | 16 (118) | 16 (137) | 17 (152) | 17 (175) | 17 (149) |
| Bahrain | 15 (110) | 17 (121) | 13 (113) | 16 (147) | 19 (187) | 16 (137) |
| Yemen | 18 (121) | 18 (126) | 19 (163) | 19 (160) | 16 (161) | 15 (130) |
| Mauritania | 19 (173) | 19 (162) | 18 (150) | 18 (157) | 18 (182) | 21 (192) |
| Djibouti | 20 (195) | 20 (203) | 20 (300) | 22 (212) | 20 (188) | 20 (187) |
| Comoros | 22 (208) | 21 (207) | 20 (300) | 20 (191) | 14 (156) | 19 (181) |
| Somalia | 21 (203) | 22 (211) | 20 (300) | 21 (211) | 22 (300) | 22 (300) |

* Figures between brackets are the international ranking of each state. A category rank of 300 indicates last place internationally. General science has been added as an overall comparative statistic.

discipline of water science and technology, with Bahraini and Algerian water science scholars being the most active environmental researchers in their respective countries. The remaining nations publish on average 18 percent of their research on water science and technology, reflecting the importance of water issues across these countries. The broad disciplines of health and pollution are also largely important research subjects, with an average of 40 percent combined. The quantity and variation of publications within the Arab world reflect the diverse nature of the general research goals of Arab nations.

### *C. The Number of Researchers in the Arab World*

It is often useful to equate the amount of research in a sector to the size of the population it supports. This method brings into focus the relative effectiveness of research institutes in educating or serving the public, showing what impact higher education has on a population and how research is valued. Another important aspect is the intellectual capital of a nation. Hanafi et al. speculate that this is a more expressive indicator for progress within scientific research when

| Health, Toxicology & Mutagenesis | Environmental Chemistry | Pollution | Management, Monitoring, Policy, & Law | Water Science & Technology | Waste Management & Disposal | Environmental Engineering | Environmental Science (Misc) |
|---|---|---|---|---|---|---|---|
| 1 (30) | 1 (33) | 1 (32) | 1 (50) | 1 (35) | 1 (34) | 1 (37) | 1 (31) |
| 2 (37) | 2 (37) | 2 (35) | 2 (54) | 2 (38) | 3 (45) | 2 (43) | 2 (39) |
| 3 (43) | 4 (48) | 4 (46) | 3 (64) | 3 (45) | 4 (47) | 3 (48) | 3 (56) |
| 4 (55) | 3 (42) | 3 (42) | 8 (75) | 5 (50) | 2 (37) | 7 (62) | 8 (70) |
| 5 (58) | 5 (53) | 5 (51) | 6 (71) | 4 (47) | 5 (51) | 4 (57) | 5 (61) |
| 6 (59) | 6 (55) | 6 (54) | 5 (66) | 6 (53) | 6 (58) | 6 (61) | 4 (58) |
| 7 (66) | 7 (65) | 7 (62) | 4 (65) | 7 (58) | 7 (63) | 5 (60) | 6 (66) |
| 8 (67) | 9 (72) | 8 (63) | 9 (78) | 8 (63) | 10 (75) | 8 (65) | 9 (72) |
| 10 (76) | 8 (67) | 9 (69) | 7 (72) | 10 (68) | 8 (70) | 9 (66) | 10 (75) |
| 12 (90) | 11 (76) | 10 (71) | 10 (81) | 9 (66) | 12 (79) | 10 (71) | 11 (79) |
| 11 (81) | 10 (73) | 11 (73) | 13 (104) | 11 (76) | 13 (80) | 11 (75) | 7 (69) |
| 9 (75) | 14 (91) | 12 (78) | 15 (122) | 13 (85) | 9 (73) | 14 (91) | 17 (107) |
| 15 (98) | 12 (83) | 14 (84) | 11 (98) | 14 (88) | 14 (83) | 13 (82) | 14 (100) |
| 13 (91) | 13 (90) | 13 (80) | 12 (99) | 12 (79) | 11 (76) | 12 (78) | 15 (101) |
| 16 (101) | 16 (103) | 18 (112) | 14 (120) | 16 (100) | 15 (102) | 17 (107) | 12 (93) |
| 14 (92) | 17 (106) | 15 (100) | 17 (153) | 17 (105) | 18 (123) | 15 (94) | 16 (103) |
| 18 (134) | 18 (124) | 17 (110) | 16 (128) | 15 (91) | 17 (113) | 16 (105) | 18 (134) |
| 17 (113) | 15 (102) | 16 (102) | 18 (166) | 18 (110) | 16 (112) | 18 (136) | 13 (98) |
| 19 (162) | 19 (146) | 19 (146) | 19 (170) | 19 (149) | 19 (144) | 19 (149) | 19 (165) |
| 21 (300) | 20 (176) | 20 (194) | 20 (202) | 20 (181) | 20 (300) | 20 (170) | 20 (202) |
| 21 (300) | 22 (300) | 21 (300) | 22 (300) | 21 (207) | 20 (300) | 21 (300) | 22 (300) |
| 20 (191) | 21 (196) | 21 (300) | 21 (207) | 22 (212) | 20 (300) | 21 (300) | 21 (207) |

correlated historically with growth in the sector (Hanafi, Arvanitis, & Hanafi, 2013).

Figures for natural sciences are provided as general indicators since reliable figures on environmental sciences could not be found. Table 9 shows the relative number of researchers per population for some Arab states, for general full-time employed (FTE) researchers, and for head counts of researchers of natural sciences. Leading the Arab nations is Jordan with 1,952 FTE researchers per million in 2005 (Hanafi et al., 2013) followed by Tunisia with 1,783 FTE researchers per million and Morocco with 856 FTE researchers per million people. Within natural sciences, Egypt takes the lead with 163 researchers per million people followed by Kuwait at 160 researchers per million people and Jordan with 154 researchers per million people. At the other end of the spectrum, Saudi Arabia employs only 8 natural scientists per million people, 24 natural scientists per million people in Iraq, 49 in Oman, and 80 in Qatar (refer to Table 9, adapted from UNESCO UIS, 2017).

According to UNESCO figures, Egypt has the

largest research force in the Arab world with 61,000 FTE researchers. Head counts for natural science researchers indicate 14,500 researchers, of whom 40 percent are female. Over half of the researchers perform natural science research in higher education and government institutes. In contrast to Egypt, Saudi Arabia employs 213 researchers in natural sciences. Qatar employs 1,203 full-time researchers, with 161 of them in natural sciences (21 percent female). Detailed information is shown in Table 9. These figures are considered low for the relative size of the Arab world even though not all research listed by the UNESCO UIS is research on science, and is used here as a measure of comparability between nation states.

### *D. Past and Recent Trends: An Update from 2008*

Since 2008, research within the field of environmental science has increased for all nations. An increasing trend appears for Egypt, Saudi Arabia, Tunisia, Morocco, Algeria, and Jordan, as shown in Figure 3. A more detailed look at Figure 3 confirms Egypt's historical lead; contributing by over double what any other nation contributed in 2008.This remains the trend in 2015, with the exception of Saudi Arabia, which has enjoyed an almost linear increase in research since 2009.

Figure 4 illustrates the number of publications every year between 1996 and 2015. In 2008, many Arab nations showed an increase in the number of publications produced. In 2011, this trend slows down in Egypt and Tunisia but is increases in Saudi Arabia. A further slowing down occurs in Egypt, Tunisia, and Algeria at the start of 2014. Morocco shows the highest rate of increase in research efforts between 2013 and 2014, followed by Egypt, Algeria, and Saudi Arabia. Between 2014 and 2015 Egypt's publication rate appears to slow down to a similar rate as in 2011, while Saudi Arabia has the highest rate of research, followed by Morocco, the UAE, and Qatar.

Figure 5 shows trends for the 22 Arab states which can be classified into two groups; the first includes Saudi Arabia, Egypt, Morocco, Tunisia, and Algeria who are most active in the broad discipline of health and pollution, and the second includes the remaining nations. With the exception of Egypt, group 1 countries have nearly doubled their research in this discipline of environmental science since 2008, and showed promising rates of publication in 2015. Egypt, although annually contributing over double what other nations contribute, has seen a drop in this rate of publication since 2011. The second group does not appear to show such publishing trends.

Data on general subjects such as miscellaneous studies and environmental engineering illustrated in Figure 6 show Egypt once again dominating the annual publication race and contributing twice what other nations have contributed since 2008.

Data on water, science and technology shown in Figure 7, shows similar trends. In 2008 Egypt led the Arab world with 72 publications, followed by Tunisia with 59 publications, and Morocco with 53 publications. In 2015, Saudi Arabia led with 226 publications, followed by Egypt with 215 publications, and Tunisia with 118 publications. Other nations are also very active in this field with the average publication per nation increasing from 20 documents in 2008 to 46 documents in 2015.

The remainder of subjects show similar trends, the most variable of which is global and planetary change, with the maximum number of 27 publications in 2015 being made by Tunisia and Saudi Arabia independently, compared to eight and none in 2008 as shown by Figure 8. For an illustration of both annual publication and historical (cumulative) trends, refer to Figure 8 and Figure 9.

The fastest growing subjects in the Arab world are health and pollution, followed by water science and technology, followed by waste management and disposal, and miscellaneous and other subjects. The slowest growing subjects are global and planetary change as well as biodiversity, conservation, and other related subjects.

### *E. What is the Arab Power of Publication?*

Arab publishers' ability to compete with foreign publishers for article publication, both within the Arab world and internationally, is an important factor in Arab scholarly knowledge dissemination.

TABLE 7 **TOP THREE ARAB COUNTIES PUBLISHING IN THE MOST POPULAR DISCIPLINES***

| Discipline | Arab World Articles | 1st | 2nd | 3rd |
|---|---|---|---|---|
| **Water Science and Technology** | 8900 | Egypt (1652) [18.56%] | Saudi Arabia (1413) [15.87%] | Tunisia (1002) [11.25%] |
| **Pollution** | 8449 | Egypt (2099) [24.84%] | Saudi Arabia (1373) [16.25%] | Morocco (1039) [12.29%] |
| **Environmental Chemistry** | 7043 | Egypt (1688) [23.96%] | Saudi Arabia (1256) [17.83%] | Morocco (1039) [14.75%] |
| **Environmental Science, Misc.** | 6193 | Egypt (1812) [29.25%] | Saudi Arabia (1266) [20.44%] | Tunisia (453) [7.31%] |
| **Waste Management and Disposal** | 4706 | Egypt (997) [21.18%] | Morocco (878) [18.65%] | Saudi Arabia (574) [12.19%] |
| **Health Toxicology and Mutagenesis** | 4638 | Egypt (1597) [34.43%] | Saudi Arabia (848) [18.28%] | Tunisia (608) [13.1%] |
| **Environmental Engineering** | 4493 | Egypt (1067) [23.74%] | Saudi Arabia (701) [15.6%] | Tunisia (589) [13.1%] |
| **Ecology** | 3421 | Egypt (914) [26.71%] | Saudi Arabia (585) [17.1%] | Tunisia (351) [10.26%] |
| **Management Monitoring Policy and Law** | 2531 | Egypt (456) [18.01%] | Saudi Arabia (370) [14.61%] | Tunisia (250) [9.87%] |
| **Global and Planetary Change** | 861 | Tunisia (160) [18.58%] | Morocco (159) [18.46%] | Egypt (137) [15.91%] |
| **Nature and Landscape Conservation** | 766 | Egypt (184) [24.02%] | Saudi Arabia (144) [18.79%] | Tunisia (76) [9.92%] |
| **Ecological Modeling** | 591 | Saudi Arabia (165) [27.91%] | Egypt (116) [19.62%] | Tunisia (41) [6.93%] |

*Figures between brackets show the number of citable documents produced. Percentages are for the country's production in comparison to Arab world production for said discipline.

In the 22 Arab nations only 12 publishers publish international scientific journals. Egypt leads with a total of 67 journals, of which five publish a variety of environmental sciences, two publish on health and pollution, two on water science and technology and one on biodiversity and ecology. The United Arab Emirates publishes 24 journals on general science, with one journal related to health and pollution. Saudi Arabia and Jordan each publish 11 journals on general science with two on health and pollution and water science and technology and one on general environmental science.

When comparing Arab journals to the journal "Science of the Total Environment", previously referred to by Zyoud et al. (2016), the scale of performance differs with an order of magnitude. For example, the most cited journal published by Jordan (Advances in Environmental Biology, with 2,256 articles in the last three years) with 31 references per document, only has an SJR impact factor of 0.11 compared to the Netherlands' Science of the Total Environment (SJR 1.7), which boasts 3,799 citable documents in the past three years and an h-index of 160 compared to the Advances in Environmental Biology's 12.

According to the current available data for the years 2012 to 2015, the listed Arab publishers published less than one percent (0.99 percent) of the world's environmental research, compared to the US's 28 percent, and the UK's 27 percent. This small number of journals, and the small amount of publications produced by Arab nations, leaves much room for expansion of the publication sector in the Arab world, both in English (as demonstrated by Egypt's international publication record for general science) and in Arabic for local and regional consumption purposes.

# ENVIRONMENTAL EDUCATION

**Laila AbuHassan**

Environmental education on the international level gained momentum after the Tbilisi Declaration in 1977, and concern over environmental issues has since been increasing. This was demonstrated through different international treaties and initiatives regarding various environmental issues that included educational reform. Arab countries responded individually through educational reform processes that targeted official school education, which started during the 1980's and 1990's.

The last decade has seen an increase in the number of institutions offering different academic degrees and training programs. Universities offering bachelor's degrees in environment and environment-related subjects are now available in all Arab countries, and masters and PhD degrees are also offered in some institutions. However, there is still a need to make such degrees and programs more available and to enhance their quality.

In the Arab countries, results of scientific research are often published in international journals or non-specialized local journals, since specialized or dedicated environmental journals are limited or absent for some subjects. The science-based reports published by the Arab Forum for Environment and Development (AFED) since 2008, together with AFED monthly magazine, Al-Bia Wal-Tanmia, and other publications dating back to 1996, have played a significant role in enhancing information and awareness regarding environment and environment-related issues in the Arab world. Contents of the magazine and reports have been regularly used not only as references and as reading material, but also in textbooks. In Lebanon, for example, almost all official final exams between 1997 and 2016 contained texts from the magazine and reports.

Since the main features of environmental education in different Arab countries are similar, with differences being quantitative rather than qualitative, the case of Jordan was selected for the purpose of this review. Different stages of education, the contribution to the literature in the fields of environment-related issues, and the unofficial programs and activities relevant to environmental education carried by non-governmental organizations (NGOs) will be briefly evaluated.

## School Education

In Jordan, a continuing improvement process in the official curricula of the different subjects has been ongoing since three decades. Educational reform processes took place in three phases – in 1989, 2004, and 2015. Environmental education components and environment-related issues have been included in the school curricula for every grade, in subjects including chemistry, biology, mathematics, geography and earth sciences. In each separate subject the curriculum materials lay out relevant environment-related issues, whether directly or indirectly. In mathematics, for example, many of the questions are based on issues related to environment and development, such as: "The population in one city increases at 2.5 percent. If the population was 100,000 in 2014, what would it be after five years?" Another exam question incorporating nature and numbers: "Seeds of sunflower plant form two styles of spiral lines, one clockwise and the other counter clockwise. The number of these spiral lines are 34 clockwise and 21 counter clockwise. Search the internet for plants other than sunflower that follow similar style. Write a report and read it in front of your colleagues."

The latest versions of the curriculum textbooks show an integrated yet comprehensive approach to the inclusion of environmental education components and environment-related issues. Such textbooks are the basic tools for a proper educational process, whether environmental or otherwise, given that the teacher, teaching method, and the supporting materials and activities in and outside the classroom are appropriate. The goal is that students earn a deeper understanding of their environment by engaging in environment-related problems and challenges, and acquiring the attitudes towards improving or maintaining quality of their environment.

Jordan's commitment towards environmental education at the different school levels has been demonstrated clearly in the continuous revision and updating of the curriculum, the implementation of the integrated approach, and suggested activities and discussions.

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To ensure the quality of the learning outcomes, the curriculum should continue to be updated and teachers' training needs to be improved.

### University Education and Research

Universities in Jordan have paid attention to environmental education since the 1980's. Courses and degrees were incorporated in the curricula and elective courses were offered. Cooperative programs with international donors and bilateral cooperation with advanced international institutions were also initiated. Presently, eleven universities in Jordan offer a bachelor's degree in the faculties of Science, Agriculture, Engineering, Marine Sciences, Natural Sciences and Environment, Earth Sciences, Agriculture Technology, and Engineering of Natural Resources. Master's degrees are offered in 13 environment-related programs. The Faculty of Agriculture at the University of Jordan offers a PhD degree in Soil, Water and Environment. Degrees in the fields of biodiversity, food security, and climate change are not offered yet, though courses and research areas in these fields are covered in the curricula.

Publication of research papers in quality specialized journals remains limited. Some research results are sent to international journals, while others are published in local non-specialized journals. There is a national journal on environmental issues in Jordan.

### Non-Governmental Organizations (NGOs)

The establishment of several NGOs in Jordan, that mainly target environment and environmental-related issues, is another indicator of increasing concern about environmental education and awareness. Their activities include conservation and protection of the environment, as well as raising public awareness and involving people in relevant projects such as cleaning public spaces, recycling solid waste, and planting trees.

In spite of growing interest, there is weakness in the production of knowledge in the field of environmental education, combined with an absence of linkages between the policy and decision-making on one side, and the academic and research institutions on the other side.

TABLE 8 **TOP THREE ARAB COUNTRIES REFERENCED IN THE MOST POPULAR ENVIRONMENTAL SCIENCE DISCIPLINES***

| Discipline | Citations Arab World | 1st | 2nd | 3rd |
|---|---|---|---|---|
| Water Science and Technology | 84585 | Egypt (15085) [17.83%] | Saudi Arabia (11829) [13.98%] | Jordan (8568) [10.12%] |
| Environmental Chemistry | 78422 | Egypt (22980) [29.3%] | Saudi Arabia (13877) [17.69%] | Tunisia (8376) [10.68%] |
| Pollution | 75846 | Egypt (19666) [25.92%] | Saudi Arabia (13201) [17.4%] | Tunisia (8608) [11.34%] |
| Waste Management and Disposal | 57116 | Egypt (14582) [25.53%] | Tunisia (7694) [13.47%] | Saudi Arabia (6971) [12.2%] |
| Environmental Engineering | 53797 | Egypt (13965) [25.95%] | Tunisia (8902) [16.54%] | Saudi Arabia (6528) [12.13%] |
| Health Toxicology and Mutagenesis | 52853 | Egypt (18303) [34.63%] | Tunisia (7652) [14.47%] | Saudi Arabia (7280) [13.77%] |
| Ecology | 35821 | Egypt (7427) [20.73%] | Saudi Arabia (6011) [16.78%] | Morocco (3809) [10.63%] |
| Environmental Science, Misc. | 32464 | Egypt (9391) [28.92%] | Tunisia (4574) [14.08%] | Saudi Arabia (4522) [13.92%] |
| Management Monitoring Policy and Law | 22338 | Egypt (4363) [19.53%] | Saudi Arabia (3728) [16.68%] | Algeria (2290) [10.25%] |
| Ecological Modeling | 10456 | Saudi Arabia (2377) [22.73%] | Egypt (2036) [19.47%] | Algeria (1261) [12.06%] |
| Nature and Landscape Conservation | 8615 | Morocco (1795) [20.83%] | Algeria (1453) [16.86%] | Saudi Arabia (1251) [14.52%] |
| Global and Planetary Change | 7431 | Morocco (1985) [26.71%] | Tunisia (1615) [21.73%] | Saudi Arabia (757) [10.18%] |

*Figures between brackets show the number of citations or quotations by each country. Percentages are for the country's number of citations for each discipline in comparison to the total Arab world citations for that discipline.

## III. CONCLUSION AND RECOMMENDATIONS

The enhancement of environmental research in the Arab world must be given a high priority since its advancement will aid in the identification and adaptation of much needed solutions for the complex environmental problems that the Arab world faces. This can be accomplished by setting an international strategy for environmental scientific research, creating and strengthening existing centers of excellence, addressing financing challenges and the availability of databases and electronic resources for scientific research.

### *A. Setting an International Strategy for Environmental Scientific Research in the Arab World*

Due to the nature of and current situation in the Arab world, Arab nations face similar industrial and economic problems. Thus, addressing such challenges by setting a common strategy for scientific research that emphasizes collaboration would be prudent. In 2014, the Arab world endorsed a draft for an "Arab Strategy for Science, Technology and innovation". Through this initiative several high priority issues were discussed which included academic training in the science and engineering fields, scientific

TABLE 9 **RESEARCHERS PER POPULATION FOR ARAB STATES**

| Country | Data collection year | Total FTE researchers | FTE researchers /million | Natural sciences | |
|---|---|---|---|---|---|
| | | | | Head count | Researchers /million |
| Egypt | 2014 | 61058.55 | 681.6 | 14597 | 162.9 |
| Saudi Arabia | 2009 | 716* | 26.1* | 213 | 7.7 |
| Tunisia | 2014 | 20070 | 1783.3 | .. | .. |
| Morocco | 2012 | 28264.86 | 856.9 | .. | .. |
| Algeria | 2005 | 5593 | 168.1 | 3350 | 100.6 |
| Jordan | 2008 | 42151* [2223**] | 1952** | 927 | 154.2 |
| Kuwait | 2013 | 158* [634**] | 166** | 577 | 160.5 |
| Lebanon | No Data | 13316* [565**] | 178** | .. | .. |
| Oman | 2013 | 497.244 | 127.2 | 192 | 49.1 |
| Iraq | 2014 | 2394 | 67.8 | 867 | 24.5 |
| Qatar | 2012 | 1203.45 | 596.9 | 161 | 79.8 |
| Sudan | 2005 | 12615* | 394.3* | 2002 | 62.5 |
| Libya | No Data | 390* | 61* | .. | .. |
| Bahrain | 2014 | 493 | 361.9 | 138 | 101.3 |

* 2005 figures for Head Counts (HC) of general research. ** 2008 figures for FTE of general researchers.
Figures are adapted from UNESCO UIS database unless stated otherwise. * and ** figures adapted from Hanafi et al. 2013. Researchers per million people for general research and natural sciences research (only available data shown).

collaboration and co-operation through regional and international means and interdisciplinary collaboration in order to improve economic value within the private and public sectors. However, according to UNESCO, the Arab world has so far only been involved in research and development (Boumedjout, 2010), and has not integrated the business community to improve or introduce value products or services through industry and other sectors.

Currently, the Arab world is actively exporting highly qualified professionals through a lack of strategic development reforms in higher education (Hanafi et al., 2013). Of Egypt's 270 thousand expatriates, 51 percent are highly skilled; the same is true for Jordan (49 percent), Kuwait (44 percent), Libya (43 percent), Palestine (43 percent), Qatar (43 percent), Sudan (40 percent), and Bahrain (40 percent), as well as many others (Hanafi et al., 2013). According to Zahlan (2004), 45 percent of Arab students who study abroad never return. These account for 50 percent of doctors, 23 percent of engineers and 15 percent of scientists in Arab countries. Mrad (2011) claims that 80 percent of Arab doctorate holders who are unable to connect with the local economy, emigrate. This export of intellectual capital has helped improve the west's development and has hindered the Arab states'. It has been termed the "Arab scientific diaspora" by Hanafi et al.

The strategy must also take into account local problems and research that can impact those local issues. It must also publicize and attract people to the research that took place, in order to inspire more people to be advocates for science and their local community, or any pertinent environmental issues. Publications and publication houses that operate in Arabic are important in enhancing the general public's exposure to science. They also alleviate the language barrier required to understand high-level scientific research, and allow a larger audience to access environmental research at large.

Educational reforms are important factors to improve science technology and innovation. Talking about educational reforms, Pasher and

FIGURE 3 **THE HISTORICAL CONTRIBUTIONS OF ARAB STATES FROM 1996 TO 2015 SHOWING THE CUMULATIVE ENVIRONMENTAL RESEARCH EFFORTS OF THE ARAB WORLD**

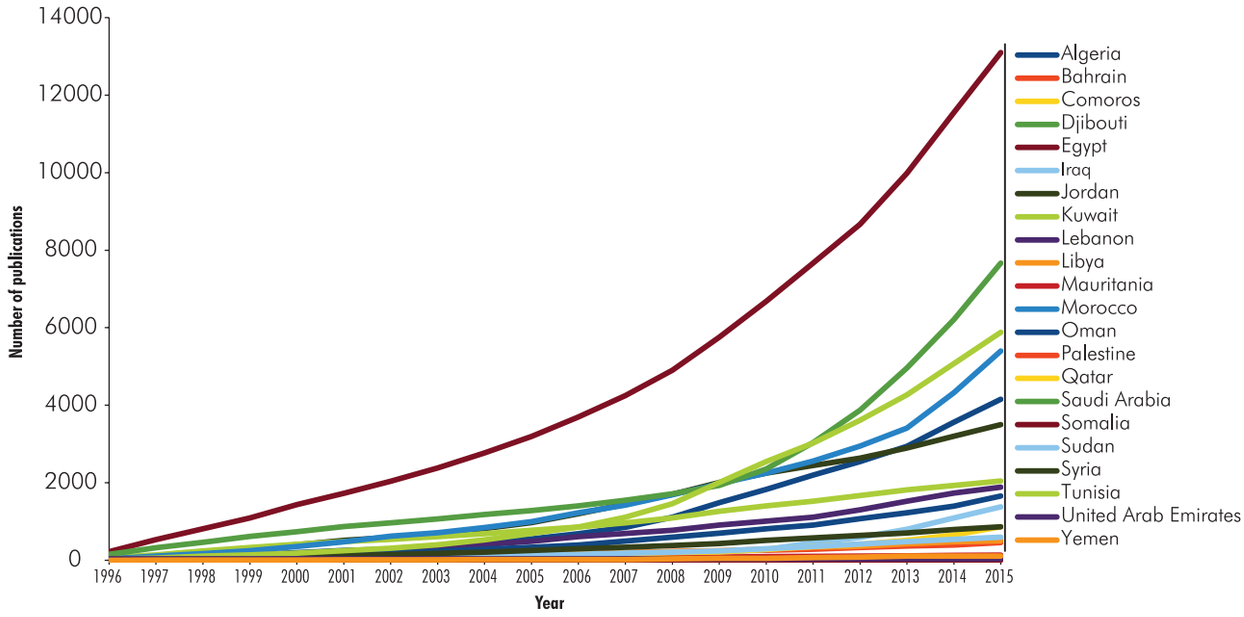



FIGURE 4 **ENVIRONMENTAL RESEARCH IN THE ARAB WORLD SHOWING THE NUMBER OF PUBLICATIONS BETWEEN 1996 AND 2015**

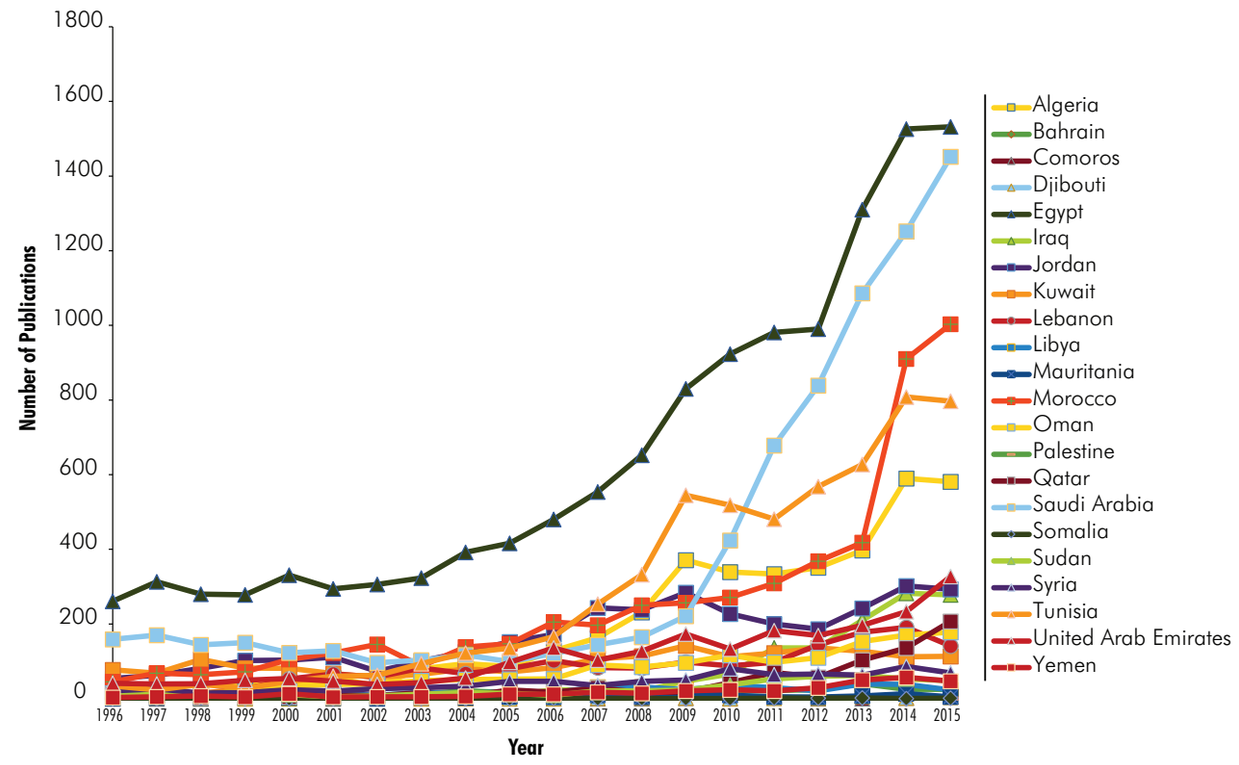


FIGURE 5 **HEALTH AND POLLUTION PUBLICATIONS IN THE ARAB WORLD**

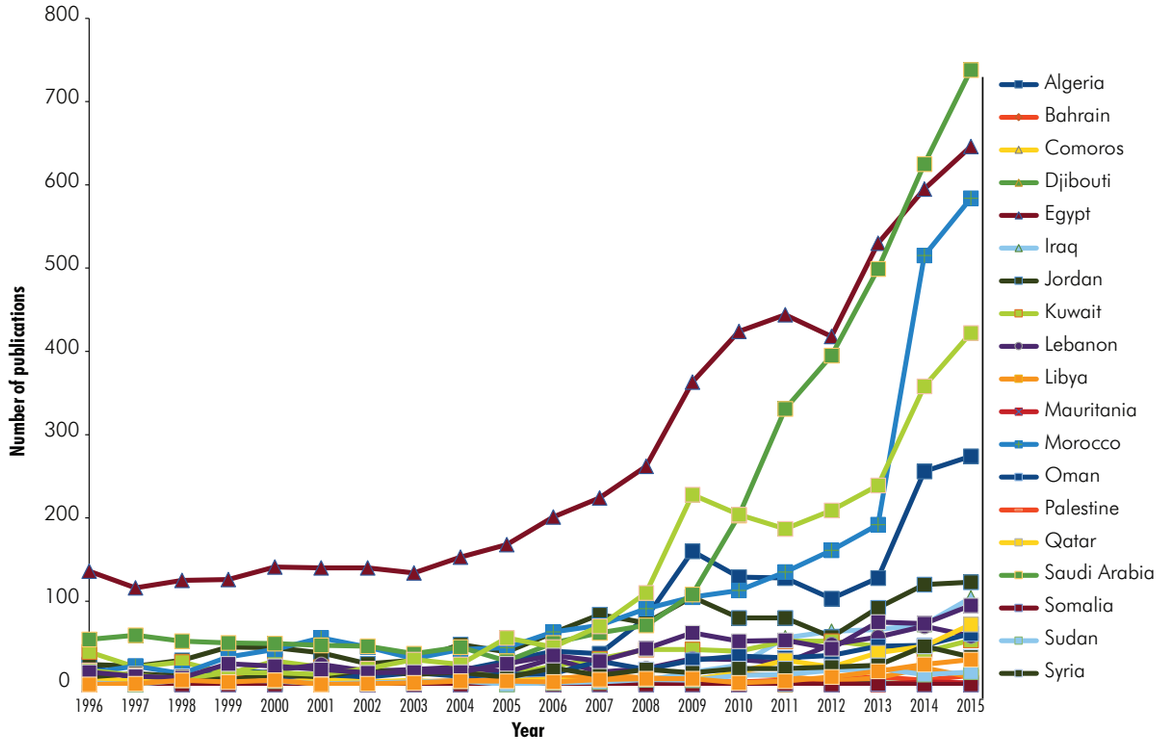



FIGURE 6 **GENERAL AND MISCELLANEOUS ENVIRONMENTAL RESEARCH IN THE ARAB WORLD BETWEEN 1996 AND 2015**

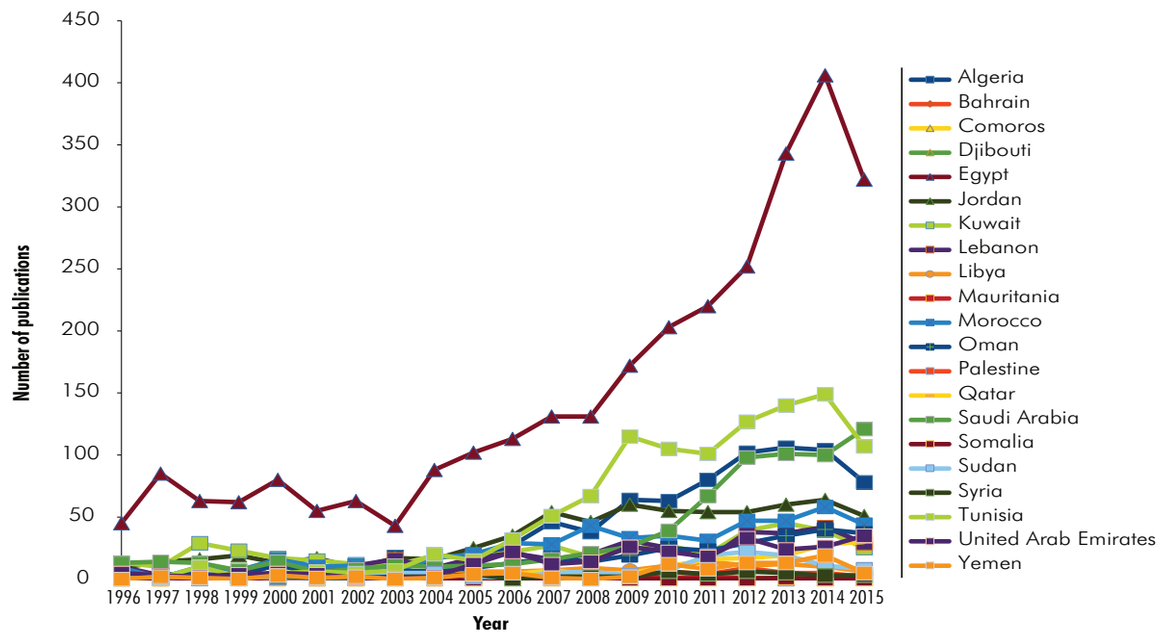


FIGURE 7 WATER SCIENCE AND TECHNOLOGY RESEARCH IN THE ARAB WORLD BETWEEN 1996 AND 2015

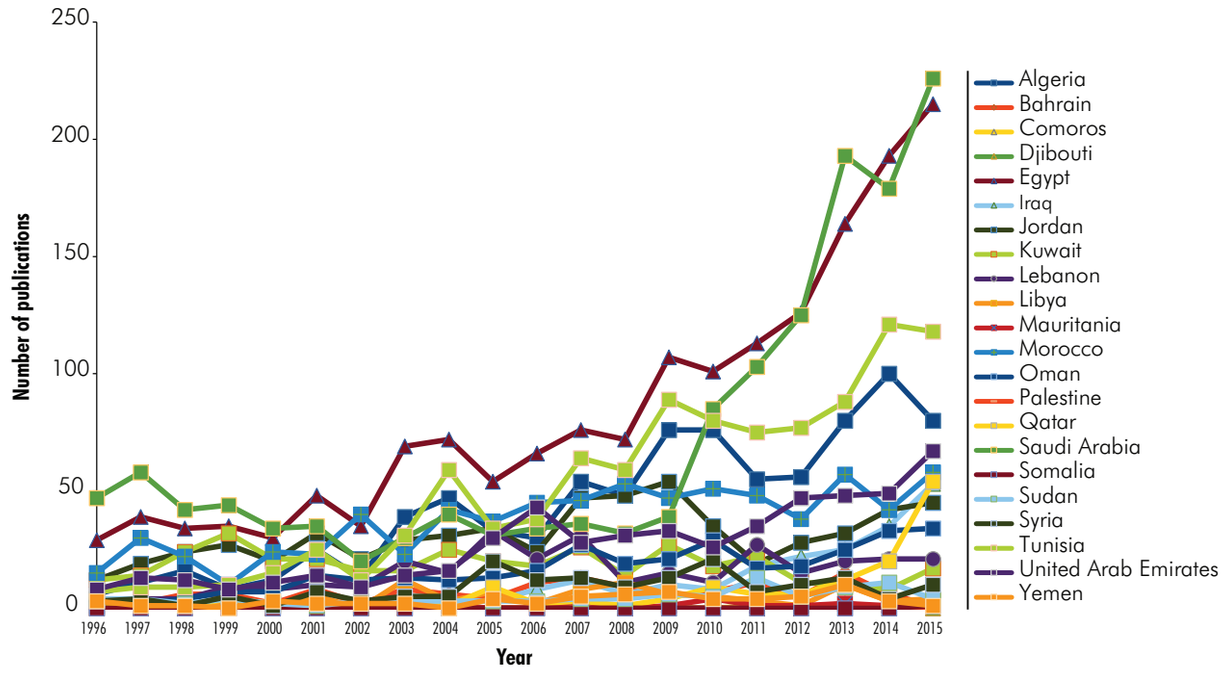



FIGURE 8 ANNUAL PUBLICATION OF GLOBAL AND PLANETARY CHANGE IN THE ARAB WORLD BETWEEN 1996 AND 2015

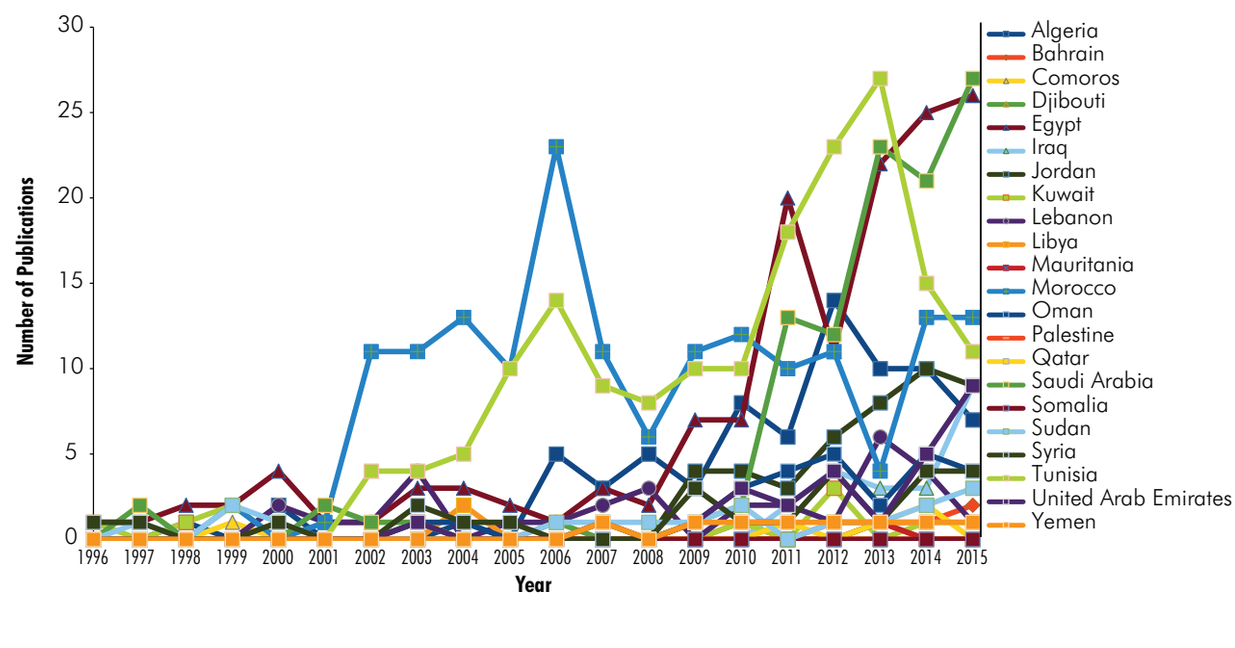
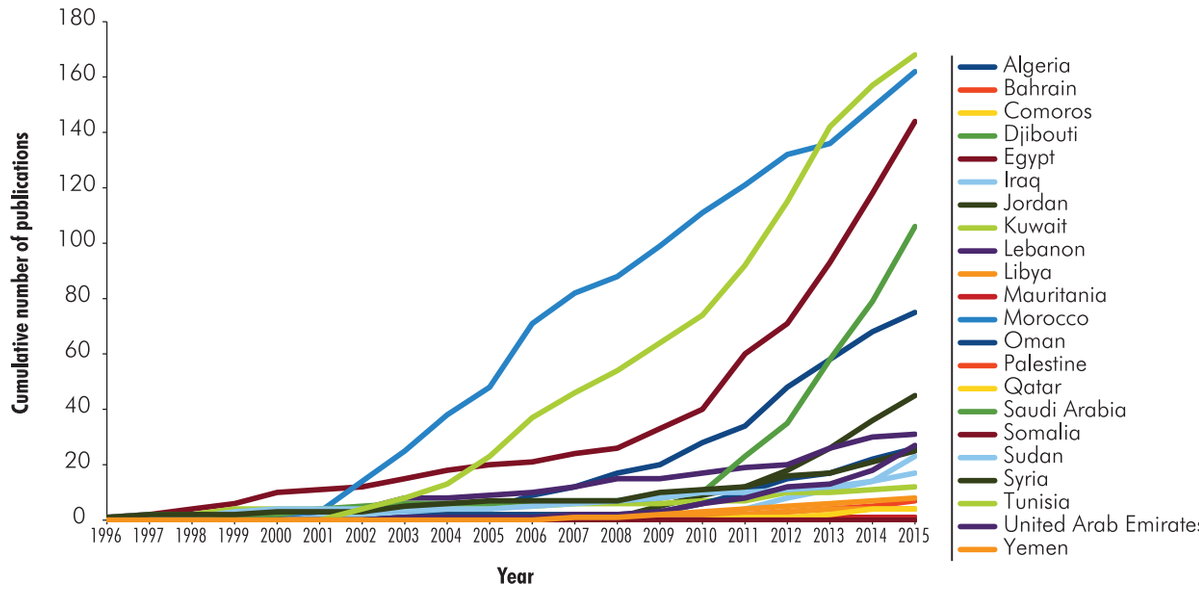


FIGURE 9 **HISTORICAL PUBLICATION OF GLOBAL AND PLANETARY CHANGE RESEARCH IN THE ARAB WORLD BETWEEN 1996 AND 2015**




Shachar (1999) state that reforms were enforced to give freedom of expression between students and teaching staff to guarantee both better communication, as well as a balanced exposure to new ideas and innovations.

Matching university curricula to market needs is another way of improving the current situation. There must also be a distinction between teaching and research bodies, which train basic needs, in contrast with places that inspire innovations in science and technology. A complete cycle where basic research feeds into applied research funded and partially derived by industrial and economic needs is necessary before any traction in the sector can take place.

## *B. Centers of Excellence*

The establishment of home institutes that are local centers of excellence is important in furthering scientific research and innovation. Egypt's National Research Centre, Saudi Arabia's King Abdullah University of Science and Technology (KAUST) and King Abdulaziz City for Science and Technology are just three leading research efforts in a number of scientific disciplines. These current centers of excellence amongst others are required to continually challenge local centers. Funding for such bodies is important since it helps in attracting competent local and international talent. As an example, KAUST attracts the majority of its faculty from leading foreign universities, effectively importing expertise, and helping train regional players.

The importance of a center of excellence is not only for the training of professionals, but also as an established central hub within an infrastructure that links industry, higher education and society. Government and social support are necessary to start a chain reaction of innovation that can lead to higher levels of compelling research and international acclaim. A lasting legacy of scientific prowess is necessary to maintain and ensure the usefulness of a center of excellence. Another important role played by these institutes is improving exposure to new ideas and innovations through the regular hosting of international and regional specialized conferences. According to Bontis (2004), Egypt hosts more conferences than the remainder of the Arab countries combined, followed by Morocco and Tunisia. However, the entire Arab region only participated in 1 percent of the 18,000 global conferences, whilst hosting only 50 of them in 1995 (Zahlan, 2004). Thus,

enhancing the participation of Arab research scientists and established scientific bodies in international conferences should also be pursued.

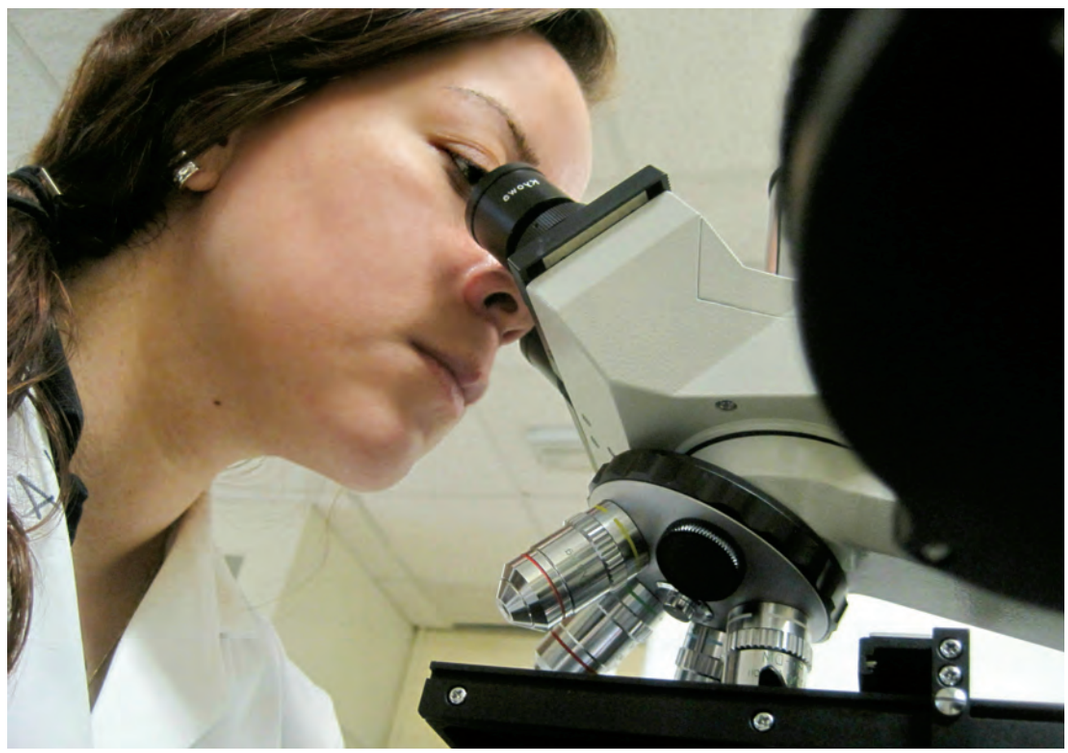
### C. Financing Challenges and the Industrial Sector

Financing is an important factor for the improvement and maintenance of scientific research. Hanafi et al. state that expenditure on research in higher education is significantly skewed in the Arab world. They draw attention to both government expenditure on higher education and the amount of money spent per student to produce a researcher. In 2007, Egypt reportedly spent USD 757 per student in higher education, with nearly 9,202 PhD students enrolled. In contrast, Saudi Arabia's 1,862 students (PhD and undergraduates) spent USD 8,186 per student. Similarly, Tunisia spent 6.45 percent of the government budget on research in higher education, spending USD 1,948 per student (Hanafi et al., 2013). When comparing the number and citations of articles produced, these figures show some correlation.

The most recent UNESCO figures for gross domestic expenditure on research and development (GERD) indicates a rise in the past ten years, with a few exceptions (where GERD stayed constant or decreased slightly such as in Iraq, Algeria, and the Gulf states, which spend more money but less of their GDP on R&D). In all Arab countries, GERD is less than 1 percent of the gross domestic product (GDP) whereas the average GERD in the US was 2.7 percent (in 2013), 1.7 percent in the UK (in 2014), and 4 percent in Israel (in 2014) (UNESCO UIS, 2017). Egypt currently leads the Arab nations in this area, spending 0.67 percent of its GDP on research and development. Percentages of GERD spent on natural sciences were comparable to those worldwide, with no significant differences. According to Hanafi et al. (2013) the industrial sector is currently disconnected from education and research, with only 2.9 percent of research sources coming from the private sector.

### D. Databases and Electronic Resources

The digitization of Arabic and international journals and university-produced documents such as PhD theses should become standardized



in order to allow for the wider distribution of research work. Current Arabic literature should be made more available for more ubiquitous internal consumption, and a focus on improving current Arab publications in international journals should take place. According to the UNESCO Science Report, the Egyptian Academy of Scientific Research and Technology have increased peer reviewed publications by 200 percent in 5 years (since 2000) by establishing a checklist of criteria that articles should meet to be accepted for publication internationally (UNESCO et al., 2015). Similar steps should be taken across the Arab scientific community, for both local and international publications. Open source material should also be considered, since it would have larger impacts such as boosting entrepreneurship, increasing collaboration and allowing for a much wider distribution of material to audiences, and would generally improve both the impact and quantity of articles that can be referenced and indexed.

In conclusion, improvement of research in general science and specifically environmental science in the Arab world has huge potential. Presented in this chapter are the current research trends and impact Arab scholars have on the Arab states, and the world at large. Arab scholars remain a force for change, as they have been historically. Scholars such as Ibn Al Haitham, Ibn Fernas, and Ibn Khaldoun are all examples of Arab scholars who impacted the modern world. More recently Ahmed Zewail, Farouk El Baz and Mohamed El Kassas amongst many others are paving the way to a better world despite the problems the world is witnessing. Significant progress is being made by Egypt, Saudi Arabia, Morocco, Tunisia, and Algeria despite local challenges in their respective regions.

Improvements of current infrastructure and innovation in the creation of new mechanisms that foster collaboration between different Arab countries, involve the private sector and industry, and connect with society are required to further this progress. Political and socio-economic goals must be aligned for productive cooperation to take place. Significant improvement of publication production both on the research front as well as on the journal publishing houses front is necessary for Arab nations to be able to compete with the international scientific community. Brain-drain reversal and better concessions for highly skilled researchers must be made in order to foster local researchers and re-attract lost local talent. Digitization of documents and indexing through an internationally recognized body, or the establishment of internationally recognized online indexers for Arabic documentation, will help improve publication impact and dispersal. Establishing centers of excellence that are acclaimed both regionally and internationally to allow the exchange of ideas and dissemination of knowledge is also needed.

Economic growth is essential for local research funding. It must be seen as a closed circle, with specific goals and outcomes in mind that link research to society and to industry. Researchers should be viewed as a commodity that will produce an intellectual capital that is part of the GDP. Researchers must therefore be afforded more funding, concessions, and exposure to modern techniques and training through travel, or through local centers of excellence, with the prospect of returning to the region, in order to contribute to its growth and revive scientific historical pride in higher education systems.

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## NOTES

1. 57 percent of the world's proven oil reserves and 28 percent of natural gas exist in the Arab world (Arab Fund for Economic and Social Development, Arab Monetary Fund, League of Arab States, & Organization of Arab Petroleum Exporting Countries, 2013).

2. Restricted to European countries within the top 10 ranking only.

3. Ranked within the top 10 researchers of environmental research.

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| 10YFP | Ten Year Framework of Programmes on Sustainable Consumption and Production |
| AAAID | Arab Authority for Agricultural Investment and Development |
| ABSP | Agricultural Biotechnology Support Programme |
| AC | Air-Conditioning |
| AC | Alternating Current |
| ACSAD | Arabic Centre for the Studies of Arid Zones and Drylands |
| ACU | Arab Custom Union |
| ADA | Arriyadh Development Authority (Riyadh) |
| ADCO | Abu Dhabi Company for Onshore Oil Operations |
| ADEREE | The National Agency for Energy Efficiency and the Development of Renewable Energy |
| ADFD | Abu Dhabi Fund for Development |
| ADR | Alternative Disputes Resolution |
| ADSG | Abu Dhabi Sustainability Group |
| ADWEA | Abu Dhabi Water & Electricity Authority |
| AED | United Arab Emirates Dirham |
| AEPC | African Environmental Protection Commission |
| AEPS | Arctic Environmental Protection Strategy |
| AEWA | African-Eurasian Waterbird Agreement |
| AFED | Arab Forum for Environment and Development |
| AFESD | Arab Fund for Economic and Social Development |
| AG | Associated Gas |
| AGDP | Agricultural Gross Domestic Product |
| AGERI | Agricultural Genetic Engineering Institute |
| AGP | Arab Gas Pipeline |
| AGU | Arabian Gulf University |
| AHD | Aswan High Dam |
| AHDR | Arab Human Development Report |
| AIA | Advance Informed Agreement |
| AIDS | Acquired Immunodeficiency Syndrome |
| AIECGC | Arab Investment and Export Credit Guarantee Corporation |
| AKTC | Aga Khan Trust for Culture |
| Al | Aluminum |
| ALBA | Aluminium Bahrain |
| ALECSO | Arab League Educational, Cultural, and Scientific Organization |
| ALMEE | Lebanese Association for Energy Saving & Environment |
| ALOA | Association for Lebanese Organic Agriculture |
| AMCEN | African Ministerial Conference on the Environment |
| AMF | Arab Monetary Fund |
| AMU | Arab Maghreb Union |
| ANME | National Agency for Energy Management |
| AoA | Agreement on Agriculture (WTO Uruguay Round) |
| AOAD | Arab Organization for Agricultural Development |
| AP | Advanced Passive reactor |
| AP | Additional Protocol |
| API | Arab Planning Institute |
| APR | Advanced Power Reactor |
| APRUE | National Agency for the Promotion and Rationalization of Use of Energy |
| AREE | Aqaba Residence Energy Efficiency |
| ARWR | Actual Renewable Water Resources |
| ASABE | American Society of Agricultural and Biological Engineers |
| ASDRR | Arab Strategy for Disaster Risk Reduction |
| ASFSD | Arab Strategic Framework for Sustainable Development |
| ASR | Aquifer Storage and Recovery |
| AU | African Union |
| AUB | American University of Beirut |
| AUM | American University of Madaba (Jordan) |
| AVL | Automatic Vehicle Location |
| AWA | Arab Water Academy |
| AWC | Arab Water Council |
| AWCUA | Arab Water Countries Utilities Association |
| b/d | Barrels per Day |
| BADEA | Arab Bank for Economic Development in Africa |
| BAU | Business as Usual |
| Bbl | Oil Barrel |
| BCH | Biosafety Clearing House |
| Bcm | Billion cubic meters |
| BCWUA | Branch Canal Water User Association |
| BDB | Beyond Design Basis |
| BDL | Central Bank of Lebanon |
| BGR | German Geological Survey |
| BMP | Best Management Practices |
| BMZ | German Federal Ministry of Economic Cooperation and Development |
| BNEF | Bloomberg New Energy Finance |
| BOD | Biological Oxygen Demand |
| boe | Barrels of Oil Equivalent |
| BOO | Build-Own-Operate |
| BOOT | Build Own Operate Transfer |
| BOT | Build Operate Transfer |
| BP | British Petroleum |

| | |
|---|---|
| BREEAM | Building Research Establishment Environmental Assessment Method |
| BRO | Brackish Water Reverse Osmosis |
| BRS | ARZ Building Rating System |
| BSI | Biome Solar Industry |
| BU | Boston University |
| C&D | Construction and Demolition |
| C&I | Commercial and Industrial |
| CA | Conservation Agriculture |
| CAB | Centre for Agriculture and Biosciences |
| CAGR | Compound Annual Growth Rate |
| CAIP | Cairo Air Improvement Project |
| CAMP | Coastal Area Management Project |
| CAMRE | Council of Arab Ministers Responsible for the Environment |
| CAN | Competent National Authority |
| CAPEX | Capital Expenditures |
| CBC | Community-Based Conservation |
| CBD | Convention on Biological Diversity |
| CBO | Community-Based Organization |
| CBSE | Center for the Study of the Built Environment (Jordan) |
| CCA | Climate Change Adaptation |
| CCAP | Climate Change Action Plan |
| CCGT | Combined Cycle Gas Turbine |
| CCS | Carbon Capture and Sequestration |
| CCS | Carbon Capture and Storage |
| CCS $CO_2$ | Capture and Storage |
| CCUS | Carbon Capture, Usage and Storage |
| CD | Compact Disk |
| CDM | Clean Development Mechanism |
| CDRs | Certified Emissions Reductions |
| CEDARE | Centre for Environment and Development for the Arab Region and Europe |
| CEDRO | Country Energy Efficiency and Renewable Energy Demonstration Project for the Recovery of Lebanon |
| CEIT | Countries with Economies in Transition |
| CEO | Chief Executive Officer |
| CEP | Coefficient of Performance |
| CERES | Coalition for Environmentally Responsible Economics |
| CERs | Credits |
| CFA | Cooperative Framework Agreement |
| CFC | Chloro-Fluoro-Carbon |
| CFL | Compact Fluorescent Light |
| CFL | Compact Fluorescent Lamp |
| CG | Coordination Groups |
| CGE | Computable General Equilibrium |
| CGIAR | Consultative Group on International Agricultural Research |
| CH4 | Methane |
| CHN | Centre Hospitalier du Nord -Lebanon |
| CHP | Combined Heat and Power |
| CILSS | Permanent Interstate Committee for Drought Control in the Sahel |
| CIRAD | Agricultural Research for Development |
| CITES | Convention on International Trade in Endangered Species of Wild Fauna and Flora |
| CIWM | Chartered Institution of Wastes Management |
| CIHEAM | International Centre for Advanced Mediterranean Agronomic Studies |
| CLO | Compost-Like-Output |
| CLRTAP | Convention on Long-Range Transboundary Air Pollution |
| CM | Carbon Management |
| CMI | Community Marketing, Inc. |
| CMS | Convention on the Conservation of Migratory Species of Wild Animals |
| CNA | Competent National Authority |
| CNCA | Public Agricultural Bank |
| CNG (CNS) | Compressed Natural Gas |
| CO | Carbon Monoxide |
| $CO_2$ | Carbon Dioxide |
| $CO_{2e/eq}$ | $CO_2$ equivalent |
| COD | Chemical Oxygen Demand |
| COP | Conference of the Parties |
| CPB | Cartagena Protocol on Biosafety |
| CPC | Calcined Petroleum Coke |
| CRS | Center for Remote Sensing |
| CSA | City Strategic Agenda |
| CSD | UN Commission on Sustainable Development |
| CSEM | Centre Suisse d'Electronique et de Microtechnique |
| CSO | Civil society organizations |
| CSP | Concentrated Solar Power |
| CSR | Corporate Social Responsibility |
| CTAB | Technical Center of Organic Agriculture |
| cum | Cubic meters |
| CZIMP | Coastal Zone Integrated Management Plan |
| DAC | Development Assistance Committee |
| DALYs | Disability-Adjusted Life Years |
| DBFO | Design Build Finance Operate |
| DBO | Design-Build-Operate |
| DC | Direct current |
| DED | Dubai Economic Department |
| DEFRA | Department for Environment, Food and Rural Affairs (UK) |
| DEM | Digital Elevation Model |
| DESA | Department of Economic and Social Affairs |
| DEWA | Dubai Electricity and Water Authority |
| DFID | UK Department for International Development |
| DHW | Domestic Hot Water |
| DII | DESERTEC Industrial Initiative |
| DMN | Moroccan National Meteorological Office |
| DNE | Daily News Egypt |
| DOE | United States Department of Energy |
| DRM | Disaster Risk Management |
| DRR | Disaster Risk Reduction |
| DSIRE | Database of State Incentives for Renewables & Efficiency |
| DTC | Dubai Transport Corporation |
| DTCM | Dubai Department for Tourism and Commerce Marketing |
| DTIE | UNEP Division of Technology, Industry, and Economics |

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|---|---|
| DTO | Dublin Transportation Office |
| DUBAL | Dubai Aluminum Company Limited |
| E3G | Third Generation Environmentalism |
| EAD | Environment Agency AbuDhabi |
| ECA | Economic Commission for Africa |
| ECAs | Energy Conversion Agreements |
| ECE | Economic Commission for Europe |
| ED | Electrodialysis |
| EDCO | Electricity Distribution Company |
| EDF | Environmental Defense Fund |
| EDL | Electricité du Liban |
| EDM | Al- BiaWal-Tanmia - Environment & Development magazine |
| EE | Energy Efficiency |
| EEAA | Egyptian Environmental Affairs Agency |
| EEHC | Egyptian Electricity Holding Company |
| EF | Ecological Footprint |
| EGBC | Egyptian Green Building Council |
| EGPC | Egyptian General Petroleum Corporation |
| EGS | Environmental Goods and Services |
| EIA | Energy Information Administration |
| EIA | Environmental Impact Assessment |
| EITI | Extractive Industries Transparency Initiative |
| EIU | Economist Intelligence Unit |
| EJ | Electro Joules |
| EMA | Europe, the Middle East, and Africa |
| EMAL | Emirates Aluminium Company Limited |
| EMAS | Eco-Management and Audit Scheme |
| EMR | Eastern Mediterranean Region |
| EMRO | WHO Regional Office for the Eastern Mediterranean |
| EMS | Environmental Management System |
| ENEC | Emirates Nuclear Energy Corporation |
| ENPI | European Neighborhood and Partnership Instrument |
| ENSO | El Niño-Southern Oscillation |
| EOR | Enhanced Oil Recovery |
| EPA | US Environmental Protection Agency |
| EPC | Engineering Procurement and Construction |
| EPD | European Patent Office |
| EPDRB | Environmental Program for the Danube River Basin |
| EPI | Environment Performance Index |
| EPSA | Exploration and Production Sharing Agreement |
| ESAUN | Department of Economic and Social Affairs |
| ESBM | Ecosystem-Based Management |
| ESCO | Energy Service Companies |
| ESCOs | Energy Service Companies |
| ESCWA | United Nations Economic and Social Commission for Western Asia |
| ESDU | Environment and Sustainable Development Unit |
| ESI | Environment Sustainability Index |
| ESMAP | World Bank Energy Sector Management Assistance Program |
| ETM | Enhanced Thematic Mapper |
| EU | European Union |
| EU ETS | European Union Emission Trading System |
| EVI | Environmental Vulnerability Index |
| EWRA | Egyptian Water Regulatory Agency |
| EWS | Emirates Wildlife Society |
| FACE | Free Air Carbon Enrichment |
| FANR | The Federal Authority for Nuclear Regulation (UAE) |
| FAO | Food and Agriculture Organization of the United Nations |
| FDI | Foreign Direct Investment |
| FEMIP | Facility for Euro-Mediterranean Investment and Partnership |
| FFEM | French Fund for Global Environment |
| FiBL | Research Institute of Organic Agriculture |
| FIFA | Fédération Internationale de Football Association |
| FIT | Feed-in-Tariff |
| FL&W | Food Lost and Wasted |
| FOEME | Friends of the Earth Middle East |
| FSP | Food Security Program |
| FSU | Former Soviet Union |
| F-T | Fischer-Tropsch process |
| FTE | Full Time Equivalent |
| FTIAB | Packaging and Newspaper Collection Service (Sweden) |
| G7 | Group of Seven: Canada, France, Germany, Italy, Japan, United Kingdom, United States |
| G8 | Group of Eight: Canada, France, Germany, Italy, Japan, Russian Federation,United Kingdom, United States |
| GAM | Greater Amman Municipality |
| GAP | Good Agricultural Practices |
| GAPs | Good Agricultural Practices |
| GAS | Guarani Aquifer System |
| GATT | General Agreement on Tariffs and Trade |
| GBC | Green Building Council |
| GBIF | Global Biodiversity Information Facility |
| GCC | Gulf Cooperation Council |
| GCF | Green Climate Fund |
| GCM | General Circulation Model |
| GCOS | Global Climate Observing System |
| GDP | Gross Domestic Product |
| GE | General Electric |
| GECF | Gas Exporting Countries Forum |
| GEF | Global Environment Facility |
| GEMS | Global Environment Monitoring System |
| GEO | Global Environment Outlook |
| GERD | Gross Domestic Expenditure on Research and Development |
| GFEI | Global Fuel Economy Initiative |
| GFU | Global Facilitation Unit for Underutilized Species |
| GGGI | Global Green Growth Institute |
| Gha | Global hectare |
| GHGs | Greenhouse Gases |
| GIPB | Global Partnership Initiative for Plant Breeding Capacity Building |
| GIS | Geographical Information Systems |
| GIWA | Global International Waters Assessment |
| GJ | GigaJoule |
| GLASOD | Global Assessment of Soil Degradation |
| GLCA | Global Leadership for Climate Action |
| GM | Genetically Modified |
| GME | Gazoduc Maghreb Europe |

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|---|---|
| GMEF | Global Ministerial Environment Forum |
| GMO | Genetically Modified Organism |
| GMP | Green Moroccan Plan |
| GNI | Gross National Income |
| GNP | Gross National Product |
| GPC | Green petroleum Coke |
| GPS | Global Positioning System |
| GPRS | Green Pyramid Rating System |
| GRI | Global Reporting Initiative |
| GRID | Global Resource Information Database |
| GSDP | General Secretariat for Development planning-Qatar |
| GSI IISD | Global Subsidies Initiative |
| GSLAS | General Secretariat of League of Arab States |
| GSR | Global Status Report |
| Gt | Gigaton |
| GTZ | German Technical Cooperation (Gesellschaft für Technische Zusamm) |
| GVC | Civil Volunteers' Group (Italy) |
| GW | Gigawatt |
| GW | Greywater |
| $GW_e$ | Gigawatt electrical |
| GWI | Global Water Intelligence |
| GWP | Global Warming Potential |
| GWP | Global Water Partnership |
| $GW_{th}$ | Gigawatt-thermal |
| ha | Hectares |
| HACCP | Hazardous Analysis and Critical Control Points |
| HDI | Human Development Index |
| HFA | Hyogo Framework for Action |
| HFCs | Hydrofluorocarbons |
| HFO | Heavy Fuel Oil |
| HICs | High-Income Countries |
| HIV | Human Immunodeficiency Virus |
| HLW | High Level Waste |
| HNWI | High Net Worth Individuals |
| HVAC | Heating, Ventilation, and Air-Conditioning |
| I/M | Inspection and Maintenance |
| IAASTD | International Assessment of Agricultural Knowledge Science and Technology for Development |
| IAEA | International Atomic Energy Agency |
| IAS | Irrigation Advisory Service |
| IC | Irrigation Council |
| ICAM | Integrated Coastal Area Management |
| ICARDA | International Center for Agricultural Research in Dry Areas |
| ICBA | International Center for Biosaline Agriculture |
| ICC | International Chamber of Commerce |
| ICGEB | International Center for Genetic Engineering and Biotechnology |
| ICLDC | Imperial College London Diabetes Centre |
| ICM | Integrated Coastal Management |
| ICPDR | International Commission for the Protection of the Danube River |
| ICT | Information and Communication Technology |
| ICZM | Integrated Coastal Zone Management |
| IDA | International Desalination Association |
| IDB | Islamic Development Bank |
| IDECO | Irbid District Electricity Company |
| IDP | Internally Displaced Persons |
| IDRC | International Development Research Center |
| IDSC | Information and Decision Support Center |
| IEA | International Energy Agency |
| IEADSM | International Energy Agency Demand-side Management |
| IEEE | Institute of Electrical and Electronic Engineers |
| IFA | International Fertilizer Industry Association |
| IFAD | International Fund for Agricultural Development |
| IFC | International Finance Corporation |
| IFOAM | International Federation of Organic Agriculture Movements |
| IFPRI | International Food Policy Research Institute |
| IGCC | Integrated Gasifier Combined Cycle |
| IHP | International Hydrology Program |
| IIED | International Institute for Environment and Development |
| IIIEE | Lund University International Institute for Industrial Environmental Economics |
| IIIP | Integrated Irrigation Improvement Project |
| IIP | Irrigation Improvement Project |
| IISD | International Institute for Sustainable Development |
| ILO | International Labour Organization |
| ILW | Intermediate Level waste |
| IMC | Istituto Mediterraneo Di Certificazione |
| IMF | International Monetary Fund |
| IMO | International Maritime Organization |
| INDC | Intended Nationally Determined Contributions |
| InWEnt | Capacity Building International-Germany |
| IO | Input-Output |
| IOC | International Oil Companies |
| IPCC | Intergovernmental Panel on Climate Change |
| IPF | Intergovernmental Panel on Forests |
| IPM | Integrated Pest Management |
| IPNS | Integrated Plant Nutrient System |
| IPP | Independent Power Producer |
| IPR | Intellectual Property Rights |
| IPTRID | International Program for Technology and Research in Irrigation and Drainage |
| IRENA | International Renewable Energy Agency |
| IRESEN | Institut de Recherche en Energie Solaire et en Energies Nouvelles |
| IRR | Internal Rate Of Return |
| ISCC | Integrated Solar Combined Cycle |
| ISESCO | Islamic Educational, Scientific, and Cultural Organization |
| ISIC | UN International Standard Industrial Classification |
| ISO | International Organization for Standardization |
| ISWM | Integrated Solid Waste Management |
| ITC | Integrated Tourism Centers |
| ITC | International Trade Center |
| ITSAM | Integrated Transport System in the Arab Mashreq |
| IUCN | International Union for Conservation of Nature |
| IUCN | World Conservation Union (International Union for the Conservation of Nature and Natural Resources) |
| IWMI | International Water Management Institute |

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|---|---|
| IWPP | Independent Water And Power Producer |
| IWRB | International Waterfowl and Wetlands Research Bureau |
| IWRM | Integrated Water Resources Management |
| JAEC | Jordan Atomic Energy Commission |
| JBAW | Jordan Business Alliance on Water |
| JCEDARE | Joint Committee on Environment and Development in the Arab Region |
| JD | Jordanian Dinar |
| JEPCO | Jordan Electric Power Company |
| JI | Joint Implementation |
| JMWI | Jordan Ministry for Water and Irrigation |
| JNRC | Jordan Nuclear Regulatory Commission |
| JVA | Jordan Valley Authority |
| KA-CARE | King Abdullah City for Atomic and Renewable Energy |
| KACST | King Abdulaziz City for Science and Technology |
| KAHRAMAA | Qatar General Electricity and Water Corporation |
| KAUST | King Abdullah University of Science and Technology |
| KEPCO | Korea Electric Power Corporation |
| KFAED | Kuwait Fund for Arab Economic Development |
| KFUPM | King Fahd University of Petroleum and Minerals |
| KfW | German Development Bank |
| KISR | Kuwait Institute for Scientific Research |
| KSA | Kingdom of Saudi Arabia |
| KW | Kilowatt |
| kWh | Kilowatt-hour |
| LADA | Land Degradation Assessment of Drylands |
| LAS | League of Arab States |
| LATA | Lebanese Appropriate Technology Association |
| LAU | Lebanese American University |
| LBNL | Lawrence Berkeley National Laboratory |
| LCC | Life Cycle Costing |
| LCEC | Lebanese Center for Energy Conservation |
| LCOE | Levelized Costs of Electricity |
| LDCs | Least Developed Countries |
| LED | Light-Emitted Diode |
| LEED | Leadership in Environmental Design |
| LEMA | Suez Lyonnaise des Eaux, Montgomery Watson and Arabtech Jardaneh |
| LEU | Low-enriched Uranium |
| LGBC | Lebanon Green Building Council |
| LICs | Low-Income Countries |
| LLW | Low Level Waste |
| LMBAs | Land and Marine Based Activities |
| LMEs | Large Marine Ecosystems |
| LMG | Like Minded Group |
| LMICs | Low Middle-Income Countries |
| LMO | Living Modified Organism |
| LNG | Liquefied Natural Gas |
| LowCVP | Low Carbon Vehicle Partnership |
| LPG | Liquefied Petroleum Gas |
| LRA | Litani River Authority |
| LV | Low Voltage |
| MAAR | Syrian Ministry of Agriculture and Agrarian Reform |
| MAD | Moroccan Dirham |
| MALR | Ministry of Agriculture and Land Reclamation |
| MAP | UNEP Mediterranean Action Plan |
| MARPOL | International Convention for the Prevention of Pollution from Ships |
| MASEN | Moroccan Agency for Solar Electricity |
| mb/d | million barrels per day |
| MBT | Mechanical-biological treatment |
| MCM | Million Cubic Meters |
| MD | Membrane Distillation |
| MDGs | Millennium Development Goals |
| MEA | Multilateral Environmental Agreement |
| MECTAT | Middle East Centre for the Transfer of Appropriate Technology |
| MED | Multiple-Effect Distillation |
| MED WWR WG | Mediterranean Wastewater Reuse Working Group |
| MED-ENEC | Energy Efficiency in the Construction Sector in the Mediterranean |
| MEES | Middle East Economic Survey |
| MEMAC | Marine Emergency Mutual Aid Centre |
| MENA | Middle East and North Africa |
| MEPS | Minimum Energy Performance Standards |
| METAP | UNEP Mediterranean Environmental Technical Assistance Program |
| MEW | Lebanese Ministry of Energy and Water |
| MGD | Million Gallon per Day |
| MHT | Mechanical Heat Treatment |
| MICE | Meetings, Incentives, Conferences, And Events |
| MICs | Middle-Income Countries |
| MIGA | Multilateral Investment Guarantee Agency |
| MJ | Mega Joule |
| MIST | Masdar Institute of Science and Technology |
| MMBTU | One Million British Thermal Units |
| MMCP | Making the Most of Commodities Programme |
| MNA | Multinational Approaches |
| MoCCE | Ministry of Climate Change and Environment |
| MOQ | Maersk Oil Qatar |
| MOU | Memorandum of Understanding |
| MOX | Mixed-Oxide |
| MPA | Marine Protected Area |
| MPAP | Multi-Stakeholder Policy Formulation and Action Planning |
| MPAR | Ministry of Planning and Administrative Reform |
| MSF | Multi-Stage Flash |
| MSF | Multi-Stakeholder Forum |
| MSP | Mediterranean Solar Plan |
| MSW | Municipal Solid Waste |
| Mt | Metric tons |
| MT | Million ton |
| Mt | Megatons |
| $MtCO_2$ | Million tons of $CO_2$ |
| Mtoe | Million tons of oil equivalent |
| MTPY | Metric Tons Per Year |
| MV | Medium Voltage |
| MW | Megawatt |
| $MW_h$ | Megawatt-hour |
| $MW_p$ | Megawatt-peak |
| MWRI | Ministry of Water Resources and Irrigation |
| $MW_{th}$ | Megawatt-thermal |
| MVR | Measurement, Reporting and Verification |

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|---|---|
| $N_2O$ | Nitrous Oxide |
| NAMA | Nationally Appropriate Mitigation Actions |
| NARI | National Agricultural Research Institutes |
| NARES | National Agricultural Research and Extension Systems |
| NASA | National Aeronautics and Space Administration |
| NBC | National Biosafety Committee |
| NBDF | Nile Basin Discourse Forum |
| NBF | National Biosafety Framework |
| NBI | Nile Basin Initiative |
| NBM | Nile Basin Management |
| NC | National Communication |
| NDC | Nationally Determined Contributions |
| NCSR | Lebanese National Council of Scientific Research |
| ND | Neighborhood Development |
| NDW | Moroccan National Drought Watch |
| NEA | Nuclear Energy Agency |
| NEAP | National Environmental Action Plan |
| NEEAP | National Energy Efficiency Action Plan |
| NEEP | National Energy Efficiency Program |
| NEEREA | National Energy Efficiency and Renewable Energy Action (Lebanon) |
| NERC | National Energy Research Centre |
| NF | Nano-Filtration |
| NFC | Nile Forecast Center |
| NFP | National Focal Point |
| NGCCs | Natural-Gas-Fired Combined Cycles |
| NGGP | National Green Growth Plan |
| NGO | Non-Governmental Organization |
| NGV | Natural Gas Vehicles |
| NGWA | Northern Governorates Water Authority (Jordan) |
| NIF | Neighborhood Investment Facility |
| NMC | Northern Mediterranean countries |
| NMVC | Non-Methane Volatile Compounds |
| NOAA | National Oceanic and Atmospheric Administration |
| NOC | National Oil Company |
| NOEC | Net Oil Exporting Countries |
| NOGA | National Oil and Gas Authority (Bahrain) |
| NOIC | Net Oil Importing Countries |
| NORDEN | Nordic Council of Ministers |
| NOx | Nitrogen Oxides |
| NPK | Nitrogen, Phosphates and Potash |
| NPP | Nuclear Power Plant |
| NPP | Net Primary Productivity |
| NPPA | Nuclear Power Plant Authority |
| NPT | Non-Proliferation treaty of nuclear weapons |
| NRC | National Research Council |
| NREL | National Renewable Energy Laboratory |
| NRW | Non-Revenue Water |
| NSAS | Nubian Sandstone Aquifer System |
| NSR | North-South Railway project |
| NUS | Neglected and underutilized species |
| NWRC | National Water Research Center (Egypt) |
| NWSAS | North Western Sahara Aquifer System |
| OA | Organic Agriculture |
| O&M | Operation and Maintenance |
| OAPEC | Organization of Arab Petroleum Exporting Countries |
| OAU | Organization for African Unity |
| ODA | Official Development Assistance |
| ODS | Ozone-Depleting Substance |
| OECD | Organization for Economic Co-operation and Development |
| OFID | OPEC Fund for International Development |
| OIES | Oxford Institute for Energy Studies |
| OME | Observatoire Méditerranéen de l'Energie |
| OMW | Olive Mills Wastewater |
| ONA | Omnium Nord-Africain |
| ONE | National Electricity Office |
| ONEP | National Office of Potable Water |
| OPEC | Organization of Petroleum Exporting Countries |
| OPEX | Operational Expenditures |
| OSS | Sahara and Sahel Observatory (Observatoire du Sahara et du Sahel) |
| OWG | Open Working Group |
| PACD | Plan of Action to Combat Desertification |
| PARC | Pan Arab Research Centre |
| PC | Personal Computer |
| PCB | Polychlorinated Biphenyls |
| PCFPI | Per Capita Food Production Index |
| PCFV | Partnership for Clean Fuels and Vehicles |
| PEA | Palestinian Energy and Natural Resources Authority |
| PERG | Global Rural Electrification Program |
| PERSGA | Protection of the Environment of the Red Sea and Gulf of Aden |
| PFCs | Perfluorocarbons |
| PICs | Pacific Island Countries |
| PIM | Participatory Irrigation Management |
| PJ | Peta Joule |
| PM | Particulate Matter |
| PMU | Program Management Unit |
| PNA | Palestinian National Authority |
| PNEEI | Tunisian National Program of Irrigation Water Conservation |
| POPs | Persistent Organic Pollutants |
| PPA | Power Purchase Agreement |
| PPIAF | Public-Private Infrastructure Advisory Facility |
| PPM | Parts Per Million |
| PPM | Process and Production Methods |
| PPP | Public-Private Partnership |
| PPP | Purchasing Power Parity |
| PPP | Public-Private Partnership |
| PRM | Persons with Reduced Mobility |
| PRY | Potential Researcher Year |
| PTSs | Persistent Toxic Substances |
| PV | Photovoltaic |
| PWA | Palestinian Water Authority |
| QNFSP | Qatar National Food Security Programme |
| QP | Qatar Petroleum |
| QSAS | Qatar Sustainable Assessment System |
| R&D | Research and Development |
| RA | Risk Assessment |
| RADEEMA | Régie autonome de distribution de l'eau et de l'électricité de Marrakech |
| RB | Raised Bed |
| RBO | River Basin Organization |
| RBP | Restrictive Business Practices |
| RCM | Regional Circulation Model |

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|---|---|
| RCREEE | Regional Center for Renewable Energy and Energy Efficiency |
| RDF | Refuse Derived Fuel |
| RE | Renewable Energy |
| REC | Renewable Energy Credits |
| REMPEC | Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea |
| REN21 | Renewable Energy Policy Network for the 21st Century |
| Rep | Republic |
| RISE | Regulatory Indicators for Sustainable Energy |
| RM | Risk Management |
| RO | Reverse Osmosis |
| ROPME | Regional Organization for the Protection of the Marine Environment of the sea area surrounded by Bahrain, I.R. Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates |
| RPS | Renewable Portfolio Standard |
| RSA | ROPME Sea Area |
| RSC | Royal Society of Chemistry (UK) |
| RSCN | Royal Society for the Conservation of Nature |
| RSGA | Red Sea and Gulf of Aden |
| RUAF | Resource Centers Network on Urban Agriculture and Food Security |
| S&T | Science and Technology |
| SAIC | Science Applications International Corporation |
| SAP | Strategic Action Program |
| SASO | Saudi Standards, Quality and Metrology Organization |
| SCP | Sustainable Consumption and Production |
| SCPI | Sustainable Crop Production Intensification |
| SCP/RAC | Regional Activity Centre for Sustainable Consumption and Production |
| SD | Sustainable Development |
| SDGs | Sustainable Development Goals |
| SDIAR | Sustainable Development Initiative in the Arab region |
| SEA | Strategic Environmental Assessment |
| SEEA | System of Environmental and Economic Accounting |
| SEEC | Saudi Energy Efficiency Cen |
| SEMC | Southern and Eastern Mediterranean Countries |
| SFD | Saudi Fund for Development |
| SHS | Solar Home System |
| SIR | Shuttle Imaging Radar |
| SIWI | Stockholm International Water Institute |
| SL | Syrian Pound |
| SLR | Sea Level Rise |
| SME | Small and Medium-Size Enterprises |
| SMS | Short Messaging Service |
| SoE | State of the Environment |
| SONEDE | Société Nationale d'Exploitation et de Distribution des Eaux |
| SOx | Sulfur Oxides |
| SPD | Sozialdemokratische Partei Deutschlands |
| SPM | Suspended Particulate Matter |
| SRES | Special Report on Emission Scenarios |
| SRTM | Shuttle Radar Topography Mission |
| SSA | Sub-Saharan Africa |
| SSR | Self-Sufficiency Ratio |
| STI | Science, Technology and Innovation |
| SWCC | Saline Water Conversion Corporation |
| SWH | Solar Water Heating |
| SWRO | Seawater Reverse Osmosis |
| T&D | Transmission and Distribution |
| TAC | Technical Advisory Committee |
| TAR | Third Assessment Report |
| Tcm | Trillion cubic meters |
| TDM | Transportation Demand Management |
| TDS | Total Dissolved Solids |
| TES | Thermal Energy Storage |
| TFP | Total Factor Productivity |
| TFEC | Total Final Energy Consumption |
| TIES | The International Ecotourism Society |
| TII | Thermal Insulation Implementation |
| Toe | Tons of Oil Equivalent |
| TPES | Total Primary Energy Supply |
| TRAFFIC | Trade Records Analysis for Flora and Fauna in International Commerce |
| TRI | Toxics Release Inventory |
| TRIPs | Trade-Related Aspects of International Property Rights |
| TRMM | Tropical Rainfall Measuring Mission |
| tU | tones of Uranium |
| TWh | Terawatt-hour |
| UA | Urban Agriculture |
| UAE | United Arab Emirates |
| UCLA | University of California at Los Angeles |
| UCS | Union of Concerned Scientists |
| UF | Ultrafiltration |
| UfM | Union for the Mediterranean |
| UHCPV | Ultra-High Concentration Photovoltaic |
| UHI | Urban Heat Island |
| UIS | UNESCO Institute for Statistics |
| UK | United Kingdom |
| UMA | Union du Maghreb Arabe (Arab Maghreb Union) |
| UMICs | Upper Middle-Income Countries |
| UN | United Nations |
| UNCBD | United Nations Convention on Biological Diversity |
| UNCCD | United Nations Convention to Combat Desertification |
| UNCED | United Nations Conference on Environment and Development |
| UNCHS | United Nations Centre for Human Settlements (now UN-Habitat) |
| UNCLOS | United Nations Convention on the Law of the Sea |
| UNCOD | United Nations Conference on Desertification |
| UNCTAD | United Nations Conference on Trade and Development |
| UNDAF | United Nations Development Assistance Framework |
| UNDP | United Nations Development Programme |
| UNEP | United Nations Environment Programme |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UNESCO-ROSTAS | UNESCO Regional Office for Science and Technology for the Arab States |

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|---|---|
| UNFCCC | United Nations Framework Convention on Climate Change |
| UNFPA | United Nations Population Fund |
| UNHCR | United Nations High Commission for Refugees |
| UNICE | United Nations Children's Fund |
| UNIDO | United Nations Industrial Development Organization |
| UNISDR | United Nations International Strategy for Disaster Reduction |
| UNWTO | United Nations World Tourism Organization |
| UPC | Abu Dhabi Urban Planning Council |
| UPI | United Press International |
| USA | United States of America |
| USAID | United States Agency for International Development |
| USCCSP | United States Climate Change Science Program |
| USEK | Université Saint-Esprit De Kaslik |
| USEPA | United States Environmental Protection Agency |
| USJ | Saint Joseph University |
| USPTO | United States Patent and Trademark Office |
| UV | Ultraviolet (A and B) |
| VAT | Value-Added Tax |
| VC | Vapor Compression |
| VCM | Volatile Combustible Matter |
| VMT | Vehicle Miles Traveled |
| VOC | Volatile Organic Compound |
| VRS | Vapor Recovery System |
| WACC | Weighted Average Cost of Capital |
| WaDImena | Water Demand Initiative for the Middle East and North Africa |
| WAJ | Water Authority of Jordan |
| WALIR | Water Law and Indigenous Rights |
| WANA | West Asia and North Africa Region |
| WB | West Bank |
| WBCSD | World Business Council for Sustainable Development |
| WBG | World Bank Group |
| WBGU | German Advisory Council on Global Change |
| WCD | World Commission on Dams |
| WCED | World Commission on Environment and Development |
| WCMC | UNEP World Conservation Monitoring Center |
| WCP | World Climate Programme |
| WCS | World Conservation Strategy |
| WDM | Water Demand Management |
| WDPA | World Database on Protected Areas |
| WEEE | Waste of Electronic and Electrical Equipment |
| WEF | World Economic Forum |
| WEF | Water-Energy-Food |
| WEI | Water Exploitation Index |
| WETC | Wind Energy Technology Centre |
| WF | Water Footprint |
| WFN | Water Footprint Network |
| WFP | World Food Programme |
| WGP-AS | Water Governance Program in the Arab States |
| WGEO | World Green Economy Organization |
| WHC | Word Heritage Convention |
| WHO | World Health Organization |
| WIPP | Waste Isolation Pilot Plant |
| WMO | World Meteorological Organization |
| WNA | World Nuclear Association |
| Wp | Watt-peak |
| WRI | World Resources Institute |
| WSSCC | Water Supply and Sanitation Collaborative Council |
| WSSD | World Summit on Sustainable Development |
| WTO | World Trade Organization |
| WTTC | World Travel and Tourism Council |
| WUA | Water User Association |
| WUE | WUE Water Use Efficiency |
| WWAP | World Water Assessment Program |
| WWC | World Water Council |
| WWF | World Wide Fund for Nature |
| WWF | World Water Forum |
| WWI | First World War |
| WWII | Second World War |
| YASAD | Yemenite Association for Sustainable Agriculture and Development |
| YR | Year |
| ZT/CA | Zero Tillage / Conservation Agriculture |

# State of Arab Environment Series
## *AFED Annual Reports*

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### Arab Environment: Future Challenges

2008 Report of the Arab Forum for Environment and Development

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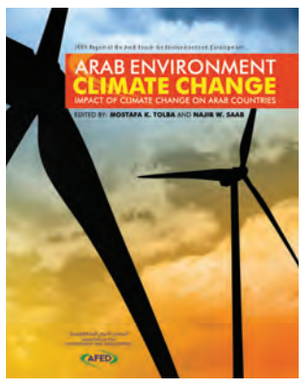
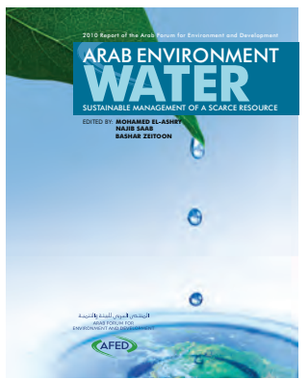



### Arab Environment: Climate Change

2009 Report of the Arab Forum for Environment and Development

*Impact of Climate Change on the Arab Countries* is the second of a series of annual reports produced by the Arab Forum for Environment and Development (AFED). The report has been designed to provide information to governments, business, academia and the public about the impact of climate change on the Arab countries, and encourage concrete action to face the challenge. The report analyzes the Arab response to the urgent need for adaptation measures, and uses the latest research findings to describe the vulnerabilities of natural and human systems in the Arab world to climate change and the impacts on different sectors. In an attempt to help shape adequate policies, the report discusses options for a post-Kyoto regime and outlines the state of international negotiations in this regard.




### Arab Environment: Water

2010 Report of the Arab Forum for Environment and Development

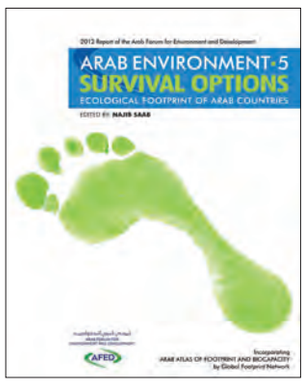
*Water: Sustainable Management of a Scarce Resource* is the third of a series of annual reports produced by the Arab Forum for Environment and Development (AFED). It follows the publication of two reports, Arab Environment: Future Challenges in 2008 and Impact of Climate Change on Arab countries in 2009. The 2010 report is designed to contribute to the discourse on the sustainable management of water resources in the arab world and provides critical understanding of water in the region without being overly technical or academic in nature. The unifying theme is presenting reforms in policies and management to develop a sustainable water sector in Arab countries. Case studies, with stories of successes and failures, are highlighted to disseminate learning. This report contributes to the ongoing dialogue on the future of water and catalyzes institutional reforms, leading to determined action for sustainable water policies in Arab countries.


## Arab Environment: Green Economy

2011 Report of the Arab Forum for Environment and Development

*Green Economy: Sustainable Transition in a Changing Arab World* is the fourth of a series of annual reports on the state of Arab environment, produced by the Arab Forum for Environment and Development (AFED). This report on options of green economy in Arab countries represents the first phase of the AFED green economy initiative. Over one hundred experts have contributed to the report, and discussed its drafts in a series of consultation meetings. The report is intended to motivate and assist governments and businesses in making a transition to the green economy.

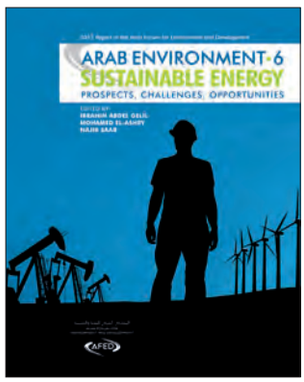
It articulates enabling public policies, business models, green investment opportunities, innovative approaches, and case studies, and addresses eight sectors: agriculture, water, energy, industry, cities and buildings, transportation, tourism, and waste management.




## Arab Environment: Survival Options

2012 Report of the Arab Forum for Environment and Development

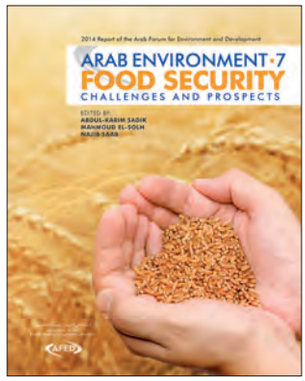
*Survival Options - Ecological Footprint of Arab Countries* is the fifth in the series of annual reports produced by the Arab Forum for Environment and Development (AFED) on the state of the Arab environment. It examines sustainability choices in Arab countries, based on a survey of people's demand of natural capital and available supply. The report discusses potential paths to sustainability based on ecological constraints. As a basis for the analysis, AFED has commissioned the Global Footprint Network, the world leader in this field, to produce an Arab Ecological Footprint and Biocapacity Atlas using the most recent data available. The Atlas covers the 22 members of the League of Arab States, as region, sub-regions and individual countries. The analysis focuses on the challenges posed by the state of food security, water and energy, while considering main drivers such as population and patterns of production and consumption. Ultimately, it prescribes regional cooperation and sound management of resources as the main options for survival in a region characterized by stark variations in ecological footprint, natural resources and income.




## Arab Environment: Sustainable Energy

2013 Report of the Arab Forum for Environment and Development

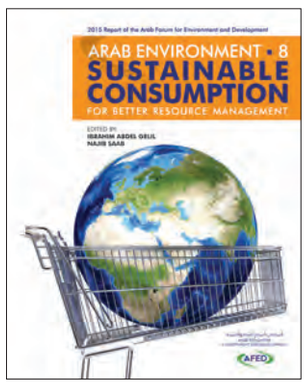
*Sustainable Energy* is the sixth in the series of annual reports produced by the Arab Forum for Environment and Development (AFED) on the state of Arab environment. The report highlights the need for more efficient management of the energy sector, in view of enhancing its contribution to sustainable development in the Arab region. The AFED 2013 report aims at: presenting a situational analysis of the current state of energy in the Arab region, shedding light on major challenges, discussing different policy options and, ultimately, recommending alternative courses of action to help facilitate the transition to a sustainable energy future. To achieve its goals, the AFED 2013 report addresses the following issues: oil and beyond, natural gas as a transition fuel to cleaner energy, renewable energy prospects, the nuclear option, energy efficiency, the energy-water-food nexus, mitigation options of climate change, resilience of the energy sector to climate risk, and the role of the private sector in financing sustainable energy.




## Arab Environment: Food Security

2014 Report of the Arab Forum for Environment and Development

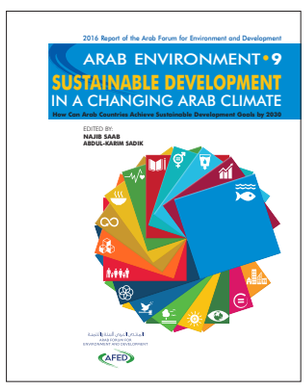
*Food Security* is the seventh in the series of annual reports on the state of Arab environment, produced by the Arab Forum for Environment and Development (AFED). The report highlights the need for more efficient management of the agriculture and water sectors, in view of enhancing the prospects of food security. *Food security* is of great concern to Arab countries. They have been pursuing a target of higher food self-sufficiency rate, but achieving this goal remained beyond reach. While they have limited cultivable land and scarce water resources, they did not use their agricultural endowments in an effective and efficient manner. Lack of appropriate agricultural policies and practices led to diminishing the bio-capacity of the resources to regenerate their services and threatened agricultural sustainability. AFED hopes that its report on Food Security will help Arab countries adopt the right policies and commit to long-term investments, allowing them to secure a sustainable supply of food to meet ever-growing needs.




## Arab Environment: Sustainable Consumption

2015 Report of the Arab Forum for Environment and Development

Increasing production alone cannot solve the need of food for hungry people and water for thirsty people, nor will it provide power to dark villages. Equally, solely building more waste dumps and incinerators cannot solve the trash crisis. Inadequate consumption patterns are at the core of the problem, and any feasible solution requires a fundamental change in the way we consume resources and produce waste. Thus, the 2015 AFED Annual Report, *Sustainable Consumption for Better Resource Management*, discusses how changing consumption patterns can help preserve resources and protect the environment, ultimately leading to sustainable development. While it is true that changing consumption patterns requires adequate policies based on expert studies, the support of consumers is a prerequisite for successful implementation. In view of tracking how people perceive consumption and to what extent they are ready for positive change, AFED carried out a wide-ranging public opinion survey, which drew over 31,000 participants from 22 countries. The survey, which has been incorporated in the report, found that the Arab public is ready to pay more for energy and water and to change their consumption patterns if this will help preserve resources and protect the environment.




## Arab Environment: Sustainable Development in a Changing Arab Climate

2016 Report of the Arab Forum for Environment and Development

This AFED report on "*Sustainable Development in a Changing Arab Climate*" highlights the policy options available for the Arab countries to realize the Sustainable Development Goals by the 2030 target set by the United Nations, in light of the new political, economic, and social developments.

The report recommends an alternative approach, based on integrating sustainable development principles within the anticipated rebuilding efforts. It calls upon local, regional, and international aid organizations not to limit their efforts to providing safety and basic necessities to those affected, but rather to use the relief plans as a launch pad for promoting new approaches to development, rooted in a transition to green economy.

This report, on prospects and challenges along the path towards achieving the SDGs, builds on the previous eight reports on the state of Arab environment, produced by the Arab Forum for Environment and Development (AFED) since 2008. AFED annual reports have so far addressed major development issues in the Arab region, including Water, Food Security, Energy, Green Economy, Ecological Footprint, Sustainable Consumption, and Climate Change.

# ملخص تنفيذي
# البيئة العربية في 10 سنين

## التقرير السنوي العاشر للمنتدى العربي للبيئة والتنمية

اتسمت حالة البيئة في البلدان العربية على مدى السنوات العشر الماضية بالفوارق والتباينات. وفي حين استمر الوضع البيئي في التدهور في جوانب كثيرة، فهو أحرز تقدماً على بعض الجبهات. وعلى الرغم من عدم حدوث تحسن حقيقي في عدة بلدان، خصوصاً تلك التي تواجه اضطرابات سياسية وعدم استقرار، فقد قطعت بلدان أخرى خطوات نحو التحول إلى أساليب أكثر استدامة، عن طريق وضع سياسات ملائمة وتخصيص المزيد من الموارد المالية للاستثمارات في البنى البيئية الأساسية.

انطلقت شرارة الشروع في سياسات تعزز الاقتصاد الأخضر والمستدام من حتمية معالجة المشاكل الاقتصادية الحرجة الناشئة، إلى جانب النقص في الموارد الطبيعية. فعلى سبيل المثال، كان الإلغاء التدريجي لدعم الأسعار وتخصيص استثمارات مرموقة في مجال كفاءة الطاقة والطاقة المتجددة مدفوعين بزيادة الطلب المحلي على الطاقة والقيود المفروضة على الموازنة نتيجة لانخفاض أسعار النفط. وأدى النقص في مصادر المياه العذبة أيضاً إلى تخصيص استثمارات في كفاءة استخدام المياه وفي مصادر المياه غير التقليدية، بما في ذلك تدوير المياه العادمة وإعادة استخدامها. ومن أجل تحقيق الأمن الغذائي، بدأ العديد من البلدان العربية في إدخال ممارسات زراعية مستدامة، بما في ذلك الري الأكثر كفاءة وزيادة الانتاجية. وعلاوة على ذلك، فإن اعتماد نهج الترابط الذي يشمل المياه والغذاء والطاقة يعتبر على نحو متزايد وسيلة حتمية لتعزيز أوجه التآزر والتكامل بين سياسات المياه والغذاء والطاقة في المنطقة. صحيح أنه تم بالفعل إدخال سياسات في الاتجاه الصحيح، ولكنها لا تزال في مراحلها الأولى، ولا يزال يتعين انتظار نتائج ملموسة. وهناك حاجة ماسة إلى الانتقال السريع من الكلام إلى التنفيذ. ويتمثل مفتاح مثل هذه التطورات في زيادة التنسيق والتعاون على المستوى الإقليمي، الذي ينبغي ألا تطغى عليه الصراعات السياسية.

وقد أظهر استطلاع للمنتدى العربي للبيئة والتنمية (أفد) أن مشاعر الجمهور العربي تتماشى مع تحليلات الخبراء بأن البيئة استمرت في التدهور على مدى السنوات العشر الماضية. وعلى الرغم من بعض النقاط المضيئة، وجد المشاركون أن الحكومات لا تبذل ما يكفي للتصدي للتحديات وإدارة البيئة بشكل صحيح، باعتبارها ركيزة أساسية للتنمية المستدامة.

### الرأي العام

كشف استطلاع للرأي العام أجراه «أفد» في 22 دولة أن غالبية كبيرة من العرب يعتقدون أن البيئة تدهورت في بلادهم خلال السنوات العشر الماضية. وقورنت النتائج مع استطلاع مماثل أجراه «أفد» عام 2006. فتبيّن أن الذين يعتقدون أن الوضع البيئي تدهور يشكلون نسبة 60 في المئة، وهو المعدل نفسه للعام 2006، في حين قال 20 في المئة إن الوضع تحسن بالمقارنة مع 30 في المئة عام 2006، وقال 20 في المئة إنه لم يتغير، مما يعكس نظرة سلبية. وتعتقد غالبية عظمى من 95 في المئة أن بلدها لا يقوم بما يكفي للتصدي للتحديات البيئية، في نتيجة مماثلة للاستطلاع السابق.

أهم التحديات البيئية وفقاً للاستطلاع هي النفايات الصلبة، يليها ضعف الوعي البيئي، وتدهور الموارد المائية، وتغير المناخ. وهذا يتماشى مع النتائج التي ظهرت قبل عشر سنوات، باستثناء تلوث الهواء الذي صنف أكبر تحدٍ عام **2006** وتراجعت أهميته في الاستطلاع الحالي.

وكانت الأسباب الرئيسية للتدهور البيئي في رأي المشاركين هي سوء إدارة البيئة وعدم الامتثال للتشريعات البيئية وضعف المؤسسات البيئية وعدم كفاية الإنفاق الحكومي على البيئة، وكل ذلك يتماشى مع نتائج عام **2006**.

وعندما سئل المشاركون عن الإجراءات الشخصية التي هم على استعداد لاتخاذها لحماية البيئة، قال **73** في المئة إنهم مستعدون للمشاركة في حملات التوعية البيئية، و**65** في المئة على استعداد للامتثال الكامل للتشريعات البيئية. وفي ما يتعلق بالتدابير المالية، أبدى **45** في المئة استعدادا لدفع الضرائب الحكومية لحماية البيئة، في حين أن **20** في المئة فقط هم على استعداد لدفع تبرعات لصندوق خاص بحماية البيئة.

وكان التطور في أراء الجمهور واضحا بشأن القضايا المتعلقة بتغير المناخ في السنوات العشر الماضية، مما يعكس مستوى أعلى من الوعي. والغالب ان إقرار اتفاق باريس كان حافزا على زيادة الاعتراف بالآثار الخطيرة لتغير المناخ. فقال **93** في المئة إن المناخ يتغير بسبب الأنشطة البشرية، ورأى **90** في المئة من المستطلعين أنه يشكل تحدياً خطيراً لبلدانهم. وهذا يمثل زيادة بنسبة **6** في المئة على مدى عشر سنوات. واعتبر **75** في المئة أن حكومتهم لم تفعل ما يكفي للتعامل مع تغير المناخ، ما يتوافق مع النتائج السابقة.

قال **83** في المئة انهم يعرفون ما هي أهداف التنمية المستدامة. ويعتقد **98** في المئة أن تغيير أنماط الاستهلاك يمكن أن يؤثر على البيئة، ويرى **95** في المئة أن حماية البيئة تساعد النمو الاقتصادي.

تظهر النتائج بوضوح مزيداً من الفهم للقضايا البيئية بين الجمهور، بما في ذلك ترابطها مع العوامل الاقتصادية والاجتماعية. وربما نتيجة لهذا الوعي المتزايد، يشير الاستطلاع إلى أن الجمهور العربي أصبح أكثر إصراراً على حكوماته لوضع خطوات ملموسة أكثر نحو رعاية البيئة وتحقيق التنمية المستدامة.

## السياسات والحوكمة

لا تزال المبادرات البيئية على الصعيد الإقليمي متشرذمة ومجزأة وغير فعالة إلى حد بعيد. ويمكن أن يعزى ذلك إلى المشاكل التي تعرقل التعاون السليم داخل المؤسسات العربية الإقليمية، والتأخر في استيعاب انعكاسات إدراج البيئة كعنصر لا يتجزأ في منظومة التنمية المستدامة.

وقد حاولت جامعة الدول العربية طوال العقد الماضي معالجة مسألة إدراج البيئة كدعامة للتنمية المستدامة. وكان ذلك متماشياً مع التحول في مفهوم الحوكمة على المستوى العالمي، الذي توج باعتماد أهداف التنمية المستدامة عام **2015**. تاريخياً، قام مجلس الوزراء العرب المسؤولين عن شؤون البيئة بهذه المهمة، إلا أن صلاحياته كانت محدودة جداً ولم تسمح بجذب لاعبين آخرين لتطوير السياسات الإقليمية. ولمعالجة هذه الفجوة، تم إنشاء لجنة مشتركة معنية بالبيئة والتنمية في المنطقة العربية (JCEDAR)، بهدف ضم وزارات أخرى إلى جانب الوزارات المعنية بالبيئة، خاصة وزارات الاقتصاد والمال والتخطيط. وبما أن هذه الآلية ايضا لم تكن فعالة بما فيه الكفاية، فقد أنشئت إدارة جديدة للتنمية المستدامة والتعاون الدولي عام **2016** ضمن جامعة الدول العربية، ومن المبكر الحكم على مدى نجاحها.

تحت رعاية جامعة الدول العربية وبدعم من وكالات دولية ومنظمات المجتمع المدني المتخصصة، أعد مجلس الوزراء العرب المسؤولين عن شؤون البيئة أوارق معلومات أساسية للمفاوضات بشأن الاتفاقيات

البيئية الدولية، وقام بدور نشط في هذه المفاوضات، لاسيما في ما يتعلق بتغير المناخ. واعتمدت جامعة الدول العربية إطاراً استراتيجياً إقليمياً للتنمية المستدامة، بالإضافة إلى استراتيجيات إقليمية بشأن المياه والزراعة وتغير المناخ وغيرها. ولكن لم يكن لهذه الاستراتيجيات الإقليمية تأثير كبير على الجهود الوطنية الرامية إلى تحقيق التنمية المستدامة.

على الصعيد الوطني، تعززت المؤسسات البيئية بوجه عام، مما أسفر عن بعض التحسينات في الإدارة البيئية، ولكن مع قدرة محدودة على التصدي الكامل للأبعاد الثلاثة للتنمية المستدامة. واستجابة لذلك، أنشأت بعض البلدان العربية مجالس وطنية للتنمية المستدامة، لكنها بقيت ذات صفة بروتوكولية ولم تظهر نتائج ملموسة منها بعد.

وعلى صعيد السياسات العامة، أدخلت الإدارة المستدامة للموارد الطبيعية على جدول أعمال التنمية في العديد من البلدان العربية. وكان التحول الرئيسي في السياسة العامة هو الاصلاحات الأخيرة في أسعار الطاقة والمياه في المنطقة، بما في ذلك البلدان الرئيسية المنتجة للنفط في مجلس التعاون الخليجي. وبالإضافة إلى إصلاح سياسات الدعم، شهدت المنطقة تقدما في اعتماد سياسات للطاقة المستدامة، مثل أهداف وخطط عمل كفاءة الطاقة، وبيانات الكفاءة للأجهزة والسيارات، وقوانين المباني الخضراء، وسياسات الطاقة المتجددة، بما في ذلك الأهداف والتغذية والتعرفة. ومع ذلك، فمن أجل تحقيق الأهداف المتفق عليها عالميا، تحتاج المؤسسات الإقليمية للانتقال من الإعلانات ذات البلاغة اللفظية إلى التنفيذ على أرض الواقع، وتحتاج البلدان العربية إلى تعزيز أطرها التشريعية والمؤسسية.

وبما أن المنطقة العربية هي من أكثر المناطق تأثراً بآثار المناخ، اقتصادياً وبيئياً، فإن التزام البلدان العربية بعملية مواجهة تغير المناخ على الصعيد الدولي، والتي بلغت ذروتها في اتفاق باريس، كان واضحاً. فقد وقع الاتفاقية جميع أعضاء جامعة الدول العربية البالغ عددهم 22 عضواً، باستثناء سورية، وصدق عليها 15 بلداً، وقدم 13 بلداً مساهماته الوطنية المحددة الأولى. غير أن النهج الإقليمي للتصدي لمخاطر تغير المناخ لم ينجح، بسبب عدم وجود التزامات سياسية بالتعاون الإقليمي.

وتشكل المياه والغذاء والطاقة شبكة معقدة من الروابط المتبادلة. وبسبب ترابطها القوي، تؤثر السياسات ودعم الأسعار في قطاع واحد تأثيراً قوياً على القطاعين الآخرين. لذلك، ينبغي على صناع السياسات العرب إعادة النظر في استراتيجياتهم وخططهم التنموية الحالية والمستقبلية من خلال عدسة الترابط الجديدة. ومن شأن ذلك أن يساعد على تحقيق أقوى لأهداف التنمية المستدامة واتفاق باريس بشأن المناخ. وتتيح الجهود الوطنية والإقليمية في مواجهة تحدي تغير المناخ فرصة غير مسبوقة لإصلاح مؤسساتي ضروري لتعميم التفكير الترابطي في وضع السياسات وتنفيذها.

علاوة على ذلك، ولتحقيق العدالة الاجتماعية، ينبغي استبدال الدعم العشوائي الشامل بدعم موجه إلى الشرائح المحرومة في المجتمع. وينبغي أن تلبي سياسات التسعير الاحتياجات البشرية الأساسية، وأن تعزز كفاءة الموارد، وأن تسترد كلفة تقديم الخدمات من دون التأثير على الفقراء.

## الاقتصاد الأخضر والتمويل

شهد العقد الماضي انتقالاً ملموسا للبلدان العربية نحو الاقتصاد الأخضر. فمن الصفر تقريباً في اعتماد انظمة اقتصاد أخضر أو استراتيجية مستدامة، أصبح هناك أكثر من سبعة بلدان وضعت استراتيجيات من هذا القبيل أو أدرجت عناصر الاقتصاد الأخضر والاستدامة في خططها. وقد ترجمت الاستراتيجيات الخضراء في مجموعة من التدابير التنظيمية والحوافز التي أدخلت في هذه البلدان لتسهيل التحول. وأعطى ذلك إشارة قوية للقطاع الخاص لزيادة الاستثمارات في قطاعات الاقتصاد الأخضر أضعافاً، وخاصة الطاقة المتجددة، وهو أمر واضح في المغرب والأردن والإمارات، حيث تم استثمار البلايين في مزارع الطاقة الشمسية وطاقة الرياح. وينفذ المغرب خطة لتوليد أكثر من نصف كهربائه من الموارد المتجددة بحلول سنة 2030.

أدى هذا التحول إلى زيادة الوعي والاعتراف بالمكاسب الاقتصادية والاجتماعية والبيئية الحقيقية الناجمة عن الانتقال إلى اقتصاد أخضر ومستدام. وينعكس ذلك في زيادة فرص العمل التي تخلقها الاستثمارات الخضراء، والكفاءة في استخدام الموارد الطبيعية والقدرة التنافسية والوصول إلى الأسواق. ويمكن تنويع الاقتصاد وتنشيطه من خلال خلق أنشطة وفرص جديدة مثل: الطاقة المتجددة، مصادر المياه المتجددة الجديدة من خلال معالجة مياه الصرف وإعادة استخدام المياه المعالجة وتحلية المياه، الزراعة المستدامة والعضوية، المنتجات الصناعية الخضراء، المجتمعات المستدامة، المباني الخضراء، نظام النقل العام الأخضر، السياحة البيئية، جنباً إلى جنب مع النظم المتكاملة لإدارة النفايات الصلبة التي يمكنها توليد الطاقة وإنتاج السماد العضوي وإعادة استخدام المواد.

وقد أدرجت مصر والمغرب وقطر والإمارات بالفعل قوانين المباني الخضراء في مجتمعات حضرية وساحلية جديدة، مثل مدينة جلالة ومدينة العلمين الجديدة في مصر ومدينة مصدر في أبوظبي ومدينة محمد السادس الخضراء في المغرب. وقد اعتمدت بعض استراتيجيات السياسة العامة، مثل رؤية السعودية 2030، نوعاً من المحاسبة للرأسمال الطبيعي، بوضع قيمة سارية للموارد الطبيعية. وتعطي رؤية السعودية 2030 مثالاً على تحول جذري، مقارنة بالمحاولات السابقة الأقل جرأة للإصلاح. وأدت الإجراءات المالية التي اتخذتها المصارف المركزية في لبنان والإمارات والأردن إلى زيادة حادة في عدد وقيمة القروض التجارية التي تقدمها المصارف للمشاريع الصديقة للبيئة. وهي تشمل المشاريع الكبيرة التي ينفذها القطاع الخاص، بالإضافة إلى المنشآت المنزلية التي تعزز الكفاءة، ولا سيما في مجال الطاقة الشمسية والمتجددة بشكل عام. واطلق الأردن سنة 2017 سلسلة مشاريع تعتمد الاقتصاد الأخضر.

و أعطى اعتماد أهداف التنمية المستدامة عام 2015 زخماً جديداً للبلدان في جميع أنحاء العالم، بما في ذلك المنطقة العربية، لتكثيف الجهود الرامية إلى وضع استراتيجيات وسياسات مستدامة وخضراء لتحقيق هذه الأهداف.

وفي حين ازداد حجم الموارد المالية الموجهة لتمويل الاستثمارات الخضراء في المنطقة العربية، لكنه بقي أقل من المطلوب. لكن من المتوقع أن توجه حصة متزايدة من إجمالي الاستثمارات إلى مشاريع التنمية الخضراء والمستدامة في السنوات المقبلة. وأحد المؤشرات على الاتجاه الجديد هو أن تمويل عمليات التنمية، خاصة للبنى التحتية، من المؤسسات الإنمائية الوطنية والإقليمية العربية خلال الفترة 2006–2016 بلغ 51 بليون دولار أميركي، أي نحو 57 في المئة من إجمالي التمويل التراكمي (90 بليون دولار أميركي) على مدى فترة الأربعين سنة منذ عام 1975.

ومع ذلك، فهناك حاجة إلى ما يتجاوز هذا بكثير، إذ يتعيّن على الدول العربية تخصيص مبلغ إضافي لا يقل عن 57 بليون دولار سنوياً من مصادر محلية وخارجية لدعم تنفيذ أهداف التنمية المستدامة. ولا يتوفر الآن سوى جزء صغير من هذا المبلغ.

## المياه

تتفاقم ندرة المياه في المنطقة العربية، بسبب محدودية موارد المياه العذبة المتجددة وتدهور الجودة من جهة، والنمو السكاني ونقص الأموال لتمويل البنية التحتية للمياه من جهة أخرى. وعلاوة على ذلك، ازدادت ندرة المياه في المنطقة بسبب تكاثر دورات الجفاف وزيادة حدتها ومدتها. وخلال السنوات العشر الماضية، انخفض متوسط نصيب الفرد من المياه العذبة في 22 بلداً عربياً من نحو 990 متر مكعب في السنة إلى أقل من 800 (أي نحو عشر المتوسط العالمي). وإذا استُثنيت موريتانيا والعراق والسودان ولبنان من المجموع، فإن معدل متوسط نصيب الفرد من المياه العذبة ينخفض إلى أقل من 500 متر مكعب. وفي حين يبلغ نصيب الفرد من المياه المتاحة في تسعة بلدان أقل من 200 متر مكعب حالياً، تقع 13 دولة عربية بين 19 دولة هي الأكثر ندرة بالمياه في العالم. وهذا يعني أن نحو 40 في المئة من السكان العرب يعيشون بالفعل في ظروف من الفقر المائي المطلق.

وتعتمد معظم البلدان العربية اعتماداً كبيراً على موارد المياه الجوفية لتلبية مطالبها المتزايدة، ولا سيما للري والاستخدام المنزلي. وفي الوقت الحاضر، تعاني جميع موارد المياه الجوفية المتجددة في المنطقة من انخفاض مستوى المياه وتدهور الجودة، في حين تعاني أحواض المياه الجوفية غير المتجددة من نضوب سريع. ولا تزال تحلية المياه تشكل مصدراً رئيسياً للمياه في المنطقة العربية، لاسيما في البلدان الغنية بالنفط، التي تعتبر المنتج الأكبر للمياه المحلاة في العالم. ومع ذلك، لا تزال تكنولوجيا التحلية ومعداتها مستوردة، مع قيمة مضافة محدودة لاقتصادات الدول العربية.

وما زالت إعادة استخدام مياه الصرف الصحي المعالجة محدودة عموماً في جميع أنحاء المنطقة، على الرغم من ظروف الشح والأحجام الكبيرة نسبياً لمياه الصرف المتولدة، التي تمثل فرصاً كبيرة ضائعة. وفي حين تتم معالجة 60 في المئة من مياه الصرف الصحي، يتم تصريف أكثر من نصف المياه المعالجة ولا يعاد استخدامها. وقد أدى تصريف مياه المجارير في البحر، حتى بعد معالجتها، إلى مشاكل كبرى في البيئة البحرية، تتجاوز التلوث البكتيري والكيميائي الى ارتفاع نسبة المغذيات العضوية، كما يحصل دورياً في الكويت. وفي السنوات العشر الماضية، يمكن ملاحظة اتجاه واضح للتنافس على استخدام المياه بين مختلف القطاعات في المنطقة، حيث تحولت النسب المئوية الإجمالية من الاستخدام في القطاع الزراعي إلى القطاعين البلدي والصناعي، مما يعكس اتجاهات التحضر والتصنيع السريعة في المنطقة، والتي من المتوقع أن تستمر في المستقبل.

وخلال السنوات العشر الماضية، ارتفعت نسبة السكان العرب الذين يحصلون على مياه الشرب المأمونة من 85 في المئة إلى 90 في المئة، وهي بذلك تقترب من المتوسط العالمي. وقد تحقق ذلك في معظم أنحاء المنطقة، باستثناء المشرق حيث تدهورت نسبة السكان الذين يحصلون على مياه الشرب المأمونة خلال هذه الفترة، إذ انخفضت من 94 في المئة إلى 88 في المئة. وتعزى التحديات في هذه البلدان أساساً إلى الاحتلال العسكري والصراعات الأهلية وعدم كفاية الاستثمارات. وقد ازداد الوصول إلى مرافق الصرف الصحي المحسنة زيادة كبيرة في السنوات العشر الماضية، حيث وصل إلى 85 في المئة من السكان.

وبما أن إدارة جانب العرض وصلت إلى حدودها الفنية والمالية، فقد بدأت عدة دول عربية تحولاً أكثر فعالية في سياساتها المائية لإدارة الطلب على الموارد وحفظها، مع استخدام الأدوات الاقتصادية بشكل متزايد لتحقيق هذا التحول. وقد تم إصلاح سياسات دعم المياه في العديد من البلدان، وهي خطوة من المتوقع أن تعزز كفاءة استخدام المياه واسترداد التكاليف.

وشهدت السنوات العشر الماضية بعض المبادرات على المستوى الإقليمي والمناطقي. فقد تأسس المجلس الوزاري العربي للمياه عام 2008 في جامعة الدول العربية، وأصدر عام 2010 استراتيجية الأمن المائي في المنطقة العربية 2010–2030. وعلى مستوى المناطق، تم عام 2016 أطلاق الاستراتيجية الموحدة للمياه في دول مجلس التعاون الخليجي 2016–2035. ويمثل تطوير كلتا الاستراتيجيتين معلماً رئيسياً في مواجهة ندرة المياه في البلدان العربية القاحلة. لكن النجاح يحتاج إلى تنفيذ سريع ومستويات أعلى من التعاون الإقليمي، ما زالت ضعيفة حتى الآن.

## الأمن الغذائي

لا يمكن أن تنجح الزراعة وإنتاج الأغذية من دون بيئة صحية ومناخ ملائم. وقد تدهور الأمن الغذائي في العديد من البلدان العربية على مدى السنوات العشر الماضية، على الرغم من بعض التقدم في مجالات أخرى. وظلت المنطقة العربية تشكل أكبر منطقة عجز غذائي في العالم، مع وجود فجوة غذائية متزايدة بين الإنتاج والاستهلاك المحليين. ومن حيث القيمة النقدية، ازداد إجمالي الفجوة الغذائية العربية بشكل كبير من 18 بليون دولار عام 2005 إلى نحو 29 بليون دولار عام 2010 و34 بليون دولار عام 2014. ويعزى هذا الازدياد إلى عدة عوامل وتطورات مترابطة في العالم العربي، أهمها النمو السكاني المرتفع (2,3 في المئة سنوياً مقابل متوسط يبلغ 1,9 في المئة في البلدان النامية)، وانخفاض الإنتاجية الزراعية

بسبب ضعف الاستثمار في العلم والتكنولوجيا والتنمية الزراعية، وزيادة تدهور الموارد الطبيعية، وتأثيرات تغير المناخ، ولاسيما انخفاض هطول الأمطار، وازدياد تواتر موجات الجفاف، وارتفاع درجات الحرارة ومواسم الزراعة الأقصر، وتسرب مياه البحر، وارتفاع نسبة هدر الأغذية إلى نحو 35 في المئة، وانتشار الاضطرابات السياسية والصراع الأهلي على نطاق واسع في العديد من البلدان العربية خلال السنوات الست الماضية، وما نتج عن ذلك من هجرة الريف إلى المدن والهجرة إلى الخارج. وبسبب الحرب الأهلية في سورية، على سبيل المثال، تقدر الكلفة المالية الاجمالية للأضرار والخسائر في القطاع الزراعي خلال الفترة 2011–2016 بأكثر من 1,6 بليون دولار أميركي.

تدهورت كمية ونوعية موارد المياه السطحية والجوفية على حد سواء بسبب تغير المناخ وضعف إدارة المياه، بما في ذلك الاستخدام غير المستدام. وقد ساهمت الملوحة في تفاقم تدهور الأراضي والتصحر في مناطق شاسعة من العالم العربي. وباستثناء عُمان والأردن، استثمرت البلدان العربية أقل من واحد في المئة من ناتجها المحلي الاجمالي في مجال البحث والتطوير الزراعيين. وعلى الرغم من ارتفاع إمكانات النمو الزراعي في الجزائر والسودان، يعاني هذان البلدان من نقص شديد في البحث والتطوير، حيث ينفق كل منهما 0,2 في المئة فقط من ناتجه المحلي الإجمالي على البحوث الزراعية، وهذا أمر غير كاف نظراً لأهمية الزراعة في أمنهما الغذائي الوطني ونموهما الاقتصادي.

وفي حين أخذ المعهد الدولي لبحوث السياسات الغذائية (IFPRI) في اعتباره الخطر العام الحالي للأمن الغذائي، فقد صنف البلدان العربية على أساس التنمية الاقتصادية والاجتماعية. وفي هذا الصدد، يتم تقييم التصنيف تبعاً لمؤشرين رئيسيين: وضع الاقتصاد الكلي للميزان التجاري ومستوى الحالة المعيشية الغذائية والصحية للأسر الصغيرة كمقياسين لانعدام الأمن الغذائي. ويستند تصنيف آخر استشرافي مهم إلى الموارد الطبيعية والإمكانات الزراعية للبلدان العربية لتعزيز الأمن الغذائي. وتشمل البلدان العربية ذات الإمكانات الزراعية العالية الجزائر ومصر والعراق والمغرب والسودان وسورية. أما البلدان ذات القدرات المتوسطة فهي موريتانيا والسعودية وتونس واليمن. وتشمل البلدان المحدودة الإمكانات الأردن ولبنان وليبيا، في حين تقع البحرين والكويت وعمان وقطر والإمارات في فئة الإمكانات المنخفضة للغاية.

وتعتبر الإنتاجية الزراعية الحالية في جميع البلدان العربية أقل كثيراً من إمكاناتها، وحتى أقل من متوسط البلدان النامية على الصعيد العالمي. وبالتالي، من الضروري أن تستفيد البلدان العربية من إمكاناتها الزراعية الكاملة لسد الفجوات في الغلال وتعزيز التعاون الاقليمي استناداً إلى مزاياها النسبية لتعزيز الأمن الغذائي. وسيؤدي ذلك إلى سد الفجوة المتزايدة بين إنتاج الأغذية المحلية والاستهلاك للحد من ارتفاع الواردات الغذائية وتعزيز الأمن الغذائي، مع تعزيز التعاون الجماعي الإقليمي.

## الطاقة

فرض الارتفاع السريع في الطلب المحلي على الطاقة في المنطقة العربية تغييرات في سياستها التقليدية في مجال الطاقة، خاصة ما يرتبط بالتسعير ومعايير الكفاءة. وفي عام 2014، شكلت المنطقة العربية 5 في المئة من إجمالي إمدادات الطاقة الأولية في العالم، و7,8 في المئة من انبعاثات ثاني أوكسيد الكربون. وقد أدى هذا النمط إلى تصنيف بعض دول الخليج بين أعلى دول العالم المنتجة لإنبعاث ثاني أوكسيد الكربون.

الاتجاهات الحالية لاستخدام الطاقة تضع الاقتصادات العربية ضمن أقل البلدان كفاءة على الصعيد العالمي. ويبلغ متوسط الخسائر في توليد الكهرباء ونقلها وتوزيعها 19,4 في المئة، أي أكثر من ضعفي المعدل العالمي. وبلغ النمو في استهلاك الطاقة 8 في المئة، أي ضعفي معدل النمو الاقتصادي. ولذلك، فإن كفاءة الطاقة تتيح فرصة كبيرة لتحقيق وفورات في الطاقة في البلدان العربية.

على مدى عقود، لعب قطاع الطاقة دوراً حاسماً في تنمية المنطقة العربية، حيث شكل النفط والغاز أكثر من 25 في المئة من إجمالي الناتج المحلي العربي، وحقق أكثر من 70 في المئة من إجمالي الإيرادات

الحكومية. ويهيمن الوقود الأحفوري على مزيج الطاقة المحلية، حيث يمثل النفط والغاز الطبيعي نحو 95 في المئة من احتياجات المنطقة من الطاقة. ومع ذلك، فإن أكثر من 50 مليون عربي لا يحصلون على خدمات الطاقة الحديثة.

وتعتبر جميع البلدان العربية غير محصنة بسبب الاعتماد المفرط على النفط، وقد شرعت في برامج لتنويع الاقتصاد. فأطلقت المملكة العربية السعودية «رؤية 2030» التي تهدف إلى زيادة الإيرادات غير النفطية بمقدار ستة أضعاف لتصل إلى 266 بليون دولار أميركي بحلول سنة 2030، إلى جانب خطط جريئة لتحسين إدارة الموارد الطبيعية وإلغاء الدعم تدريجياً وتعزيز كفاءة استخدام الطاقة. وتم إقرار خطط رئيسية لإصلاح دعم الطاقة في ثمانية بلدان عربية.

وعلى الرغم من أن العديد من الدول العربية قطعت خطوات ملحوظة نحو تعزيز الطاقة المتجددة، فإن مساهمتها في مزيج الطاقة تبقى هامشية، حيث تبلغ نحو 3,5 في المئة. ومع ذلك تعتبر توقعات طاقة الرياح والطاقة الشمسية في المنطقة العربية إيجابية في الغالب، بشرط استمرار المزيد من سياسات الإصلاح لتحفيز الاستثمار في مصادر جديدة للطاقة. وتوقعت الوكالة الدولية للطاقة أن يتضاعف حجم الطاقة المتجددة في منطقة الشرق الأوسط بين 2013 و2020. ومن المتوقع أن تحصل معظم التطورات الكبرى في السعودية، التي أعلنت عن خطط لإنتاج 9,5 جيغاواط من الكهرباء المتجددة بحلول سنة 2023 و54 جيغاواط بحلول سنة 2040.

ويبرز هدف المغرب للطاقة النظيفة البالغ 52 في المئة بحلول سنة 2030 باعتباره الأكثر طموحاً في المنطقة العربية. وقد أعلنت 12 دولة عربية عن أهداف للطاقة المتجددة، بينها الإمارات والأردن والجزائر ومصر والسعودية وتونس، التي حددت أهدافاً طموحة تتجاوز 20 في المئة. وبالإضافة إلى ذلك، اعتمدت عدة بلدان أنواعاً مختلفة من تدابير السياسة العامة لتعزيز كفاءة استخدام الطاقة.

ومن المتوقع أن يؤدي اكتشاف احتياطات الغاز الكبيرة في شرق البحر المتوسط إلى تعزيز اقتصادات البلدان المعنية، وتوفير مصدر للطاقة الاحفورية الأقل تلويثاً، كجسر نحو مزيد من المصادر المتجددة النظيفة. بيد أن على صناعة الطاقة اعتماد قواعد صارمة تأخذ في الاعتبار الطبيعة الهشة لهذا البحر شبه المقفل.

الطلب السريع على الطاقة في المنطقة العربية، مقروناً بآفاق تحول الشرق الأوسط إلى مركز اقتصادي عالمي بحلول سنة 2030 إلى جانب منطقة آسيا والمحيط الهادئ، يتطلب تنويع مصادر الطاقة من أجل الانتقال إلى قطاع طاقة أكثر استدامة. لكن هذا لا يبرر الاستخدام العشوائي لنموذج «مزيج الطاقة» كذريعة لإدخال أنواع إضافية من الوقود ضارة بيئياً مثل الفحم، أو الطاقة النووية كمصدر آخر تحاول بعض الدول العربية إدخاله تحت عنوان مزيج الطاقة. وكلاهما بحاجة إلى أن يدرسا بدقة لتقييم الفوائد والمخاطر الحقيقية، فيما الاتجاه العالمي الطاغي هو نحو التخلص التدريجي من محطات الفحم ومحطات الطاقة النووية القائمة وعدم إنشاء محطات جديدة.

يتطلب تحقيق هدف الطاقة المستدامة فصل النمو الاقتصادي عن استخدام الموارد من خلال الاستخدام الفعال، وتخفيف الكربون من مزيج الطاقة للحد من البصمة الكربونية، والقضاء على فقر الطاقة لتحقيق العدالة الاجتماعية وإزالة التفاوت في مؤشرات الطاقة والاقتصاد.

## جودة الهواء

تدهورت نوعية الهواء في البلدان العربية على مدى العقود القليلة الماضية. وتضاعفت تقريباً انبعاثات ثاني أوكسيد الكربون. وكانت التغيرات في قطاع الطاقة مدفوعة باستراتيجيات نفذت بنجاح في العديد من بلدان المنطقة لتحسين الوصول إلى الطاقة، مما أدى إلى حرق المزيد من الوقود الأحفوري في محطات الطاقة الحرارية لتلبية الزيادة في الطلب على الطاقة. وقد ارتفع استهلاك الكهرباء بنسبة 75 في المئة، مما أدى إلى انبعاث 766 مليون طن من ثاني أوكسيد الكربون عام 2015، في مقابل 436

مليون طن عام 2006. وازدادت الانبعاثات الناجمة عن قطاع النقل بسبب النمو الكبير في القطاع في غياب أي تدابير تخفيف فعالة، وضعف وسائل النقل العام في معظم البلدان.

ووفق دراسة أجريت في مدن كبرى في المنطقة، فقد أدت الاضطرابات في بعض البلدان إلى انخفاض الانبعاثات. وفي حين قد يكون هذا صحيحاً بالنسبة لبعض الغازات نتيجة تباطؤ الصناعات والنقل الشخصي، ولكن الغبار والملوثات الأخرى الناجمة عن الصراعات المسلحة ازدادت بشكل واضح.

واعتبرت منظمة الصحة العالمية أن المنطقة العربية من بين أسوأ المناطق أداء في نوعية الهواء. وكثيراً ما تجاوزت المستويات المسجلة لتلوث الهواء 5 إلى 10 أضعاف الحدود القصوى المحددة من المنظمة، بينما العديد من المدن العربية تقع بين أكثر 20 مدينة تلوثاً في العالم. وتشمل الانبعاثات المفرطة أول أوكسيد الكربون الناتج عن قطاع النقل وأكاسيد الكبريت وأكاسيد النيتروجين، مما يؤدي إلى تشكيل الأمطار الحمضية والأوزون والمركبات العضوية المتطايرة. وقد تم الحد من محتوى الكبريت في وقود الديزل في معظم البلدان العربية من خلال تشديد المعايير، مما أدى إلى انخفاض من مستويات عالية تصل إلى 1000 جزء في المليون إلى نحو 50 جزءاً في المليون. كما تحقق التحول إلى البنزين الخالي من الرصاص عن طريق تطبيق فروق في الأسعار، تلاها حظر كامل على استخدام الوقود المحتوي على الرصاص. وتشمل تدابير التخفيف التي يمكن تنفيذها لزيادة خفض الانبعاثات من قطاع الطاقة تعزيز نوعية الوقود وتعميم التكنولوجيات المتجددة والأجهزة ذات الكفاءة في استخدام الطاقة. وتقوم معظم البلدان العربية بتطوير سوق قابلة للاستمرار لاستثمارات الطاقة المتجددة. فبين عامي 2012 و2015، شهد إجمالي الطاقة المتجددة المركبة زيادة بنسبة 150 في المئة، فتجاوزت 3 جيغاواط باستثناء الطاقة الكهرمائية، مقارنة ب 1,2 جيغاواط عام 2012.

وتقع معظم استراتيجيات النقل المستدامة في واحدة من ثلاث فئات هي: تعزيز تكنولوجيا المركبات/ الوقود، وتحسين الطرق/المركبات، وإدارة الطلب. ولا يزال يتعين تنفيذ نظام رسمي للنقل الجماعي على نطاق واسع في المنطقة. فمحركات البنزين عموماً تنتج انبعاثات أقل ضرراً مقارنة بالديزل، وبالتالي فإن تشديد المعايير المتعلقة بنوعية البنزين سيؤدي إلى انخفاض كبير في الانبعاثات.

ويعد نجاح إدخال السيارات الهجينة والكهربائية في الأردن خلال السنوات الثماني الماضية مثالاً ساطعاً على كيفية تأثير السياسات المالية المستهدفة على السوق. ففي غضون بضع سنوات، ساهمت مجموعة من الإعفاءات الضريبية على السيارات الأنظف، وزيادة الرسوم المفروضة على تلك التي تطلق انبعاثات أعلى، في زيادة عدد السيارات الهجينة والكهربائية في الأردن لتشكل نصف عدد السيارات المسجلة حديثاً.

## الأبحاث البيئية

يواجه العالم العربي العديد من الضغوط البيئية التي تتراوح بين التحديات في إدارة الموارد ونقص المياه بسبب التلوث وتغير المناخ، والتي تتطلب جميعها أبحاثاً علمية جادة. وتساهم الدول العربية بنسبة 1,7 في المئة من إجمالي قيمة الموازنات التي رصدت للأبحاث البيئية في جميع أنحاء العالم. وتعد مصر والسعودية والمغرب وتونس من أكثر البلدان نشاطاً في الأبحاث العلمية العامة والأبحاث البيئية. وقد ازداد البحث العلمي في السنوات العشر الماضية، حيث قادت مصر العالم العربي في هذا المجال، تلتها السعودية، لكل من عدد ومعدل المنشورات المنتجة. وساهمت مصر بما لا يقل عن ضعفي حجم المنشورات العلمية مقارنة بالدول العربية الأخرى منذ عام 2008، ووصلت مساهمتها إلى ما معدله 26 في المئة من المنشورات البيئية بشكل تراكمي بحلول عام 2015. ويمكن أن يعزى ذلك جزئياً إلى عدد سكان مصر، الذي يمثل ربع سكان الدول العربية مجتمعة. وشهدت السعودية زيادة في الأبحاث منذ عام 2008 بنسبة 1,67 في المئة في متوسط المساهمات السنوية بالوثائق، يليها المغرب 0,59 في المئة، والعراق 0,35 في المئة، وقطر 0,18 في المئة.

الصحة والتلوث وعلوم وتكنولوجيا المياه هي أسرع المواضيع البحثية نمواً في مجال العلوم البيئية في العالم العربي، حيث ازدادت الأبحاث بمعدل مرتين منذ عام 2008، وتقود مصر العالم العربي في كلا المجالين. أما أبطأ المواضيع نمواً فهي تغير المناخ والسياسات البيئية والتنوع البيولوجي وحماية الطبيعة.

نادراً ما تنعكس نتائج المشاريع البحثية والمنشورات في البلدان العربية على السياسات، ونادراً ما تساهم في إيجاد حلول للمشاكل البيئية. وبعكس ضعف مساهمة وتأثير الباحثين العاملين في البلدان العربية، ساهم باحثون عرب يعملون في الخارج بشكل جيد في العديد من المجالات المتعلقة بالعلوم البيئية، وكان لهم تأثير عميق على المجتمع.

يتطلب تعزيز الأبحاث البيئية لإحداث أثر في البلدان العربية تهيئة ظروف تمكينية وبيئة عمل محفزة وربط البحوث بالسياسة العامة. ومن الخطوات الأساسية نحو تحقيق هذا الهدف بناء بنية تحتية تربط بين المؤسسات البحثية والصناعة والمجتمع وتخلق نظاماً متكاملاً يضمن التنمية المستدامة. وينبغي تعزيز الميزانيات المخصصة للبحوث البيئية، وإنشاء مراكز للتميز، وتعزيز التعاون البحثي بين البلدان العربية ومع المراكز الأخرى في أنحاء العالم. ويجب تحسين وتحديث آليات النشر لدى معاهد الأبحاث من أجل تيسير عملية النشر. ومن أجل سد الفجوة المتزايدة، ينبغي تشجيع الأبحاث في مجالي وضع السياسات وتغير المناخ. وأخيراً، ومن أجل عكس اتجاه هجرة الأدمغة المتمثلة في نسبة كبيرة من الطلاب العرب الذين يدرسون في الخارج ولا يعودون أبداً، ينبغي تشجيع الاستثمار في الباحثين الشباب ورأس المال الفكري.

## خاتمة

على الرغم من استمرار تدهور البيئة العربية، فقد حصل تقدم بطيء على بعض الجبهات. ولكن حتى هذا التحسن الصغير مهدد بأن تقضي عليه الصراعات والحروب وعدم الاستقرار.

ومن أجل ضمان الانتقال الناجح إلى بيئة أفضل كدعامة أساسية للتنمية المستدامة، تحتاج البلدان العربية بشكل عاجل إلى ترجمة إعلاناتها السياسية واستراتيجياتها الإقليمية العديدة إلى برامج عمل ملموسة. ويلزم تعزيز التعاون الإقليمي بين البلدان العربية، بما في ذلك المشاريع المشتركة في مجالات المياه والطاقة وإنتاج الأغذية، فضلاً عن الأبحاث والتعليم وبناء القدرات.

ويجب تقييم المكونات والموارد البيئية باعتبارها أصولاً ذات ثمن، مع تحديد قيمة نقدية لنضوب الموارد والتلوث، وإدراجها في الموازنات الوطنية. ومن الضروري اعتماد إدارة حكيمة تشمل سياسات مالية وأنظمة وحوافز سوقية مستقرة ويمكن التنبؤ بها، وتشجيع الاستثمار المحلي والأجنبي في مشاريع البنية التحتية الخضراء.

وفي نهاية المطاف، يشكل الاستقرار السياسي والأمن في البلدان العربية شرطاً ضرورياً لصياغة وتنفيذ خطط استراتيجية طويلة الأجل للتنمية المستدامة تشمل البيئة.

# ARAB ENVIRONMENT IN 10 YEARS

## 2017 Report of the Arab Forum for Environment and Development

ARAB ENVIRONMENT IN 10 YEARS crowns a decade of the series of annual reports produced by the Arab Forum for Environment and Development (AFED) on the state of Arab environment. It tracks and analyzes changes focusing on policies and governance, including level of response and engagement in international environmental treaties. It also highlights developments in six selected priority areas, namely water, energy, air, food, green economy and environmental scientific research.

AFED launched in 2008 the first report in its annual series entitled "Arab Environment: Future Challenges." That inaugural report provided for the first time a comprehensive baseline on the status of environment in the region, which the present report relied on to track changes over the past decade.

Eight topical reports followed, on Climate Change (2009), Water (2010), Green Economy (2011), Ecological Footprint (2012), Sustainable Energy (2013), Food Security (2014), Sustainable Consumption (2015) and Sustainable Development in a Changing Arab Climate (2016).

This report found that the state of environment in the Arab countries over the past ten years has been characterized by disparities. While progress was slow and the situation deteriorated in many aspects, there were advances in others, especially regarding matters related to governance and commitment to international treaties, particularly regarding climate change. Despite the lack of real progress in several countries, mainly those which are facing political unrest and instability, others have made strides towards shifting to a more sustainable path, with more financial resources directed towards investments in environmental infrastructure.

Despite slow progress, we noted with satisfaction that what AFED called for in its reports has become prime driver for policy reforms in many Arab countries. AFED continues to engage many regional players, including public policy officials, corporations, academia, NGOs, and the media, in a meaningful debate.

As part of the 2017 report, AFED carried out a public opinion survey across the Arab countries to track environmental perceptions and attitudes. Results showed that a majority of 80 percent thought that the environmental situation deteriorated or did not improve, while 95 percent found that their country is not doing enough to tackle environmental challenges.

It is hoped that this report will assist in developing robust policies and implementation plans for better environmental management, as pillar of sustainable economic and social development.

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*Arab Forum for Environment and Development (AFED) is an international not-for-profit, non-governmental, membership-based organization headquartered in Beirut, Lebanon. Members include corporations, universities, research centers, media networks, and civil society alongside government entities as observers. Since 2007, AFED has been a public forum for influential eco-advocates. During ten years, it has become a major dynamic player in the global environmental arena.*

*The flagship contribution of AFED is an annual report written and edited by experts on the state of Arab environment, tracking developments and proposing policy measures. Other initiatives include a regional Corporate Environmental Responsibility (CER) program, capacity building, public awareness, and environmental education.*

*AFED enjoys Consultative Status with the United Nations Economic and Social Commission (ECOSOC), and has an observer member status with the United Nations Environment Program (UNEP), the League of Arab States (LAS), and many other regional and international organizations and conventions. As an Arab think tank, it has played a major role in international negotiations on environment and development, including advising governments and regional organizations on matters such as climate change, green economy and sustainable development.*

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