POLICY PAPER NO. 2

# Food and Water Security: Important Post-Pandemic Drivers of Economic Growth and Social Development in the MENA Region

## A Technical Paper

*Shawki Barghouti*

GROWTH DIALOGUE INSTITUTE

POLICY PAPER NO. 2

# Food and Water Security: Important Post-Pandemic Drivers of Economic Growth and Social Development in the MENA Region

A Technical Paper

*Shawki Barghouti*

August 2021

GROWTH DIALOGUE INSTITUTE

Washington, DC 20006
Internet: www.growthdialogue.org
E-mail: info@growthdialogue.org



1 2 3 4 21 20 19 18

The Growth Dialogue Institute has been sponsored by the following organizations:

Korea Institute for International Economic Policy (KIEP)
The Center for Mediterranean Integration (CMI)



Cover design: Michael Alwan

# Contents

## About the Author

**Shawki Barghouti** is a Senior Adviser for the Growth Dialogue Institute and a consultant for The World Bank, USAID, and IFAD. In 2015–16 he served as the executive director of the USAID/SIDA-funded Middle East and North Africa Network for Water Research Center (MENA NWC) to support research and field studies designed to address the increasing challenges driving the interaction between food security and water security. From 2014–16, Dr. Barghouti served as a consultant to the International Fund for Agricultural Development (IFAD) and The Research Triangle Institute (RTI) to review national and regional strategies for agricultural growth and to prepare a strategic framework defining options for investment in agricultural development and water management and to advance public policies in food, agriculture, water, and natural resources. From 2007–12 he was Director General the International Center for Biosaline Agriculture (ICBA), Dubai, UAE. His work for ICBA involved research and development and capacity building in both science and technology and institution and policy development in agriculture and the water sectors. Dr. Barghouti was Director General of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) from 1997–99; Chief, Agriculture and Water Division in South Asia, The World Bank from 1980–97; Project Officer at the Food and Agriculture Organization of the United Nations (FAO) from 1971–74; and a Senior Officer in The Government of Jordan from 1963–67.

Dr. Barghouti holds a B.Sc. from University of Cairo, Egypt (1963), an M.Sc. from the University of Wisconsin (1968), and a Ph.D. from the University of Wisconsin (1971). A list of publications and books is available on request.

## About the Report

This Technical Paper was supported by a grant from the Center for Mediterranean Integration as part of a larger project, **A Post-Pandemic Development Strategy for Southern and Eastern Mediterranean Countries,** undertaken by GDI and authored by Carl J. Dahlman and Danny M. Leipziger (2021) and including an earlier version of this paper. Our thanks to the CMI for their support.

# Food and Water Security: Important Post-Pandemic Drivers of Economic Growth and Social Development in the MENA Region

*Shawki Barghouti*

## The Alarming Urgency of Water and Food Security Issues

Among the Middle East and North Africa (MENA) countries hit hard by the impact of COVID-19, water and food security are important drivers of economic growth and social development. These countries are at a crossroads and urgent action needs to be taken to avoid an impending crisis. In addition to increasing challenges caused by climate change, COVID-19 has compounded the burden of addressing the increasing demand for water and food in the region where managing these commodities was already encountering economic and political challenges.

Simple hygiene practices to limit the spread of COVID-19, e.g., handwashing, are adding additional pressure on already scarce and fragile water resources in most countries in the region. According to a recent World Bank Report "13 percent of the population—over 74 million people—still lacks access to handwashing facilities, and another 87 million people lack access to improved water sources in their homes." This situation forces them to congregate at crowded public sources to collect water, immediately increasing the risk of contracting the virus. Refugees and internally displaced persons in the region are also particularly vulnerable to the virus; 26 million of them have no adequate water supply and sanitation services (Nonay and Advani 2020).

Several MENA countries—especially Jordan, Palestine, Egypt, Tunisia, Algeria, and Morocco—have expanded the use of treated wastewater for reuse in agriculture and other sectors. Recent studies and reports from the United Nations Environment Programme (UNEP) have highlighted the alarming risks that traces of COVID-19 are likely to be found in wastewater treatment plants (UNEP 2020; Sarkodie et al. 2020). Water and health authorities in these countries are required to develop guidelines and tools for keeping such water infrastructure and its services safe and secure. As a result, these countries are expanding investment in water ingratitude and services to increase the use of treated effluent for their agricultural activities. This paper discusses the key issues that influence the fragile contribution of the water sector to economic growth and social development in the MENA region. These issues go beyond managing scarce water resources to including other components of the complex water system. While the public sector is responsible for developing, managing, and monitoring water resources, the role of main stakeholders and the private sector is crucial in delivering water services and other components of the water system.

This paper explores eight key issues that preceded the pandemic, but which have become ever more important due to the new stress placed on the region and the increased competition for domestic resources. There is a tendency to see water and food security issues in a longer-run context; however, both the urgency of the issues and the costs of continuing to ignore them

will make both recovery and long-term economic growth objectives harder to attain. It is for this reason that this Technical Paper has been prepared separately as part of the larger project on Post-Pandemic Growth Outlook in the MENA region.

A discussion of the eight key issues follows.

## Issue #1: Water security is at risk: current water resources are limited and new sources are expensive.

The MedEc First Mediterranean Assessment Report (MAR1) on *Climate and Environmental Change in the Mediterranean Basin—Current Situation and Risks for the Future* highlights the challenges facing the supply and demand of the water sector, especially in the southern Mediterranean countries. The report describes that water resources are limited, unevenly distributed, and often mismatched to human and environmental needs. Three quarters of the regional water supply is located in the northern Mediterranean while three quarters of the demand is in the south and east. As a result, 180 million people in the southern and eastern Mediterranean suffer from water scarcity (Fader et al. 2020).

To illustrate the gravity of the situation: the total human population of Mediterranean countries is rising and is expected to increase from 466 million people in 2010 to 529 million people in 2025. Thus, while only covering 2.6 percent of the freshwater resources, 7.4 percent of the world's population has to be supplied with water. Contrary to the total population development of the Mediterranean region, some single country projections show a decrease in population of 1–5 percent until 2025 and even 16 percent to 62 percent until 2100. Most of the countries with a negative population growth rate are in the northern Mediterranean region (Albania, Bosnia and Herzegovina, Greece, Italy, Malta, Montenegro, Macedonia, Portugal) except for Lebanon, which belongs to the eastern part (UN 2019). Comparing available freshwater resources to the population of the Mediterranean regions, the north has 36 percent of the population and 72–74 percent of the renewable freshwater, the east 24 percent and 19.5–21 percent, and the southern Mediterranean 40 percent and 5–8.5 percent respectively (FAO 2016).

**Main water resources have been developed.**

Countries in the southern Mediterranean region have developed a higher proportion of their available water resources and have constructed more water dams and storage per capita than any other region in the world (World Bank 2007). Today the region is at a crossroads. Conflict is taking a severe human and economic toll, fueling massive displacements of populations. What water remains available is dwindling, under pressure from rapid population growth and urbanization combined with climate change. Governments in the region have introduced new water policies and water laws to address growing risks to the water cycle, including water resources management; water transfer, treatment, and utilization; and water recycling. Governments are also increasing investment in modern water infrastructure, especially water data and information collection and advanced irrigation technologies.

### Box 1: Water Policies and Water Laws and Regulations in Selected MENA Countries

Tunisia, Algeria, Morocco, Egypt, and Jordan, as well as the West Bank and Gaza, have prepared water national plans and water strategies over the last decades. These strategies share an increased emphasis on the application of integrated water resources management. Integrated management includes important pillars: institutional development, efficient economic and financial management, and transparent policies for water allocation among economic sectors. These pillars are supported through advances in information and data systems, modern technologies, communications strategy aimed at engaging stakeholders, and reliable monitoring and evaluation systems to assess investments in the water sector by the public and private sectors. Water policies and laws and regulations are the public sector foundation of integrated management, and guide investment in the sector. Their functions include the following:

1. Guide sustainable management of water resources, including polices to regulate and monitor access to surface water and springs, to monitor and regulate groundwater resources, develop and define licensing and contract agreements to monitor water wells, and regulate extraction of shallow and deep aquifers.
2. Protect land use planning and watersheds for sustainable management of land water resources and enhance water usage upstream and downstream of watersheds.
3. Public sector regulation of the collection and reuse of treated wastewater, and monitoring water quality and application for agriculture, groundwater recharge, and environmental services.
4. Manage water desalination for better disposal of salt and minerals to protect costal zones and the marine environment.
5. Improve water services and management and enhance efficient financial management of water utilities to increase cost recovery, reduce water leaks throughout the water networks and reduce non-revenue water, and devise options to deliver water services to poor communities.
6. Build pricing structures for water and wastewater services to provide strong incentives for economical use above the threshold of a minimum daily requirement, and adopt water and sanitation service costs for both domestic and non-domestic use that balances economic, social, and environmental sustainability.
7. Monitor water quality accompanied by regulations to meet health and environmental standards for urban and rural communities.
8. Provide incentives to engage stakeholders and consumers in national campaigns to reduce water use, and to build and invest in wastewater treatment and disposal plans.
9. Modernize irrigation to expand the adoption of modern irrigation technologies and diversify cropping systems toward water-efficient crops.
10. Monitor the use of chemicals in water to protect human health and the environment, and establish national standards to monitor pollutants and unsafe chemicals in discharged wastewater.
11. Facilitate private sector investment in the water sector under well-prepared and transparent rules and regulations.
12. Invest in research and technology and support field lessons to better manage complex water systems at the national and local levels.

Table 1 summarizes the water situation in most MENA countries in 2010, including the main sources of water (surface and groundwater, desalination, and treated wastewater).

**Table 1. Water Availability and Usage in MENA Countries, 2010**

| | Annual availability | | | | Annual water usage | | % Use by sector | | |
|---|---|---|---|---|---|---|---|---|---|
| Country | Natural renewable resource $bm^3/yr$ | Desalinated end water $bm^3/yr$ | Waste-water reuse $bm^3/yr$ | Per capita renewable availability $m^3$ 2000 | $bm^3$ | As a % of total water resources | Domestic | Industry | Agriculture |
| Algeria | 12,345 | 0.07 | Nag. | 380 | 4.59 | 40 | 25 | 15 | 60 |
| Djibouti | 0.02 | 0.00 | Nag. | 24 | 0.02 | 113 | 88 | 0 | 12 |
| Egypt | 61.90 | 00.06 | 5.90 | 1,060 | 73.10 | 108 | 6 | 8 | 86 |
| Jordan | 0.87 | 0.00 | 0.07 | 193 | 0.98 | 104 | 26 | 7 | 68 |
| Lebanon | 3.20 | 0.00 | n.a. | 740 | 1.29 | 40 | 28 | 4 | 68 |
| Libya | 0.80 | 0.03 | n.a. | 157 | 3.89 | 469 | 9 | 4 | 87 |
| Morocco | 20.00 | 0.02 | 0.07 | 700 | 16.84 | 84 | 5 | - | 95 |
| Syria | 18.70 | 0.00 | 0.26 | 1122 | 14.70 | 78 | 9 | 1 | 87 |
| Tunisia | 3.35 | 0.00 | 0.14 | 365 | 2.53 | 72 | 12 | 4 | 84 |
| West Bank and Gaza | 0.76 | 0.00 | 0.01 | 260 | 0.44 | 57 | 51 | 49 | |

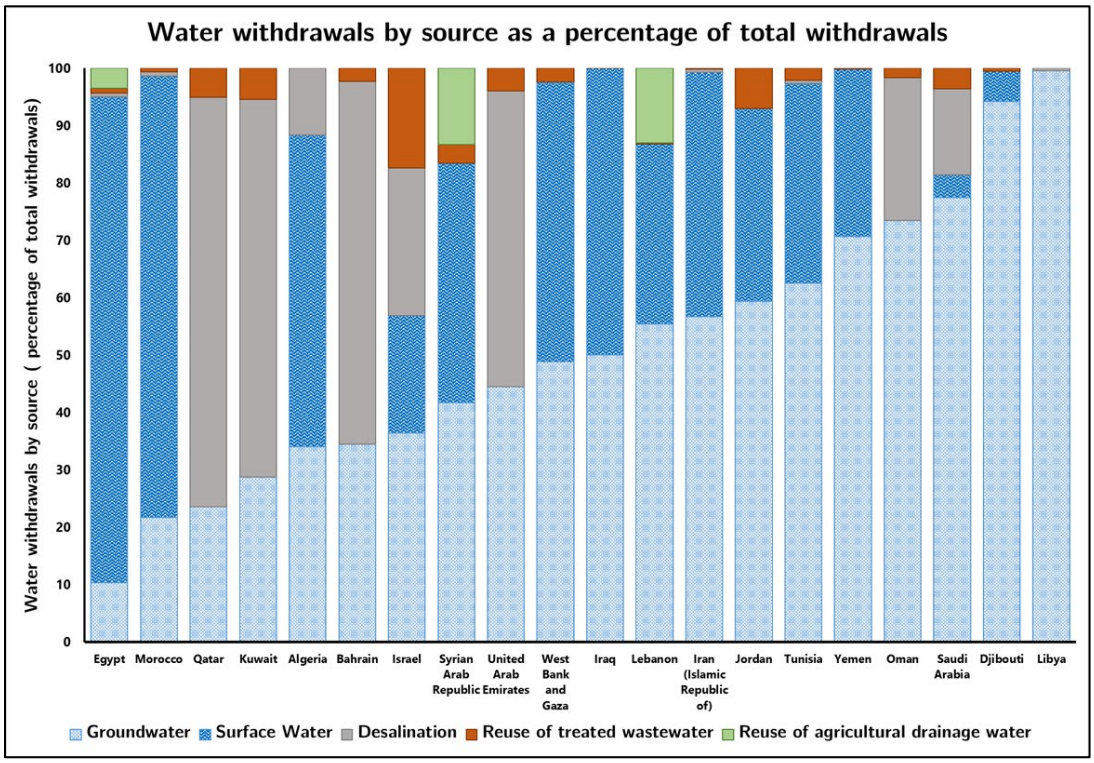
*Source:* AFED (2010).
*Note:* $m^3$ = cubic meters; $bm^3$ = billion cubic meters

Surface water is limited and subject to increasing variability due to climate change and increasing risks of droughts and floods. River basins draining into the Mediterranean Sea cover an area of over 5 million square kilometers ($km^2$), including the entire Nile River basin. Of these rivers, seven rivers are located in the northern Mediterranean countries, two in the eastern Mediterranean (Turkey), and one (the Nile) in the southern Mediterranean. Consequently, 71 percent of the mean annual discharge into the Mediterranean Sea originates from the northern region, whereas the eastern countries contribute 12 percent and the southern 17 percent. Due to the Mediterranean climate, precipitation is mostly available for river discharge during autumn, winter, and spring. Some Mediterranean rivers have an ephemeral or intermittent flow.

**MENA countries have different water resource endowments that shape their broader water challenges (see Figure 1).**

Some countries rely most heavily on groundwater, while others are more reliant on large and medium transboundary rivers.

**Figure 1: Water Withdrawals by Source as a Percentage of Total Withdrawals, by Country and Economy, 2010**




More countries in the region are investing in non-conventional water resources such as desalination and recycling used water for non-potable uses as alternatives to the continued withdrawal of non-renewable 'fossil' groundwater.

**Non-conventional water resources are expensive.**

Jordan Tunisia, Egypt, the West Bank and Gaza, and Israel have to increase investment in the following areas:

*Treatment and reuse of wastewater*

1. Increase household connectivity to wastewater treatment networks/other sanitary disposal facilities.
2. Enhance treatment capacity to match demand for reuse and ensure efficiency and safety of treated wastewater usage for activities that provide the highest return to the economy.
3. Develop a comprehensive package for water supply and water treatment hygiene improvement in all schools to promote hygiene and health awareness amongst children.
4. Enable better reuse of treated wastewater and increase locations and facilities in participation with beneficiaries and local communities. This will facilitate decentralized systems of water management.
5. Enact a sanitation strategy that takes health, hygiene, and environmental imperatives into consideration while implementing the larger task of waste and wastewater treatment in urban centers and small towns.

6. Create a strategic national infrastructure framework for a well-coordinated sanitation development for wastewater collection and treatment facilities in all major cities and small towns. For localities with fewer than 5,000 inhabitants, construction of wastewater collection and treatment systems is not proposed unless the localities are in close proximity to existing treatment and collection facilities or face exceptional circumstances based on sanitation and health considerations. About 28 percent of the national population falls in this category. Because sanitation implementation is a shared responsibility, inclusion of all aspects of sanitary disposal of liquid and solid waste and hygiene promotion will need to be part of a single unifying sanitation policy framework that encompasses the work of several relevant sectors including health, education, housing, and municipal and rural development. The MWI will initiate and coordinate the development of such a unified policy framework on sanitation around which all government and other relevant entities can develop their appropriate and harmonized approaches and inputs.

7. Assess options for recycling treated wastewater to recharge groundwater, enhance environmental services, and expand forestry and green cover in select watersheds.

***Desalination of brackish water and seawater:***

The cost of desalination and treated and recycled wastewater is declining through investment in scientific research by both government water agencies and the private sector. Algeria, Morocco, Tunisia, Jordan, and Egypt are increasing allocation to water research and development. Investment in science and technology is a crucial driver for sustainable development in all countries. The research cited in Table 2 confirms the importance of new knowledge as a crucial national asset through long term and substantial investment in scientific inquiries. Public investment in applied research for development (R&D) has evolved in these countries to become a major component of the national intellectual infrastructure to guide and inform water public policy and to create an important input for innovations. The objective of this investment by these countries is to target selective water issues rather than trying to import a full set of institutions and policies from elsewhere. These countries also confirm they are keen on building partnership with water research and study centers in Europe and the United States.

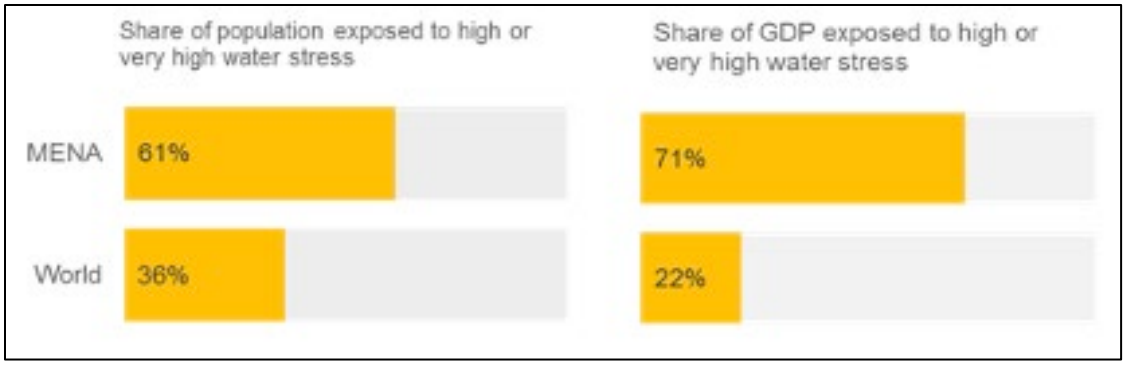
## Table 2: Investment in Non-conventional Water Resources in MENA

| Country | Desalination of brackish and sea water | Treated wastewater and reuse |
|---|---|---|
| Tunisia (Bouchrka, Jouber, and Bardi 2015; Jemli 2015) | Tunisia sees desalination as a way to bridge the gap between water supply and demand within an integrated water resources management framework. More than 110 desalination plants have been constructed, mainly for domestic water supply, and have a capacity of about 200,000 cubic meters per day ($m^3$/day). Desalination has been introduced gradually, even though it is the only possible alternative for the production of fresh water for domestic use. Its cost is still high, mainly because of the initial investment required and subsequent operation and maintenance costs. | The government developed a national strategy for wastewater reuse to promote reuse for agricultural irrigation and other purposes. About 80 percent of the used water is treated and recycled in Tunisia, or about 5 percent of available water resources. The main wastewater treatment plants are located along the coast to protect coastal resorts and prevent marine sea pollution. More than 75 percent of treated wastewater is not yet reused and is discharged into the environment to become part of the hydrological cycle. Also discharged is wastewater from communities unconnected to the sewerage network. |
| Israel (Marin et al. 2017) | Israel uses large-scale desalination of seawater and brackish water to supply almost all potable water that municipal and regional utilities distribute in the country. Five “mega” seawater reverse osmosis (SWRO) desalination plants supply 85 percent of domestic urban water. In a bid to achieve water security, Israel has opened five desalination plants since 2005 and plans to expand that effort in the coming years. Roughly 40 percent of Israel's drinking-quality water now comes from desalination and this source is expected to hit 70 percent in 2050. | Reuse of treated wastewater for irrigation allows Israel to replace and release scarce fresh water for domestic and industrial uses and to safeguard the environment. More than 87 percent of treated wastewater effluents are reused for agriculture, representing approximately half of all irrigation water nationwide. Widespread tertiary wastewater treatment makes unrestricted reuse for irrigation possible. |
| Algeria (Drouiche et al. 2012) | Algeria has turned to desalination to meet increasing demand for water from expanding urbanization. Thorough public-private partnerships, the government and national companies build, operate, and transfer (BOT) projects for the desalination of seawater. The Algerian government has built desalination plants designed to reach a volume of 1 million $m^3$/day in the next five years and about 4 million $m^3$/day by the year 2020 | The number of water purification plants in Algeria exceeds 60, with a total purifying volume of approximately 1 million $m^3$/day. Over the last 30 years, Algeria has invested US$15 billion in this technology. The government’s five-year development plan for the years 2009–13 includes the construction of five additional plants (Table 2). These plants are expected to expand treatment capacity by 554,512 $m^3$/day, to be added to the 20 plants already under construction or built. |
| Morocco (Kurtze et al. 2015) | Inland areas of Morocco are focusing primarily on wastewater treatment. In the limited space of the urban coastal cities, a desalination plant is often the most efficient way to provide water to local residents. These plants generally operate using one of two methods, membrane filtration or distillation. The largest desalination plant in Morocco (Laayoune Desalination Plant) is run by a national company through a BOT contract with the government. | Wastewater treatment is relatively new to Morocco. Prior to 2009, recycling and purifying facilities were independently owned and competed against one another. This caused nearly all facilities to fail, forcing them to close due to high overhead and running costs. The Moroccan government responded by centralizing the wastewater industry and built 43 wastewater treatment plants utilizing stabilization ponds in rural settings. Stabilization ponds are used to separate hazardous materials and heavy metals from water. The total length of wastewater treatment pipe is about 13,000 km. |
| Jordan (Jordan 2016) | Current investment in desalination is limited to one plant in the south on the Red Sea. Long-term plans are being negotiated with Israel and the West Bank and Gaza to connect desalination with an ambitious project to build a canal connecting the Red Sea with the Dead Sea to distribute brine from the Dead Sea and to slow the sea’s drying. | As a result of the risks of COVID-19, the government is increasing household connectivity to wastewater treatment networks/other sanitary disposal facilities and enhanced treatment capacity. These actions match demand for reuse and ensure efficiency and safety of treated wastewater. The government is supporting activities that provide the highest return to the economy, improve hygiene and health awareness, and reduce environmental impact. |
| Egypt | The country has developed plans to build desalination plants for sea and brackish water to serve costal cities in West Egypt. These plans also support development of of South Sinai—the triangle between the ‘horns’ of the Red Sea. | Non-conventional water, including brackish water collected from drainage canals and municipal wastewater, is used for agricultural irrigation. Water utilities in Egypt are expanding the collection and treatment of used water for recycling. |

## Issue #2: Conflict over shared scarce natural resources is increasing.

Conflict is common in the region and is creating a vicious cycle of insecurity. Half of the top 10 countries with the highest internally displaced people due to conflict in 2015 were located in the MENA region (IDMC 2016). MENA has the largest refugee population in the world (PRB 2001). Countries such as Lebanon and Jordan are hosting large numbers of refugees, resulting in further pressure and demand on their already vulnerable resources (Lebanon 2014). Most of the MENA population lives in high or very highly stressed water areas, compared to a global average of about 35 percent (see Figure 2). Over 70 percent of the region's GDP is generated in areas with high to very high surface water stress, compared to a global average of some 22 percent (World Bank 2018).

**Figure 2: MENA's exposure to high or very high water stress is greater than global averages**




*Sources:* World Bank (2018); "Estimates for the Middle East and North Africa from the World Bank." World averages were taken from Veolia Water and IFPRI 2011.

Water resources per capita in MENA are just one sixth of the world average (FAO 2015). The road ahead to increase water availability is difficult and expensive. Countries in the region have developed a higher proportion of their available water resources and have constructed more water dams and storage per capita than any other region in the world (World Bank 2007). The region has always coped with water scarcity but today is at a crossroads. Conflict is taking a severe human and economic toll, fueling massive displacements of populations. What water remains available is dwindling, under pressure from rapid population growth and urbanization combined with climate change. Governments in the region have introduced new water policies and water laws to address the risks of increasing water security throughout the water cycle, from water resources management to water transfer, treatment, and utilization and water recycling for reuse (Box 1). Countries have also increased investment in water infrastructure and in scaling up water technologies designed to increase water productivity (World Bank 2018).

## Issue #3: Cooperation in managing transboundary water resources is limited.

**Surface water resources are fully utilized.**

A large portion of water resources in MENA is transboundary. About 60 percent of surface water flows across international boundaries, and all countries share at least one aquifer with a neighboring nation (World Bank 2017). All major surface water bodies are shared: eleven riparian countries share the Nile; Turkey, Syria, and Iraq and the Gulf countries share the Tigris-Euphrates; Syria, Jordan, and Israel share the Yarmouk River; and Lebanon, Syria, Jordan, and the West Bank and Gaza share the Jordan. Yet, there are no management and water benefit sharing agreements among the riparian countries. This situation is in contrast with the agreements reached in the 1960s between India and Pakistan for sharing the waters of the Indus Basin; or the European countries' legal agreements for sharing the management of the Danube; or the 1940 agreement between Mexico and the United States to manage and protect the Colorado and Tijuana rivers in the border region.

The complex political dimension of shared water resources is a major barrier to productive cooperation among riparian countries. Most dams and storage infrastructure have been built along the main international rivers of the region with little or no cooperation between upstream and downstream riparian. Turkey built dams on the Euphrates with little or no cooperation from Syria and Iraq. Israel and Lebanon, Syria, Jordan, and the West Bank and Gaza have divided water allocation of the Jordan river and the Yarmouk with little consideration to the impact on the environment of the Jordan Basin. As a result, the Dead Sea is drying and is suffering environmental risks similar to those observed in the Aral Sea in Central Asia.

The latest example of limited collaboration is the conflict between Egypt and Ethiopia over the construction of the Grand Ethiopian Renaissance Dam. The dam is being built close to the Sudanese boarder with limited consultation with Egypt or Sudan. In addition to sharing surface water running through international rivers, all countries in the region share at least one aquifer with a neighboring country with no agreements for joint management of shared groundwater resources. Cooperation among the riparian countries has been narrow and restricted to sharing water resources. Every effort should be made to expand cooperation to cover the complex issues of water's role in regional development, including water quality and priority allocation to sustain human needs.

**Groundwater resources are under increasing pressure of abstraction.**

Water demand in Northern Africa is increasingly met by non-renewable water resources. More than 60 percent of water is withdrawn from fossil resources and more than 30 percent from overexploited renewable groundwater. Groundwater has been increasingly tapped in most countries to supplement the widening water deficit, specially to meet the growing need for drinking water to the expanding urban populations in Jordan, Tunisia, Algeria, Morocco, and the West Bank and Gaza. These countries have also expanded their use of treated wastewater to recharge groundwater aquafers. The MedEC water report points to the risk of recharge of groundwater aquifers with treated wastewater, which is often seen as critical because of potential water quality problems (Fader et al. 2020). Application of this technique is therefore often restricted by regulatory authorities and lacks public acceptance. Special attention is

needed to monitor water quality of tapped groundwater, especially from shallow aquifers, that is being provided to households.

COVID-19 has placed a new burden on already scarce and expensive water resources in MENA. There is an increasing risk of contamination from reused treated wastewater to recharge groundwater especially related to COVID-19. Greater efforts are needed to ensure a safe water supply and sanitation and to assess hygienic requirements to control the spread of the virus (UNEP 2020; Sarkodie et al. 2000).

Most countries are expanding investment in groundwater drilling and connecting rural and urban communities to new sources of water. But competition for groundwater from both national and transboundary aquifers for agricultural water has increased across the region. Groundwater forms the basis for the rapid growth of new agricultural economies of most countries in the region. Every country in the region is now experiencing the challenge of groundwater depletion, and the overall high rates of withdrawal of both surface and groundwater are hardly enough to meet the growing needs for clean water supply and sanitation and to sustain irrigated agriculture. These trends make agriculture vulnerable to water claims from other sectors, in addition to the risks of climate change that do not recognize national boundaries (GEF 2015; FAO 2016).

The "Water" chapter of the MedEC report presents detailed information about transboundary groundwater aquifers in the North African countries of Tunisia, Algeria, Jordan, and Morocco (Fader et al. 2020). These countries have recognized the complex problems of managing shared groundwater resources and have introduced regulations to regulate drilling wells and license water extraction (Box 1). Algeria, Morocco and Tunisia, Libya and Egypt are expanding investment in large transboundary aquifers, with limited agreements among the riparian countries for sharing groundwater resources (Fader et al. 2020).

The implementation of these policies is not easy because of political and governance issues. For example, targeting subsidies to the energy requires attention to the complex political economy of the energy sector. But the implementation of these regulations needs further enforcement as groundwater, like surface water, is a fluid that recognizes no national boundaries. Conflict is common over groundwater use between both private owners as well as sharing nations. Criteria for establishing rights and equity in sharing groundwater resources are not adequately clear or well defined in many countries. Where groundwater flows naturally from one state to another, cooperation is needed in areas such as the exchange of information and data required to better monitor and manage both water quality and quantity, and to enforce agreements reached. Especially important is the sharing of information on water recharge and other changes in water tables in order to coordinate and adjust withdrawal rates among the riparian owners or states. The over-extraction of groundwater beyond safe yield levels has resulted in the pollution of existing groundwater aquifers, due to intrusion of saline seawater and the upcoming of brackish and saline water supplies from lower aquifers. Throughout the region considerable public and private investments have also been made in groundwater irrigation without paying heed to the sustainability of the shared water resources.

The absence of a strategic national water framework to protect non-renewable water supplies, especially for future generations, is causing many MENA countries to waste precious water resources on activities such as cultivating low value crops, which have not received adequate economic or environmental assessment and evaluation. This situation could be addressed

through carefully developed and articulated integrated water management approaches specifically designed to change the way groundwater is being abstracted and used. This requires an appreciation that groundwater is part of the integrated water cycle in the country, and part of a river basin that includes both surface and underground water flow networks. This recognition is essential to harmonize water use among high-priority social and economic objectives, within a framework that also takes into consideration the water needs of future generations. Efficient management of groundwater resources recognizes that some of the tapped aquifers are connected with the national hydrological network of both surface and underground, and thus may also be recharged by the irrigation networks distributing surface water to the fields. As such, managing groundwater becomes an integral part of national water plans.

Most North African countries are increasing investment in water science and technology to model data on the vulnerability of ground water resources. These investments are being used to monitor groundwater reserves and to study groundwater depletion and possible exhaustion of water resources at local or national levels. The main challenge facing such analysis is the lack of a detailed understanding of when a depleting resource becomes unviable for further exploitation. The question is not simply how much water is physically available, but when the financial costs and environmental and water quality impacts of extracting more groundwater render the resource unviable for human applications. Scientists and modelers employ a global and local data set to specify the cost of groundwater extraction as a function of depletion and to test if future rates of groundwater depletion could be reduced by higher extraction costs. Regions that deplete water to costly levels lose competitive advantage for crop production, which shifts to regions where water resources are cheap and plentiful (Turner et al. 2019).

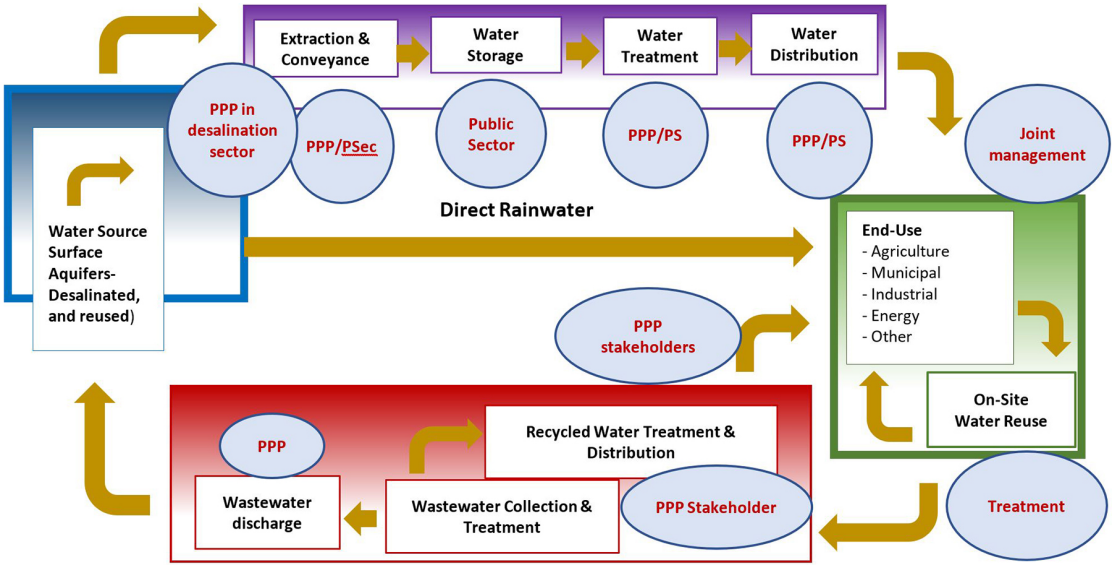
To improve access to these shared resources, governments in North African countries have updated their water regulations and established a joint technical commission for water resources planning and management. The commission will facilitate exchange of information and data management, including monitoring water use, pollution, and environmental conditions. To date, the riparian countries have not approved legal agreements. Despite a long history of shared water management in the region, there have been limited cooperative agreements for joint management of transboundary water. Absence of cooperative agreements on transboundary water resources has had severe consequences on livelihoods and ecosystems. Cooperation over transboundary waters is especially complex when conflict and fragility affect riparian countries.

Working together within countries and across boundaries is essential for collective management of transboundary water resources and associated issues, including increased regional floods and droughts because of climate change. Although there are joint actions plans for the large aquifers in North Africa, unfortunately, no legal agreements have been signed regarding the transboundary rivers or to regulate groundwater aquifers in the region. By contrast, the Pakistan/India agreement governs sharing of the Indus Basin; and there are more than 170 legal agreements among countries along the Danube River. Efforts by international organizations should be made to encourage cooperation to sign binding agreements among the riparian countries in the region.

## Issue #4: Public private partnership (PPP) is increasing in the water sector.

Most countries in the region have expanded the use of public-private partnerships (PPPs) in managing several components of the water system (see Chart 1). The most common PPP is with water utilities to tackle financial constraints in water service delivery. In particular, PPPs with utilities are important tools available to governments for improving water services to enhance protection against COVID-19. Reliable services and clean water are essential to maintain high standards of hygienic practices at the household level. Note that financial sustainability affects the performance of water utilities, including improvements in efficiency and quality of service delivery.

**Chart 1: Overarching Innovation Data, Water System Management, Water/Energy Nexus, Water Quality**




*Source:* Hannegan (2014), modified for this note.

PPPs with water utilities have mostly worked using management and performance-based contracts. While water pricing and cost recovery are important in the performance of water utilities, the spread of COVID-19 and the risk of contamination of water supplies requires that the public sector closely monitor the performance of water utilities to ensure they effectively handle the extra hygienic requirements. These issues should be clearly defined in the type of partnership, where ownership of the assets remains in the hands of the public utility. The engagement of the private sector has not been easy because of weak governance and weak engagement by the stakeholders and water users in designing the conditions under which each component of the water system would be managed and delivered.

According to UN Resolution 64/292, drinking clean water is a human right.[1] Therefore, engagement of the private sector in this service, especially in the era of widespread COVID-19, requires careful assessment of the risk of neglect of this serious challenge for private profit.

Chart 1 above is adapted here to suggest that the complex water system requires an elaborate policy framework to define the roles of government, the private sector, and users as integrated stakeholders of this system. Water services are essential to effective management of COVID-19 at the national and householder level, which requires close cooperation among the stakeholders in the water system as described in the chart. The public sector is crucial to developing and managing and protecting water resources and water quality as a public good. This includes building and managing water infrastructure such as river banks and dams, national water distribution networks, water storage, and water quality and treatment facilities. The public sector is also responsible for monitoring and establishing public data for health hygienic data, hydrology of water resources, and water information services. Private sector firms, water users, and other stakeholders can play crucial roles in managing and delivering other components of the water system, such as joint management, operation, and cost recovery of water delivery services and water collection and treatment and reuse. Engaging the private sector and the stakeholders requires transparent governance, responsive water laws and regulations, and competent legal and regulatory capacity in public water organizations.

## Issue #5: Food security in the region.

Currently, ample food supplies exist globally despite the pandemic. COVID-19 has caused disruptions to the food supply chains around the world and raised concerns about food security. Global cereal markets are expected to remain well supplied and balanced but localized disruptions, largely due to logistical issues, pose challenges to the functioning of the food supply chains of several countries in the region. FAO reports indicate that food supplies and reserves are currently satisfactory in most countries in the MENA region, but worries remain for countries affected by conflict and instability.

For decades, countries in North Africa and East Mediterranean have been allocating more than 75 percent of their scarce water resources to the agricultural sector to enhance food security, despite the fact that all countries in the region are increasing their dependence on international markets for main staple food commodities. While domestic food production has increased due to substantial investment in modern agricultural and irrigation technology (FAO 2009), the increase is not enough to secure food for the growing population which has more than tripled between 1970 and 2020 (FAO 2020) (see Figure 4). The "Water" chapter in the First Mediterranean Assessment Report (MAR1) describes advances in irrigation technologies adopted in the region (Fader et al. 2020). FAO data confirms that these countries have expanded the adoption of micro-irrigation to enhance the efficiency of crop irrigation. Water scarcity and challenges caused by climate change, including frequency and intensity of

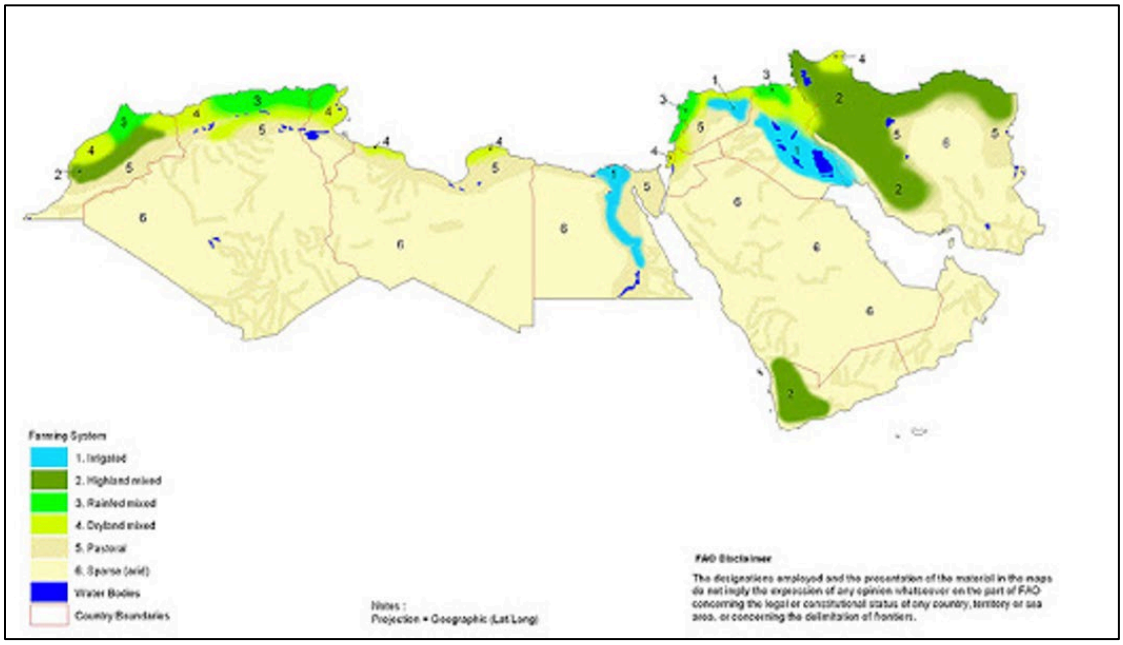
[1] On July 28, 2010, through Resolution 64/292, the United Nations General Assembly explicitly recognized the human right to water and sanitation and acknowledged that clean drinking water and sanitation are essential to the realization of all human rights. The Resolution calls upon States and international organizations to provide financial resources, help capacity-building and technology transfer to help countries, especially developing countries, to provide safe, clean, accessible, and affordable drinking water and sanitation for all.

drought and floods and rising temperature in the region, will restrict opportunities to improve irrigation.

These countries have differentiated exposure levels to the impact of COVID-19. While most countries may withstand the initial supply- and demand-side shocks associated with COVID-19, a deepening of the global economic recession and prolonged disruption in the global and local supply chains may have considerable impacts on production, availability, and access to food. Countries affected by conflict and instability in the region are the most at risk. Conflict countries are already host to more than 28 million people in a crisis situation or worse, and may descend further into food insecurity, especially if the lifeline of food assistance is cut or disrupted (Mrabet et al. 2020).

Geography and climate combine to impose severe constraints on agriculture production in much of MENA. Vast deserts stretch across North Africa in Jordan and Syria, leaving little arable land for most of the region's population.

**Figure 4: Major Farming Systems, Middle East and North Africa**




*Source:* FAO.

Growing populations, in fact, have reduced per capita arable land availability to 0.19 hectares, one of the world's lowest rates (Nigatu and Motamed 2015; FAO 2014). Exceptions exist, of course. In particular, the historic Fertile Crescent—which includes Turkey, Lebanon, parts of Syria and Jordan, and the Nile River Delta—offers sufficient moisture to sustain productive agriculture.[2] Rain-fed agriculture in MENA is supplemented with irrigation systems on about 30 percent of arable land.

[2] Historically and scientifically the Fertile Crescent is recognized as the center of origin of wheat, barley, lentils, and chickpeas, which have formed the main diet of the region for centuries. Larger global producers of these crops rely on wild relatives that still grow in the MENA region to enhance breeding varieties resistant to disease and climate.

Climate change projections indicate significant warming and drying in the Mediterranean Basin, together with intensification of climate extremes such as drought and heat waves. The MedEC report warns of severe impacts on the agriculture sector are to be expected if no adaptation and mitigation will take place. These impacts include changes on crop production and fishery and marine food ecosystem. The impact is likely to be on crop phenology and growing cycle of many crops. Immediate risks of climate change observed in rainfed agriculture are large swings in year-to-year yields and in the evolution of pests and disease of plants and livestock due to changes in fermeture and humidity.

MENA's marine food production has also declined due to overexploitation. Mediterranean total fishery landings have been declining in recent years (FAO 2018), as are the reconstructed catches that included discarded, illegal, and unreported and recreational fishing. Total landings of the entire Mediterranean basin exceeded 1.16 million tons in 1994 and declined to around 842,000 tons in 2017. Climate change is projected to heavily impact marine food resources, which are overexploited already. Ocean warming, acidification, water pollution, and constrained marine migration possibilities to cooler areas (due to sea enclosure) may lead to local extinction of up to 50 percent of exploited fish and marine invertebrates by around 2050. Pollution from anthropogenic activities also affects fish population, notably in the Nile delta, with potentially serious consequences on human food security (Mrabet et al. 2020).

Land and water are scarce, and both rain-fed and irrigated land in use suffer from ongoing degradation caused by wind and water erosion and unsustainable farming practices. Of the total land area of the MENA region, only one third is agricultural land (cropland and pastures), while only 5 percent is arable (cropland). The rest of the land is either urban or dry desert.

Unfortunately, poor land use planning has combined with political expediency. Most urban communities built and expanded in the last four decades have done so at the expense of arable lands surrounding existing cities rather than building cities in the marginal zones of most countries. The growing urban populations in Egypt, Jordan, Israel, and the West Bank and Gaza have expanded around urban centers traditionally built around water resources. Egypt has expanded settlement in the western desert through substantial investment in groundwater. More recently, Egypt and Jordan have initiated strict land use planning to prevent further encroachment on diminishing agricultural lands. Egypt is investing in infrastructure to expand settlements in the western and eastern deserts of the country. The increasing pressure on limited productive lands and water resources has diminished the regional capacity to feed its growing and urbanizing population (OECD-FAO 2018).

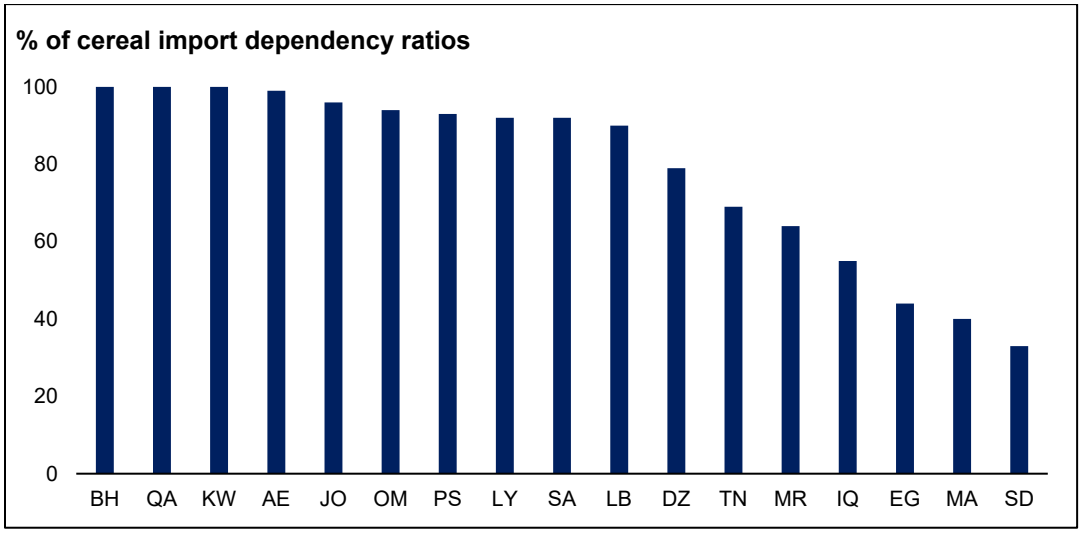
With urbanization growth at the expense of currently cultivated land, and with little prospect to expand cultivation into new lands, farmers are transforming their farming system to produce high-value crops as the next generation for food and water and sustainable environment (FAO 2018).

While production has grown over the past decade, cereal yields across the MENA region average around 1.9 tons per hectare, well below the 3.7 tons per hectare world average (FAO 2014). Gaps between world and regional average yields for all crops combined are estimated at 60 percent in North Africa and 49 percent in the Middle East (FAO 2011), suggesting considerable room for growth through improved inputs and pests and disease management.

When all inputs are calculated including the opportunity cost of water resources, the cost of producing one ton of cereal crops in the MENA region is much higher than the cost of one

imported ton from the main producing countries in Europe or the Americas. Because of the above constraints, the region is the largest grain-importing region in the world (Chart 2).

**Chart 2: Cereal import dependency ratios (in percent) of selected MENA countries**




*Sources:* FAO 2020; FAOSTAT (reference year: 2017).
*Note:* The cereal import dependency ratio is defined as the share of imported cereals in domestic consumption. It is calculated using the following formula: Imports/(imports + domestic production—exports)

Severe constraints on arable land and water, coupled with a growing population and rising incomes, make the region inherently dependent on imports to meet rising demand for food, particularly cereals.

These imports became exorbitantly expensive in recent years, as world market prices for cereals were high and erratic. As a result, MENA countries, as well as food-importing countries throughout the world, have placed a new premium on designing strategies for improving food security by reducing the risks that accompany being a food-importing nation. The three main risks of food security facing the region are: (i) availability risk, i.e., the risk that grains may not be available for import, potentially because of crop failures in producing countries or due to there being barriers to import (physical or political); (ii) counterparty performance risk, i.e., despite grains being available at an acceptable price, the party who contracted to deliver the grain defaults on the contract; and, (iii) price risk, i.e., the risk that the price of imported grains will increase above levels that the importing country considers to be acceptable and/or may be able to afford (Sadler and Magnan 2011).

## Issue #6: Increase investment in science and technology to develop an innovative pathway toward food and water security during natural disasters and pandemics.

Key messages include:

a. Increase investment in national science-based programs to guide policy for sustainable and resilient agriculture and water resources.

b. Strengthen partnerships with the Mediterranean and CGIAR[3] research networks and the national stakeholders.

c. Build inclusive research and development programs in partnership with stakeholders and the private sector.

The global impact of the COVID-19 pandemic is evident in the massive disruptions to health, economies, and livelihoods in the countries of North Africa and the East Mediterranean. These countries have been building on existing programs, institutions, and partnerships to address the challenging impacts of the pandemic. These challenges include health risks; social and economic containment measures such as social isolation directives, travel bans, and border closures; and how these measures form threats to food, nutrition, and water security. The impact of COVID-19 also includes the disruption of food systems and the food supply and value chains, which can increase the costs of farming inputs and other imported goods. The food security crises linked to COVID-19 are driven by disruptions in local job and product markets. Massive income and remittance losses have reduced both urban and rural households' ability to purchase food. In addition, supply disruptions to local markets have reduced food availability and increased local food prices.

The response of the countries of North Africa, including Egypt, Tunisia, Algeria, and Morocco, to the impact of COVID-19 on food security builds on their track record over the past decade. The food security agenda in these countries is large and urgent. Health crisis and the consequent economic downturns caused by COVID-19 elevate the risk of new and different types of food crises, attended by growing poverty and malnutrition. In particular, the dramatically increased food insecurity in the poorest and most vulnerable communities demands attention (UNICEF 2020).

The North Africa countries have made progress on their long-term and short-term programs designed to enhance the resilience of their food and water systems. Important drivers of these programs are: (i) expanding support for science-based interventions; (ii) enhancing partnerships with national stakeholders and international centers of excellence in research and development; and (iii) strengthening institutional capacity and related government policies at national and local levels.

In the face of the pandemic, science on resilient, healthy, and sustainable food systems has never been more critical. Spreading fast, the COVID-19 pandemic is exposing gaps and exploiting weaknesses in every nation's disease preparedness, socioeconomic equity issues, and levels of resilience. Addressing these challenges requires solutions from across health, economic, food, social, environment, cultural, and business sectors. That so many diverse sectors and actors must contribute to an effective response to this pandemic necessitates that national agriculture and water and nutrition research play an increasing role in combating the risks of pandemics along with other natural disasters.

These countries have expanded investment in agriculture and water research and development to address challenges facing food and water systems. In Egypt, the Agricultural Research Center has developed high-yielding food crop varieties and fruit and forest trees resilient to

[3] Consultative Group on International Agricultural Research; https://www.cgiar.org/.

drought and heat and diseases. In addition, Egypt's National Water Research Center has been playing a crucial role in developing technologies to inform policies and investment in irrigation for food crops and water management at the national and local levels.

In Tunisia, the National Agricultural Research Institute of Tunisia (INRAT) has a successful record in helping farmers address challenges facing dryland agriculture where drought and heat are often severe and numerous biotic stresses affect the wide range of crops grown. The center has helped farmers test and adopt modern irrigation technologies to increase water productivity through the expansion of drip irrigation on more than 60 percent of irrigated land in the country. INRAT has produced wheat, barley, grain, legumes and vegetables, olives, dates, and forestry numerous varieties and crosses for evaluation and testing at several sites in the country (Stads, Allani, and Hedri 2005).

In Morocco, the National Institute for Agricultural Research (INRA) has been playing a crucial role in advancing research to develop resilient heat- and drought-tolerant cereal crops, vegetables, olives, dates, and forest trees. INRA is organized as a network of 10 regional research centers in the main ecological zones of the country.

These centers promote science-based interventions needed to address the short-term impacts of natural crises such as COVID-19. Their record is well documented in conducting research on climate change, including floods and drought, as well as early warning systems to guide national preparedness to address challenges such as those caused by pandemics including COVID-19. The research centers help guide these countries to rebuild their food systems for the long term (Verner et al. 2018; World Bank Group 2021).

## Issue #7: Agriculture, trade, and water productivity.

Recent studies indicate a diet transition affecting the Mediterranean countries and posing a threat for the preservation and enhancement of the Mediterranean diet. These changes may further affect nutritional issues and human health in Mediterranean countries, where already malnutrition (characterized by a significant percentage of overweight and underweight population) takes place. Changes in the EU Common Agricultural Policy and in trade agreements may have important impacts on national agri-food sectors in Mediterranean countries. For instance, the Euro-Mediterranean trade partnership between the EU and the southern and eastern Mediterranean non-EU countries (except for Syria and Libya) tends to influence market fundamentals in all Mediterranean countries. Furthermore, food quality standards and entry price mechanisms are very important for trade patterns.

Trade has prioritized the export of fruits and vegetables and has widened the production-consumption gap of cereals, which are the main food of the most vulnerable segments of the population in southern and eastern MENA. The vulnerability of the cereal sector has intensified the impact of food price fluctuations on food security, which may have further severe impacts (e.g., in terms of income level and income distribution) depending on the countries' capacity to be self-sufficient (Mrabet et al. 2020).

Since it is easier to import food than to import water, all countries of the region are net importers of food, a practice that is the equivalent of augmenting water supplies. All MENA countries but Syria are net importers of water embedded in food, since they do not have

sufficient rain or irrigation water to grow crops domestically. More than half of total water needs of MENA countries are imported in the form of food, a concept known as virtual water. Given these circumstances, trade is an increasingly important issue for water policy. Trade will become increasingly important as farmers begin using irrigation water more efficiently—for higher value-added per drop. Farmers will grow more of the crops in which the region has a comparative advantage, which they will export, while increasing imports of staples. In effect, the countries would be exporting high-value virtual water and importing larger quantities of low-value virtual water from countries with more abundant supplies (Hoekstra and Hung 2002; Chapagain and Hoekstra 2003). There is growing interest in using water productivity as measured in terms of the unit of crops production per one unit of water to inform and guide management and allocation of water resources.

Studies at the International Center for Agricultural Research in the Dry Areas (ICARDA) have addressed optimal use of water for optimal farm economic and crops yield. These studies concluded that productivity of water used to irrigate cereals is among the lowest (see Table 2).

### Table 2. Average water productivity for selected agricultural products in the MENA region

| Crops | Physical water productivity, midrange value (kilograms per $m^3$ of water) | Average producer price in MENA, 2010–16 (US$ per kg)** | Average economic water productivity (US$ per $m^3$ of water in producing agricultural commodity) |
|---|---|---|---|
| | 1 | 2 | 1x2=3 |
| Tomatoes | 12.5 | 0.4 | 4.98 |
| Onions | 6.5 | 0.42 | 2.76 |
| Apples | 3.0 | 0.88 | 2.64 |
| Potatoes | 5.0 | 0.45 | 2.23 |
| Olives | 2.0 | 0.90 | 1.80 |
| Lentils | 0.7 | 1.17 | 0.82 |
| Dates | 0.6 | 1.33 | 0.80 |
| Fava Beans | 0.6 | 0.98 | 0.54 |
| Maize | 1.2 | 0.45 | 0.51 |
| Rice | 0.9 | 0.59 | 0.51 |
| Bovine meat | 0.1 | 7.48 | 0.49 |
| Wheat | 0.7 | 0.52 | 0.33 |
| Ground nuts | 0.3 | 1.33 | 0.33 |

*Source:* Molden et al. (2010).
*Note:* Water is not the only input in agricultural production, and other factors influence the decision of which crops or livestock to produce. Decisions on product selection also depend on the type of land available (e.g. pasture *vs.* cropland), the location of the farm (e.g. in rain-fed or irrigated areas), and farmers' attitudes towards risk. However, if other costs are similar, a farmer in the MENA region would obtain the highest payoff per drop of water by producing fruits and vegetables.

Additional theoretical studies on virtual water estimate water consumption per unit of crop production based on common water application methods. For example, one hectare of wheat crop requires about 6,000 $m^3$ under efficient irrigation throughout the growing season. As mentioned earlier, a hectare of wheat is expected to produce an average 2.5–3 tons under a

well-managed system in most countries in the region. The opportunity cost of water in most MENA countries is about one U.S. dollar per $m^3$ (the cost of $m^3$ from new sources including fossil aquifer or desalination) or close to US$2,000 per ton for the cost of water alone. Farmers also grow vegetables during the off-season when Europe is unable to produce these commodities, especially in winter. The expanding of modern packaging and freight and international supermarkets has facilitated the growth of cultivation of high-value perishable crops for export from MENA countries to Europe.

There is a growing trend in the region to invest in innovative policies and practices and water governance. Table 1 lists select policies being advanced by the North Africa countries to promote sustainable water resources management through rules and regulations to allocate water to competing sectors. There is increasing demand for clean water supply and sanitation to all households, which is essential to combat the spread of COVID-19. This reallocation of clean water away from agriculture becomes possible through the ongoing efforts by governments to diversify agricultural production toward high-value, water-efficient crops.

More investment is needed in research and technology development and transfer to further enhance water efficiency and water and crop productivity in the region. Also needed are policy reforms to better manage subsidies to the energy sector and to balance the use of energy for water food production; and responsive policies to expand high-quality and safe recycled water for recycling. More investment is needed to test, adapt, and scale up new technologies and policies for water resources management and water service delivery. An example is smart metering to improve accuracy in billing, evaluate consumption, and increase users' awareness of their own consumption. Smart metering also helps water service providers identify leaks, reduce operating costs, and communicate the value of water to users.

The private sector and small farmers in several countries in the region such as Jordan, Tunisia, and Morocco are promoting hydroponics farming to produce fresh vegetables for domestic and export markets. Governments are targeting financial support and agricultural credits to expand these innovations among small farmers. Moreover, several donor agencies including USAID support training and capacity building to link producers with providers of production and marketing innovations. The term hydroponics is a subset of "hydroculture," which refers to growing plants without the use of soil. It uses nutrient-rich solutions in a water solvent and is typically done indoors, in a controlled environment. The latter is a growing area of commercial food production and is also used for home food. It is recognized as one of the fastest developing soil-less cultivating practices globally. Hydroponics produces higher yield than conventional farming, an increase of 3 to 10 times in the same amount of space. Furthermore, it is up to 90 percent more water efficient than traditional methods, allowing a longer growing season.

In addition to increasing revenues, hydroponic techniques also provide a platform to increase economic opportunity and new, competitive skillsets to members of underserved communities. Introducing hydroponic systems to farmers also helps vulnerable groups, such as women and youth, garner workforce skills and vocational training.

The high "crop per drop" ratio inherent to hydroponic systems is achieved by reusing water runoff and limiting water loss associated with evaporation and percolation. Root mass is much smaller in hydroponic systems, where plants are given nutrients directly and in precise proportions.

**Box 2. Hydroponic system benefits and government initiatives**

The benefits of hydroponic systems include:

- Improving water efficiency in agriculture through hydroponic systems that use significantly less water than traditional farming practice.
- Strengthening agricultural productivity by increasing the quantity and value of produce.
- Using cost-effective and environmentally friendly green energy sources for farming instead of fossil fuels.

Government initiatives the in MENA region include the following objectives:

- Promote hydroponic technology in established farmer networks and targeted communities throughout the Jordan Valley and highlands.
- Demonstrate the feasibility of hydroponics through field days at HGFI program sites.
- Bridge the gap between traditional agricultural knowledge and hydroponic systems through educational material and training exercises.

## Issue #8: Climate change and impact on water security and food security in the region.

Previous sections highlighted the effects of population and economic growth on increasing water demands. But recent studies warn that climate change will be the primary driver for the most pronounced changes in surface water stress across the region (Kelley et al. 2014). Water is the primary medium through which the impacts of climate change will be felt. Climate change increases water stress through multiple mechanisms, including reductions in rainfall and increasing temperatures (IPCC 2014). Climate models project an increase in temperature (Verner 2012) and heat extremes in the Middle East and North Africa.

The effects of climate change on water resources will be spatially variable across MENA region and may be felt most severely in the medium to longer term. While spatially variable, generally forecasted accelerated warming in coming decades is likely to increase desertification, reduce river flow due to increased evaporation, increase risk of flash flooding, and reduce long-cycle crop production. Not only will climate change lead to less water in many areas, but it will increase variability in terms of when rains occur, thus presenting added challenges for the region's agriculture. Increasing water stress will reduce GDP growth rates between 6 and 14 percent by 2050 (World Bank 2016). This will amplify existing stress on water availability in the region and ultimately become a key constraint on the region's continued economic development.

Recent studies by The World Resources Institute warn that some of the biggest climate change-induced changes in surface water stress will occur in countries already facing politically and environmentally fragile situations. Iraq, Lebanon, Jordan, Israel, Syria, and Morocco will all experience increased water stress driven by climate change (Water Resources Institute 2020). Climate change and socioeconomic change will influence surface water stress in 2030.

In addition to water scarcity, the main challenge facing expanding cultivation in the Middle East's desert environment is climate change. Projections indicate that climate change will reduce the rate of increase in agricultural productivity. Yields of the region's most important food, feed, and fiber crops decline precipitously at temperatures much above 30°C. Among other reasons, this is because photosynthesis has a temperature optimum in the range of 20° to 25°C for the major temperate crops. Plants develop faster as temperature increases, leaving less time to accumulate the carbohydrates, fats, and proteins that constitute the bulk of fruits and grains. Widespread adoption of more effective and sustainable agronomic practices can help buffer crops against warmer and drier environments, but it will be increasingly difficult to maintain, much less increase, yields of MENA's current major crops as temperatures rise and dry lands expand. Climate change will further affect agriculture as the case in the Nile Delta, where sea level rises would increase saline intrusions from the sea and also increase the risk of flooding and salinization in MENA's coastal areas. Low-lying deltas such as the Nile delta and the Shatt-al Arab have been identified as at risk from the impacts of climate change, as are low-lying coastal areas such as Morocco's Mediterranean coastal zone (Fedoroff 2010).

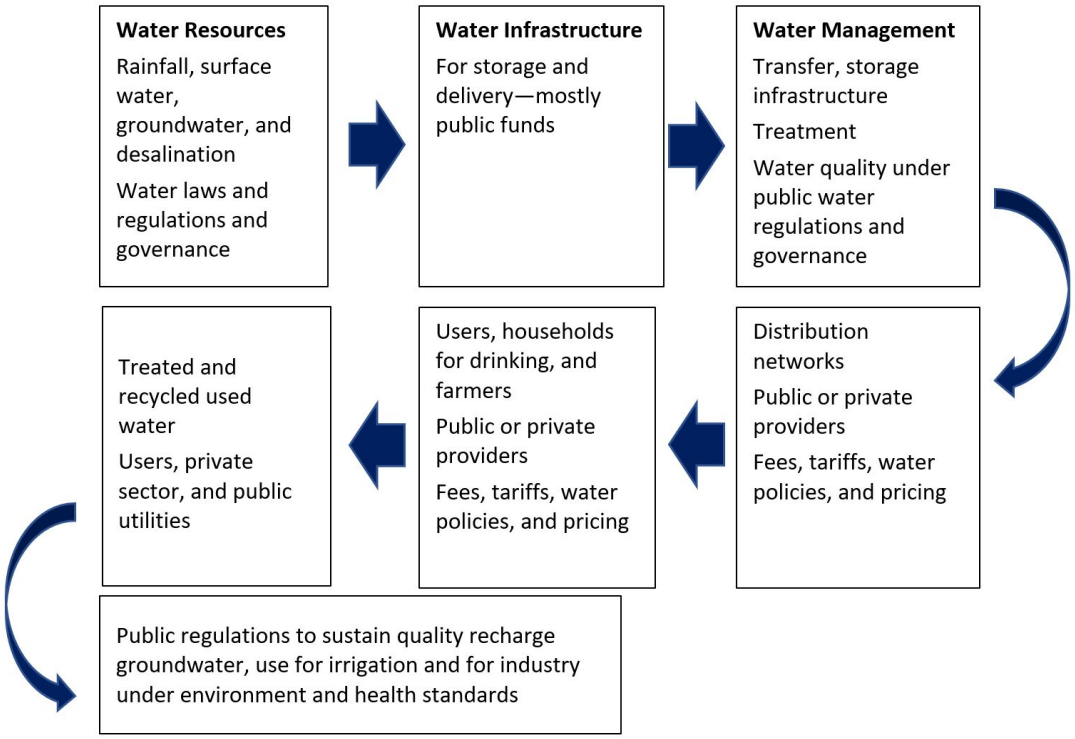
## Summary

Combating COVID-19 requires reliable supplies of clean water and food. Poor communities in the MENA region suffer from scarcity and limited accessibility to both resources. Achieving water security requires targeting attention to the hygienic needs of all households through efficient management supported by a solid policy and legal framework. The challenge is devising a balanced policy framework designed to provide adequate clean water and at the same time provide irrigation to important crops needed to sustain food production needed in domestic markets.

Management should have sufficient scope to address all components of a water system (Chart 3). Key messages are:

1. in the water sector to create a responsive framework that can better manage available water and food to meet urgent needs, both during and after the COVID-19 pandemic.
2. Facilitate communication and partnership with national and international research and study centers to identify best practices and to exchange relevant lessons and experiences to guide national and local actions.
3. Determine the scope of water scarcity and the role of the public sector in securing adequate supplies from rainfall, surface water, groundwater, and desalination.
4. Clarify the role of the public sector in protecting, managing, developing, and monitoring and updating data and information and knowledge about these resources. The main issue here is water laws and regulations and governance. Most countries in the region have advanced, responsive laws for managing the three sources of water: surface water, groundwater, and non-conventional water resources.
5. Establish productive partnerships among stakeholders at the national and local levels
6. Strengthen the legal and regulatory framework that guides regulates public and private investment in water infrastructure, such as dams, groundwater wells, and desalination plants.

**Chart 3: Components of national water systems: public private partnerships desirable in select components under transparent governance and regulations**



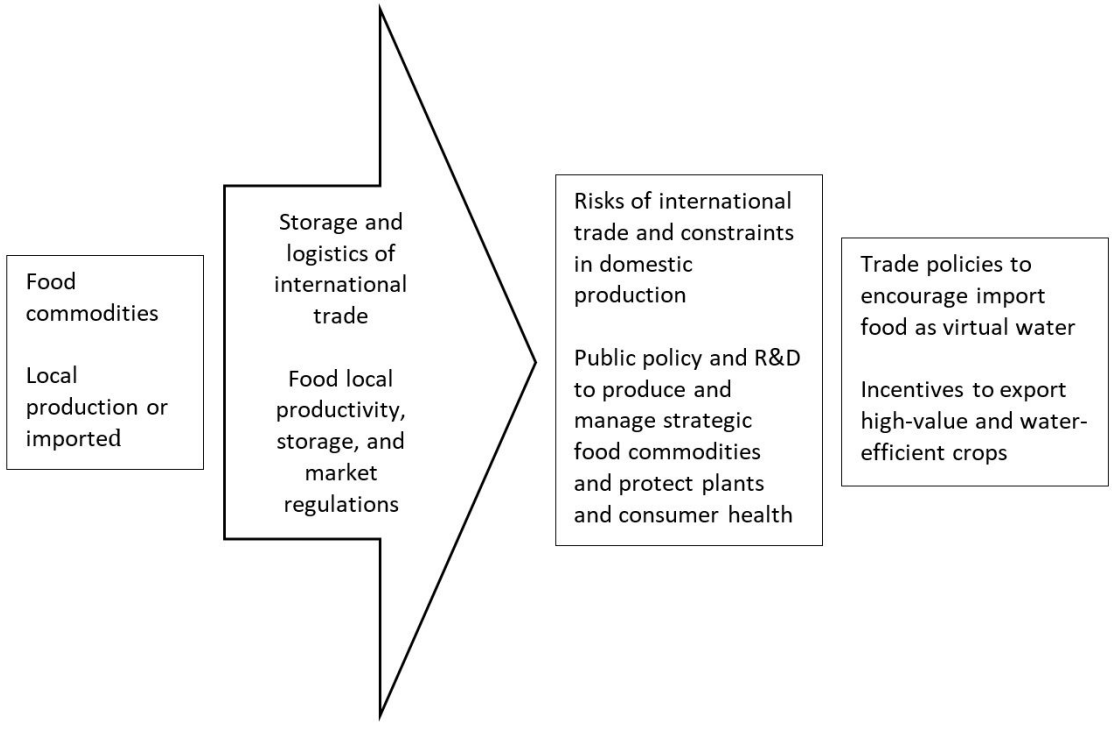

*Source:* Authors.

7. Build and secure adequate water stock for national needs, especially during political upheaval and the COVID-19 pandemic. The issues here are managing storage facilities, applying approved standards of water treatment to ensure healthy and acceptable water quality, and responsiveness to national and international water regulations and governance.
8. Ensure the reliability and stability of public or private providers of water distribution and services. The issues here are reliability and stability of these services, as well as adequate water pricing, fees, and tariffs to support operating and maintaining these services.
9. Promote substantial engagement with water users, which is essential to operating an efficient water system. Users have a variety of water needs, including drinking water for households, irrigation water for farmers, and other water uses for industries. Agree on allocations of water across sectors based on economic and social indicators, especially to address salient human needs and strategic economic objectives.
10. Carefully manage water usage under scarce conditions. Incorporate environmental and ecological factors into water use valuations. Treated and recycled used water is crucial to the efficient management of the water cycle and adds a valuable resource which can be used to recharge groundwater, for irrigation for landscape and environmental purposes, and for select industries.

Key messages for food security (see Chart 4) are as follows:

1. Water productivity for food production should guide the process of producing domestic food crops and imported food commodities. It is desirable to allocate water to crops with high water efficiency (see Table 2 above). Well-defined policies should be in place to guide increasing imports of staples. In effect, the countries would be exporting high-value virtual water and importing larger quantities of low-value virtual water from countries with more abundant supplies. There is growing interest in using **water productivity as measured in terms of unit of crops production per one unit of water to inform and guide management and allocation of water resources.** A primary challenge is to increase the productivity of water used in irrigated agriculture by introducing modern irrigation technologies to reduce losses and unproductive water use. Another challenge is to develop agricultural production practices to shift cropping patterns to include increased production of higher-value crops.
2. A priority objective of food security is to maintain the traditional Mediterranean diet and shift back to locally produced Mediterranean food, in conjunction with a reduction of food waste. This objective could generate water savings in comparison to the increasingly meat-based diet in the MENA region, in addition to benefits for health (such as less obesity and diabetes).[4]

**Chart 4: Components of Food Security**




*Source:* Authors

[4] An important recommendation of Chapter 3.2, "Food," in the MedEC report (Mrabet et al. 2020).

3. The private sector plays an important role in the logistics of food, including the import of strategic food commodities (especially cereals) and domestic food production, storage, and marketing. Well-defined regulations and public procedures should uphold high environmental standards and protect consumers. The government, in participation with other stakeholders (e.g. the private sector and local communities), has to make difficult decisions on water allocation and selection of crops for domestic production and commodities for import form foreign markets. Policies should embrace a holistic, multisectoral approach that balances diminishing supplies between ever-increasing demands, taking into account national priorities and socioeconomic and environmental impacts. Such an approach would entail close collaboration among all concerned sectors and activities (planning, water and irrigation, agriculture, environment, tourism, industry and trade, health) regarding water-related policy, especially for the inter-sectoral use of water.

4. Trade policies are increasingly important as farmers begin using irrigation water more efficiently—for higher value-added per drop. Farmers will grow more of the crops in which the region has a comparative advantage, which they will export. An enhanced government role is key in managing risks of international trade and constraints in domestic production. The challenge is to ensure the safety and exportability of produce grown with water quality accepted in international markets. Government policies should ensure that water for agricultural use is well managed to ensure food safety on domestic and export markets. Such policies should be based on reliable market intelligence and be guided by transparent and qualified analytical tools. In addition, transparent trade policies are needed to import food.

5. The three main risks of food security facing the region are: (i) availability risk, i.e., the risk that grains may not be available for import, potentially because of crop failures in producing countries or due to there being barriers to import (physical or political); (ii) counterparty performance risk, i.e., despite grains being available at an acceptable price", the party who contracted to deliver the grain defaults on the contract; and (iii) price risk, i.e., the risk that the price of imported grains will increase above levels that the importing country considers to be acceptable and/or may be able to afford.

## References


Arab Forum for Environment and Development (AFED). 2010. "Water: Sustainable Management of a Scarce Resource." http://www.afedonline.org/en/reports/details/water.

Bouchrka, A., H. Jouber, and W. Bardi. 2015. "The Water Management in Tunisia: A Trend towards Unconventional Resources." *Journal of Management Research* 7(3): 71–84.

Drouiche, N. et al. 2012. "Towards Sustainable Water Management in Algeria." *Desalination and Water Treatment* 50: 272–284.

Chapagain, A., and A. Hoekstra. 2003. "Virtual Water Flows between Nations in Relation to Trade in Livestock and Livestock Products." Value of Water Research Report Series No. 13, UNESCO-IHE Institute for Water Education, Delft, The Netherlands.

Closas, A., and F. Molle. 2016. "Groundwater Governance in the Middle East and North Africa." IWMI Project Report No 1. IWMI, Colombo.

Commander, S., Z. Nikoloski, and M. Vagliasindi. 2015. "Estimating the Size of External Effects of Energy Subsidies in Transport and Agriculture." Policy Research Working Paper No. 7227. World Bank Group, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/21674 License: CC BY 3.0 IGO.

Cramer, W., J. Guiot, and K. Marini (eds.) 2020. *Climate and Environmental Change in the Mediterranean Basin—Current Situation and Risks for the Future.* First Mediterranean Assessment Report. Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, 57pp, in press.

Dixon, J., A. Gulliver, and D. Gibbon. 2001. *Farming Systems and Poverty: Improving Livelihood in a Changing World*. Rome and Washington, DC: FAO and World Bank.

Fedoroff, N. V. 2010. "Radically Rethinking Agriculture for the 21st Century." *Science* 327(5967): 833–834.

Fader M, Giupponi C, Burak S, Dakhlaoui H, Koutroulis A, Lange MA, Llasat MC, Pulido-Velazquez D, Sanz-Cobeña A. 2020. "Water." In: *Climate and Environmental Change in the Mediterranean Basin—Current Situation and Risks for the Future. First Mediterranean Assessment Report* [Cramer W, Guiot J, Marini K (eds.)]. Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, 57pp, in press.

Food and Agriculture Organization of the United Nations (FAO). 2020. "COVID-19 and Its Impact on Food Security in the Near East and North Africa." FAO, Cairo. http://www.fao.org/3/ca8778en/CA8778EN.pdf.

FAO. 2018. "Water Management in Fragile Systems: Building Resilience to Shocks and Protracted Crises in the Middle East and North Africa." FAO, Cairo. http://www.fao.org/3/i9730en/I9730EN.pdf.

FAO. 2014. *FAO Statistical Yearbook 2014: Near East and North Africa Food and Agriculture.* Rome: FAO.

FAO. 2009. *Irrigation in the Middle East Region in Figures.* AQUASTAT Survey—2008. Rome: FAO. http://www.fao.org/3/i0936e/i0936e00.htm.

FAO. 2016. "Global Diagnostic on Groundwater Governance." FAO. http://www.fao.org/3/i5706e/i5706e.pdf.

Global Environment Faculty (GEF). 2015. "Global Diagnostic on Groundwater Governance." GEF/FAO. Rome.

Hajj, R., N. Farajalla, T. Terpstra, and A. Jägerskog. 2017. "Enhancing Regional Cooperation in the Middle East and North Africa through the Water-Energy-Food Security Nexus." Planetary Security Initiative. https://www.planetarysecurityinitiative.org/sites/default/files/2017-06/PB_PSI_MENA.pdf.

Hamza, W., and S. Mason. 2004. "Water Availability and Food Security Challenges in Egypt." Paper presented at the International Forum on Food Security Under Water Scarcity in the Middle East: Problems and Solutions, Como, Italy, Nov. 24–27, 2004.

Hannegan, B. 2014. "Achieving a Sustainable California Water Future through Innovations in Science and Technology." California Council on Science and Technology.10.13140/2.1.3696.9284.

Hoekstra, A., and P. Hung. 2002. "A Quantification of Virtual Water Flows between Nations in Relation to International Crop Trade." Value of Water Research Report Series No. 11, UNESCO-IHE Institute for Water Education, Delft, The Netherlands.

Internal Displacement Monitoring Center (IDMC). 2016. Global Internal Displacement Database, 2016. https://www.internal-displacement.org/database/displacement-data.

Jemli, M. 2015. "Performance of Urban Wastewater Treatment of Four Activate Sludge Treatment Plants in Tunisia." *International Journal of Water and Wastewater Treatment* 1(1). (ISSN 2381-5299). DOI: 10.16966/2381-5299.104.

Jordan. 2016. "National Water Strategy of Jordan, 2016–2025." Ministry of Water and Irrigation. Hashemite Kingdom of Jordan.

Kelley, C., S. Mohtadi, M. Cane, R. Seager, and Y. Kushnir. 2014. "Climate Change in the Fertile Crescent and Implications of the Recent Syrian Drought." *PNAS (Proceedings of the National Academy of Sciences)* 112(11): 3241–46.

Kfouri,C., et. al., "Water Reuse in the MENA Region: Constraints, Experiences and Policy Recommendations". Water in the Arab World, World Bank 2009

Kurtze, J., M. Morais, E. Platko, and H. Thompson. 2015. "Advancing Water Management Strategies in Morocco." Submitted to Ribat Al Fatah, October 16, 2015. https://web.wpi.edu/Pubs/E-project/Available/E-project-101615-040211/unrestricted/IQP-Sponsor_Edition.pdf.

Lebanon. 2014. "Lebanon Environmental Assessment of the Syrian Conflict and Priority Interventions." Lebanese Ministry of Environment. Report of European Union and United Nations Development Program. file:///C:/Users/skyli/AppData/Local/Temp/EASC-WEB-1.pdf.

Marin, P. S. Tal, J. Yeres, and K. Ringskog. 2017. "Water Management in Israel" World Bank, Washington, DC.

Molden, D., T. Oweis, P. Steduto, P. Bindraban, M. Hanjra, and J. Kijne. 2010. "Improving Agricultural Water Productivity: Between Optimism and Caution." *Agricultural Water Management* 97(4): 528–535. http://www.icarda.org/wli/pdfs/articles/4- ImprovingAgriculturalWaterProductivity.pdf.

Molle, F., T. Shah, and R. Baker. 2003. "The Groundswell of Pumps: Multilevel Impacts of a Silent Revolution." ICID Asian Regional Workshop. https://www.researchgate.net/publication/42765835_The_Groundswell_of_Pumps_Multilevel_Impacts_of_a_Silent_Revolution.

Mrabet, R., R. Savé, A. Toreti, N. Caiola, M. Chentouf, M. Llasat, A. Mohamed, F. Santeramo, A. Sanz-Cobena, and A. Tsikliras. 2020. Chapter 3.2: "Food." In: *Climate and Environmental Change in the Mediterranean Basin—Current Situation and Risks for the Future.* First Mediterranean Assessment Report [Cramer W, Guiot J, Marini K (eds.)]. Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, 26pp.

Nigatu G., and M. Motamed. 2015. "The Middle East and North Africa Region: An Important Driver of World Agricultural Trade." The Economic Research Service, USDA (2015). https://www.ers.usda.gov/publications/pub-details/?pubid=35797.

Nonay, C., and R. Advani. 2020. "MENA, The time to act is now." World Bank Blogs. October 15, 2020. https://blogs.worldbank.org/arabvoices/mena-time-to-act-is-now.

OECD and Food and Agriculture Organization of the United Nations (OECD-FAO). 2018. "Chapter 2. The Middle East and North Africa: Prospects and Challenges." In *OECD-FAO Agricultural Outlook, 2018–2027. Special Focus: Middle East and North Africa*. OECD and FAO.

Palestinian Water Authority. 2013. National Water and Wastewater Policy and Strategy for Palestine: Toward Building a Palestinian State from Water Perspective.

Population Reference Bureau (PRB) 2001. "Population Trends and Challenges in the Middle East and North Africa." PRB, Washington, DC. https://www.prb.org/populationtrendsandchallengesinthemiddleeastandnorthafrica/.

Rana El Hajj, et al. 2017 "Enhancing Regional Cooperation in the Middle East and North Africa through the Water-Energy-Food Security Nexus." Issam Fares Institute for Public Policy and International Affairs, American University of Beirut.

Roudi-Fahimi, F. L. Creeli, and R. D. De Souza. 2002. "Finding the Balance: Population and Water Scarcity in the Middle East and North Africa." The Population Reference Bureau, Washington, DC.

Rajsekhar, D., and S. Gorelick. 2017. "Increasing Drought in Jordan: Climate Change and Cascading Syrian Land-Use Impacts on Reducing Transboundary Flow." *Science Advances* 3(8): e1700581.

Sadler, M., and N. Magnan. 2011. "Grain Import Dependency in the MENA Region: Risk Management Options." *Food Security* 3: 77–89. 10.1007/s12571-010-0095-y.

Sarkodie, S., and P. Owusu. "Impact of COVID-19 Pandemic on Waste Management." *Environ Dev Sustain* (2020). https://doi.org/10.1007/s10668-020-00956-y.

Sheta, A. 2014. Presentation at the Ministry of Agriculture and Land Reclamation (MALR). A. Sheta, Head of the Soils and GPS Study Group.

Shah, T., 2009. "Taming the Anarchy: Groundwater Governance in South Asia." Resources for the Future Press, Washington DC.

Stads, G., S. Allani, and M. Hedri. 2005. "Tunisia." ASTI Country Brief No. 29. Washington, DC: International Food Policy Research Institute and National Agronomic Research Institute.

Turner, S., M. Hejazi, C. Yonkofski, S. Kim, and P. Kyle. 2019. "Influence of Groundwater Extraction Costs and Resource Depletion Limits on Simulated Global Nonrenewable Water Withdrawals Over the Twenty-First Century Earth Future." *Earth's Future* 7(2): 123–135. https://doi.org/10.1029/2018EF001105.

United Nations Environment Programme (UNEP). 2020. "COVID-19, wastewater, and sanitation, factsheet #9." https://wedocs.unep.org/bitstream/handle/20.500.11822/32802/FS9.pdf.

United Nations Educational, Scientific and Cultural Organization (UNESCO). 2015. Transboundary Aquifers of the World (2015). The International Groundwater Assessment Center. http://ihp-wins.unesco.org/layers/geonode:tba_map2015.

United Nations International Children's Emergency Fund (UNICEF). 2020. "COVID-19 WASH Responses by Governments, Water Utilities and Stakeholders in Middle East and North Africa (MENA) Countries." UNICEF COVID-19 WASH response c/3.2020. https://www.siwi.org/wp-content/uploads/2020/08/2020-WASH-COVID19-MENA_Final.pdf.

Verner, D. 2012. "Adaptation to a Changing Climate in the Arab Countries: A Case for Adaptation Governance and Leadership in Building Climate Resilience." MENA Development Report. Washington, DC: World Bank.

Verner, D., D. Treguer, J. Redwood, J. Christensen, R. McDonnell, C. Elbert, and Yasuo Konishi. 2018. "Climate Variability, Drought, and Drought Management in Tunisia's Agricultural Sector." World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/30604 License: CC BY 3.0 IGO.

Water Resources Institute (WRI). 2020. "State of Climate Action: Assessing Progress toward 2030 and 2050." WRI, Washington, DC. https://doi.org/10.46830/wrirpt.20.00001.

World Food Programme (WFP). 2020. "WFP Palestine Country Brief October 2020." https://reliefweb.int/report/occupied-palestinian-territory/wfp-palestine-country-brief-october-2020.

World Bank Group. 2021. "Climate Risk Profile: Tunisia (2021)." The World Bank Group. https://reliefweb.int/sites/reliefweb.int/files/resources/15727-WB_Tunisia%20Country%20Profile-WEB.pdf.

World Bank. 2018. *Beyond Scarcity: Water Security in the Middle East and North Africa.* Washington, DC: World Bank.

World Bank. 2016. *High and Dry: Climate Change, Water, and the Economy.* Washington, DC: World Bank.

World Bank. 2007. "Making the Most of Scarcity Accountability for Better Water Management in the Middle East and North Africa." MENA Development Report. Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/6845 License: CC BY 3.0 IGO.

World Resources Institute (WRI). 2020. *State of Climate Action: Assessing Progress toward 2030 and 2050.* Washington, DC: WRI.

Among the Middle East and North Africa (MENA) countries hit hard by the impact of COVID-19, water and food security are important drivers of economic growth and social development. These countries are at a crossroads and urgent action needs to be taken to avoid an impending crisis. In addition to increasing challenges caused by climate change, COVID-19 has compounded the burden of addressing the increasing demand for water and food in the region where managing these commodities was already encountering economic and political challenges. This paper explores eight key issues that preceded the pandemic, but which have become ever more important due to the new stress placed on the region and the increased competition for domestic resources. There is a tendency to see water and food security issues in a longer-run context; however, both the urgency of the issues and the costs of continuing to ignore them will make both recovery and long-term economic growth objectives harder to attain. It is for this reason that this Technical Paper has been prepared separately as part of the larger project on Post-Pandemic Growth Outlook in the MENA region.

**Shawki Barghouti** is a Senior Adviser for the Growth Dialogue Institute

**The Growth Dialogue Institute** is an independent entity dedicated to promulgating new ideas and policy analysis on the challenges facing developing countries in their quest for sustainable and equitable economic growth. The GDI highlights views of academics, seasoned development experts, and ex-policymakers. It serves to provide the global community with new ideas and unfettered opinions to help influence and shape the development debate.

GROWTH DIALOGUE INSTITUTE

http://www.growthdialogue.org/
info@growthdialogue.org