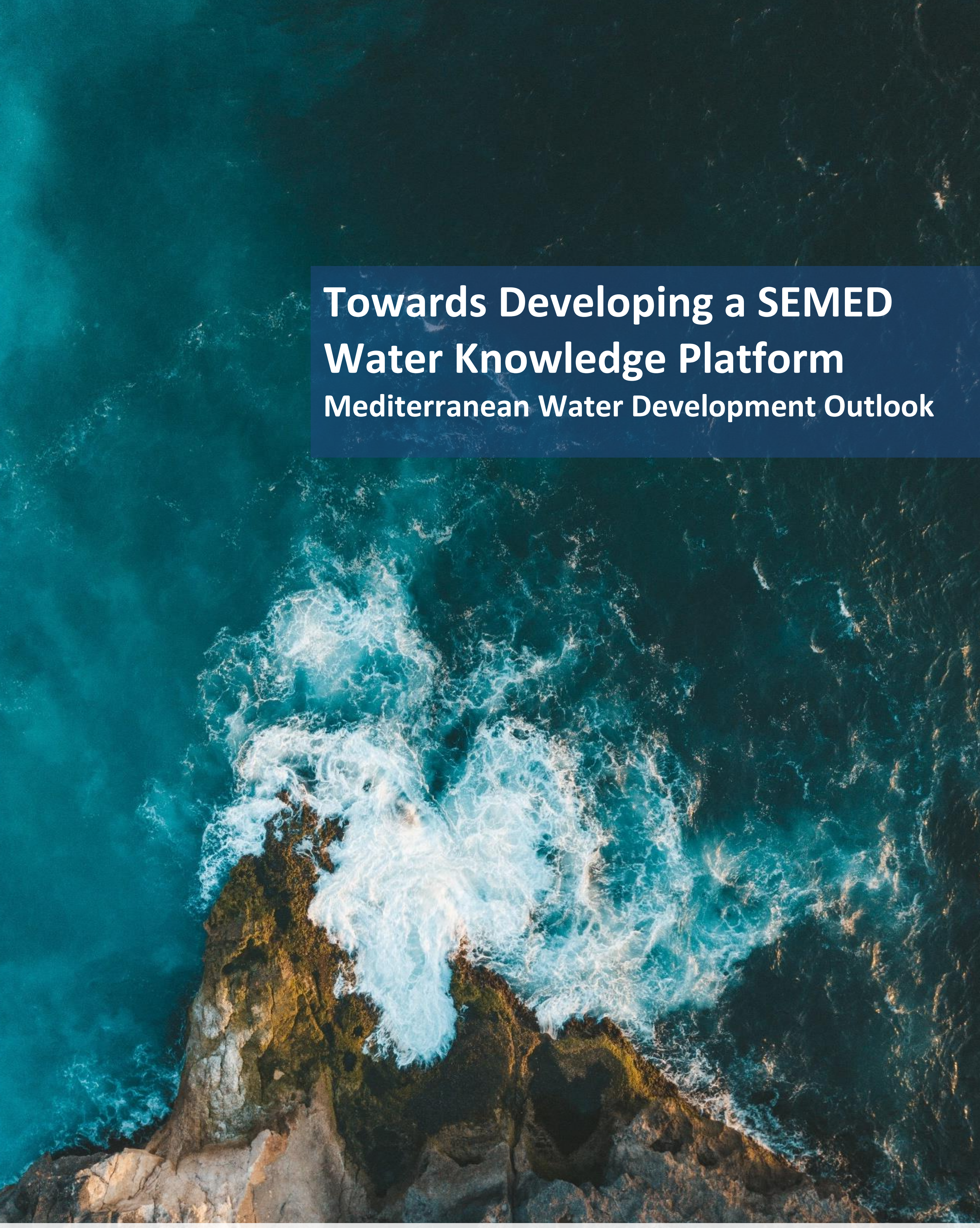

Towards Developing a SEMED Water Knowledge Platform

Mediterranean Water Development Outlook

Prepared by

INWRDAM WATER DIPLOMACY

Developed for

Union for the Mediterranean
Union pour la Méditerranée
الاتحاد من أجل المتوسط

KONRAD ADENAUER STIFTUNG

Table of Contents

Table of Figures

Abbreviations

BCM	Billion Cubic Meter
CA	Civil Administration
CI	Continental Intercalary
CRDA	Regional Rural Development Commissions (Tunisia)
CT	Terminal Complex
DSI	The General Directorate of State Hydraulic Works in Turkey
EBML	Water of Beirut and Mount Lebanon
EEA	The European Environment Agency
ESCWA	United Nations Economic and Social Commission for West Asia
FAO	United Nations Food and Agriculture Organisation
GDA	Groupement de Développement Agricole (Tunisia)
GDP	Gross Domestic Product
GERD	The Grand Ethiopian Renaissance Dam
GMP	Green Morocco Plan
ICRC	International Committee of the Red Cross
IDA	The International Desalination Association
IPCC	Intergovernmental Panel on Climate Change
IWA	Israel Water Authority
IWMI	International Water Management Institute
JV	The Jordan Valley
JVA	Jordan Valley Authority
JWC	the Joint Water Committee
MCM	Million Cubic Meter
MENA	Middle East and North Africa
MMRP	The Man-Made River project (Libya)
MWI	The Ministry of Water and Irrigation (Jordan)
NRW	The Non-revenue Water
NWSAS	The North-Western Sahara Aquifer System
OECD	Organization for Economic Co-operation and Development
ONA	Office National d'Assinissement (Algeria)
ONAS	Office National d'Assinissement (Tunisia)
PNA	The National Plan for Liquid Sanitation (Morocco)
PNAM	The National Shared Plan of liquid sanitation program(Morocco)
PNAR	the National Rural Sanitation Program (Morocco)
PNE	The National Water Plan (Morocco)
PNEEI	The National Irrigation Water Saving Program (Morocco)
PNREUE	The National Plan for Wastewater Reuse (Morocco)
PWA	The Palestinian Water Authority
PWA	Palestinian Water Authority
SEMED	Southern Eastern Mediterranean Countries
SONEDE	Sociéte Nationale d'Exploitation et de Distribution des Eaux (Tunisia)
SWRO	Seawater reverse osmosis
TWW	Treated wastewater
UfM	Union for the Mediterranean
UNHCR	United Nations High Commissioner for Refugees,
UNICEF	United Nations International Children's Emergency Fund
WASH	Water, Sanitation and Hygiene
WEF	World Economic Forum

WHO	World Health Organization
WMO	World Meteorological Organization
WUAs	Water User Associations
WWF	World Wildlife Fund
WWTP	Wastewater Treatment Plant

1. Executive Summary

At the cross-roads of three continents, the Mediterranean region is one of the most historic, culturally rich and diverse regions in the world. Endowed with unique geographical, ecological and geopolitical features, it benefits from the continuous exchanges across peoples and territories.

In a constantly changing world, the Mediterranean faces serious natural and human-made challenges, including water scarcity, population growth, migration, industrialization, urbanization, pollution, and climate and other environmental change, along with the proliferation of energy-intensive lifestyles.

These issues entail a rather blurry picture for the present and the future of the Mediterranean region, posing threats also to its water security. Not far from the Mare Nostrum, the MENA region (Middle East and North Africa) extending, south of the Mediterranean Sea, from Morocco to Egypt and, east of the Mediterranean Sea, from Yemen across the countries of the Arabian Peninsula all the way to Syria is also facing a particularly alarming situation of water, making it as one of the most water insecure regions of the planet. Annual renewable water supplies in MENA are approximately 620 billion cubic meters (BCM), compared to Africa's almost 4000 BCM, Asia's 12,000 BCM, and a world total of approximately 43,000 BCM. In 2015, the World bank estimated that MENA's per capita annual water availability is estimated on average of only 1,200 cubic meters, around six times less than the worldwide average of 7,000 cubic meters which is below the amount needed to prevent a significant constraint on socio-economic development, making the region the most water stressed in the world.

Indeed, many MENA countries suffer from levels as low as 10 percent of the MENA regional figure, the same source reported. The region has approximately seven percent of the world's population and less than 1.5 percent of the world's renewable freshwater supply. This has led experts to predict that stress on water endowments and supplies in the region could in turn spur conflict and population displacement in the world's most water-scarce region.

The Southern and Eastern Mediterranean (SEMED) countries are a part of the MENA region, excluding some countries such as the Arabian Peninsula countries. SEMED countries
are no exception to the situation in the MENA region. The SEMED region's current water challenges go far beyond age-old constraints of water scarcity. While the region's water scarcity challenges have been apparent for hundreds of years, newer challenges are adding both hazards and complexity. The complexities of the water-food-energy Nexus , climate change, droughts and floods, water quality, transboundary water management, and the management of water in the context of fragility, conflict, and violence compound the challenge of water scarcity. Meeting these challenges will depend as much on better management of water resources as on more and better resource endowments, infrastructure investments, and technologies.
Managing water has been fundamental to the development of human societies in the region. The role of the Nile in Egyptian civilization, from antiquity to the present, is axiomatic, and the role of water management in the rise of civilization itself is reflected in the legal codes of ancient Mesopotamia, where the Codes of Ur-Nammu and Hammurabi, dating back four millennia, set

rules for the proper use and maintenance of common water works. This suggests the need to understand water as a resource that is, has been, and should be managed carefully to preserve, and the need to emphasize the importance of water policies and best water use practices within and from outside the SEMED region.

Issues of water scarcity and choices about water policies affect farming (crop choice, growing seasons, and pests), fisheries, forestry, livestock, hydropower, and industry, all of which have an impact on agricultural production, food security, and rural and urban livelihoods. Competition among uses, such as irrigation, municipal uses, industry, tourism and energy production, can damage public health and social welfare, thus creating political instability and posing significant internal security risks. The World Bank estimates that a 20 percent reduction in water supply could decrease the Gross Domestic Product (GDP) by up to 10 percent, compared to 2016 levels. Furthermore, increased water scarcity could reduce labor demand by up to 12 percent and lead to significant land-use changes, including loss of beneficial hydrological services.

Water resources are aggravated by global climate change in the SEMED region, which makes it difficult to store and rationally distribute the little of that is available. Projections suggest that Lebanon, Jordan, Morocco, and Syria will all experience significantly increased water stress driven by climate change (World Bank, 2018).

Some SEMED countries such as the Gaza Strip have low levels of renewable water resources, such as flowing rivers, and must rely on groundwater and desalination for most of their supply. Others such as Egypt, Jordan, Lebanon, the West Bank, and Syria get much of their water from river systems they share with other countries.

Moreover, some of the SEMED countries of this study such as Jordan, Egypt, Syria and Turkey rely on transboundary water resources. International competition and conflict are inevitable and have, in many cases, already occurred. However, these shared resources can also be opportunities for unprecedented cooperation, given the urgent need for water.

In this context, meeting the water scarcity challenge will require enhanced innovation and reform within the water policy communities and economies of the SEMED countries, as well as adopting new technologies and practices to preserve water resources. Technologies and practices to recycle water and curb waste are increasingly being used in the SEMED region. Several countries have recognized the benefits of recycling water; some aim to recycle all of their wastewater by 2030. Positive experiences in Jordan (As-Samra) and Tunisia (Souhil Wadi) show that urban wastewater can be safely recycled for use in irrigation and managed aquifer recharge. Likewise, desalination[1] is becoming increasingly important as a solution to the water challenges and a serious climate change adaptation option in the region, and also an important strategic technology to fulfill the sustainable development goals (SDGs). Moreover, recent decreases in the cost of desalination and advances in membrane technology also mean that desalination is increasingly becoming a viable alternative to traditional freshwater resources (World Bank, 2018).

[1] https://www.kas.de/en/web/remena/single-title/-/content/desalination-an-alternative-to-alleviate-water-scarcity-in-the-mena-region

Even though the intensity of the water scarcity varies from one country to another in the SEMED region, no one can deny the negative impacts of water shortage can cause in the whole region either in the short or the long terms. Thus, substantive regional collaboration is needed to address the water scarcity in the Mediterranean, to find common solutions and turn challenges into opportunities. This could only be done through a multitude of tangible actions ranging from increased cooperation, data sharing, knowledge, financing for water quality monitoring and improvement, climate change adaptation, community and stakeholder participation, and capacity building between the different SEMED countries, and a recognition of their responsibility to support these efforts.

2. Background

Current patterns of water management and development in the southern and East Mediterranean region are often not sustainable. The region is facing severe water scarcity with freshwater availability per capita among the lowest in the world, representing a serious constraint for socio-economic development and a potential cause for water-related conflicts. The Mediterranean region holds only 3 percent of global water resources but hosts over 50 percent of the world's water poor populations, around 180 million people. Natural water scarcity in the region is compounded by new threats of population growth, growing food and energy demands, pollution, transboundary competition and climate changes consequences such as weather extremes. Whereby, there is a clear connection between water scarcity, food insecurity and social instability, which in turn can trigger and intensify migration patterns. The World Bank reported in 2017 that in the Middle East and North Africa region, 60 percent of the populations live in areas of high or very high water-stress, compared to the global average of 35 percent.

The COVID-19 pandemic has forced governments to re-think the linear models they were following and consider circular growth models that rely on nexus opportunities, especially between key resources like water, energy, and agriculture. A water ,energy and food (WEF) nexus , or expanded to include the eco-system (WEFE) nexus circular growth model is seen as the way forward for many countries around the globe. Such a model can address key issues in a comprehensive way such as the use of non-conventional water resources, non-revenue water (loss), aging infrastructure, process controls, high operating costs, compliance costs, and high unemployment or low resource contribution to GDP. Operational resilience and economic sustainability through smart job creation have become key issues post-COVID. The SEMED region specifically has seen high youth unemployment rates that can lead to civil unrest if not addressed quickly and smartly. Digital transformation across the value chain is also seen as a key priority post-COVID due to the opportunity presented in operational cost efficiency improvement and additional job creation opportunities. Internet of things, big data, knowledge management, and data to decision are all seen as key future focus areas SEMED countries will look into and begin to implement.

SEMED countries have also seen growing disputes over transboundary water resources. These disputes have negatively affected fair water contribution to GDP in many SEMED countries. This ‘silenced conflict’ will need to be addressed by political leaders sometime in the future, which presents an opportunity to engage young public sector water professionals in a SEMED-wide dialogue that will eventually lead to solving these disputes. Water citizenship, defined as the establishment of fair ownership and loyalty towards water resources and infrastructure, will also need to be improved for national and regional confidence building.

This report looks at all these issues both at the level of the SEMED region and on country-by-country basis and closes with opportunities for economic development across SEMED that can turn identified challenges into job growth engines and sustainable circular economic growth models.

3. Methodology

This desk study aims to provide an overview of the main water use practices, socioeconomic influence of water, threats and challenges related to water of selected Southern and Eastern Mediterranean (SEMED) countries, here after called : Algeria, Egypt, Jordan, Israel, Lebanon, Libya, Morocco, Palestine, Syria, Tunisia and Turkey. This report aims at viewing these components through mapping in each country the most relevant water use practices specifically in agriculture as this sector is taking over the lion share of all water demand in most of the SEMED countries of this study. These water use practices consist principally of improving the irrigation efficiency throughout the use of modernized irrigation techniques and preserving the available water resources by shifting to the use of non-conventional water such as the desalinated water and the treated wastewater.

This report will shed the light on how these water use practices alter from one country to another based on climatic, financial political and geographical factors. The report will also zoom in on each country with specific knowledge related to water as a source of socioeconomic empowerment and threat that can put the food security and the country stability at risks. This is likely to encapsulate the importance of the WEFE Nexus approach by corroborating the need of an integrated management and governance across the multiple sectors such as food and energy where water plays a vital role.

The Nexus approach will support the implementation of the 2030 Sustainable Development Agenda sustainable development goals (SDGs)s especially SDG 2 (Food), SDG 6 (Water), and SDG 7 (Energy), but most SDGs have elements linked to food, water, and energy in one or more ways, and will benefit from a Nexus approach. The SDGs are designed to be cross-cutting and to be implemented together, which is also reflected in a WEFE Nexus approach. Once the threats and the challenges are identified in the different SEMED countries, the last section of the report will be dedicated to showcase and assess the different measures undertaken by the SEMED countries of this study to overcome the water crisis by turning threats into opportunities and seeking tangibles solutions.

Solutions encompass better regional cooperation through hydro diplomacy and transboundary water arrangements governed by international water law, improved water conservation practices, reforms of water pricing and subsidies for farmers, and new sustainable water resources powered by sustainable energy such as desalination linked to solar and wind energy and the reuse of the wastewater.

Throughout the compilation of this desk study, many data resources have been found describing at great length regional water scarcity. However, this data has not been translated into meaningful actions. This report will be a steppingstone towards a compelling narrative to generate added-valued services for a change, contribute to sustainable growth in the SEMED region and promote investment in the region. Hence, more efforts needed to be exerted to compile more in-depth studies in order to process the scientific data properly and turn it into information that could help governors and stakeholders to take the right decisions. Therefore, this study will be an initiation to develop the SEMED Water Development outlook towards establishing “A SEMED Water Knowledge Platform”.

This work facilitates the production, harmonization and sharing of water information among key stakeholders in the Southern and Eastern Mediterranean region and will contribute to improving dialogue and planning processes and making information more easily available and reachable to involved stakeholders.

4. Water Use Practices at a regional Scale

The early development of the agrarian way of life has been a remarkable feature that distinguished the population of the Mediterranean since the ancient times. They have laid the foundation of an irrigation-based agriculture with intensive agricultural systems which are still used today. Additionally, based on historical evidence, the abundance of rainfall back then, allowed the farmers to extend rained and irrigated cultivation of cereals and other crops. However, throughout time, the deterioration of the climatic conditions and the water scarcity, have disabled the excessive use of water and consequently have shifted the efforts towards alternative water use practices to meet the growing demand for food by a rapidly growing population to preserve the available water resources while achieving water and food security for all.

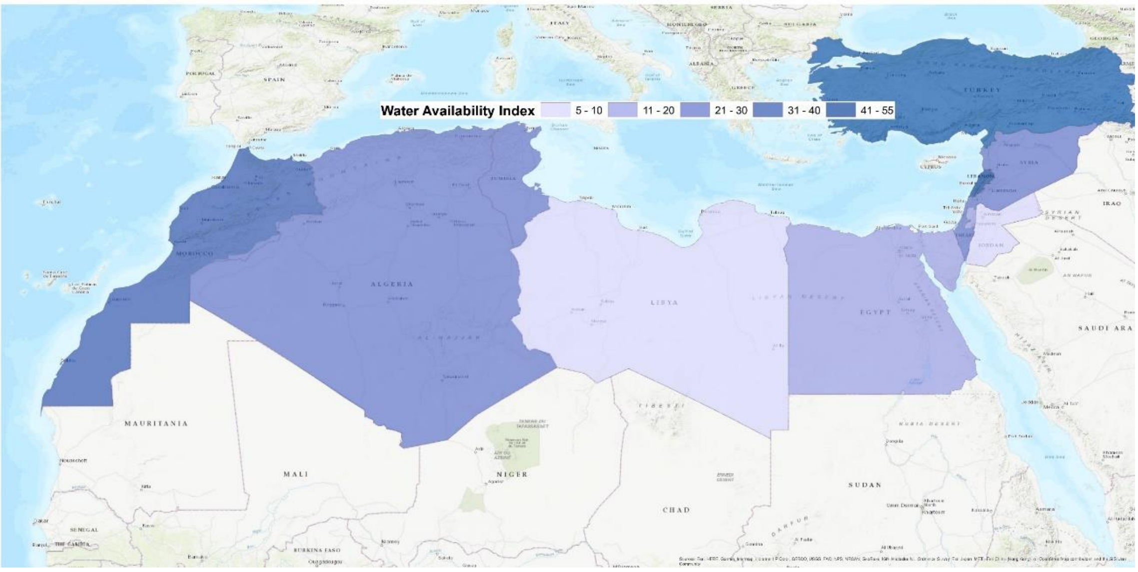

Figure 1: Water *Availability Index in the selected SEMED Countries 2021)*

The Middle East and North Africa (MENA) region is the most water-scarce and dry region in the world where water availability is merely 1,200 m^3/person/year while this rate is 7 times more in other regions of the world[2]. Similarly, many countries in the region extending westwards across the Southern and Eastern shores of the Mediterranean basin, which are usually known as the Southern Eastern Mediterranean (SEMED) countries, are not an exception from this predicament as their Water Availability Index[*] (WAI) is very low and ranging, for instance, from 5 to 10 percent in Libya and Jordan, and from to 41 to 55 percent in Morocco and Turkey (See Figure 1). Contrariwise, SEMED countries are highly dependent on agriculture. Agriculture is an important cultural tradition vital to the economy of the SEMED countries which requires significant and considerable allocation of water resources especially in the light of the water scarcity. Water resources are unevenly distributed between these countries; for example, Jordan is among the poorest countries in the world on the basis of per capita water availability,

[2] https://www.ecomena.org/water-scarcity-in-mena/

[*] Water Availability Index is the relationship between total water use and water availability. The index includes surface water as well as groundwater resources, and compares the total amount to the demands of all sectors, i.e. domestic, industrial and agricultural demands

with only 147 cubic meters per person per year in 2010, and less than 100 cubic meters per person per year in 2020. Water Resources are also unevenly distributed within countries and often mismatching human and environmental needs. For instance, the northern areas of Tunisia have the main source of surface water, the Medjerda River, while many groundwater sources are concentrated in the south and fewer water resources are available in the center[3] .The over-extraction of groundwater beyond safe yield levels has not only resulted in the decline of the groundwater table, but also in the pollution of existing groundwater aquifers in coastal areas, due to intrusion of saline seawater and the up-coming of brackish and saline water supplies from lower aquifers. This is particularly serious in Libya, Tunisia and other countries of the SEMED countries where deterioration of groundwater tables has been observed and measured over the last years as shown in Figure 2.

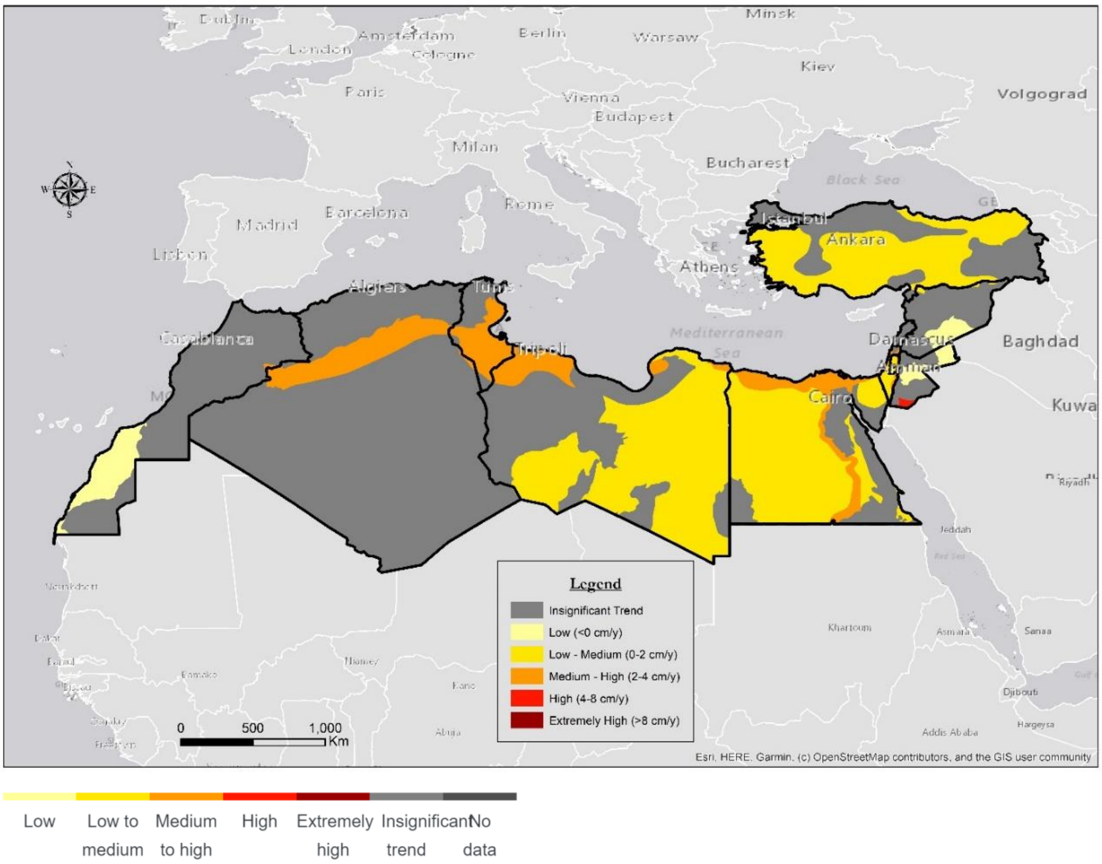

Figure 2: Groundwater table decline from 1990 to 1994

Three quarters of the water resources in the Mediterranean Region are located in the northern shores while three quarters of the needs are in the south and east[4]. Climate change, bringing an expected 20 percent reduction in rainfall,[5] with the expected reduction in rainfall being more severe in the south and eastern Mediterranean (SEMED Region) puts the agriculture sector into risks and hinders food production which makes the livelihoods of some farming communities

[3] ESCWA Water Development Report 8
[4] https://www.medecc.org/wp-content/uploads/2020/11/MedECC_MAR1_3_1_Water.pdf
[5] https://web.worldbank.org/archive/website01418/WEB/0__CO-48.HTM

even more perilous and challenging in the region. The intensive abstraction of aquifers in the SEMED Region has exhausted the surface and groundwater resources and led to the intrusion of seawater into coastal aquifers. The surface water resources in some of the SEMED countries are not only the scarcest; they are also the most variable and unpredictable in the world. Compared to other regions, surface freshwater availability in these countries varies greatly from year to year (World Bank, 2018).

Water demand by all sectors of the economy has doubled to 280 km^3 /year over the 50 years to 2007[6] and is still increasing. The need to better manage the scarce water resources is an utmost importance. These water availability challenges are exacerbated by many factors; the first factor is population growth. The SEMED countries of this study are characterized by big population growth, which means more people each year t~~hat~~ need access to clean water for household use, more need for food from agriculture, and more services and industry to fulfill their demands. The second factor is urbanization and a modern lifestyle coupled with intra-country migration, as more people migrate from the countryside to the cities in search for better life and economic opportunities, which means higher demand for water. The third factor is immigration from one country to another, which has been a tragic consequence for the many conflicts around the region such as Syria and Libya, where millions have become refugees in neighboring countries, thus putting extra pressure on the scarce water resources.

Many studies have reported that agriculture is the region's largest water consumer (An average of 70 percent of the water use is for irrigation according to the World Bank in 2020). For instance, in 2018, Egypt and Turkey have withdrawn 61.35 BCM and 51.735 BCM respectively for agricultural water (Figure 3). However, agriculture plays a significant role in the economies of most of the SEMED region and provides a substantial proportion of employment in some of the region's countries[7]. The average water use efficiency in irrigation fluctuates from one country to another in the selected SEMED countries according to Figure 4. This value reflects the allotment required in each country to meet the agricultural needs as shown in Figure 4. For instance, the water use efficiency in irrigation in both Algeria and Libya is around 30 percent whilst it is reaching 75 percent in Israel. Nevertheless, agricultural water use can be reduced substantially without decreasing productivity through improved irrigation technologies (sprinkler and drip systems) and efficient water management practices.

[6] Revolve, 2017, "Water around the Mediterranean"
[7] https://journals.openedition.org/poldev/2274

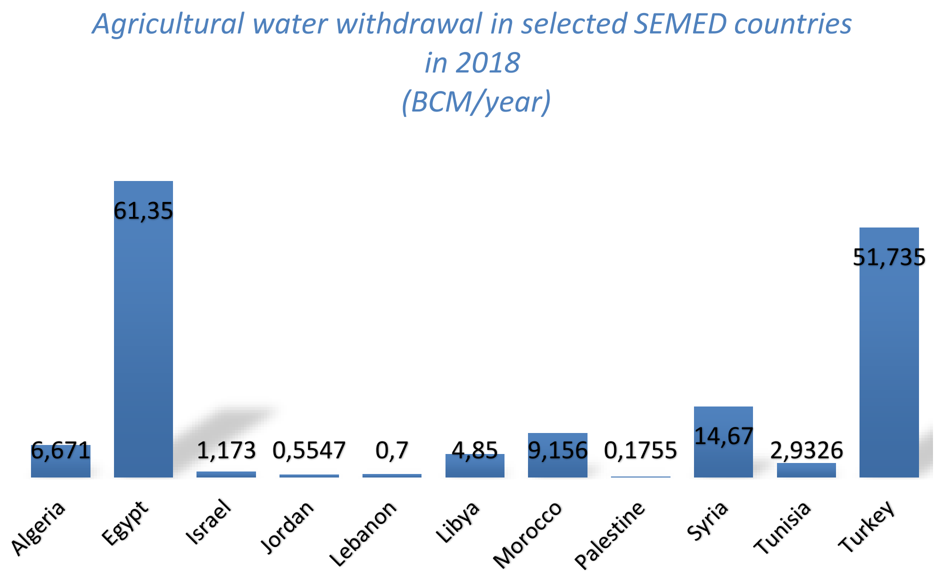

Figure 3: Agricultural water withdrawal in selected SEMED countries, Source: FAO Aquastat

Large areas in the SEMED region still use low efficiency irrigation methods, as large areas still use open concrete irrigation channels to convey water to agricultural lands, and agricultural lands are still being irrigated using surface irrigation, which causes big losses in irrigation water and low water use efficiency. There is an urgent need to improve irrigation practices and technologies to make better use of the scarce water resources and improve water use efficiency. The other main water users are municipal water and water for industry. Of all fresh water diverted for human use in Turkey, industrial and household uses account for 21 percent and 10 percent, respectively, while irrigated agriculture consumes on average around 69 percent and much more in specific locations (FAO, 2003). Furthermore, physical water losses in municipal and industrial supplies in the region are way above world averages. Non-revenue water[8] (NRW) is 30 to 50 percent in some countries such as Tunisia and Turkey. While Jordan, West Bank and Gaza are among the countries in the region where the overuse of renewable aquifers is most acute (World Bank, 2000).

Because of the arid dry weather in large areas in the SEMED region, the water evaporation is very considerable in the region where a large portion of the surface water is being lost which reduces the water availability for population consumption and the agricultural sector. Due to these harsh climatic conditions, some countries of the SEMED region sought solutions to overcome the water scarcity. For instance, in Libya, the Great Man-Made River (GMR) Project[9] would yield five times more water effectively than the earlier traditional water resource options before 1983.

[8] https://www.ecomena.org/water-scarcity-in-mena/
[9] https://en.wikipedia.org/wiki/Great_Man-Made_River

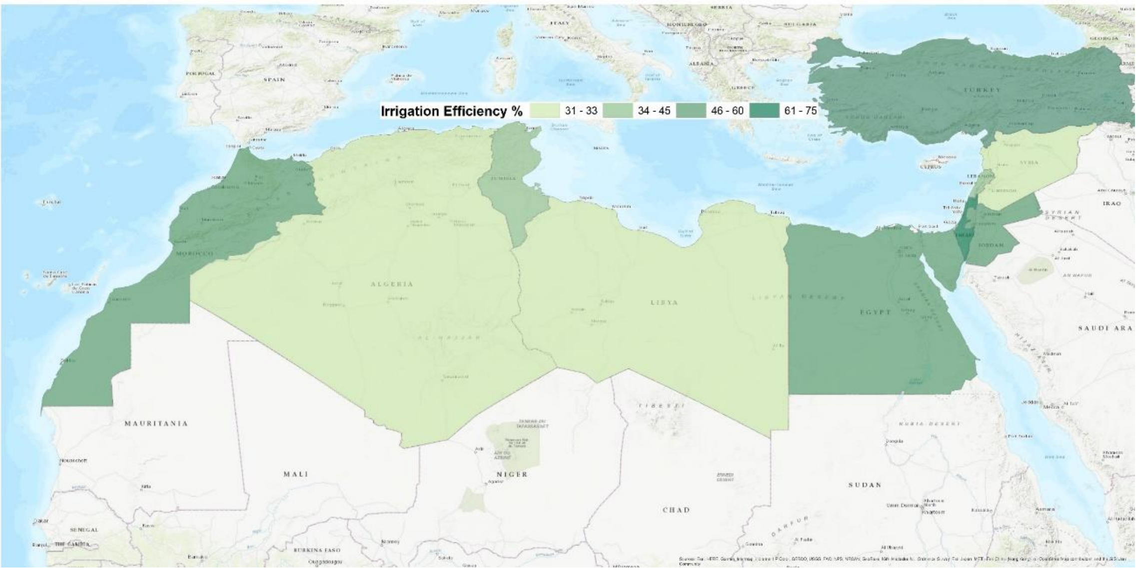

Figure 4: Irrigation Efficiency % in selected SEMED countries

The deterioration of the conventional water resources in the region is implying the necessity of an urgent shift towards non-conventional water resources to help improving the quality, reliability, and sustainability of urban and agricultural water services.

The development of nonconventional water resources such as the use of treated wastewater as a water use practice for agricultural needs or managed aquifer recharge has a potential role to play in meeting water demands in agriculture. This practice was met with too much acclaim across the SEMED region as there is a growing understanding that treated wastewater is a good source of agricultural water that could contribute to the conservation of water resources and improve soil fertility (Xu et al. 2010). Some countries[10], like Jordan and Tunisia, promote wastewater treatment and reuse as an integral part of their water management strategies. Nevertheless, many people are still reluctant yet suspicious of the reuse of the treated wastewater since they are uncertain of the quality of these waters. Moreover, the lack of political commitment and of national policies and/or strategies to support wastewater treatment and reuse remain significant limitations in most SEMED region countries. This reluctance did not deter some countries of the region to continue introducing and extending the wastewater treatment and reuse as an additional water resource in their national water resource management plans. The Bahr al-Baqar wastewater treatment plant located in northwest Egypt[11] is an exemplary case being one of the largest in the world with a treatment capacity of 5.6 MCM/d and the largest in Africa. This plant will contribute to preserve and leverage the available natural resources by providing additional water for agricultural and domestic purposes but also preventing pollution coming from the industrial water while using the formed sludge in agricultural applications such as land reclamation or in construction such as cement bricks, backfill materials…etc.

According to the World Bank the per capita water availability in countries like Algeria, Morocco and Tunisia, is estimated to be reduced to 80 percent by 2050. Therefore, In Algeria, the government is making huge investments to turn seawater into potable water by building many

[10] Revolve,2017. Water around the Mediterranean countries
[11] https://www.acciona.com/projects/wwtp-bahr-al-baqar/?_adin=02021864894

desalination plants. The Fouka desalination plant, built in 2011, covers the potable water needs of the region of Zeralda and the western part of Algiers[12]. Likewise, Morocco is being involved in the construction of a new seawater desalination plant, which, when it is ready for use by the end of 2022, will become the largest industry of its kind in the world[13]. The capacity of the plant will occupy an area of 275,000 cubic metres and will provide the water for food comsumption and irrigation.

The SEMED countries are trying to adopt a spectrum of water use practices emanating from improving water policies and strategies, infrastructure development, economy of water use, wastewater treatment, and desalination, among others in order to meet the growing demand for water and food by a growing population (Figure 5).

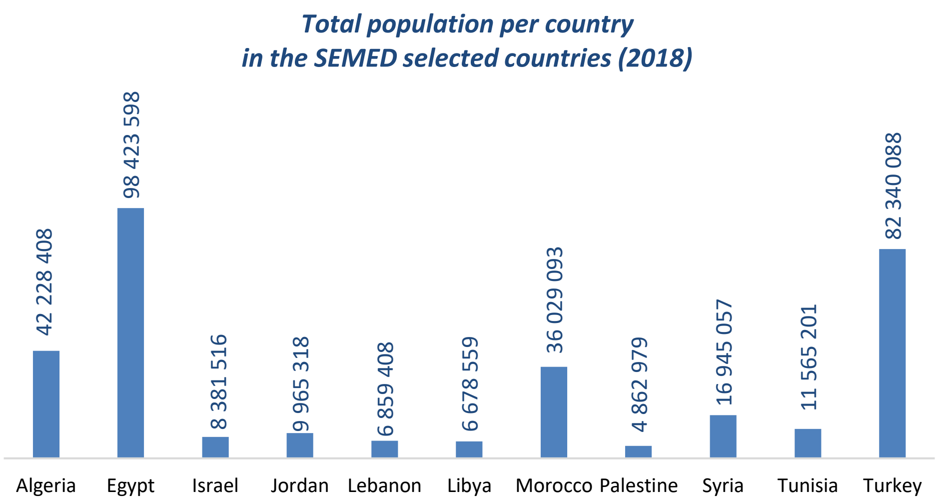

Figure 5: Total population per country in selected SEMED countries, Source: FAO Aquastat

This will be a challenging task for the SEMED countries, especially in the light of the dire economic situation of the region which has been exacerbated by the climate change, a severe water shortage, disputes over transboundary water basins, tensions within countries and not forgetting the arduous effect of the COVID-19 pandemic which has exposed serious fault lines and vulnerabilities in societies, institutions and economies all around the world.

In the following section, we will shed the light on specific water use practices adopted by selected SEMED countries such as Algeria, Egypt, Israel, Jordan, Libya, Morocco, Palestine, Syria, Tunisia and Turkey. Fortunately, these countries have demonstrated varying degrees of success in implementing innovative irrigation techniques to diminish the pressure on the use of the water resources for agriculture, to increase water productivity, and to produce nonconventional water through wastewater treatment and desalination. The treated wastewater is mainly used for agricultural purposes, while desalinated water is destined to meet the household water demand of the population which consequently will reduce the pressure on the existing water

[12] https://www.water-technology.net/projects/fouka-desalination-plant/
[13] https://atalayar.com/en/content/morocco-installs-largest-seawater-desalination-plant-world

resources already available for agriculture. Though, the discharge of brine (i.e.,desalination by-product) poses a major problem with negative impacts on hydro-ecosystems and has detrimental effects on the desalination process itself.

4.1. Water Use Practices in Algeria

Agriculture and Irrigation efficiency

The agricultural sector contributes to about 12 percent of Algeria's GDP and employs around 20 percent of the population in rural areas. Agriculture is by far the foremost consumer of water in Algeria, but its share within the other uses (industries, municipalities) has diminished from 80 percent to 60 percent from 1975 to 2019 (FAO Aquastat, 2019). This is moderately due to the increased adoption of more efficient irrigation techniques but is also due to the increase in the drinking water share, which increased from 16 percent to 36 percent in that same period (FAO Aquastat).

In Algeria, several pilots and innovations in the field of irrigation are stated, with farmers trying to move away from less water-efficient furrow irrigation[14]. Many other irrigation system techniques were adopted in agriculture such as the subsurface fertigation system in the desert and the portable sprinkler system in Northern Algeria. However, gravity irrigation is still the most used irrigation method in small and medium-scale farms.

In order to improve positively the actual availability of water in Algeria, operators in charge of water production/distribution are called to improve their methods and their technical and economic performances which will lead to considerable savings. With modern subsurface drip irrigation[15] the water savings can be increased by around 50 percent.

Treated wastewater

The use of treated wastewater for agriculture in Algeria is still in progress to meet the demand in water quality. The reuse of wastewater is being applied on a reasonably large scale. Of 154 treatment plants operated by Office National d'Assinissement (ONA) across 44 cities, 16 plants are concerned with the reuse of purified wastewater in agriculture. During 2019, a volume of 12 MCMof purified water was used for the irrigation of 11,045 hectares of agricultural land[16]. This constitutes a good start, however it shows there is a big potential for increasing the number of wastewater treatment plants, the level of treated water quality, the volume of purified water and the area of agricultural lands irrigated with this water.

Desalination

To overcome the water scarcity crisis, Algeria is making huge investments in developing seawater desalination projects. Fouka Desalination Plant[17] is a sea water reverse osmosis

---

[14] V. Langenberg, B. Bruning, A. de Vos, AHeijden, B. Gonzalez, 2021, "Water in Agriculture in Three Maghreb countries"

[15] V. Langenberg, B. Bruning, A. de Vos, AHeijden, B. Gonzalez, 2021, "Water in Agriculture in Three Maghreb countries"

[16] V. Langenberg, B. Bruning, A. de Vos, AHeijden, B. Gonzalez, 2021, "Water in Agriculture in Three Maghreb countries"

[17] https://www.water-technology.net/projects/fouka-desalination-plant/

(SWRO) desalination facility located in Fouka, in the Tipaza province of Algeria. It was commissioned in August 2011 and was built with a total capital expenditure **of $185M**. The daily water treatment capacity of the plant is 120,000 m^3. It is expected to serve a population of more than half a million people.

4.2. Water Use Practices in Egypt

Agriculture and Irrigation efficiency

Agriculture is a major component of the Egyptian economy, contributing 11.3 percent of the country's GDP[18]. The agricultural sector accounts for 28 percent of all jobs, and over 55 percent of employment in Upper Egypt is agriculture-related. The agriculture is by far the biggest water-consumer in the country, as it consumes 84% of the water in Egypt. In 2018, Egypt has withdrawn more than 61 BCM for agricultural purposes (FAO Aquastat, See Figure 3).

To sustain this sector, Egypt is taking a number of serious and ambitious measures in order to improve the quality and efficiency of irrigation systems. Some of these measures have been applied to domestic water systems and industrial requirement[19]. These measures consist on the use of modern irrigation systems such as sprinkler and drip irrigation systems in newly reclaimed lands namely the desert. Gravity or flood irrigation in these areas is prohibited by law and this is obviously due to the high permeability of these soils and their high capacity of natural drainage. The change from surface irrigation to drip irrigation in the orchards and vegetable farms in the old lands has been one of the measures too. These changes require high costs that are expected to be taken conjointly by the farmers and the state. The night irrigation practice is very solicited since it reduces evaporation losses contrary to the day time irrigation.

Another way of encouraging water savings in agriculture is to raise crops which stay a shorter period in the fields by reducing their growing period. A good example is represented by the shortage varieties of rice which stay in the field only 150 days compared with the traditional variety that need 180-210 days[20].

Treated wastewater

The main driving factor of the exploration of unconventional sources that can meet the water demands of the increasing population in Egypt is the water resources scarcity. The application of the treated wastewater (TWW) to agriculture has proved its reliability and effectiveness of reducing the gap between current water demand and supply. Moreover, the long-term reuse of TWW can improve the soil fertility without negatively affecting soil quality[21].

A new wastewater treatment plant was built in the locality of Bahr El-Baqar, in the Sinai Peninsula, east of the Suez Canal. It has a production capacity of 5.6 MCM per day, making it one of the largest wastewater treatment plants in operation in the world. The plant collects domestic, industrial and agricultural wastewater that flows along the Bahr al-Baqar Drain, which

[18] https://www.usaid.gov/egypt/agriculture-and-food-
[19] https://om.ciheam.org/om/pdf/a88/00801177.pdf
[20] https://om.ciheam.org/om/pdf/a88/00801177.pdf
[21] https://www.mdpi.com/2071-1050/14/6/3177/htm

meanders 106 km from Dakahlia Governorate to Sharqia and from Ismailia Governorate to Port Said Governorate. The effluent then passes through four treatment lines of 1,250,000 m^3 each per day before being made available to farmers for irrigation[22]. There are significant opportunities to maximize the benefits of TWW reuse in Egypt as studies showed that less than 75 percent of collected wastewater is currently being treated.

Desalination

Given the geographical location of Egypt between two seas and its almost absolute reliance on the Nile river as a water resource, in addition its highly saline groundwater and the threats from salt sea water intrusion into coastal aquifers and wells, desalination seems to be a propitious approach to the dire water scarcity crisis both in drinking and irrigation water. As stated in 2014, by the Egyptian Ministry of Water Resources and Irrigation, the country has 66 BCM of water, of which 55.5 BCM comes from the Nile and the remainder is distributed as follows; 1.6 BCM from effective rainfall on the northern strip of the Mediterranean Sea so as Sinai, 2.4 BCM from non-renewable deep groundwater from western desert so as Sinai and 6.5 billion cubic meters from shallow groundwater. The total water supply is 66 BCM, while the total current water requirement for different sectors is 114 BCM /year[23] (in 2021). The gap between the needs and availability of water is about 48 BCM /year. This gap is compensated by the reuse of agricultural wastewater and groundwater in the Valley and Delta, in addition to importing food products that would otherwise consume 34 BCM of water annually to produce[24].

In 2021, Egypt planned to avoid future water stress by spending some $2.5 Billion on new desalination capacity over the next five years[25]. 17 facilities will be constructed on the shores of both the Mediterranean and the red sea over mentioned period, all of which will be operated using solar energy to reduce their environmental impact and running costs. They will produce 2.8 MCM of water a day, compared with the country's present capacity of 800,000 m^3.

4.3. Water Use Practices in Israel

Agriculture and Irrigation efficiency

Israel is located on the southeastern coast of the Mediterranean and it is considered as one of the most water-scarce countries in the world. However, this predicament has shaped the development of the Israeli water sector over the last five decades.

Sustaining a competitive agricultural sector has always been a national precedence for Israel. As it has a limited water and arable land, the country has taken several measures to develop innovative agricultural practices and technologies and shift the focus of farmers to high-value

---

[22] https://www.afrik21.africa/en/egypt-el-sisi-inaugurates-the-worlds-largest-sewage-plant-in-bahr-el-baqar/

[23] https://english.ahram.org.eg/NewsContent/1/64/414376/Egypt/Politics-/Egypt-one-of-worlds-most-waterscarce-countries,-ir.aspx

[24] https://english.ahram.org.eg/NewsContent/1/64/414376/Egypt/Politics-/Egypt-one-of-worlds-most-waterscarce-countries,-ir.aspx

[25] https://www.globalconstructionreview.com/egypt-plans-desalination-plants-worth-2-5bn-over-next-five-years/

crops so that they could afford to invest in modern irrigation techniques. Israeli companies were pioneers in the early 1950s in the development of efficient low-volume irrigation technologies [26]such as drip irrigation and mini sprinklers. The efficiency of irrigation systems has been a major factor making possible the reduction in average water supply to agricultural land, down from 7,000 m3 /ha in 1990 to 5,000 m3 /ha in 2000 (world Bank, 2017).
The successful development of these technologies has allowed the development of a thriving irrigation industry in Israel.

Treated wastewater

The limitations of water scarcity, combined with a fast growing population and the decision to stop over-exploiting the groundwater, made it compulsory for Israel to engage in a massive program of reuse of treated wastewater since 1998. According to the World Bank, reclaimed wastewater has become a major source of water for farmers, supplying more than 40 percent of the country's needs for irrigation and more than 87 percent of wastewater being reused. Of the 507 MCM/year of wastewater produced, 468 MCM/year (93 percent) is treated and 410 MCM/year (85 percent) is reused in irrigation[27].

Domestic sewage is collected and treated by Israel's national water utility, Mekorot[*], or by private companies. As such, Israel is today one of the few countries in the world that has managed to almost entirely close the urban water cycle (World Bank, 2017).

Desalination

In the early 2000s, understanding that Israel is confronted by a structural water scarcity, the government made the strategic decision to advance desalination plants on a large scale. The aim was that most of the water supply for municipal consumption would come from desalinated water, to ensure the country's water security (World Bank, 2017). In Israel, desalination is expected to meet the future growth in domestic and industrial demand through generating an equivalent increase in the amount of treated wastewater available to farmers for reuse. Desalination[28] plants are using reverse osmosis technology to treat seawater for drinking-water purposes and brackish water for agriculture. Today, desalination accounts for approximately 42 percent of the country's drinking-water needs.

Over the last 15 years, five mega desalination plants based on seawater reverse osmosis (SWRO) were constructed along the Mediterranean Coast with a total capacity of 585 MCM per year. According to the World Bank, desalinated water now supplies 85 percent of domestic urban water consumption and 40 percent of the country's total water consumption. This move has allowed Israel to be one of the world leaders in seawater desalination.

---

[26] https://documents1.worldbank.org/curated/en/657531504204943236/pdf/Water-management-in-Israel-key-innovations-and-lessons-learned-for-water-scarce-countries.pdf
[27] https://water.fanack.com/israel/water-resources/
[*] Merokot is the national water company of Israel and the country's top agency for water management
[28] https://water.fanack.com/israel/water-resources/#_ftn2

4.4. Water Use Practices in Jordan

Agriculture and Irrigation efficiency

Jordan is located in the Middle East in the Eastern Mediterranean and it is considered as the fourth driest country in the world, due to the desert environment that covers 92 percent of its land area. Its per capita share of renewable water resources is less than 100 m^3 per year, which is expected to fall to 90 m^3 per year by the year 2025[29]. Agriculture in the Jordan Valley is extremely vital to the local economy. However, it is a water consuming sector, taking over the lion share of all water demand in Jordan for approximately 45 percent. The vast majority of commercial agriculture in the Jordan Valley is irrigated rather than rain-fed and water consumption in the agriculture sector is about 588 MCM per year[30].

The irrigated area in the Jordan Valley is about 40,000 ha. Crops planted in the different agro-climatic zones in the Jordan Valley are field crops, vegetables, fruit trees, banana, citrus, green house vegetables, and dates[31]. There are several methods that farmers use to irrigate their land in these different agro-climatic zones in the Jordan Valley. Farmers' choices of irrigation technique depend on the kind of crops they grow, their financial reality, and the information they have access to. In the Jordan Valley [32](JV), 68 percent of the farmers use drip irrigation, 30 percent use surface irrigation and 2 percent use sprinklers. It is estimated that water savings through optimization of irrigation could reach almost 40 MCM/year by the year 2020 at a cost of 0.5 US$/$m^3$. A study has shown that by the year 2020, drip irrigation and sprinkler irrigation percentages will be increased at the expenses of surface irrigation which will reflect positively on the application of the water use efficiency practices[33].

Treated wastewater

The Ministry of Water and Irrigation (MWI) is reinforcing the national priority to address the imbalance of water consumption across Jordan's economic sectors relative to their importance and their contribution towards the country's GDP. Despite the irrigated agriculture significant reduction in the consumption ratio (from 75 percent to 60 percent), MWI is aiming for substituting the use of fresh water by treated domestic wastewater and may be other non-conventional resources[34].

Wastewater has been used for irrigation in Jordan for several decades. More than 70 MCM of reclaimed water, around 10 percent of the total national water supply, is used in Jordan each year. One of the exemplary wastewater facilities in Jordan is the As-Samra wastewater treatment plant which was built to improve the quality of water. It treats the wastewater released from the Zerqa river basin, which is part of the two populated cities of Greater Amman and Zerqa. The Construction of the plant was undertaken between 2003 and August 2008, at a

---

[29] https://jordankmportal.com/resources/water-sector-capital-investment-plan-2016-2025
[30] Khaleq, Rania A. Abdel. "Water Demand Management in Jordan." Water Demand Management Unit, Ministry of Water and Irrigation (June 2008)
[31] Abbas S. Al-Omari, 2015, "Irrigation water management in the Jordan valley under water scarcity"
[32] M. Shatanawi, A. Fardous, N. Mazahrih, and M. Duqqah, "Irrigation systems performance in Jordan"
[33] Abbas S. Al-Omari, 2015, "Irrigation water management in the Jordan valley under water scarcity"
[34] https://jordankmportal.com/resources/water-sector-capital-investment-plan-2016-2025

cost of $169M. With a peak flow of 840,000m³ each day, the facility provides 365,000 m³ per day of treated water for irrigation and serving a population of 2.2 million living in the Greater Amman and Zarqa areas[35].

Desalination

Jordan's only access to the sea is at Aqaba, where it has a short shore line. After several studies being carried out in the past on the possibilities for desalination at Aqaba, the ministry of water and irrigation has finally announced in mid-2021 that a $1 billion desalination plant will be built in the Red Sea. The water from the plant will be sent by pipeline throughout the country. The plant[36] is expected to produce 250-300 million cubic meters of potable water per year and should be ready for operation in 2025 or 2026. Jordan's experience in brackish water desalination has been fairly limited. All of the plants built to date have been small and built for commercial/ industrial use or for agriculture[37].

4.5. Water Use Practices in Lebanon

Agriculture and Irrigation efficiency

Lebanon is one of the smallest countries in the SEMED region of our study. It is located on the eastern shore of the Mediterranean Sea. It borders the Sea in the west, Syria in the north and east, and Israel in the south. Its surface is officially 10,400 square kilometers, but small parts of the borders with Syria and Israel are contested[38]. Compared to its immediate neighbors, Lebanon is about half the size of Israel, and almost 18 times smaller than Syria.

Despite Lebanon's moderate climate, abundant water resources, the highest proportion of arable land in the Arab world with more than 200,000 hectares (494,000 acres), Lebanon's own agricultural sector has gone underfunded and underdeveloped for many years, hindered by a lack of modern equipment and inefficient production techniques[39]. Moreover, the agriculture sector is the biggest consumer of water, estimated at 70 percent [40]of the total water supply, exacerbated by inefficient irrigation practices where irrigation efficiency is merely 40 percent. According to the Ministry of Agriculture, 50 percent of the farmers use surface irrigation, 25 percent use drip irrigation and 25 percent use sprinklers. This is due primarily to lack of knowhow and guidance to farmers, and outdated technologies. This is triggering major wastage and contributing to pollution of water resources.

Agriculture is seen as a critical sector for employment creation and poverty reduction in Lebanon, for both Lebanese people and Syrian refugees. The Lebanese agriculture sector has been severely affected by the recent economic and financial crisis and the COVID-19 pandemic. The absence of credit facilities, the currency devaluation and the capital control

[35] https://www.water-technology.net/projects/as-samra-wastewater-treatment-plant-jordan/
[36] https://www.i24news.tv/en/news/middle-east/1623589631-jordan-to-build-red-sea-desalination-plant-to-combat-drinking-water-shortage
[37] M. Mohsen, 2007, "Water strategies and potential of desalination in Jordan"
[38] https://water.fanack.com/lebanon/
[39] https://www.salaamgateway.com/story/lebanese-agriculture-faces-devastating-losses-after-export-ban
[40] USAID, 2017, Lebanon Country Plan

measures hindering the payment of suppliers in the agriculture sector have severely impacted agriculture production given the country's reliance on imports of agricultural inputs[41].

Agriculture and food are important for the economy of Lebanon. Approximately 20 to 25 percent of Lebanon's active population are involved in the agriculture and food sector[42]. While primary agriculture makes a small share of Labanon's income (about 4 percent of the GDP), agriculture contributes 25-30 percent of the GDP when indirect contributions (the food sector) is considered.

According to data in the literature, at scheme level, overall efficiency, which is the result of storage, conveyance, network and on-farm efficiency, is between 40 and 45 percent. At farm level, irrigation efficiency is on average 50 percent with traditional irrigation techniques, such as the basin and furrow systems, but it could reach 70 percent-90 percent when modern pressurized techniques are used[43].

Treated wastewater

In 2001, 310 million m³ of wastewater were produced in Lebanon by the domestic and industrial sectors (FAO AQUASTAT). In 2006, 4 million m³ of wastewater were treated and 2 million m³ were used for informal irrigation (FAO AQUASTAT). Raw wastewater is also being reused for irrigation in several regions of Lebanon. Such is the case in the Bekaa region where some of the sewers are purposely blocked to allow sewage to be diverted for irrigation. In other regions[44], wastewater is being discharged in rivers or streams used for irrigation such as in Akkar and Bekaa (Ras El Ain, Zahleh).

4.6. Water Use Practices in Libya

Agriculture and Irrigation efficiency

Libya is one of the several SEMED countries facing high water stress, mostly because of its semi-arid to arid climate and low rainfall. Water resources in Libya rely heavily on groundwater (about 97 percent of the total water consumption[45]). As a result of population increase, urbanization, improving economic conditions and the Libyan Civil War, experts[46] project Libya will need 8 BCM of water annually by 2025. However, actions to avoid a possible water crisis have so far been insufficient as the excessive use of water in domestic and industrial sectors and particularly in agriculture is putting an additional stress on demand and has contributed to the agricultural land holdings. Moreover, the water imbalance and the increasing soil salinization relying on scarce

[41] United Nations in Lebanon, 2021

[42] https://documents1.worldbank.org/curated/ar/325551536597194695/pdf/Agricultural-Sector-Note-Jordan-and-Lebanon.pdf

[43] https://www.idaea.csic.es/meliaproject/sites/default/files/517612-MELIA-Modernization-of-irrigation-systems-measures-to-reduce-pressure-on-water-demand-in-Lebanon.pdf

[44] https://hispagua.cedex.es/sites/default/files/hispagua_documento/documentacion/documentos/Chapter7.pdf

[45] https://water.fanack.com/libya/

[46] https://www.borgenmagazine.com/libyas-water-crisis-affects-millions-nationwide/

Libyan fossil[47] groundwater resources have exacerbated the water situation in the country. In addition, irrigated agriculture is intensifying in the coastal zone as well as in the oases and along wadis.

The estimated agricultural water use in 2018 is 4,85 BCM,(FAO, Aquastat) or about 85 percent of water demand. This amount remains continuously increasing as the actual mining is not well known and uncontrolled withdrawals of groundwater for agricultural purposes.

Libya, like many other countries facing the water crisis, is seeking solutions to sustain its water resources. Hence, it is required to take innovative measures to attain economical sustainability and, expanding agriculture is quite a significant element to consider. Increasing irrigation efficiency practices has a clear impact in terms of shifting from managing water supply to managing water demand.
Since 1970[48], several water-efficient irrigation methods have been successfully introduced. Among them are sprinkler and drip irrigation in Kufra in eastern Libya and in Garaboulli, about 60 km east of Tripoli. However, many parts of the irrigated areas are either over-irrigated or under-irrigated because of spatial variability in soil water capacity, infiltration rates and topography.

Treated wastewater

The treated wastewater is an important non-conventional water resource. Libya has built more than 75 WWTPs, with design capacities exceeding 450,000 m^3/d. The water produced by WWTPs is designed for agricultural use only[49]. Unfortunately, these produced quantities of effluents are currently very small because of technical and non-technical problems. The current unstable conditions of the Man-made River project[50] make it an unreliable water source in the future. Hence, the reuse of the treated wastewater as an alternative to conventional water supply stands a crucial need. Two agricultural projects (of 6,000 hectares) were shown to benefit from water produced by wastewater treatment plants established in Tripoli and Benghazi[51].

Desalination

The extensive use of conventional water resources like groundwater, the lack of awareness of how to optimally use and save water, the seawater intrusion into the coastal water aquifers, have all contributed to a severe water crisis in Libya. There is an urgent need to look for alternative water sources to meet people needs and compensate the reduction in groundwater. Desalination is one of such alternative water resources that can solve water shortage problem in Libya. It is considered to be the second non-conventional water resource adapted in the country after The Man-made River project (MMRP). Desalination technology has been used in

---

[47] K. Al-Samarrai, 2018, “Precision irrigation efficient technologies practices in libya from the water and energy point of view”
[48] K. Al-Samarrai, 2018, “Precision irrigation efficient technologies practices in libya from the water and energy point of view”
[49] https://water.fanack.com/libya/water-resources-in-libya/#_ftn22
[50] B. Brika, 2018, “Water Resources and Desalination in Libya: A Review”
[51] https://water.fanack.com/libya/water-resources-in-libya/#_ftn22

Libya since the early 1960s, although few desalination plants have been established since then. There are currently about 21 operating desalination plants, with a total capacity[52] of 525,680 m3/d. The overall contribution of desalination in the overall local water supply represent 1.4 percent in the year 2002.

4.7. Water Use Practices in Morocco

Agriculture and Irrigation efficiency

In Morocco there is clear demand for more water-use efficient technologies because the water use efficiency in general is low. The conveyance of water to, and application on the fields is in the order of 40 percent, which means that less than half of the water delivered to farms currently reaches the crops (World Bank, 1998). In 2008, Morocco began an ambitious agricultural policy called the Green Morocco Plan[53] (GMP). The Green Morocco Plan is based on a global approach integrating the whole actors operating in the agricultural sector within a contractual framework at all levels and is founded on two pillars: a first pillar focused on the development of a modern agriculture with high added value in the irrigated areas and favorable Bour, and a second pillar focused on raising agricultural income in the most vulnerable areas. In order to endorse and support the GMP, the National Irrigation Water Saving Programme (PNEEI) and the National Water Strategy were formulated in 2009 aiming at making agriculture a national growth engine.

The PNEEI adopted more striving targets such as the conversion of 550.000 ha of land irrigated by gravity or sprinkler to drip irrigation in 15 years, at the cost of 37 billion Dirhams (~3.7 € billion). Of this conversion, 72 percent would involve large-scale public irrigation (including some individual farm conversions and the modernization of the collective distribution of pressurized water through pipes). As per the remainder, it will be devoted to private individual irrigation (ADB, 2009).

Drip irrigation is promoted and used more and more and adopted already in nine broad areas in the country, some areas of which apply drip irrigation on more than 50 percent of the agricultural area[54]. Additionally, farmers are interested and successful implementation has been reported. Multiple packages with sensors, mobile phone apps etc. now exist, ready to be implemented[55].

Treated wastewater

The volume of treated wastewater mobilized for reuse at the end of 2019 is around 65 MCM including nearly 19 M m^3 for watering golf courses and green spaces in the city of Marrakech

[52] B. Brika, 2018, “Water Resources and Desalination in Libya: A Review”
[53] https://agritrop.cirad.fr/579049/13/GreenMoroccoPlanFaysse_post-peer-reviewed-version.pdf
[54] V. Langenberg, B. Bruning, A. de Vos, AHeijden, B. Gonzalez, 2021, “Water in Agriculture in Three Maghreb countries”
[55] V. Langenberg, B. Bruning, A. de Vos, AHeijden, B. Gonzalez, 2021, “Water in Agriculture in Three Maghreb countries”

and 11 Mm³ for the city of Agadir[56]. Upon completion of the implementation of the projects in progress, the volume of purified wastewater mobilized will reach 100 M m³/year in 2021. Based on the National Shared Plan of liquid sanitation, purification, and reuse (PNAM) the reusable potential for 2050 is about 600 Mm³/year. It is worth mentioning that the National Shared Sanitation Plan (PNAM) is a shared update of the previously existing sanitation programming documents (The National Plan for Liquid Sanitation (PNA), the National Rural Sanitation Program (PNAR) and the National Program for the Reuse of Treated Wastewater (PNREUE).[57]

According to the projections presented in the water demand section, it is more likely that the volume of waste and purified water available is only in the order of 340 Mm³/year by 2050 representing 30 percent of the total treated wastewater volume. This can be attributed to the technical and regulatory constraints and the high costs.[58]

According to a study of World Bank in 2017, Morocco had in 2015 a total of 62 wastewater treatment plants, 6 plants with primary level sanitation (capacity 100,000 m3 /day), 40 plants with secondary level sanitation (capacity 240,000 m3 /day), and 16 plants with tertiary level sanitation (capacity 161,000 m3 /day), equivalent to a capacity of about 150 MCM /year with at least secondary level sanitation, or only about 20 percent of all urban wastewater produced in 2015. Morocco thus still has a long way to go to achieve its long-term objective of developing and improving wastewater treatment to 90 percent and reuse to 100 percent of the collected wastewater.

The rapid increase of the production and the collection of the wastewater in urban areas over the past few decades reflect the massive potential of this practice. In this context, in order to encourage this practice and to meet the growing demand for water, The Moroccan government announced in early 2022, that it plans to mobilize 2.34 billion Moroccan dirhams (nearly €220 million) for the implementation of the National Shared Liquid Sanitation Program (PNAM) with the objective to provide 100 MCM of treated wastewater to Moroccans per year by 2027 and to recycle wastewater for the irrigation of green spaces and agricultural land. By 2050, this figure is expected to rise to nearly 340 MCM per year, representing an 80 percent treatment rate in Morocco[59].

Desalination

The National water plan[*] (PNE) proposes the construction of seawater desalination plants to produce nearly 515 MCM per year in 2030. By 2016, Morocco had 15 desalination installations, with a total desalination capacity of 132 MCM /year. Almost all desalination plants (96 percent) operate with reverse osmosis (RO) systems. The current capacity is relatively evenly split between medium-, large- and extra-large-scale plants. The Agadir Desalination Plant is under

[56] V. Langenberg, B. Bruning, A. de Vos, AHeijden, B. Gonzalez, 2021, "Water in Agriculture in Three Maghreb countries"

[57] https://www.pseau.org/fr/maroc/cadre-sectoriel

[58] V. Langenberg, B. Bruning, A. de Vos, AHeijden, B. Gonzalez, 2021, "Water in Agriculture in Three Maghreb countries

[59] https://www.afrik21.africa/en/morocco-rabat-wants-to-mobilize-e220-million-for-wastewater-reuse-by-2027/

[*] The National Water Plan (PNE) is an ambitious action plan to invest nearly $40 billion into the water sector in Morocco finalized in 2015

construction at a cost of about $112 million, using RO technology to produce 36 MCM/year, to fulfil the drinking water and irrigation needs of 800,000 people (123 liter/capita/day) (World Bank, 2017).

4.8. Water Use Practices in Palestine

Agriculture and Irrigation efficiency

Palestine stretches across the Levant. Even though its boundaries changed since 1947, Palestine is still located between the Mediterranean Sea and the Jordan River. Currently, Palestine is divided into two physically separated areas known as the West Bank (including East Jerusalem) and the Gaza Strip, with areas of 5,661 km2 and 365 km2 respectively.

Water scarcity coupled with poor management and underuse of accessible water resources are key issues hindering agricultural growth in the West Bank. According to the Palestinian Water Authority (PWA), old and damaged irrigation pipes can cause leakages of up to 40 percent of the total amount of pumped water[60].

The PWA regulates the water sector and maintains water resources and services in its territories. However, the current governance framework prevents the PWA from implementing and operating an integrated water resource management system in the West Bank This includes the fact that the PWA has to get approval from the Joint Water Committee (JWC) for any proposed management measure or infrastructure project in the West Bank. Israel has used the veto power of its own Civil Administration (CA) to block many Palestinian-proposed water projects, which in turn has affected the PWA's long-term water management policies and basic principles[61]. Yet, this blockade coupled with the water scarcity did not deter farmers in the West Bank and Gaza to find ways to cope with this dire situation. They are employing new strategies to improve their methods of water usage and maximize the small available water. Their solutions include improving and introducing rainwater collection systems (ground cisterns, pools to collect water from greenhouse roofs), using plastic coverings to minimize evaporative water loss, and introducing irrigation systems (mainly drip) that have the highest water use efficiency. Some open water distribution canals have been replaced by closed piping systems. Farmers are also collaborating by linking communities into the nearest available reserves and creating more agricultural cooperatives related to water usage[62].

Treated wastewater

The reuse of reclaimed wastewater in Palestine is a major priority, as confirmed by the Palestinian Water Policy adopted by the PWA the Ministry of Agriculture. According to the European Environment Agency (EEA), the wastewater management in Palestine is mostly limited to the collection of wastewaters by sewage networks and cesspits. Furthermore, wastewater treatment facilities are restricted to a few localities in Palestine. The lack of sufficient and appropriate infrastructure for wastewater collection and treatment associated with political,

[60] https://www.un.org/unispal/document/supporting-efficient-irrigation-systems-in-the-west-bank-fao-article/
[61] https://water.fanack.com/palestine/water-management/
[62] https://www.anera.org/wp-content/uploads/2017/03/AgReport.pdf

financial, social, institutional, and technical obstacles, has been the limiting factor in the development of the wastewater sector. All these challenges have made building wastewater treatment facilities projects in Gaza a factual concern. Moreover, due to the ongoing conflict between Israel and the Palestinians, the import and the procurement of building materials are restricted and take more time than in other countries.

Despite these unexpected circumstances, three new wastewater treatment plants in the town of Bureij, middle of the Gaza Strip, went into test operation at the end of 2020, and regular operation and regular operation at the start in April 2021. Then, the wastewater from eleven communities with around one million inhabitants will be reliably treated - this will significantly improve resource protection and thus the conditions for a proper water supply. German Financial Cooperation supported the project on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ) with a total of EUR 85 million. The operation[63] of the plants is only the first stage of the project with the capacity of treating 60,000 m^3 of sewage. The construction of the second phase of the project is expected to start on 2025 in order to double the amount of treated sewage to become 120,000 m^3.

Desalination

Gaza has a water crisis as only 3 percent of its freshwater meets the World Health Organization's quality guidelines. Being one of the most densely populated places in the world, Gaza faces the worst drinking-water conditions in the region. The Gaza Central Desalination[64] Plant and Associated Works Program was created to respond to these pressing humanitarian needs and will provide 55 MCM of quality drinking water a year for the more than two million people in Gaza. It will help regenerate the coastal aquifer, improve living conditions, boost the economy by adding construction jobs and provide water for industry.

The project will help regenerate the only fresh water source in Gaza, which is the coastal aquifer that also runs underneath neighboring countries. The project is a step forward towards effective reduction of pollution in the Eastern Mediterranean, as a component of a broader water and wastewater program including complimentary development of wastewater treatment facilities[65]. The completion construction of Gaza Central Desalination Plant is expected by October 2023.

4.9. Water Use Practices in Syria

Agriculture and Irrigation efficiency

Syria has a total irrigated area of approximately 1.5 million ha (out of a total 5.3 million cultivated ha), most of which is situated in the valleys around the Euphrates River. The total public schemes run by the government but implemented by individuals account for 550,000 ha or just over a third of the total. Some schemes are gravity fed but most are irrigated with pumped water.

[63] https://www.middleeastmonitor.com/20211211-three-large-wastewater-treatment-plants-put-into-operation-in-gaza/
[64] https://www.eib.org/attachments/country/bringing_water_to_gaza_en.pdf
[65] https://ufmsecretariat.org/wp-content/uploads/2019/04/Policy-Framework-WEB_Nov2020.pdf

Before the war[66], about 60-70 percent of the irrigated area was supplied with groundwater and about 25 percent through government-run surface water irrigation schemes. Unlicensed wells represented about 57 percent of the total 215,000 wells. Modern irrigation techniques such as sprinkler and drip irrigation systems, were still at an early stage of implementation, accounting for about 360,000 ha (24 percent).

Despite the crisis in Syria, agriculture remains a key part of the economy. The World Health Organization (WHO) reported in 2017, that the sector still accounts for an estimated 26 percent of GDP and represents a critical safety net for the 6.7 million Syrians – including those internally displaced - who still remain in rural areas. However, in the recent years, the government refocused all its efforts on developing urban cities the reason for which fuel subsidies to cover the cost of pumping water have been removed. Most of the farmers were put out of business as they could not afford the increasing expense for irrigation purposes and transportation.

Treated wastewater

The Damascus and the Homs wastewater treatment plants in Syria account for more than 98 percent of all treated wastewater with capacities of 177 million m^3/year and 49 million m^3/ year, respectively (WHO, 2005). Since then, new wastewater treatment plants under construction may have come online in other cities such as Aleppo and Latakia. The same source reported that about 177 MCM per year of treated wastewater are reused for irrigating 9000 hectares in Damascus.

Desalination

The total desalination capacity in Syria has always had a marginal value and this could be attributed primarily to the fact that the water-deficit areas are far away from the Mediterranean cost, besides to the high costs of desalination process. The IDA Worldwide Desalination Plants Inventory informed in 2011 on 8 functional desalination plants in Syria which total capacity is 7,893 m3/day; and 6 desalination plants, with a total capacity of 6,088 m3/day, considered presumed on line. So, the presumed water desalination capacity was 13,981 m3/day. This means less than 0,02 percent of the renewable water resources of the country. In 2019, even after the war, this value has slightly declined to reach a value of 8,180 m3/day, which amounts to less than 3 MCM/year. This is approximately 0.01 percent of the total water withdrawal, and therefore the importance of this component is negligible[67].

4.10. Water Use Practices in Tunisia

Agriculture and Irrigation efficiency

Irrigated agriculture in Tunisia is the most water consuming economic sector with about 80 percent of the total water resources exploited (FAO, 2018). The irrigated sector consumes about 2.40 BCM per year of which 80 percent comes from groundwater and 20 percent from dams. Its

[66] https://water.fanack.com/syria/water-use/
[67] https://water.fanack.com/syria/water-resources/#_ftn4

contribution to economic prosperity was 8.7 percent in 2013[68], and has improved in 2018 to reach 10.5 percent as shown in Figure 6.

The new technologies introduced in irrigation equipment are improving the efficiency, while reducing the proportion of labor required for agricultural work. These technologies such as the drip and sprinkle systems irrigation became more widely adopted by farmers as Tunisian agriculture is in a transition phase from traditional agricultural systems to innovative sustainable agricultural systems. The focus of the government is mainly on the smallholders[69] as they present the majority of the farmers. Therefore, they present the biggest future challenge. The association Groupement de Développement Agricole[70] (GDA) in Sidi Amor (north of Tunis, Tunisia) has become a model of sustainable water management for the smallholders through the adoption of water efficient irrigation systems (drip irrigation, mulching) and the reuse of treated wastewater, combined with soil conservation and biodiversity protection. Another technology is being implemented which is climate-smart irrigation practices which may act as a billboard for more efficient approaches that are needed to move away from traditional irrigation methods, which are still widely used (Green Climate Fund, 2019).

The national irrigation water saving program has enabled 405,000 ha to be equipped with water saving equipment, i.e. 93 percent of the perimeters. Localized irrigation has gradually replaced other equipment and now accounts for 49 percent of the equipped areas (198,000 ha), compared to 8 percent in 1995. Over the same period (1995 - 2018), sprinkling increased from 28 percent to 47 percent (113,000 ha). Improved gravity-fed irrigation is applied for the irrigation of 23 percent of the perimeters (94,000 ha). With the entry into force of the new Investment Incentive Law in 2017[71], subsidies for water saving equipment have begun to increase significantly.

Treated wastewater

Tunisia was among the first Mediterranean countries equipped with wastewater treatment facilities. The first experience for irrigation was implemented in 1965 in order to save the citrus region of Soukra affected by the overexploitation of groundwater and the saline water intrusion. With the success of this experiment, and due to the increasing amounts of available treated wastewater, the government increased the number of projects that uses TWW for irrigation, and to water golf courses, whenever it is technically and economically feasible.

Tunisia has 119 wastewater treatment plants (WWTP) using in general activated sludge process and producing 260 MCM per year. Only 10 percent of Tunisian WWTP has a tertiary treatment. The total volume of directly reused wastewater is 29 MCM per year and 33 million per m3 after treatment. 62 WWTP are concerned by the reuse of treated water. 12.7 percent of total treated

[68] https://journals.openedition.org/poldev/2274
[69] V. Langenberg, B. Bruning, A. de Vos, AHeijden, B. Gonzalez, 2021, “Water in Agriculture in Three Maghreb countries”
[70] EU, 2020,Agriculture and food security in climate sensitive areas
[71] V. Langenberg, B. Bruning, A. de Vos, AHeijden, B. Gonzalez, 2021, “Water in Agriculture in Three Maghreb countries”

wastewater is reused to irrigate 2734 exploited hectares from 8415 managed ones in the agricultural sector. 45 percent of treated wastewater is used to irrigate arboriculture, 36 percent for forage crops, 15 percent for cereals and 4 percent for industrial crops[72].Treated wastewater is produced by the National Sanitation Office (Office National d'Assainissement, (ONAS) and collected by regional representatives of the Ministry of Agriculture called Regional Rural Development Commissions (CRDA) for irrigation. CRDAs are responsible for transferring the treated effluents, storing it and pumping it to the end user. The water must be tested before any use.

In 2018, based on the masterplan study developed by ONAS, analysis of the existing situation, and taking into consideration the future situation, ONAS recommended, to establish three new wastewater treatment plants (WWTP) in Greater Tunis for a total budget of TND 257 million to expand the treatment services to increase the capacity of re-used water for irrigation purposes[73].

Desalination

Water desalination is strategic for Tunisia. But there are some constraints for desalination for agricultural production: the high cost, the high energy consumption, the desalination processes are energy consuming, and the impact on hydro-ecosystems.

The main objective of the desalination plants is strengthening the sustainability of water resources and improving water quality supply for the population. According to the SONEDE (Sociéte Nationale d'Exploitation et de Distribution des Eaux), the production capacity of desalination plants in June 2020 is about 250 000 m^3 / day. There are in total 21 desalination plants as per end of 2020. Desalination plants for domestic water supply are mainly present in the South of Tunisia which accounts for 60 percent of production capacity.

4.11. Water Use Practices in Turkey

Agriculture and Irrigation efficiency

Turkey has 28 million hectares of arable land, and while the agricultural sector accounts for about two-thirds of the country's water use, its overall contribution to GDP has steadily declined from 18 percent in 1990 to 8 percent in 2014. However, agriculture still employs 21 percent of the population, and accounts for 60 percent of the rural workforce (World Bank, 2018).

Agriculture utilizes most of the abstracted freshwater: in 2018, agriculture accounted for 74 percent of national water abstractions (compared to 75 percent in 2000). The share of irrigated areas also augmented, from 8 percent to 10 percent (OECD, 2020c).

The increasing demand for water by a rapidly growing population is diminishing the amount of water available for use in agriculture. This situation emphasizes the need for optimal water resource management, as well as the economic use of water in agriculture.

[72] ONAS. (2017). Sanitation National office Activity report. Tunisia

[73] http://www.igppp.tn/sites/default/files/Fiches_descriptives/03-Fiche%20Station%20d%27%C3%A9puration%20%C3%A0%20Tunis%20Nord.pdf

According to the Turkish State Institute of Statistics in 2001, the number of farms equipped with drip and sprinkler irrigation is very small compared to the number of farms equipped with flood irrigation .Drip irrigation is mostly used in the Aegean, Marmara, and the Mediterranean regions of Turkey[74].

Turkey has taken concrete steps to encourage performance improvements in water supply and wastewater reuse to offset demand and has made a significant effort to increase irrigation efficiency and agriculture productivity. Therefore, the General Directorate of State Hydraulic Works (DSI) in Turkey, started irrigation modernization in 2008. Thereby, focusing on converting the water delivery networks to pressurized and closed-channel (pipe-based) systems instead of rehabilitating the traditional and open-channel systems. This approach reduced water losses in conveyance and allowed the use of high-efficiency on-farm irrigation systems such as drip and sprinklers. Since 1993, the Government has significantly accelerated the program for transferring the operation and maintenance (O&M) of irrigation systems to local irrigation institutions, which in most cases are Water User Associations (WUAs). To date, WUAs' interest in irrigation modernization has been quite high, and 185 applications for modernization have been received since 2008.(World Bank, 2018).

As results, thanks to the transition[75] to modern irrigation, transmission losses are minimized, providing 35 percent water savings in sprinkler irrigation and 65 percent in drip irrigation. In 2021, The Ministry of Agriculture and Forestry announced that it aims further to increase the use of modern irrigation systems, to 94 percent with the completion of ongoing hydraulic projects.

Treated wastewater

The Ministry of Environment and Urbanization (MoEU), engaged in planning WWTPs with the approach that WWTPs are a source of energy and water recovery, has set the target for 2023 of 5 percent reuse by different purposes such as agricultural irrigation, groundwater supply, irrigation for urban purposes, irrigation for wetlands and rivers, environmental/ecological use as well as for prevention of saltwater incursion into fresh groundwater due to excessive groundwater use at the seaside in Turkey[76]. To reach its goal, the Ministry carried out a major project entitled "Determination of the Current Status of Domestic/Urban Wastewater Treatment Plants and Determining the Need for Revision (TURAAT)' in 2016 to determine the status of wastewater treatment in Turkey including the efficiency and operational problems of domestic wastewater treatment plants in the whole country. It has been determined that Turkey has 1,015 domestic wastewater treatment plants either in operation or under construction and 10.5 MCM wastewater is treated daily (MoEU & SU 2016). The project demonstrated that the proportion of treated wastewater is found to be 82.9 percent generated by municipalities. In

[74] H. Buyukcangaz, 2007, "Efficient Water Use in Agriculture in Turkey: The Need for Pressurized Irrigation Systems"
[75] https://www.growtech.com.tr/en/agri-post/news-from-turkey/the-rate-of-modern-irrigation-systems-in-agriculture-rise-to-94percent.html
[76] B. Nas, 2020, "Wastewater reuse in Turkey: from present status to future potential"

2018, this rate had increased to 85 percent. Turkey's final target rate of municipality wastewater treatment is 100 percent in the year 2023. In Turkey[77], industrial reuse of treated domestic wastewater has first place with a 56.8 percent ratio, followed by 16.3 percent environmental/ecological reuse, in-plant reuse with 6.4 percent (green area irrigation, processes, washing etc.) and urban reuse (green area irrigation) with 2.6 percent.

Desalination

Like many countries in the developing world, Turkey faces the huge challenge of providing enough water to meet the needs of a growing population. According to the world bank, Istanbul is one of the largest urban agglomerations in the world with some 15 million inhabitants.
The International Desalination Association (IDA) Worldwide Desalination Plants Inventory (2011) informs on 59 desalination plants in Turkey built since 1952 until 2009 with total capacity of 468.749 m^3/day. So, this water desalination capacity means less than 0,01 percent of renewable water resources of the country. The total capacity of desalinated water production is shared by 433.464 m^3/day (92,47 percent) proceeding from seawater; 31.380 m3/day (6,70 percent) from brackish water; 3.602 m3/day (0,76 percent) from river water; and 303 m^3/day (0,06 percent) from waste water[78]. In 2007, Turkey's largest scale industrial seawater desalination complex has been designed, manufactured and installed. The second phase of the system has been installed in 2013. The system treats Marmara seawater with ultrafiltration, sea water reverse osmosis and pass~~es~~ reverse osmosis with the capacity of 14400 m3/day.

5. Socioeconomic Impact of Water at a Regional Scale

Water dominates about three quarters of the earth. It is vital for every living organism and a cross-cutting element for production and all economic activity, from agriculture, to manufacturing, to human and natural capital. Water is recognized as an economic good, as stated in the 1992 Dublin statement which supports social and economic development. Lack of water can, therefore, hinder the socio-economic progress and threatens the countries stability. Water development and management, however, is the key to maintaining water's essential factors, which includes effective policy and pricing structures79.

The SEMED countries of this study, which is stretching across a latitudinal landmass belt known for its acute water scarcity and aridity, is confronting serious water balance predicament that threatens its socioeconomic development. Climate change and more recurrent drought are expected to leave even less water to be available for agriculture. This is an alarming situation as the agricultural sector continues to consume the largest amount of the region's total freshwater withdrawal80 (between 45 percent and 84 percent of the total supply) with very limited arable land resources. Of the total land area of some countries of the SEMED region, only one-third is agricultural land (cropland and pastures), from which only 5 percent is arable (cropland).

[77] B. Nas, 2020, "Wastewater reuse in Turkey: from present status to future potential"

[78] Instituto Muriciano de Investigacion y Desarallo Agroalimentario, 2012, "Report on water desalination status in the Mediterranean countries"

[79] James A. Tindall, and Campbell, Andrew, A., Water Security: Conflicts, Threats, Policies (Denver: DTP 2011).

[80] EU, 2020, Agriculture and food security in climate sensitive areas in the Mediterranean

The rest of the land is either urban or dry desert. Due to the dry climate, about 40 percent of cropped area in the region requires irrigation (FAO, 2018a, 2018b). Besides limited appropriate land for cultivation, soils currently used for farming are harshly degraded. Soil degradation in rainfed systems is caused by wind and water erosion, while in irrigated systems the farming practices themselves are responsible for soil salinity and sodicity (i.e., High concentrations of sodium in soils). Recent studies have estimated the economic cost of land degradation in the region at USD 9 billion each year (between 2 percent and 7 percent of individual countries' GDP). Losses from salinity alone across the region are estimated at USD 1 billion annually, or USD 1 600 to USD 2 750 per ha of affected lands[81] (ESCWA and FAO, 2018). As a result, the deteriorating soil productivity and increasing aridity will eventually put more pressure on the demand for irrigation water.

Irrigation water scarcity in the SEMED region originates from both natural and anthropogenic impacts that have led to tensions between farmers' demands and government attempts to respond effectively. For instance, farmers in Jordan receive water from the Jordan Valley Authority (JVA) according to crop varieties. Regrettably, due to water shortages, farmers often do not receive their full quota and in turn steal water or dig illegal wells. Similarly, In Zaouiet Jdidi, northern Tunisia, farmers using irrigation schemes previously received water through pipes fed from an aquifer managed by the government and whose allocation was based on schedules where only two farmers could irrigate during each allocation period. In 1998, the irrigation management of small delivery pipes was transferred to the community level, which led to deterioration in water provision services and increased salinity.

Though the amount of water allocated to the system remained unchanged, the rules went unenforced, and farmers irrigated simultaneously. With increased pressure, more wealthy farmers sought individual strategies to secure water by drilling private wells (often illegally) and over-exploiting the deep aquifer. This exacerbated inequalities and left small farmers vulnerable to prolonged irrigation with low quality water [82]which in turn causes loss of revenues and labor. The World Bank reported in 2020 that countries like Syria, Jordan and Turkey could face an annual drop in GDP of between 5 percent to 10 percent compared to 2016 levels if water availability decreases by 20 percent. As these economies shrink because of water scarcity, demand for labor could drop by more than 10 percent in some of these countries, posing additional challenges on an already stagnant labor market[83].

---

[81] https://www.oecd-ilibrary.org/agriculture-and-food/oecd-fao-agricultural-outlook-2018-2027/overview_agr_outlook-2018-4-en
[82] https://ufmsecretariat.org/wp-content/uploads/2018/01/water-report-2017.pdf
[83] https://openknowledge.worldbank.org/handle/10986/34498

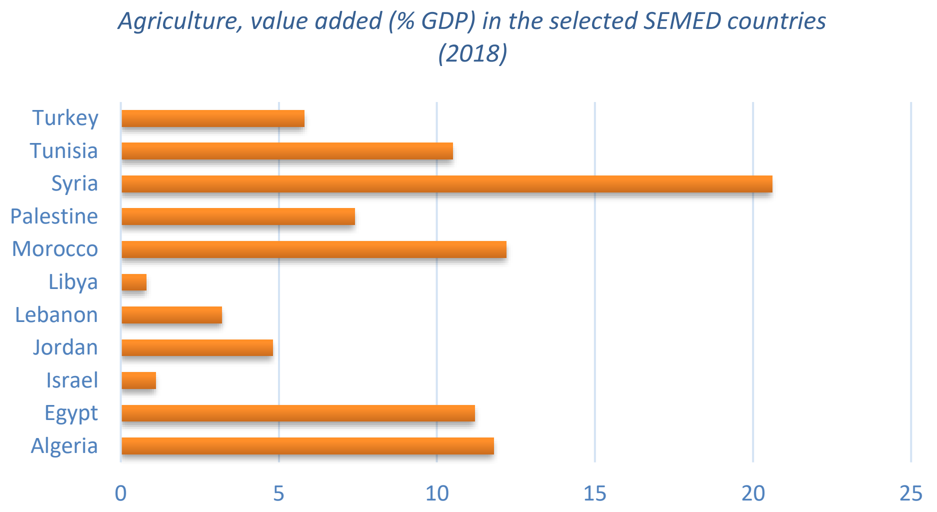

Figure 6: Agriculture, value added (%GDP) in selected SEMED countries, Source: FAO

Water scarcity directly diminishes agricultural output, but its impacts on economies spread well beyond agriculture, and because water is a key input factor, agriculture is the hardest hit. Even in countries with small agricultural sectors, such as Jordan, the impact of water scarcity on the economy is high because water is a prolific input to many sectors, including mining, manufacturing, energy, and services. Therefore, Jordan has reallocated water resources from agriculture to drinking and industrial uses.

Water scarcity is not the only factor that is hampering the socioeconomic development of the region, but also the disproportion and imbalance of the share of the available water within the same geographic area between the water users or within countries. For instance, water resources in Tunisia are not equally distributed on the national geographic scale. The northern areas have the main source of surface water, the Medjerda River, while many groundwater sources are concentrated in the south and fewer water resources are available in the center of Tunisia which has led to an accentuated economic imbalance between the North and the South.

Likewise, the water sector in Egypt is characterized by water scarcity and increasing demand due to population growth and related socioeconomic activities. The country is almost completely reliant on the Nile River for its water resources, with a dependency ratio estimated at 97 percent. The Nile is shared between 10 countries and with Egypt's position being the most downstream country it is highly impacted by upstream developments[84].

Ensuring water security in a water-scarce region[85] must be grounded in inclusive and integrated socioeconomic and environmental assessments, policies and measures. For example, reallocation of water resources from agriculture to drinking and industrial uses will have significant social implications on labor in the agricultural sector, women farmers, etc., and will affect the contribution of different sectors in the GDP in the SEMED countries. Furthermore, water accounting can be capacitated as one of the instruments or tools that can lessen the

[84] ESCWA, Water development report
[85] ESCWA,2019, Water developemt rReport 8

pressure on water use for agricultural purposes, but across the main socioeconomic sectors as water has proved to be central throughout the 2030 Sustainable Development Agenda[86].

Deteriorating and lacking access to water and sanitation services has also deleterious impacts on the socio-economic aspects of the region. Lacking access to water means that many young girls living in some rural areas of some of the SEMED countries can spend hours walking to collect water rather than attending school. This impact is even more exacerbated in conflict-affected countries. For instance, Libya has lost as much as 2–4 percent of GDP[87] annually due to the unsafe water. Similarly, the conflict in Syria has pushed more than 3 million people into poverty due to the deterioration of access to water and sanitation services which consequently has led to one hand, to a drastic decrease of its food production from 4 Metric Tons of wheat, to only 1.8 Metric Tons in 2017[88] .

On the other hand to increased incidence of waterborne diseases. As a result, the mortality rate of children under five due to diarrhea has increased threefold since the start of the conflict[89]. The Israeli occupation in the State of Palestine has been aggravating the water situation, specifically in Gaza where 1.2 million people (approximately 67 percent of Gaza's population) have lacked access to water since the war[90] in 2014.

Also the Israeli occupation controls most of the water resources in the State of Palestine, as a result there is a huge discrepancy of the water resources per capita between Israel and Palestine. Palestinians[91] are allocated only 13 percent of the water from the shared Mountain Aquifer compared to 87 percent share for Israel, despite the fact that 85 percent of water refilling the aquifer occurs within the State of Palestine. These restrictions have forced the Palestinian government to purchase water from the Israeli national water carrier which increase the financial burden and reflects negatively on all the economic and social aspects of life and human activity. However, anthropogenic impacts that are leading to a hard impact socially and economically, are not only caused by conflicts but also by under design and poor maintenance and lack of structural measures in countries without conflict. For instance, deficiencies in wastewater and rainfall drainage systems such as works for rivers, embankments and detention dam, dyke. Etc. could intensify the floods damages. This was the case in Tunisia that has witnessed in September 2003, great floods which resulted in total damage 396 million $ and devastated the capital Tunis and the north areas of the country, where the Medjerda River basin is located, suffered the greatest damage on record[92].

In an age of extended conflicts, rising inequality, and systemic risks such as pandemics and trade wars, addressing the impacts of water scarcity may seem like a secondary issue for the SEMED countries. The impact of COVID-19 for instance which is manifesting in decreased economic activity and a disproportionate impact on the poor, is leading to a significant risk.

[86] ESCWA, 2019, Water development Report 8
[87] World Bank, 2018, Beyond scarcity
[88] https://www.oecd-ilibrary.org/agriculture-and-food/oecd-fao-agricultural-outlook-2018-2027_agr_outlook-2018-en?itemId=/content/component/agr_outlook-2018-5-en&_csp_=e68d1cefa2ba709acf877e9f69eb22d6&itemIGO=oecd&itemContentType=chapter
[89] https://www.fao.org/fao-stories/article/en/c/1150870/
[90] ESCWA, 2019, water development Report 8
[91] ESCWA, 2019, water development Report 8
[92] Review of flood risk management in Tunisia: Current state and challenges, 2019

Moreover, water scarcity has been a central feature of the Mediterranean region as a whole through its history, and water has been always recognized as an impetus for the socio-economic development yet a limiting factor that could engender problems if not used properly or shared with justice. There are many examples in history depicting the power of water regulation to maintain the welfare of people such as the "Tribunal de las Aguas de la Vega de Valencia", better known by its shorter name of "Tribunal de las Aguas" (Water Court), is the most ancient institution of justice. Established by the Cordoba Caliphate (Abd El-Rahman III and Al-Hakem II), this Court[93] was in charge of preserving peace among farmers and ensuring fair water distribution acknowledging that water can play a significant role in the socio-economic development if managed suitably.

In the light of the deterioration of climate conditions and the population growth in the Mediterranean generally and the SEMED region specifically, the sweeping impacts of water scarcity can significantly destabilize economic development and bring about larger instabilities. This entails unprecedented transformation in the water sector that goes beyond simple supply-side augmentation, and includes strategic and cooperative water planning, water governance, and improved water measurement and accounting.

In the following section, we will depict the main socioeconomic impacts of water in the different SEMED countries of this study. These impacts are depending on the context and the conditions of each country.

5.1. Socioeconomic Impact of Water in Algeria

The importance of the agricultural sector for the society and economy of Algeria is significant. The agricultural sector contributes to about 12 percent of Algeria's GDP (2018 estimates, Figure 6). The agricultural sector employs 20 percent of the population in rural areas. Algeria has about 8.4 million ha of arable land. About 51 percent of the total arable land is dedicated to field crops, mostly cereals and pulses[94].

Like many countries, agriculture is the leading consumer of water in Algeria. To satisfy the agricultural needs, farmers had recourse to use different water resources from groundwater to surface water without examining the quality of these waters that could be contaminants and diseases prone.

Surface water is known to be polluted in several sections of rivers[95]: the Tafna, Macta, Cheliff, Soummam and Seybous are affected by inflowing untreated municipal and industrial wastewater. Irregular and intensive agricultural management practices have also resulted in elevated phosphorous, nitrate and pesticide concentrations in some natural waterbodies. In addition, surface waters in West Algeria have shown heavy metal concentrations above the WHO standards. This has led to the outbreaks of MTH (water-borne disease). The cost of these

[93] Tarek Majzoub, Water Laws and Customary Water Arrangements

[94] https://agfstorage.blob.core.windows.net/misc/AGF_nl/2021/06/23/Water_in_Agriculture_Maghreb_Final_Report.pdf

[95] V. Langenberg, B. Bruning, A. de Vos, AHeijden, B. Gonzalez, 2021, "Water in Agriculture in Three Maghreb countries"

outbreaks has been estimated at the equivalent of the construction budget of more than a dozen water treatment stations.

5.2. Socioeconomic Impact of Water in Egypt

Agriculture is a major component of the Egyptian economy, contributing 11.3 percent of the country's gross domestic product GDP (Estimates 2018, Figure 6) and providing livelihoods for 57 percent of the population and directly employing about 26 percent of the labor force[96].

Egypt's population is rapidly increasing at a very high rate and has increased by 41 percent since the early 1990s from 56 million to 98 million in 2018 (Figure 5, FAO Aquastat). New studies by the government report that around 4,700 newborns are added to the population every week, and future projections say that the population will grow from its current total to 110 million by the year 2025[97].

The mushrooming population accompanied simultaneously by a growing food demand increases the stress on Egypt's water supply due to more water requirements for domestic consumption and increased use of irrigation water. However, Egypt faces many challenges to provide the sufficient water requirement to reconcile its food security while ensuring positive but sustainable social and economic progress. One of the major challenges facing Egypt that is limiting its water requirement for irrigation use, is the fixed annual water share (i.e. according to the 1959 Treaty with Sudan, this share is 55.5 billion cubic meters per year). This share did not change since the construction of the Aswan High Dam in 1968. Likewise, many Nile projects are constructed for agriculture purpose which might affect Egypt's share.

The Aswan High Dam is the main source from which Egypt's irrigation network draws, regulating more than 18,000 miles of canals and sub-canals that push out into the country's farmlands adjacent to the river. Unfortunately, this system is highly inefficient, losing as much as 3 BCM of Nile water per year through evaporation[98]. The fixed water share and the inefficient irrigation system coupled with a decrease in water supply would lead to deterioration in arable land available for agriculture, and with agriculture being the biggest employer of youth in Egypt; water scarcity could lead to increased unemployment levels.

Pollution and contamination of open water canals from illegal dumping of household sewage in many areas that are not linked to municipal sewage systems.

[96] https://www.ifad.org/en/web/operations/w/country/egypt
[97] https://www.ecomena.org/egypt-water/
[98] https://www.researchgate.net/publication/310482249_Water_Scarcity_and_its_Impact_on_the_Socio-Economic_Aspects_of_the_National_Projects_in_Egypt

5.3. Socioeconomic Impact of Water in Israel

Israel is one of the driest countries in the SEMED region with no major rivers and only one lake of sweet water (Sea of Galilee). Almost 50 percent of Israel's landmass is arid and rainfall is scanty. Economically, agriculture constitutes a minor fraction of national income and exports in particular for many years and its contribution to the Israel economy has a minor importance with only 1.1 percent of the GDP (Figure 6, FAO Aquastat).

The prevailing arid and semi-arid conditions of Israel make irrigation imperative for the development of intensive agriculture and food production, but at the same time it puts more pressure on the water resources, as agriculture being the largest water user (about 54 percent), consuming around 1173 MCM of water in 2018 (FAO Aquastat). The overall overexploitation of water resources has been a long-standing problem in Israel, which threatens water security and affects both the population and the environment. The overuse of groundwater is causing the depletion of aquifers, which has in turn increased pumping costs as the water table drops and springs and shallow wells dry up. It has also increased salinity levels in the Coastal Aquifer as seawater seeps into the groundwater. A recent study revealed that water shortage can lead to a significant decline of Israel's GDP, where a considerable part of the decline is attributed to the decrease in agricultural outputs.

To respond to this ongoing overexploitation, Israel has invested heavily in technology and infrastructure to develop nonconventional water supplies and to integrate the water resources systems. In agriculture, the wide scale adoption of low volume irrigation systems (e.g. drip, micro-sprinklers) and automation has increased the average efficiency to 90 percent as compared to 64 percent for furrow irrigation. As a result, the average requirement of water per unit of land area has decreased from 8,700 m3/ha in 1975 to the current application rate 5,500 m3/ha[99]. At the same time agricultural output has increased twelve fold, while total water consumption by the sector has remained almost constant, this has a significant impact on the country´s national economy. Similarly, the IWA (Israel Water Authority) has applied prices and quotas to lessen the pressure on the water use. However, even these quotas have reduced agricultural consumption of water resources; they have also put many farmers out of business[100].

As it was mentioned before, Israel is one of the world´s leaders when it comes to seawater desalination. Therefore, the use of the desalinated water is a reliable approach to meet the growing demand of agricultural sector and diminish the impact of water shortage. The magnitude of the impact depends on the underlying assumptions regarding future desalination capacity[101].

5.4. Socioeconomic Impact of Water in Jordan

Jordan lies in the heart of the Middle East and has a combination of semi-arid and Mediterranean climate. It is known to be the second most water scarce country in the world as

[99] https://mfa.gov.il/MFA/IsraelExperience/AboutIsrael/
[100] http://support.jnf.org/site/PageServer?pagename=Water_facts
[101] https://www.gtap.agecon.purdue.edu/resources/download/8166.pdf

its annual renewable water resources are less than 100 m^3 per person, meaning it is significantly below the threshold of 500 m^3 per person which defines severe water scarcity[102].

Water resources in Jordan are directed towards four different sectors[103]: agriculture, municipal supplies, industry, and tourism. By far, the largest user of the country's water resources is the agriculture sector, which uses roughly 45 percent (reduced from 75 percent in 2006) of the total water supply, while 36 percent goes to municipal uses, 4 percent for industry. Agriculture in Jordan is concentrated in two primary regions, the Jordan Valley and the Highlands. While the Jordan Valley is a much smaller area of land, this is where the bulk of the country's agricultural production occurs and thus, where most of Jordan's surface water resources are directed. In much of the Highlands, water is acquired from rainfall or wells. Although agriculture has the lion share of water consumption it has serious socio-economic impacts and high political significance. Agriculture comprises a relatively small share of GDP (around 4.8 percent, Figure 6, FAO Aquastat), but is important in providing most of the agricultural production in Jordan and offering the higher percentage of direct agricultural jobs and other jobs in support services.

The production of food in semi-arid countries like Jordan to sustain its food security is hardly possible without irrigation. Jordanian farmers, in some parts of Jordan such as the Zarqa River Basin, have had to adopt unsustainable agricultural practices which have resulted in extreme groundwater and river pollution, leading to the closure of most of the farms along the river. More frequent droughts and heat waves will have long-lasting effects on Jordan's water and food security (caused by reduced agricultural production and rising food prices), with particularly harmful socio-economic impacts on Jordanian farmers along the Jordan, Yarmouk, and Zarqa Rivers[104].

The ability to access to water for irrigation and the adoption of water-intensive crops has created a social disparity between the farmers in Jordan. Eighty-five percent[105] of water consumption for fruit crops goes towards production of bananas (21 MCM/year) and citrus (71 MCM/year) which are water-intensive crops and it is acceptable to Jordanian farmers because socially speaking, growers of fruit trees are seen as having a higher social status than farmers of field crops, and because of assured prices and water, tend to be financially more secure[106].

The Jordan Valley Authority [107](JVA) under the Ministry of Water and irrigation is entrusted with the integrated socio-economic development of the Jordan Valley. During the last 30 years, JVA completed numerous infrastructure projects in the Valley that changed the lifestyle of its inhabitants and reversed rural to urban migration and even attracted others to settle in the area.

---

[102] https://www.unicef.org/jordan/water-sanitation-and-hygiene

[103] https://jordankmportal.com/resources/water-sector-capital-investment-plan-2016-2025

[104] EcoPeace, 2019,Climate Change, Water Security, and National Security for Jordan, Palestine, and Israel

[105] https://old.ecopeaceme.org/wp-content/uploads/2021/04/13622989291%5E%5EJordan_Agricultural_Policy_Paper_English.pdf

[106] https://www.oecd.org/countries/jordan/36489193.pdf

[107] Y.Ayadi, 2006, "Policy and Adaptation in the Jordan Valley"

The JVA is responsible for managing bulk water supply for irrigation, domestic, and industrial purposes, as well as promoting land development.

Irrigated agriculture in the highlands has spread and expanded over the last 30 years, almost exclusively dependent on underground water, made possible by digging artesian wells to extract water to irrigate expanding areas of fruit trees and vegetables. This intensive water extraction and the overuse of groundwater is causing the depletion to almost of water aquifers in Jordan as water extraction exceeds natural recharge, which has in turn increased pumping costs as the water table drops significantly and water becomes more saline, and shallower wells dry up, prompting farmers to abandon their farms or to deepen their existing wells at high financial costs.

The Syrian refugee influx into Jordan had a big impact on the water situation in the country, as more than 1 million Syrian refugees entered Jordan in the past 10 years, equivalent to 10 percent of the population of Jordan, most of them concentrated in the north of the country. This caused an immediate increase in water for municipal uses, and more water for consumption that needed to be directed to the North part of Jordan, which exceeded the natural growth plans for municipal water delivery. The extra demand meant more pressure on fragile water resources and necessity to redirect water resources to serve the refugees.

In addition, the Syrian refugee influx had other socioeconomic impacts, such as increased demand for food, the impact on the job market as they need employment to sustain livelihoods, need for sanitation, schools, health services and investments in infrastructure for the equivalent of 10 percent of Jordan's population.

5.5. Socioeconomic Impact of Water in Lebanon

Lebanon is naturally water rich compared to other countries in the Middle East and North Africa region. However, much of this water flows to the sea unused due to inefficient use and poorly maintained or absent infrastructure. As a result, water shortages are increasingly common. Moreover, the escalating current economic crisis in Lebanon, water loss caused by non-revenue water, the parallel collapse of the power grid and the threat of rising fuel costs, have exacerbated the water crisis in the country. This alarming situation is putting more than four million people[108], including one million refugees, at immediate risk of losing access to safe water in Lebanon. UNICEF Representative in Lebanon have estimated that a loss of access to the public water supply could force households to make extremely difficult decisions regarding their basic water, sanitation and hygiene needs.

Moreover, if the public water supply system collapses, UNICEF estimates that water costs could skyrocket by 200 per cent a month when securing water from alternative or private water suppliers. For far too many of Lebanon's extremely vulnerable households, this cost will be too much to bear as it represents 263 per cent of the monthly average income

[108] https://www.unicef.org/press-releases/water-supply-systems-verge-collapse-lebanon-over-71-cent-people-risk-losing-access

The presence of high numbers of refugees continues to add pressure on Lebanon’s existing water and waste water infrastructure as the country hosts the highest number of refugees per capita worldwide with 1.5 million Syrian refugees and 13,715 refugees of other nationalities[109].

The World Bank’s 2013 Economic and Social Impact Assessment estimated that population increase by refugees (nearly 30 percent of the resident population) has created an additional water demand of 26.1 MCM per year (equivalent to 7 percent of the pre-crisis demand)

The lack of awareness for wise-use of water resources in Lebanon has led to the deterioration and loss of water quality and quantity. Consequently, government sector is supplying water less than 35% of water demand and this has resulted in several financial and socioeconomic problems and often negative behaviour of consumers. This is well pronounced in the agricultural sector (which accounts for about 70% of water use) where farmers often follow chaotic irrigation approaches such as uncontrolled digging for boreholes followed with extensive pumping. However, small farmers, especially in the light of the current economic crisis, are vulnerable to the high cost of drilling boreholes, hence water deficit for irrigation, created unfavorable socioeconomic and demographic changes from the rural to urbanized areas, notably to the coastal zone which comprises more than 70 percent of Lebanon’s population[110].

5.6. Socioeconomic Impact of Water in Libya

Libya is located in a dry and semi-arid region of the southern Mediterranean with no perennial rivers or real freshwater lakes and an average yearly rainfall of less than 100 mm. The main water resources in Libya are this scarce and erratic rainfall and the fossil groundwater. The limited access to surface water resources has resulted in heavy dependence on available groundwater.

The agricultural sector is the biggest consumer of water in Libya (85 percent) and contributes little to the country’s economy with only 0.8 percent of GDP (Estimates 2018, Figure 6). The demand of water for agricultureis also increasing due the continuous growth of the Libyan population and resulting increasing demand for food.

According to a recent consumption of water, it is predicted [111]that water requirements for the year 2025 will possibly reach from 8,200 to 8,840 MCM due to the increasing number of population and the various industrial and agricultural needs with water shortage that could reach about 4,339 MCM.

After discovering, accidentally, the Nubian Sandstone Aquifer System, the world's largest, the Libyan government created in 1983, the Great Man-Made River Project (GMMRP), to supply water from desert aquifers to the coastal region for the majority of the Libya's population, as well as to expand agriculture production through irrigation. In 1993, Libya decided that 80 percent of the water collected in the GMMRP will be used for agriculture for the country’s goal

---

109 https://www.unhcr.org/lebanon.html#:~:text=Lebanon%20faces%20its%20worst%20socioeconomic,are%20living%20in%20extreme%20poverty.

110 A. Shaban, 2019, Striking Challengeis on Water Resources of Lebanon

111 H.Aqeil, 2012, "Water Security and Interconnected Challenges in Libya"

to be agriculturally self-sufficient and economically independent thus, becoming a truly sovereign state[112].

Unfortunately, and due to violence and conflicts in some areas in the Southern part of Libya, citizens of Tripoli have experienced difficulties getting access to water from the MMRP. The water supply was deliberately cut off by some rebels and protesters. Rebels and protesters and their commanders shut down the man-made river water supply system as a mechanism to force the government to make decisions in their favor. The present government is struggling to take control of the entire land of Libya and if this scenario continues, people of the capital and other coastal cities supplied by this water source will continue to suffer[113].

Although The GMMR has helped to expand the green areas in the north and west of the country and to stem further desertification, increased the agricultural production, and spared traditional water resources in the north as people are rely on GMMR water instead, the civil war and the mismanagement of the water resources coupled with a growing population, water shortage is a continuing problem in most parts of Libya and undeniably affecting its socio-economic progress.

5.7. Socioeconomic Impact of Water in Morocco

Morocco borders Algeria to the east and southeast, Muritania to the south, the Atlantic Ocean to the west, and the Mediterranean Sea to the north. It is the only African country with coastal exposure to both the Atlantic Ocean and the Mediterranean Sea. Its rich soil and mild climate have resulted in thriving local agriculture sectors.

The share of agriculture in GDP of Morocco usually fluctuates around 12 percent (2018 estimates, Figure 6), the value added to this sector fluctuates frequently because of changes in annual rainfall. However, agricultural activities offer many job opportunities for a large portion of the labor force. It provides nearly 120 million working days per year, or approximately 1,600,000 jobs, of which 250,000 are permanent. Additionally, farmers' incomes have improved, which have been multiplied by a factor of 5 to 13, depending on the perimeters[114]. This has been accomplished through some of the investments made in the GMP. The positive effects that these investments have caused can serve as an example for the other Maghreb countries to boost the local economy, create jobs and improve the livelihoods of farmers[115].

In general, about 40 percent of the labor force in Morocco works in agricultural activities, including forestry and fishery (Danish Trade Union 2015; Ghanem 2015; HCP 2016). This share was about 38 percent at the national level in 2016. The corresponding figures for urban and rural areas were 4.5 and 72.9 percent, respectively, in that year, according to the High Commission for Planning of Morocco (HCP) report (2016). Hence, reduction in water supply could directly and indirectly eliminate job opportunities in agricultural and nonagricultural activities.

---

[112] http://www.tinmore.com/pdf/WS121027_WaterSecurityLibya.pdf
[113] https://www.deswater.com/DWT_articles/vol_167_papers/167_2019_351.pdf
[114] V. Langenberg, B. Bruning, A. de Vos, AHeijden, B. Gonzalez, 2021, "Water in Agriculture in Three Maghreb countries
[115] V. Langenberg, B. Bruning, A. de Vos, AHeijden, B. Gonzalez, 2021, "Water in Agriculture in Three Maghreb countries

In addition, a major reduction in water supply could cause idled capacity across the country, which could intensify the adverse impacts of water scarcity on the job market [116]and GDP. A recent study of the World Bank has shown the undeniable impact of both water scarcity and climate change in decreasing demand for (unskilled) labor in Morocco at considerable rates. For example, a 25 percent reduction in water supply and changes in crop yields jointly drop Morocco's demand for unskilled labor by 7 percent.

However, not only water scarcity and climate change are impeding the socio-economic development of Morocco. Due to a lack of sanitation services and inadequate wastewater treatment, the already scarce water resources for irrigation are often contaminated which affect the quality of the crops. Moreover, one-third of Moroccans without access to proper sanitation services are at high risk of waterborne diseases such as gastrointestinal infections, malaria and typhoid[117].

5.8. Socioeconomic Impact of Water in Palestine

Agriculture is an important cultural tradition playing a significant role in the economy of the West Bank and Gaza. Agriculture used to contribute with 30-35 percent of the Gross National Product (GNP) and nearly 35 percent of the labor force in Palestine. However according to the FAO in 2018, this percentage has dropped considerably and its current contribution to GDP has dropped to nearly 7 percent. Palestine, as many of the SEMED countries is suffering from water shortage and problems due to natural and political reasons. Water problems rise to severe challenges for agricultural farms. According to the International Water Management Institute (IWMI), agriculture, which accounts for about 70 percent of global water withdrawals, is constantly competing with domestic, industrial and environmental uses for a scarce water supply. Moreover, the shortage of water supply has severely and gravely affected the activities needed to satisfy the agriculture production, which cannot be achieved without enough water for irrigation. Furthermore, even the little water available for irrigation, has been shrinking over the past three decades due to restrictions imposed on developing existing resources and the prohibition imposed on Palestinians by Israel for the development of non–conventional resources to meet their growing water needs since Israel considers reused wastewater as part of Palestinian total freshwater allocation. This, in turn, has impacted the agricultural sector as a whole, leading to a general decline in irrigated land[118].

Moreover, in some places, Palestinian farmers have been forced to purchase water at high prices from the water sources controlled by the Israeli Water Company. This has led to increased production costs for agricultural crops, thus affecting the ability of Palestinian farmers to compete with the heavily subsidized Israeli agriculture, leading to substantial economic losses at farmer and national levels.

The situation has become particularly critical since the construction of the separation Wall in the West Bank, which draws apart people from each other, people from their land and people from their water sources, threatening food security and the already fragile economy and

[116] World Bank, 2020, Water Scarcity in Morocco
[117] https://borgenproject.org/about-water-quality-in-morocco/
[118] https://www.foei.org/wp-content/uploads/2014/08/Water-injustice-in-Palestine.pdf

jeopardizing their entire livelihoods. Nearly one fifth[119] of West Bank agricultural land is inaccessible.

5.9. Socioeconomic Impact of Water in Syria

Syria stretches at the eastern end of the Mediterranean Sea, at the northern end of the Afro-Asian Rift Valley and it is located in large part of Fertile Crescent region. Syria, like many of the SEMED countries, is suffering from water shortage but the ongoing conflict that started back in 2010 and described by the United Nations as the worst man-made disaster since World War II, has worsened the situation leading to arduous socio-economic impacts.

When the talk about how bad the socioeconomic impact of water could be is put on the table, the Syrian case forms a perfect multi-dimensional platform to showcase the gravity of this impact incited by both conflict and water crisis. Even though the causes of the water crisis are layered and complex, they are indubitably the direct and indirect consequences of the ongoing conflict.

More than ten years of conflict in Syria has resulted in widespread destruction of water facilities across the country. Access to safe drinking water is a challenge affecting millions of people across Syria, which now has up to 40 percent less drinking water than a decade ago according to the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA). This has increased food insecurity, diminished livelihoods and incited further migration in search of resources and employment.

The International Committee of the Red Cross (ICRC) in Syria has reported early of 2021 that the large and very centralized drinking water facilities of Syria's eight main water systems have all been severely affected by the hostilities. They further deteriorated over the past decade due to the lack of proper operation and maintenance, lack of spare parts and human resources. From another side, and due to poor governance and increasing effects of the war in Syria[120], these hostilities were able to locate in important water resources in the country and threat water and food security.

Syria was already experiencing increased water scarcity even before the start of the conflict, due to climate change. But, like most areas affected by conflict around the world[121], climate change and environmental degradation are amplified due to the consequences of conflict, and one of the results is a change in the availability and quality of water, leading consequently to a deterioration of the Agricultural sector. The conflict has directly led to major losses in this sector. According to the FAO, the financial cost of damage and loss had reached $16 billion by the end

---

[119] https://www.anera.org/wp-content/uploads/2017/03/AgReport.pdf
[120] https://doi.org/10.30897/ijegeo.406273
[121] https://reliefweb.int/report/syrian-arab-republic/syria-water-crisis-40-less-drinking-water-after-10-years-war

of 2016. As violence is persisting, the cost to recovery has most likely increased beyond the assessed FAO figure[122].

5.10. Socioeconomic Impact of Water in Tunisia

Tunisia is a small country by North African standards. It is bordered by Algeria to the west, Libya to the southeast. The northern most country in Africa is bounded on the north and east by the Mediterranean.

In Tunisia, water resources are characterized by severe scarcity as data from the Tunisian ministry of agriculture shows that the total amount of water available in the country can only provide 420 m^3 per person per year, making it a “very water scarce country”, according to the U.N. Water standards. Moreover, Water resources are unevenly distributed across the country with around 60 percent located in the North, especially in the Medjerda river basin, 18 percent in the Centre, and 22 percent in the South. Water quality, especially salinity, is a serious constraint[123].

The Medjerda river basin is the largest water resource in Tunisia and accounts for about 80 percent of the total surface water resources while it covers only 17 percent of the national territory. The Mejerda River [124](also known as the Wadi Majardah, Wadi Mejerha, Oued Majardah, and Bagradas) is a river in Algeria and Tunisia. Medjerda is Tunisia's crucial waterway providing water to the country supply facilities. It is dammed in several locations in Tunisia as a major supplier of water to the country's wheat crops and plays a pivotal role in the region's agriculture. It is also vital to the people living near the river.

Being a very strategic river in North Africa, it was fought over and settled many times in history by the Berbers, Phoenicians, Punics, Romans, Vandals, Byzantines, Arabs, and the Ottomans. Several major cities, such as Utica, Carthage, and eventually Tunis were founded on or in close proximity to it.

The majority of the water resources are mobilized to sustain the agricultural sector in Tunisia, making it by far the largest consumptive water use and withdrawal. Tunisians are very dependent of agriculture for its significant socio-economic impacts. It has important implications on water and land resources, as most of the water resources (about 80 percent) and fertile lands are used for food production. This sector also has a significant contribution to the GDP with almost 11 percent (Estimates FAO Aquastat 2018, Figure 6) and developing exports and reducing the country’s trade deficits, as well as supporting employment generation and reduction of the rural exodus in the marginalized regions of Tunisia[125].

[122] https://syria.chathamhouse.org/research/the-importance-of-the-agricultural-sector-for-syrias-stability
[123] https://www.inderscienceonline.com/doi/pdf/10.1504/IJW.2011.043319
[124] https://www.touristlink.com/algeria/medjerda-river/overview.html
[125] A. Frija, 2021, Socio-Economic Implications and Potential Structural Adaptations of the Tunisian Agricultural Sector to Climate Change

However, as water being the prime input to this sector to thrive, a decrease of the amount of the water resources would have a negative impact on agriculture and its related activities, putting in evidence the interplay complexity between water and agriculture. A recent study[126] showed that the agricultural sector in Tunisia, particularly the agricultural employment, would be negatively affected in case of decreasing irrigation water availability, and mostly affected regions would be the north east, central west, and southern areas. Experts from the world Bank reported that climate change's adverse impacts on agriculture are a contingent liability for the Tunisian economy, including for the country's GDP, trade balance, and balance of payments. As agricultural and agro-industrial outputs fall, food and fodder imports must rise to meet domestic demand[127].

Furthermore, in the absence of specific policies, farmers who are depending on irrigation in several areas of southeast Tunisia are always obliged to invest in order to continue to have sufficient fresh water for their crops, or to change their cropping patterns to suit this water scarcity. Farmers who have small family farms and who have limited financial capacity to dig ever deeper or leave to other regions to continue their agricultural activities are the most vulnerable to such unsustainable uses of water and soil. In the absence of a management of this unsustainable use, the differences between the farmers who have the means to invest ever so as to have enough water and those who need to adapt their activities to the shortage of water are on the rise[128].

5.11. Socioeconomic Impact of Water in Turkey

Water is an essential component of Turkey's economy and environment. The country's annual average potential of economically exploitable water resources is 112 BCM . Annual freshwater consumption is about 44 BCM , of which 74 percent is used for agriculture, 15 percent for domestic uses, and 11 percent towards industrial ones[129]. Besides its contribution to economic production, water and its related ecosystems (e.g. lakes, wetlands, coastal zones, etc.) provide a wide range of benefits such as flood protection, pollution abatement, and biodiversity conservation (World Bank, 2016).

Turkey is the world's 7th largest agricultural producer with 24 million hectares of agricultural land, and a top producer and exporter of crops ranging from hazelnuts and chestnuts to apricots, cherries, figs, olives, tobacco and tea. However, statistics and studies have shown recently that the agricultural industry is in sharp decline.

In 2011 the OECD reported that agriculture is Turkey's largest employer, representing 25 percent of the workforce, and contributes with 8 percent of the country's economic activity. While in 2018, according to both FAO and World Bank, the agricultural sector's contribution of the GDP fell to 5.8 percent with only 18.4 percent of all jobs. This was attributed by critics to failing

---

[126] https://www.intechopen.com/chapters/65227
[127] World Bank, 2018, Climate Variability, Drought, and Drought Management in Tunisia's Agricultural Sector
[128] M.Naceur, A. Fouzai, 2020, Coping with Water Scarcity in Private Irrigated Perimeters Farmers' Adjustments in Southeastern Tunisia
[129] https://openknowledge.worldbank.org/handle/10986/25291

government policies, spiraling costs and meagre state support but also to water supply shortage. According to the world Bank' report, *Water in the Balance*, reductions in water supply curtail economic production across all countries, with larger increases in water scarcity leading to greater reductions in GDP. As Turkey being an agricultural powerhouse, economic consequences are larger. Moreover, the report shows that if water scarcity increases by 20 percent, then cropland under irrigation is expected to decrease across the country, leading to a return to low-productivity rainfed agriculture. Nearly one million hectares of natural forest cover could be lost in Turkey, as farmers seek to recoup their losses by extending the area under cultivation.[130]

Turkey is one of the most vulnerable countries in Europe and Central Asia to climate change. According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC,2014), regional and global simulations project an increase in duration and intensity of drought in Mediterranean Region. Therefore, the climate trend would inevitably make water a very sensitive and critical issue, which poses a potential problem to the economy and environment in Turkey.[131]

[130] World Bank, 2018, Water in the Balance
[131] https://openknowledge.worldbank.org/handle/10986/25291

6. Main Threats Related to Water at a Regional Scale

The intensifying water-related risks due to rapid population growth, combined with climate variability and change, and the increase in unemployment, constitute intimidating socio-economic perspectives across the SEMED region.

When a water-related challenge arises, it can trigger or worsen wider economic and political crises. Water challenges can compound existing and emerging instabilities and can contribute to unrest and conflict. The UfM Ministerial declaration on Water, held in Malta in 2017, underlined in one of its 25 key statements and observations regarding the value of water to humanity and the Mediterranean region that regional socio-economic trends and environmental impacts are interlinked with water inadequacy, which can contribute to social and political instability. When institutions fail to address water insecurity, for instance, they fail to protect populations from the consequences of a flood or provide basic water services which may undermine government credibility and weaken the social contract. When water insecurity adversely affects populations, it fuels perceptions that governments are not doing enough, exacerbating grievances, and destabilizing already-fragile situations (World Bank, 2018).

Flood and drought risks are acute in the SEMED region and increasing. They are likely to harm the poor disproportionately. In the SEMED region, poorer populations are the most vulnerable to weather-related shocks. Floods are the most frequent natural disaster in the region. The percentage of the region's GDP produced in areas exposed to floods tripled from 1979 to 2009. More severe and intense droughts are expected as a consequence of climate change. Recent rainfall variability observed in the last millennium, are increasing concerns that drought conditions will be further exacerbated by climate change[132] and are expected to be one of the contributing forces in migration, according to a new World Bank report, Ebb and Flow, recently released in 2021. The report finds that water deficits are linked to 10 percent of the increase in total migration within countries between 1970 and 2000. By the end of this century, worsening droughts are projected to affect about 700 million people. These climate shocks will have a disproportionate impact on the developing world, with more than 85 percent of people affected living in low- or middle-income countries. Yet it is often the poor who cannot afford to leave. The World Bank report finds that residents of poor countries are four times less likely to move than residents of wealthier countries. In the SEMED region, being a water-scarce area, water is already one of the main vulnerabilities faced by people living in the region, particularly those displaced by conflicts and their host communities. Whether the reason of migration is triggered by climate shocks or conflict, there is one clear fact; water scarcity affects not only the number of people who move, but also the receiving countries. At the beginning of the influx of Syrian refugees in 2013, Jordanians complained that the Syrians were not attentive to Jordan's water shortage problem. The overall demand for water has increased by 40 percent in the Northern Governorates in the last few years as a direct result of hosting Syrian refugees, while the

[132] World Bank, Beyond scarcity: Water security in the MENA region

frequency of water supply in some locations has decreased from once a week to once every four weeks[133].

The lack of agreements on transboundary water rivers and systems have reflected negatively on water supply equity and have always presented a significant threat in some of the SEMED countries. One of these countries is Jordan, where the conflict over the Jordan River basin is difficult to resolve due to the predominant position of Israel. Similarly, the weak political position of the Palestinians places them at a disadvantage in securing their rightful share of water resources[134]. Israel had recourse to use military force to guarantee access to water resources. In 1964, Syria, with the support of the Arab League, began devising plans to divert the Banias River, threatening roughly 10 percent of Israel's water supply at the time. From 1965-1967, Israel launched attacks to destroy the diversion projects under construction in an effort to maintain access to the water source[135].

Water quality deterioration from pollution and increasing salinity is also another threat compounding water shortages in the SEMED region. Pollution is mainly caused by the discharge of sewage or leakage from unsanitary landfills, and fertilizer and pesticides. As it was explained in the previous sections, increasing salinity of groundwater can be caused by seawater intrusion of coastal aquifers or by overexploitation of inland aquifers. Surface water salinity increases due to drainage and wastewater return flows and because of low flow conditions in the lower reaches of rivers caused by upstream abstraction (World Bank, 2000). In many countries in the region, untreated municipal and industrial sewage is released into the environment, either into the sea or into the beds of wadis (small river beds that are filled with water only for a short time of the year), as it is the case in the West Bank, Lebanon and Morocco (World Bank, 2000). In some cases, untreated or inadequately treated sewage is reused for irrigation in an uncontrolled manner, which obviously entails substantial health risks. Treatment is often deficient, and this is due to the lack of maintenance of treatment plants. And even in the few cases where treatment is adequate, wastewater is sometimes discharged into the sea. Unsanitary landfills are another significant source of pollution, as they are potentially impacting the quality of aquifers that are used as a source of municipal water supply. Besides potential pollution, the municipal water services fees are very low and its effective water subsidies are the highest in the world despite the water scarcity in the region (Kochhar et al. 2015). High water subsidies undermine incentives for efficient water use and encourage overexploitation (World Bank, 2018).

6.1. Main Threats Related to Water in Algeria

As outlined in previous sections, Algeria is already experiencing water shortages, but the worst is likely still to come, given the forecasted drop in per capita water availability in 2050 to below 220 m^3/year. With high growth in the demographic and economic scale, serious difficulties are facing the Algerian authority to manage its water resources. This finding is reflected in several strategic evaluation reports on the future prospects of the water sector, especially made by the National Economic and Social Council and World Bank.

---

133 https://reliefweb.int/sites/reliefweb.int/files/resources/2021_Influx%20of%20Syrian%20Refugees%20in%20Jordan%20-%20Effects%20on%20the%20Water%20Sector.pdf

134 Hamed Assaf, Water Resources and Climate Change

135 https://worldview.stratfor.com/article/israels-water-challenge?app=old

Many risks make the water resources vulnerable to depletion in the two aspects (quality and quantity), these risks can be natural or result to Industrial, agricultural, and public activities. The main threats affecting water's quantity and quality in Algeria are as follow; over-exploitation of groundwater resources (Increase of needs), the pollution of water resources (Rivers, Aquifer, dams ...) by all nature of discharges (chemical discharges from industries and fertilizers used in agriculture…), the silting of dams, and the alteration of groundwater quality due to marine intrusion in coastal zones[136].

The climate change is adding more pressure on the availability of the water resources in Algeria. Given the country's arid and semi-arid climate, it is important to mention that 85 percent of the rainfall naturally evaporates, whereas the remaining 15 percent either replenishes the surface water resources (12.4 percent) or recharges the groundwater (2.6 percent)[137]. Climate change – especially higher temperatures and less rain – is predicted to impact Algeria and the wider region in the coming decades. At the same time, the population is expanding (more than 42 million in 2018 according to FAO, see Figure 2) and urbanizing, consuming more water than ever before which makes the well-being of households far from being achieved. Indeed, according to the World Bank statistics, per capita water availability continues to decline, from 1,500 m^3 in 1962 to 430 m^3 in 2020, and is projected to maintain this trend to reach an alarming 220 m3 in 2050.

Shared surface and groundwater resources represent a real threat if water is not shared and managed with equal benefits across communities, countries and regions. Algeria shares five aquifers with its neighbors: Errachidia with Morocco, Tin-Sérririne with Niger, Air Christalline with Mali and Niger, Taoudéni with Mali and Mauritania, and the North-Western Sahara Aquifer System (NWSAS) with Tunisia and Libya. The NWSAS is the most important and biggest transboundary groundwater reserve in North Africa, extending over 1 million km^2. It is located in a desert and arid area shared between Algeria (700,000 km^2), Libya (250,000 km^2), and Tunisia (80,000 km^2) and consists of two superimposed deep aquifers[138], the Intercalary Continental (CI); and the Terminal Complex (CT). However, the water resources of the NWSAS are largely non-renewable, and their replenishment is limited to around 1 BCM/year. In addition, socioeconomic expansion in the basin over the last decades and technological advancement in well-drilling have led to increasingly growing water withdrawal. Currently the combined abstraction from the aquifer by the three countries exceeds three times the natural rate of recharge[139]. As a consequence, the countries are facing important challenges – depletion and the loss of groundwater pressure; salinization; degradation of soil and reduced agricultural productivity; increased energy demand to pump water; and demineralization.

6.2. Main Threats Related to Water in Egypt

In the recent years, Egypt has been struggling from perilous water scarcity and the situation can get even worse as the United Nations has warned that Egypt could be water scarce by 2025. Uneven water distribution, mismanagement of water resources, climate change, pollution and

[136] https://www.hilarispublisher.com/open-access/water-supply-prediction-for-the-next-10-years-in-algeria-risks-and-challenges-2168-9768-1000197.pdf
[137] Chaoui MS, Benterki A and van Cauwenbergh N, 2016. 'Analyse de la politique hydrique en Algérie depuis l'indépendance
[138] https://unece.org/sites/default/files/2021-07/NWSAS-UNECE_EN_Web.pdf
[139] https://unece.org/sites/default/files/2021-07/NWSAS-UNECE_EN_Web.pdf

inefficient irrigation techniques are some of the main issues causing havoc in water security of the country. Egypt fell below the World Bank's water scarcity threshold of 1,000 m^3 of renewable water available per capita per year in 1997. By 2007, this figure sunk below the 700 m^3 international water poverty limit and is expected to drop to 500 m^3 by 2025[140].

The increasing population growth multiplies the stress on Egypt's water supply due to more water requirements for domestic consumption and increased use of irrigation water to meet higher food demands. According to United Nations projections, the population of Egypt will grow from 62.3 million in 1995 to 95.6 million by 2026 and will expectedly reach 114.8 million before it stabilizes in the year 2065[141]. In spite of Egypt using most of its share of the Nile water for irrigation, at present it imports more than half of its food grains. Growing demand for food in the future will undoubtedly bring additional pressure on the scarce water supply.

Egypt is dependent on Nile River as the major source of its water supply for all economic and service activities. The River Nile is the backbone of Egypt's industrial and agricultural and economic sector and is the primary source of drinking water for the population. The supply of Nile water is allocated by the Nile Water Agreement, signed with the Sudan in 1959 prior to the construction of Aswan High Dam; Egypt's quota is fixed at 55.5 BCM/year. This quota constitutes about 90 percent of the country's water budget; the remaining 10 percent represents minor quantities of renewable and fossil groundwater, and a few showers of rainfall.

The Nile River is shared by nine countries besides Egypt. Being the most downstream country on the Nile, Egypt is affected by the economic developments in upstream countries and measures they might take to enhance economic development, provide water for agriculture, generate electricity or to adapt to climate change which are likely putting more pressure on water resources in Egypt. The construction of the Grand Ethiopian Renaissance Dam (GERD), in 2010, in the Blue Nile watershed which is a main source of water for the Nile River, is representing a major concern for Egypt, which is worrying that this dam would decrease the amount of water it receives (55.5 BCM) from the Nile River and in open irrigation canals.

Due to the progressive increase of population and the unceasing expansion of urbanized areas, pollution has increased too. One of the utmost water related challenges facing Egypt is the pollution of its surface and ground water resources from agricultural, domestic and industrial sources, leakage of wastewater and the dumping of dead animal carcasses in the Nile River.
Irrigation inefficiency is adding another burden on a water-scarce country. The less water supply, the less arable land available for agriculture. This can create unemployment as agriculture being the biggest employer of youth in the country. Egypt's irrigation network draws almost entirely from the Aswan High Dam, which regulates more than 18,000 miles of canals and sub-canals that push out into the country's farmlands adjacent to the river. This system is highly inefficient, losing as much as 3 billion cubic meters of Nile water per year through evaporation and this could not only intensify the water stress but also create unemployment. The government is

[140] https://www.weforum.org/agenda/2019/11/water-crisis-builds-in-egypt-as-dam-talks-falter-temperatures-rise
[141] Waseem A.Geed, 2017,Water scarcity in Egypt : causes and consequences

urging farmers to use more efficient irrigation and plant seeds with shorter life spans that require less water. It is also trying to recycle more water. But the water management and irrigation schemes have not reached everyone[142].

Climate change presents another problem in Egypt. With temperatures rising, Egypt could lose 30 percent of its food production in southern areas by 2040, according to the U.N. World Food Programme. Heatwaves have already reduced crop productivity and in Fayoum143, residents say temperatures have been rising for years, forcing farmers to use more water for less land. But UN development agency UNDP stated that any alteration to Nile flows could make a "huge difference", and every 2 percent drop of water affects one million people.

6.3. Main Threats Related to Water in Israel

The main threats related to water in Israel are both natural and man-made. Israel has suffered from four consecutive years of drought. The increase in demand for water for domestic uses, caused by population growth and the rising standard of living, together with the need to supply water pursuant to international undertakings have led to over-utilization of its renewable water sources. Israel's total annual internal renewable natural resources of freshwater stand at 0.75 BCM. It has roughly 265 m^3 per year of water per person available. This is well below the U.N. definition of water poverty, which is anything below 1,000 cubic meters per person per year. For groundwater, Israel relies on two main aquifers: the Coastal Aquifer and the Mountain Aquifer. Both also lie under the Palestinian territory — in Gaza and the West Bank, respectively. Crucially, more than half of Israel's total natural water originates outside its borders: 310 million cubic meters come from Lebanon, 375 million cubic meters come from Syria and 345 million cubic meters originate in the West Bank. All the countries in this arid region compete for the limited resources of the basin[144].

Water allocations from transboundary river systems are often disputed. Thus, many treaties and plans were signed and established in order to ensure an equal allocation of these shared water resources. However, The Oslo II agreement in 1995 between Israel and the Palestinian National Authority was not the case as the Palestinian population remains heavily dependent on Israel for access to water. Israel has always demonstrated a willingness to use military force to guarantee access to water resources and considered any upstream water management schemes as a threat and a violation to its national security. In 2002, villages in southern Lebanon installed small pumping stations and irrigation pipelines on the Hasbani River. Ariel Sharon, Israeli prime minister at the time, claimed these actions constituted a "case for war" and threated military action.

6.4. Main Threats Related to Water in Jordan

Jordan is a nation burdened with extreme water scarcity that has always been one of the biggest barriers to its economic growth and development. This crisis situation has been aggravated by a population increase that has doubled in the last two decades alone because of refugees fleeing

[142] https://www.weforum.org/agenda/2019/11/water-crisis-builds-in-egypt-as-dam-talks-falter-temperatures-rise
[143] https://www.weforum.org/agenda/2019/11/water-crisis-builds-in-egypt-as-dam-talks-falter-temperatures-rise
[144] https://worldview.stratfor.com/article/israels-water-challenge?app=old

to Jordan from neighboring countries. Jordan has received[145] millions of refugees, from Palestine in 1948 and 1967, from Iraq in 2003 and from Syria since 2011. The influx of refugees is and continues to be an unexpected or surprise contributor to population growth and has further widened the gap between water supply and demand. A further difficulty is that Jordan shares both surface and groundwater resources with its neighbors, leading to additional challenges as conditions of water scarcity increase in addition to climate change where precipitation decreased by 20 percent over the last few decades.

Growing water demand in Jordan puts huge pressure on the country's water resources. The gap between supply and demand has been growing mainly due to rapid population growth, the rising standard of living and agricultural expansion.

The Non-revenue Water (NRW) is a major operational challenge for Ministry of Water and Irrigation. it is estimated that around 40 percent of water is lost in the water pipes network in the Greater Amman Municipality, thus not reaching consumers and not getting billed nor paid for. This is one of the major challenges especially in light of the severe water scarcity faced by Jordan. Non-revenue water (NRW) loss in Agriculture is also a problem, NRW in the Jordan Valley results from leaks in poor-quality equipment, inadequate maintenance, non-working meters, or unauthorized connections.

6.5. Main Threats Related to Water in Lebanon

Even though Lebanon was described as the "water tower of the Middle East," the current status is contradictory, and water supply/demand gap has become imbalanced. Water is available, yet water shortage is a major challenge in Lebanon. This is attributed to the undefined hydrological cycle and the lack of sufficient hydrologic data to establish proper strategies and policies[146].

In 2014, Lebanon struggled with water shortages in the summer and fall but the combination of a particularly severe drought and the strain more than a million Syrian refugees were placing on Lebanon's infrastructure, made the problem more acute. Lebanon stores-up only six percent of its fresh water supplies, though the Middle East and North Africa region's average is much higher than that. As a result, a significant portion of Lebanon's fresh water supply is lost[147].

The lack of sufficient infrastructure for water storage, rain harvesting, and water reuse is contributing to an overall deficient water supply even while demand continues to grow. Lebanon's wastewater network covers 60 percent of the country, while only 8 percent of wastewater produced is properly treated, with untreated effluents causing severe pollution to heavily exploited ground and surface water resources. Moreover, most of the Lebanese farmers

[145] Yorke, V., 2013. 'Politics matter: Jordan's path to water security lies through political reforms and regional cooperation'.
[146] A. Shaban, 2019, Striking Challenges on Water Resources of Lebanon
[147] https://www.worldbank.org/en/news/feature/2014/09/30/preserving-lebanon-s-water-before-the-wells-run-dry

are still using old irrigation techniques with low efficiencies in their lands and thus they usually over irrigate and contribute to the depletion of this scarce resource[148].

Unfortunately, the unwise use of water resources in Lebanon accompanied with the lack of governmental controls have reflected in poor water quality and quantity, and thus several examples on water deterioration have been witnessed. Only 48 percent of the population has access to safely managed water, while 20 percent has access to safely managed sanitation[149]. Furthermore, hundreds of thousands of Beirut residents only have tap water available for a few hours each day. Even when the taps are running, the water itself is unsafe, despite assurances from the Lebanese state-run Water of Beirut and Mount Lebanon (EBML) in 2018 that its tap water was safe and adhered to international standards[150].

6.6. Main Threats Related to Water in Libya

Libya is located in a region of North Africa and prevailed by a dry and semi-arid climate. With no perennial rivers or real freshwater lakes and an average yearly rainfall of less than 100 mm Libya is considered as a water-scarce country. The limited access to surface water resources has resulted in heavy dependence on groundwater. Extensively use of conventional water resources like groundwater, poor awareness of how to optimally use and save water and seawater intrusion into the coastal water aquifers, all contributed to a severe water crisis in Libya. Libya's water crisis issues are further complex by the distribution of the population relative to the available water resources. 75 percent of Libya's population is concentrated in only 1.5 percent of the total land area in the western coastal centers of Jiffarah plain and Misurata, and the eastern coastal area of Al Jabal Al Akhdar. Since 2014, the conflict in Libya was the straw that broke the camel's back when it comes to water scarcity. Challenges with the country's water supply were one of the many humanitarian problems that have arisen due to this conflict.

One of the main reasons of the water crisis in Libya is the excessive coastal groundwater exploitation that has led consequently the seawater intrusion[151]. Further, records have determined that seawater intrusion has invaded about 60 percent of freshwater wells. The freshwater in these aquifers cannot replenish either, meaning that every drop must count for use. Another reason for the Libyan freshwater shortage is the expanding agricultural industry. Some crops demand vast amounts of water; typically, this extensive use results in water waste throughout agricultural production and processing. In fact, Libya uses about 93 percent of its water for agricultural purposes[152].

Moreover, the prolonged conflict has left the water sector fragile and facing immense challenges, leading to a significant decline in services. This is mainly attributed to the lack of required budgets for the purchase of equipment, operational materials and spare parts for

[148] USAID, 2017, Lebanon Country Plan

[149] USAID, 2017, Lebanon Country Plan
[150] https://www.geopoliticalmonitor.com/water-as-a-building-block-for-peace-in-lebanon-and-beyond/
[151] https://borgenproject.org/water-crisis-in-libya/
[152] https://borgenproject.org/water-crisis-in-libya/

regular maintenance. Suppliers are also struggling to open bank credits in hard currency to import equipment from outside the country[153].

The repeated attacks on the Manmade River systems caused about 190 wells to be rendered out of service (Al-Jafara - Al-Hasawna and Al-Sirir-Tazarbo), bringing this vital sector to the brink of collapse. The General Company for Water and Wastewater suffers from the deterioration of the water network, causing the loss of large quantities of water of up to 50 percent. In the sanitation sector, only 45 percent of households and institutions are connected to the public network; the rest are connected to cesspits, which leads to pollution of groundwater reservoirs. Furthermore, most of the wastewater is discharged directly into the sea without treatment, negatively impacting the environment and marine life[154].

6.7. Main Threats Related to Water in Morocco

Morocco[155] is classified as a country with high water scarcity below the "water poverty level", facing possibly extreme water scarcity by 2050. 80 percent of Morocco's territory is arid to semi-arid. Due to a combination of strong population growth in the 20th century (from 12.3 million people in 1960 to 36 million in 2018), economic development and a strong decline since 1980 in precipitation (-15 percent to -20 percent) and river runoff (-30 percent to 40 percent), water resources availability is already under severe pressure. Water availability in Morocco has dropped from 3,500 m3 per person per year in 19603 to 7314 m3 per person in 2005 (SNE, 2009) for a population of 30.4 million, and 645 m3 per person in 2015, well below the "water poverty level" of 1,000 m3 per person per year. With a projected 43.7 million inhabitants by 2050 and no further change in water resources availability due to climate change, this would yield 510 m3 per person per year by 2050, near the UN's "extreme water scarcity" level of 500 m3 per capita. However, a severe future reduction of the available water resources with 25 percent to 50 percent due to climate change is well possible if not likely, which would push the country over the next decades on average far below the "extreme water scarcity" level.

Morocco has suffered from droughts every three years over the past few decades[156], with temperatures predicted to rise by three degrees by 2050 and rainfall to decline by 10 percent. In this same period, demand for water is projected to increase by six times. With most farmland located in areas that receive less than 400mm of rainfall each year, this has serious implications. The government faces a huge challenge in mitigating the impact of climate change and has even been attempting to desalinate seawater for agricultural use.

These elongated droughts are increasing soil degradation, with desertification threatening 80 percent of land, and soil erosion affecting nearly half of it. A growing population is leading to increased pressure on resources and the removal of natural vegetation as more land is

[153] https://reliefweb.int/report/libya/over-4-million-people-including-15-million-children-are-about-face-imminent-water
[154] https://reliefweb.int/report/libya/over-4-million-people-including-15-million-children-are-about-face-imminent-water
[155] https://documents1.worldbank.org/curated/fr/820871516882762722/pdf/122698-WP-v2-PUBLIC-anneces-to-sections-2-to-4.pdf
[156] https://sustainablefoodtrust.org/articles/moroccan-agriculture-facing-challenges-divided-system/

converted to cultivation. The erosion rate in the Rif Mountains, for example, is one of the most severe in the world. This problem is also causing water pollution through rising siltation levels in reservoirs and rivers and is leading to conflict in regions where land is collectively owned and grazed.

6.8. Main Threats Related to Water in Palestine

The Occupied Palestinian Territory is situated in a generally hot, arid, and water-scarce region that has experienced an increase in average temperatures over the past fifty years. Climate change has also modified the water cycle, altering precipitation patterns and seasons. Average monthly precipitation may fall by 8–10 mm by the end of the century and seasonal rainfall patterns may also change leading to greater aridity. Half of the Palestinian wells in the West Bank have dried up over the last 20 years. Climate-related hazards are projected to occur more frequently and be more severe, straining already-constrained water management structures[157]. Demand for water in the Occupied Palestinian Territory is increasing primarily due to population growth. The population of the Occupied Palestinian Territory is estimated at 4.9 million (FAO Aquastat, 2018) and is expected to increase to 7.2 million by 2030[158]. The UN Environment Programme (UNEP) projects an annual domestic supply gap for Gaza and the West Bank of approximately 79 and 92 MCM, respectively, by 2030 unless supply and service options are expanded.

The Israeli occupation of the Palestinian territory has increased land scarcity, territorial fragmentation, and urbanization. The occupation has also imposed restrictions on access to and control over natural resources, including water. Urban populations in the Occupied Palestinian Territory have nearly tripled in the past 25 years, contributing to a reduction of local groundwater recharge. From 1992 and 2015, the land area in the Occupied Palestinian Territory under artificial surfaces increased from 1.4 to 4.3 percent while areas under vegetation cover decreased, increasing vulnerability to extreme weather events. In Gaza159 this phenomenon has also reduced groundwater recharge, where built-up areas increased from 8.25 percent (1982) to 25 percent (2010).

In Gaza, severe electricity shortages have significantly affected the functionality of the existing infrastructure and the population's access to clean water. While In the West Bank, the already-restricted access to water in many locations, including in Area C (which constitutes about 61 percent of the West Bank territory), has been compounded by an aging water infrastructure and limited physical space to develop water resources or construct new infrastructure160. There is also a shortage of infrastructure allowing for the reuse of treated wastewater, with serious environmental consequences. In 2018, it was reported that only one-quarter of wastewater generated was collected in sewage networks and of that only two-thirds (approximately 13 MCM annually) was treated, while 25 MCM of untreated sewage from the West Bank is

[157] https://wedocs.unep.org/20.500.11822/32268
[158] https://www.unfpa.org/data/world-population/PS.
[159] https://wedocs.unep.org/20.500.11822/32268;
[160] https://documents1.worldbank.org/curated/en/684341535731512591/pdf/Toward-Water-Security-for-Palestinians.pdf

discharged into the environment annually. Almost none of the treated amount is reused due challenges in planning and developing infrastructure. This has direct consequences for Palestinians' health and environment, as water left untreated can enter into waterways and have a detrimental impact on the health of the population[161].

Beyond the challenges noted above, it is estimated that one-third of all water supplied to the Palestinian Authority is lost to leakage due to the poor condition of pipelines and water grids linking Palestinian communities in the West Bank162 .According to the Palestinian Authority, Israel has both blocked maintenance and upgrades, and limited the ability to increase water availability by stalling the creation of desalination plants, advanced irrigation and wastewater recycling systems, the approval of deep well drilling, as well as the deployment of rain-harvesting cisterns.

The rights to water and sanitation are particularly critical during health crises such as the COVID-19 pandemic. The WHO has identified access to WASH infrastructures and facilities as a critical priority to prevent COVID-19 transmission. Access to water and sanitation is important for hydration, personal hygiene and reducing the risk of infection. Palestinians who have been displaced as a result of Israeli demolitions in Area C, have been particularly vulnerable to the pandemic, in particular where water and sanitation facilities were also demolished163.

6.9. Main Threats Related to Water in Syria

The Syrian Arab Republic is located in the east coast of the Mediterranean Sea and southwestern Asia. It is bordered by Turkey to the north, Iraq to the east, Jordan to the south, Lebanon to the west, and Israel to the south-west. Water scarcity is one of the main challenges facing the SEMED countries and Syria is a typical country in this respect. Syria's main water resources challenges are resulting from poor management and several periods of droughts due to climate change. The increasing population growth, rapid urbanization, pollution and economic decline are additional factors on the list leading to a continuous deterioration of the water resources threatening their sustainability and not forgetting the conflict that has drastically exacerbated the situation. It is noteworthy to mention that according to UNHCR (2019), the conflict makes the accurate count of the Syrian population difficult to precise, as the numbers of Syrian refugees, internally displaced Syrians and casualty numbers are in flux. According to the FAO Aquastat estimates (See Figure 5), the total Population in 2018 was about 17 million. At the same year, The CIA World Factbook showed an estimated 20.4 million people as of July 2021[164]. Since 2017, around 49 percent of the Population lives in poverty[165].

---

[161] https://wedocs.unep.org/20.500.11822/32268

[162] https://www.btselem.org/water.

[163] https://www.humanitarianresponse.info/fr/operations/occupied-palestinian-territory/document/critical-access-water-case-masafer-yatta

[164] https://www.cia.gov/the-world-factbook/countries/syria/

[165] https://ecfr.eu/publication/the_displacement_dilemma_should_europe_help_syrian_refugees_return_home/

Since the beginning of the 20th century, Syria has faced six major droughts and, like many countries in the region, invested in infrastructure such as dams, irrigation systems, and wastewater treatment plants to source and control the movement of water towards communities and agricultural spaces. Before the conflict, Syria experienced an extreme drought from 2006 to 2011, creating population displacement and a decline in water, sanitation, and hygiene (WASH) provision, particularly in rural areas [166]. Now, after more than ten years of conflict in Syria, water facilities across the country have been severely destroyed. Access to safe drinking water is a challenge affecting millions of people across Syria, which now has up to 40 percent less drinking water than a decade ago[167]. The International Committee of the Red Cross (ICRC) has reported that before 2010, 98 percent of people in cities and 92 percent of people in rural communities had reliable access to safe water. Today, the situation is obviously different: only 50 percent of water and sanitation systems function properly across Syria.

The water crisis has also led to larger problems for Syria. Water scarcity has deteriorated crops and agricultural livelihoods, dwindling access to food and dramatically raising the prices of food and basic goods[168]. According to the U.N., at least 12.4 million Syrians are estimated to be food insecure. This figure is likely to be worsened, along with malnutrition rates, with drought.

6.10. Main Threats Related to Water in Tunisia

Tunisia is located in North Africa bordering Algeria in the west, Libya in the southeast and the Mediterranean Sea in the east and north. As one of the most arid countries in Northern Africa and among the least water resources endowed countries in the Mediterranean basin, Tunisia has suffered from high water scarcity for a long time. The history of Tunisia reveals how the scarcity of water resources forced its inhabitants to deal with its unequal distribution within the country. As early as 130 B.C., the Roman Emperor Adrian constructed a temple of water and a huge aqueduct to transfer water over 123 kilometers from a spring located in the region of Zaghouan to the city of Carthage. In the early eighth century, the Arabic Dynasty of Aghlabides transferred groundwater and stored it in big basins to supply the new founded town of Kairouan[169].

The water scarcity challenges have been put under more pressure throughout the course of time because of the population growth, the rise in living standards, the rapid urbanization and the economic development. This threatens the water availability in all sectors and particularly agriculture being the biggest water-consumer and leads to both an intensification in water consumption and pollution of water resources. The availability of water per year and per capita has now been below the absolute water scarcity threshold of 500 m^3 per year per capita for over 30 years with a rate of 367 m^3 in 2017 according to the FAO Aquastat. Extreme weather events

[166] https://www.diva-portal.org/smash/get/diva2:1569845/FULLTEXT01.pdf
[167] https://reliefweb.int/report/syrian-arab-republic/syria-water-crisis-40-less-drinking-water-after-10-years-war
[168] https://www.voanews.com/a/after-years-of-war-millions-of-syrians-now-face-serious-water-crisis-/6318836.html
[169] https://epdf.pub/agricultural-water-management-proceedings-of-a-workshop-in-tunisia.html

such as flooding, drought and heatwaves, due to the climate change, are also one of the main reasons of the water shortage in Tunisia. The summer months are getting hotter in Tunisia; the average temperature in July between the years of 1991 and 2015 was 2.3 degrees Celsius warmer than it was 90 years earlier, according to data from the World Bank. This is having a dire impact on the replenishment of groundwater reserves, the availability of drinking water, as well as on both irrigated and rainfed agriculture.

Even though Tunisia has made remarkable progress, in recent decades, in reducing poverty and increasing access to water supply, sanitation, and hygiene (WASH) services that has ranked it on the top of the highest access rates to water and sanitation services among middle-income countries in the Middle East and North Africa region[170], the low level of sanitation coverage in rural area is still an issue that is not only crating disparities between urban and rural areas but it is also responsible for the pollution of discharge environments (such as wadis) by wastewater. What's more, only 50 percent of wastewater treatment plants supply treated water that meets wastewater standards. This in turn augments the pollution of the surrounding ecosystems and the sea, which is the final place of discharge for domestic water[171.]

6.11. Main Threats Related to Water in Turkey

Turkey is one of the biggest countries of the SMEMED region of this study, covering 78 million hectares. It has borders on the east with Iran, Azerbaijan, Georgia and Armenia. On the southeast, Turkey's neighbors are Iran, Iraq and Syria. On the south and west, the country surrounded by the Mediterranean and Aegean Sea. On the northwest, Turkey has borders with Bulgaria and Greece. The Black Sea lies in the north of the country[172].

Due to several droughts in the last four decades and its semi-arid climate, Turkey is considered a water-stressed country. According to a survey[173] conducted by the World Meteorological Organization (WMO), among 87 member countries, it was determined that 74 countries are drought-affected, including Turkey.

And even though the recent drought has ended, water supplies are poised to become more stressed in the near future due to a combination of factors, including climate change, a growing population, industrialization and changing standards of living. The enormous population increase from 28 million in the 1960's to 82 million in 2018 (FAO Aquastat, Figure 5) has dwindled the availability of water resources from around 4000 m^3 to 1500 m^3 per capita/year today. the World Wildlife Fund (WWF), projects that over the course of the next decade, the amount of water available per capita will drop from 1500 m^3 to 1100 m^3 bringing the country

[170] https://www.worldbank.org/en/news/feature/2014/09/04/water-tunisia-s-other-development-challenge
[171] https://en.qantara.de/node/41774
[172] A. Bobat, 2019, Water Scarcity in Kocaeli/Turkey: Problems and Measures
[173] A. Bobat, 2019, Water Scarcity in Kocaeli/Turkey: Problems and Measures

closer to a "water poor" designation[174]. And this amount of water per capita per year is expected to fall even more to 700 m^3 by 2050[175].

A study[176] conducted by OECD to assess the projections of the climate change impacts on water systems in Turkey has shown that water resources needed for food production and rural development are threatened by climate change impacts such as an increase in summer temperatures (Increase in the annual mean temperature for Turkey is around 2 °C to 3 °C for the period 2071-2100), a decrease in winter precipitation (in western provinces in particular), a loss of surface waters, an increase in the frequency of droughts, land degradation, coastal erosion and floods. This can lead to possible major changes in the quantity and quality of water and stream flow in Turkey's river basins. Rivers are the main sources of water for Turkey, not only for safe drinking water, domestic and industrial use, but also for irrigation and power generation. Given that about 74 percent of the total water supply of Turkey is used for agricultural irrigation[177], remaining 15 percent and 11 percent are used for drinking-domestic and industrial purposes respectively, the concern about the water scarcity is becoming worrying.

Besides water scarcity, the interdependence among water-sharing countries has created complex conflicts over shared water resources around the world and Turkey is a typical example in this regard as it has five transboundary river basins. Forty percent of Turkey's water resources are transboundary waters -- the Euphrates, Tigris, Çoruh, Kura and Aras Rivers, which originate in Turkey, and the Meric and Asi (Orontes), whose headwaters are in neighboring countries[178]. The Euphrates and Tigris rivers are Turkey's major contributing water sources with 31 percent of the country's water supply. As Turkey has access to the headwaters of the Tigris and Euphrates, it is building dams which its downstream neighbors, Syria and Iraq, claim allow unfair distribution of water resources especially in the light of the severe droughts periods. This even was consolidated by an IPCC Report[179] indicating that "declines in flows for Turkey and water allocation between upstream and downstream countries will become a challenging issue for regions exposed to prolonged droughts, such as the Euphrates-Tigris river basin". However, the Turkish government continues major diversions of water for agriculture claiming that, since the rivers originate in Turkey, it is their right to control the water. This has led to an escalation of tensions in the region.

---

[174] https://www.earthisland.org/journal/index.php/articles/entry/drought-water-stressed-turkey-solutions/#:~:text=Turkey%20is%20currently%20considered%20a,a%20growing%20population%2C%20and%20industrialization.
[175] A. Bobat, 2019, Water Scarcity in Kocaeli/Turkey: Problems and Measures
[176] https://www.oecd.org/env/resources/Turkey.pdf
[177] https://www.climatechangepost.com/turkey/fresh-water-resources/
[178] https://waterandconflict.web.unc.edu/turkey-and-transboundary-water/
[179] https://documents1.worldbank.org/curated/en/600681476343083047/pdf/AUS10650-REVISED-PUBLIC-Turkey-NCA-Water-Valuation-Report-FINAL-CLEAN.pdf

7. Turning Challenges in Opportunities: Recommendations for Regional Collaboration

From the previous sections, we see several themes repeating across the SEMED region including big knowledge gaps in the sector, weak GDP water contribution, poor irrigation efficiency, focus on conventional water resources, weak enforcement of laws and regulations, especially related to treated wastewater reuse, political instability, and several climatic challenges. These challenges are all viewed as opportunities that can lead to national and regional socioeconomic development, sustainable job creation, innovations, and confidence building. We list below the most impactful opportunities.

The intersections between water, energy, and food are not clearly leveraged in an accessible and unified knowledge platform. As there are no regional coordination mechanisms already presented to develop a unified hub or information sharing mechanism, it is important to establish regional efforts to harmonize approaches between different information-collecting bodies. In order to improve cooperation/coordination, a system needs to be created to strengthen information exchange and cooperation at the regional and national levels. The goal is to achieve a fully transparent, harmonized and up to date integrated SEMED-wide information system. The knowledge hub would provide public accessibility with capacity for updating and would make available high-quality data required for effective resource allocation and decision making. In addition, a new approach for knowledge presentation will be created through real-time updates of an online knowledge platform for WEF Nexus (e.g., living WEF-related indexes such as the INWRDAM WEFE Nexus indexing system).

Hence, a unified regional database/databank for ongoing Nexus initiatives should be developed. This should include project scopes, best practices, donor alignment, pool of experts, and level of contribution to SDGs. The lack of existing data has prevented the establishment of comprehensive Nexus projects that benefit multiple countries, which limits proper allocation of resources. While there are different networks for data on the national levels, a consolidated and credible regional knowledge platform is still lacking. Problems include low capacity for collecting and managing high-quality data, deteriorating monitoring networks; insufficient budgets for maintaining data networks, and regional information sources have no incentive to provide improved data and information.

Moreover, there is a need to identify Nexus-related opportunities at regional levels, which in turn could lead to job creation, economic reform, economic empowerment of marginalized, fragile, and indigenous communities, with greater participation by youth and women. A regional opportunity mapping body can help identify repeatable and scalable success stories that can be taken to other countries or executed at a regional level.

The replication and scaling up of successfully executed Nexus projects are also essential. Scaling up Nexus projects will help in expanding or replicating innovative pilot or small-scale projects in order to broaden the effectiveness of an intervention on a regional scale. This will also ensure de-risking investments and avoiding mistakes faced by pilots/initial projects. In addition, this can allow in using existing resources where available (e.g., phone apps, studies, reports, programs, etc.). The value ~~o~~ replicating and scaling up successful Nexus projects ensure sustainability, productivity, quality, and enhances cost efficiency, while minimizing impact. Scaling up especially depends on knowledge/skills transfer, thus a database/knowledge platform can provide a more integrated governance and incentivize further Nexus implementations and investments and upscaling of solutions beyond pilot scale, which in turn would further and strengthen the Nexus evidence and knowledge base.

There is also a need to support the development of Nexus projects through identification, proposal writing, feasibility studies, technical support, M&E, and provision of expert support. This will enhance quality and a deeper understanding.

This will also include the strengthening of institutional capacities, while improving public sector youth participation in Nexus through capacity building programs. One aim of the capacity-building program is to strengthen the capacities of young researchers to cope with challenges associated with water quality and quantity, energy provision, and food security in the SEMED region. Capacity building goes beyond offering research opportunities and includes mentorship and on the job-training programs as well as technology and skills transfer to youth. It is critical that development initiatives prepare youth as emerging professionals to contribute meaningfully to research for development. young people should be prepared to be stronger participants in the WEF value chains and agents of change.

Specifically, a WEFE Nexus hub should be established to execute the above interventions at the SEMED region. This hub should focus on the following key activities:

1. Designing and implementing a **WEFE Nexus data and knowledge hub** that includes a SEMED-based capacity assessment and gap analysis in terms of governments, academia, and legislative/regulatory. In addition to a database composed of Nexus experts within SEMED member states. The knowledge hub will also include an interactive online platform including relevant knowledge about agriculture, energy, water and economic opportunities. The database will include a list of previous and existing Nexus projects for scaling up or wider geographic dissemination. In order to increase the chances of implementing Nexus related projects, a list of project opportunities and calls for proposals will also be prepared for member states as needed.

2. **"WEFE-Talk"** will be a SEMED-based dialogue initiative aimed at building a young water professionals' network made up of young public sector employees with SEMED-based chapters. In addition, this will include identifying Nexus opportunities resulting in the creation of incentives and confidence building within the region through projects that ensure cooperation through regional win-win Nexus joint activities. In order to achieve correct decisions, a fully transparent, harmonized and up-to date integrated SEMED-wide information system needs to be available. Thus, this knowledge hub output will be used as an effective tool to transform data into decisions (D2D). This D2D approach will lead to basin-wide evidence-based policymaking. Whereby Nexus related policy briefs and white papers will also be published.

3. Implementation of a **“Nexus Food Security Envelope”** which includes:
    - Farming job creation through smart Nexus resource allocation (e.g., smart crop selection, irrigation efficiency, solar PV, RWH, NCWR, etc.).
    - Capacity building (technical, business, legal).
    - Market linkages.
    - Private sector investment attraction.
    - Smart home-based and small food processing business empowerment.
    - Disaster Risk Reduction.

4. Trans-boundary joint monitoring coordination:
   Due to weak cooperation between countries and institutions, there are no current documents to guide transboundary Nexus use, and decision making remains centralized. Thus, the trans-boundary joint monitoring coordination will enhance intra-SEMED cooperation across several riparian countries by acting as neutral coordinators for joint monitoring and contamination prevention programs (an inter-governmental neutral entity such as INWRDAM can play a key role here). Water efficiency is worst in the agricultural sector, largely due to neglected irrigation infrastructure, outdated technology, and inadequate monitoring and data, exacerbated by fragmented institutional mandates for water management and low levels of trust between riparian states. Thus, regional water indexes will be improved (e.g., INWRDAM WEFE indexes), through focus on weak index components. The coordination will act as a trusted partner for issues related to trans-boundary confidence/trust building.

References

Abbara, A., Zakieh, O., Rayes, D., Collin, S. M., Almhawish, N., Sullivan, R., Aladhan, I., Tarnas, M., Whalen-Browne,
M., Omar, M., Tarakji, A., & Karah, N. (2021). Weaponizing water as an instrument of war in Syria: Impact on
diarrhoeal disease in Idlib and Aleppo governorates, 2011–2019. International Journal of Infectious Diseases, 108,
202–208. https://doi.org/10.1016/j.ijid.2021.05.030

Abbas S. Al-Omari. (2015). Irrigation water management in the Jordan valley under water scarcity. https://www.researchgate.net/publication/275034233_Irrigation_water_management_in_the_Jordan_valley_under_water_scarcity

Abdel Khaleq, Rania A. (2008, June). Water Demand Management in Jordan. Water Demand Management Unit, Ministry of Water and Irrigation.http://www.emwis.org/documents/database/water-demand-management-jordan

Agriculture in the West Bank and Gaza Volume 1 ANERA Reports on the ground in the Middle East. (n.d.). https://www.anera.org/wp-content/uploads/2017/03/AgReport.pdf

Ahram Online. (2021, June). Egypt one of world's most water-scarce countries, irrigation minister tells UK energy minister. https://english.ahram.org.eg/NewsContent/1/64/414376/Egypt/Politics-/Egypt-one-of-worlds-most-waterscarce-countries,-ir.aspx

Alexander, L. (2020, March 27). Resolving the Water Crisis in Libya. The Borgen Project. https://borgenproject.org/water-crisis-in-libya/

Alloush, B. (2018, August). The importance of the agricultural sector for Syria's stability. Chatham House. https://syria.chathamhouse.org/research/the-importance-of-the-agricultural-sector-for-syrias-stability

Anadolu Ajansi. (2022, November). The Rate of Modern Irrigation Systems in Agriculture Rise to 94 Percent | Agri Post. Growtech. https://www.growtech.com.tr/en/agri-post/news-from-turkey/the-rate-of-modern-irrigation-systems-in-agriculture-rise-to-94percent.html

Aqeil, H., Tindall, J., & Moran, E. (2012). Water Security and Interconnected Challenges in Libya Sponsor: TinMore
Institute Center for Water Security Disclaimer. http://www.tinmore.com/pdf/WS121027_WaterSecurityLibya.pdf

Asad, M. (2021, December 11). Three large wastewater treatment plants put into operation in Gaza. Middle East Monitor. https://www.middleeastmonitor.com/20211211-three-large-wastewater-treatment-plants-put-into-operation-in-gaza/

Assaf, H. (n.d.). Water Resources and Climate Change. Chapter 2. https://hispagua.cedex.es/sites/default/files/hispagua_documento/documentacion/documentos/Chapter2.pdf

Ayadi, Y. H. (2006, September). Policy and adaptation in the Jordan Valley. Icimod. https://lib.icimod.org/record/12348

B'Tselem. (2017, November 11). Water Crisis. B'Tselem. https://www.btselem.org/water

Bahr Al-Baqar WWTP | ACCIONA | Business as unusual. (2020). Acciona.https://www.acciona.com/projects/wwtp-bahr-al-baqar/?_adin=02021864894

Baum, Z., Palatnik, R. R., Kan, I., & Rapaport-Rom, M. (2016). Economic Impacts of Water Scarcity Under Diverse
Water Salinities. Water Economics and Policy, 02(01), 1550013. https://doi.org/10.1142/s2382624x15500137

Belhout, Z., Fujimi, T. (2019). Review of flood risk management in Tunisia: Current State and Challenges.

Bobat, A. (2019). Water Scarcity in Kocaeli/Turkey: Problems and Measures. Journal of Scientific and Engineering
Research, 6(12). https://avesis.kocaeli.edu.tr/yayin/df38cdaa-d539-4560-886d-5572a461af59/water-scarcity-in-
kocaeli-turkey-problems-and-measures

Brika, B. (2018). Water Resources and Desalination in Libya: A Review. Proceedings, 2(11), 586. https://doi.org/10.3390/proceedings2110586

Brika, B. (2019). The water crisis in Libya: causes, consequences and potential solutions. Desalination and Water treatment, 167, 351–358. https://doi.org/10.5004/dwt.2019.24592

Buyukcangaz, H., Demirtas, C., Yazgan, S., & Korukcu, A. (2007). Efficient water use in agriculture in Turkey: The
need for pressurized irrigation systems. Water International, 32(sup1), 776–785. https://doi.org/10.1080/02508060.2007.9671997

Canovas Cuenca, J. (2012, September) Report on water desalination status in the Mediterranean countries. Instituto Muriciano de Investigacion y Desarallo Agroalimentario.

https://www.imida.es/documents/13436/877249/06_REPORT_ON_WATER+DESALINATION.pdf/ae6203f4-68f9-4a37-b728-22b5d247909e

Chaoui, M. S., Cauwenbergh, N. V., & Benterki, A. (2016). Analyse De La Poplitique Hydrique En Algerie Depuis
L'independence. مجلة العلوم الإنسانية, 65. https://doi.org/10.34174/0079-000-046-045

Chebil, A., Frija, A., Makhlouf, M., Thabet, C., & Jebari, S. (2019). Effects of Water Scarcity on the Performances of the Agricultural Sector and Adaptation Strategies in Tunisia. In (Ed.), Agricultural Economics - Current Issues. IntechOpen. https://doi.org/10.5772/intechopen.83568

Choukr-Allah, R. (n.d.). Wastewater Treatment and Reuse. Chapter 7. https://hispagua.cedex.es/sites/default/files/hispagua_documento/documentacion/documentos/Chapter7.pdf

CIHEAM. (2009). Abdin A.E., Gaafar I. Rational water use in Egypt (pp. 11–27). https://om.ciheam.org/om/pdf/a88/00801177.pdf

Dakkak, A. (2020, August 11). Water Crisis in Egypt. EcoMENA. https://www.ecomena.org/egypt-water/

Economic and Social Commission for Western Asia (ESCWA). (2020, October 15). ESCWA Water Development
Report 8: The Water-related Sustainable Development Goals in the Arab Region. United Nations Economic and

Social Commission for Western Asia.https://archive.unescwa.org/publications/water-development-report-8

EcoPeace. (2019, January 31). Climate Change, Water Security, and National Security for Jordan, Palestine, and Israel - January 2019 - occupied Palestinian territory. ReliefWeb. https://reliefweb.int/report/occupied-palestinian-territory/climate-change-water-security-and-national-security-jordan

El-Gamal, J. M. (2019, March 13). The displacement dilemma: Should Europe help Syrian refugees return home? ECFR. https://ecfr.eu/publication/the_displacement_dilemma_should_europe_help_syrian_refugees_return_home/

European Committee of the Regions. (2020, September 21). Agriculture and food security in climate sensitive areas in the Mediterranean. Https://Cor.Europa.Eu/. https://op.europa.eu/en/publication-detail/-publication/18b8b758-fc85-11ea-b44f-01aa75ed71a1/language-en

European Investment Bank. (2019, May). Bringing water to Gaza. https://www.eib.org/attachments/country/bringing_water_to_gaza_en.pdf

Fanack Water. (2015, October). Water Resources in Israel. https://water.fanack.com/israel/water-resources/

Fanack Water. (2015, October). Lebanon Water Report. https://water.fanack.com/lebanon/

Fanack Water. (2019, July). Water Resources in Syria. https://water.fanack.com/syria/water-resources/#_ftn4

Fanack Water. (2020, August). Water Resources in Libya. https://water.fanack.com/libya/water-resources-in-libya/#_ftn22

Fanack Water. (2015, June). Water Management in Palestine. https://water.fanack.com/palestine/water-management/

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. https://www.medecc.org/wp-content/uploads/2020/11/MedECC_MAR1_3_1_Water.pdf

FAO. (2018, August 30). Solutions to water challenges in the Middle East and North Africa region. Food and Agriculture Organization of the United Nations. https://www.fao.org/fao-stories/article/en/c/1150870/

Fouka Desalination Plant, Tipaza - Water Technology. (n.d.). https://www.water-technology.net/projects/fouka-desalination-plant/

Fresh water resources in Turkey. (n.d.). Climatechangepost.com. https://www.climatechangepost.com/turkey/fresh-water-resources/

Frija, A. (2021, October 21). Socio-Economic Implications and Potential Structural Adaptations of the Tunisian Agricultural Sector to Climate Change. MDPI. https://www.mdpi.com/2073-4395/11/11/2112

Gaaloul, N. (2011). Water resources and management in Tunisia. International Journal of Water, 6(1/2), 92.
https://doi.org/10.1504/ijw.2011.043319

Gafrej, R. (2020, October 6). Water shortage in the Maghreb: Climate change and Tunisia's water. Qantara.de - Dialogue with the Islamic World. https://en.qantara.de/node/41774

Gargouri, B., Ben Brahim, S., Marrakchi, F., Ben Rouina, B., Kujawski, W., Bouaziz, M. Impact of Wastewater Spreading on Properties of Tunisian Soil under Arid Climate. Sustainability 2022, 14, 3177. https:// doi.org/10.3390/su14063177

Gateway, S. (n.d.). Lebanese agriculture faces devastating losses in wake of Saudi export ban. Salaam Gateway –
Global Islamic Economy Gateway.
https://www.salaamgateway.com/story/lebanese-agriculture-faces-devastating-losses-after-export-ban

Global Construction Review. (2021, October 22). Egypt plans desalination plants worth $2.5bn over next five years. https://www.globalconstructionreview.com/egypt-plans-desalination-plants-worth-2-5bn-over-next-five-years/

Goverment of Jordan, Goverment of Germany. (2021, February 14). Influx of Syrian Refugees in Jordan | Effects on the Water Sector - Jordan. Researchgate.
https://www.researchgate.net/publication/349141468_Influx_of_Syrian_Refugees_in_Jordan_Effects_on_the_Water_Sector

Great Man-Made River. (2021, May 19). In Wikipedia. https://en.wikipedia.org/wiki/Great_Man-Made_River

Guerra, G. (2020, September 1). Water as a Building Block for Peace in Lebanon and Beyond. Geopolitical Monitor. https://www.geopoliticalmonitor.com/water-as-a-building-block-for-peace-in-lebanon-and-beyond/

Heaney, C. (2018, August 15). Supporting Efficient Irrigation Systems in the West Bank - FAO Article. https://www.un.org/unispal/document/supporting-efficient-irrigation-systems-in-the-west-bank-fao-article/

Holliday, L., Developing, I., & Firm, P. (2007). Agricultural water management : proceedings of a workshop in
Tunisia. National Academies Press.

i24NEWS - AFP. (2021, June 13). Jordan to build Red Sea desalination plant to combat drinking water shortage. I24news. https://www.i24news.tv/en/news/middle-east/1623589631-jordan-to-build-red-sea-desalination-plant-to-combat-drinking-water-shortage

Ibrahim Al-Samarrai, K. (2021, June 7). Precision Irrigation Efficient Technologies Practice in Libya from the Water and Energy Point of View. ResearchBib. http://paper.researchbib.com/view/paper/285470

International Fund for Agricultural Development. (n.d.). Egypt.
https://www.ifad.org/en/web/operations/w/country/egypt

International Committee of the Red Cross. (2021, October 1). Syria Water Crisis: Up to 40% less drinking water after 10 years of war - Syrian Arab Republic. ReliefWeb. https://reliefweb.int/report/syrian-arab-republic/syria-water-crisis-40-less-drinking-water-after-10-years-war

Israel's Water Challenge. (2013, December 25). Rane. https://worldview.stratfor.com/article/israels-water-challenge?app=old

Jewish National Fund. (2020). Israel water crisis facts & figures.
http://support.jnf.org/site/PageServer?pagename=Water_facts

Karaa, K., Karam, F., & Raad, R. (n.d.). A n° 88, 2009 -Technological Perspectives for Rational Use of Water
Resources in the Mediterranean Region.
https://www.idaea.csic.es/meliaproject/sites/default/files/517612-MELIA-Modernization-of-irrigation-systems-
measures-to-reduce-pressure-on-water-demand-in-Lebanon.pdf

KAS. (2022, January 25). Desalination: An alternative to alleviate water scarcity in the MENA region. Regional Programme Energy Security and Climate Change in Middle East and North Africa. https://www.kas.de/en/web/remena/single-title/-/content/desalination-an-alternative-to-alleviate-water-scarcity-in-the-mena-region

Langenberg, V., Bruning, B., Gonzalez, B. (2021, March 16). Water in agriculture in three Maghreb countries. Acacia Water UK.
https://agfstorage.blob.core.windows.net/misc/AGF_nl/2021/06/23/Water_in_Agriculture_Maghreb_Final_Report.pdf

Libya's Water Crisis Affects Millions Nationwide. (2020, June 2). BORGEN.
https://www.borgenmagazine.com/libyas-water-crisis-affects-millions-nationwide/

Magoum, I. (2021, September 28). EGYPT: El Sisi inaugurates the world's largest sewage plant in Bahr El-Baqar. Afrik 21.
https://www.afrik21.africa/en/egypt-el-sisi-inaugurates-the-worlds-largest-sewage-plant-in-bahr-el-baqar/

Magoum, I. (2022, February 11). MOROCCO: Rabat wants to mobilize €220 million for wastewater reuse by 2027. Afrik 21. https://www.afrik21.africa/en/morocco-rabat-wants-to-mobilize-e220-million-for-wastewater-reuse-by-2027/

Majzoub, T. (n.d.). Water Laws and Customary Water Arrangements. Chapter 9.
https://hispagua.cedex.es/sites/default/files/hispagua_documento/documentacion/documentos/Chapter9.pdf

Medjerda River, Algeria Tourist Information. (n.d.). Www.touristlink.com.
https://www.touristlink.com/algeria/medjerda-river/overview.html

Ministry of Water and Irrigation. (2016). WATER SECTOR CAPITAL INVESTMENT PLAN 2016–2025. Jordankmportal.
https://jordankmportal.com/resources/water-sector-capital-investment-plan-2016-2025

Mohsen, M. S. (2007). Water strategies and potential of desalination in Jordan. Desalination, 203(1-3), 27–46.
https://doi.org/10.1016/j.desal.2006.03.524

Naceur, M. (2019). Coping with Water Scarcity in Private Irrigated Perimeters: Farmers' Adjustments in Southeastern Tunisia. Semantic Scholar. https://www.semanticscholar.org/paper/Coping-with-Water-Scarcity-in-Private-Irrigated-in-Naceur-Fouzai/360a3046958c7f022fea8ec417fdc2fd0fcace23

Nas, B. (2020, February 1). Wastewater reuse in Turkey: from present status to future potential | Water Supply |
IWA Publishing. https://iwaponline.com/ws/article/20/1/73/69913/Wastewater-reuse-in-Turkey-from-present-status-to

Nunnally, S. (2017, June 27). 8 Facts About Water Quality in Morocco. The Borgen Project. https://borgenproject.org/about-water-quality-in-morocco/

OCHA. (2021, April 1). Critical access to water-The case of Masafer Yatta | HumanitarianResponse. OCHA services. https://www.humanitarianresponse.info/fr/operations/occupied-palestinian-territory/document/critical-access-water-case-masafer-yatta

OECD. (2013). Water and Climate Change Adaptation. https://www.oecd-ilibrary.org/environment/water-and-climate-change-adaptation_9789264200449-en

OECD-FAO. (2018, July 3). OECD-FAO Agricultural Outlook 2018–2027. OECD iLibrary. https://www.oecd-ilibrary.org/agriculture-and-food/oecd-fao-agricultural-outlook-2018-2027/overview_agr_outlook-2018-4-en
Taheripour, Farzad; Tyner, Wallace E.; Sajedinia, Ehsanreza; Aguiar, Angel; Chepeliev, Maksym; Corong, Erwin; de Lima, Cicero Z.; Haqiqi, Iman. (2020). Water in the Balance : The Economic Impacts of Climate Change and Water Scarcity in the Middle East. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/34498

ONAS. (2017). Sanitation National office Activity report. Tunisia

Ortiz, J. (2022, April 5). Morocco installs the largest seawater desalination plant in the world. Atalayar. https://atalayar.com/en/content/morocco-installs-largest-seawater-desalination-plant-world

Pipeline of PPP projects in Tunisia. (2018). http://www.igppp.tn/sites/default/files/Fiches_descriptives/03-Fiche%20Station%20d%27%C3%A9puration%20%C3%A0%20Tunis%20Nord.pdf

Perry, M. (2015, April 10). Moroccan agriculture: Facing the challenges of a divided system. Sustainable Food Trust. https://sustainablefoodtrust.org/articles/moroccan-agriculture-facing-challenges-divided-system

PSEAU. (2020). https://www.pseau.org/fr/maroc/cadre-sectoriel

Pitman, G. (n.d.). The world bank operations evaluation department Jordan An Evaluation of Bank Assistance for
Water Development and Management A Country Assistance Evaluation. https://www.oecd.org/countries/jordan/36489193.pdf

Rahmani, A. & Brahim, C. (2017). Water Supply Prediction for the Next 10 Years in Algeria: Risks and Challenges. Irrigation & Drainage Systems Engineering, 06(03). https://doi.org/10.4172/2168-9768.1000197

REVOLVE. (2017). Water Around the Mediterranean 2017. https://revolve.media/magazine/water-around-the-mediterranean-2017/

Sadek, N. (2013). Water Scarcity and its Impact on the Socio-Economic Aspects of the National Projects in Egypt

Shaban, A. (2019). Striking Challenges on Water Resources of Lebanon. Hydrology - the Science of Water.
https://doi.org/10.5772/intechopen.81878

Shatanawi, M., Fardous, A., Mazahrih, N., & Duqqah, M. (2005). Irrigation systems performance in Jordan. In Options Méditerranéennes : Série B. Etudes et Recherches (pp. 123–131). https://om.ciheam.org/om/pdf/b52/05002253.pdf

Syria - The World Factbook. (n.d.). Www.cia.gov. https://www.cia.gov/the-world-factbook/countries/syria/

Taheripour, F., Tyner, Wallace E.; Haqiqi, I., Sajedinia, E. (2020). Water Scarcity in Morocco : Analysis of Key Water Challenges. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/33306

Tansel, S. (2021, May 5). In Water-Stressed Turkey, Cities Look to Solutions New and Old. Earth Island Journal. https://www.earthisland.org/journal/index.php/articles/entry/drought-water-stressed-turkey-solutions/#:%7E:text=Turkey%20is%20currently%20considered%20a,a%20growing%20population%2C%20and%20industrialization

The Journal of North Africans Studies. (2015, June 9). The rationale of the Green Morocco Plan: missing links between goals and implementation. Taylor & Francis. https://www.tandfonline.com/doi/abs/10.1080/13629387.2015.1053112

The Role of Food and Agriculture for Job Creation and Poverty Reduction in Jordan and Lebanon (English). Washington, D.C. : World Bank Group. http://documents.worldbank.org/curated/en/325551536597194695/The-Role-of-Food-and-Agriculture-for-Job-Creation-and-Poverty-Reduction-in-Jordan-and-Lebanon

Tindall, J., Campbell, A., & Moran, E. (2012). Water Security -A Synopsis. http://www.tinmore.com/pdf/TinMoreWaterSecSynopsis120729.pdf

Ülker, D., Ergüven, O., & Gazioğlu, C. (2018). Socio-economic impacts in a Changing Climate: Case Study Syria. International Journal of Environment and Geoinformatics, 5(1), 84–93. https://doi.org/10.30897/ijegeo.406273

UNECE. (2020, August 31). Reconciling resource uses: Assessment of the water-food-energy-ecosystems nexus in the North Western Sahara Aquifer System, Part A - "Nexus Challenges and Solutions. https://unece.org/environment-policy/publications/reconciling-resource-uses-assessment-water-food-energy-ecosystems

UNEP. (2020). State of Environment and Outlook Report for the occupied Palestinian territory 2020. UNEP - UN Environment Programme. https://wedocs.unep.org/20.500.11822/32268

UNFPA. (2020). World Population Dashboard -Palestine. United Nations Population Fund. https://www.unfpa.org/data/world-population/PS

UNICEF. (n.d.). Water, sanitation and hygiene. UNICEF Jordan. https://www.unicef.org/jordan/water-sanitation-and-hygiene

UNICEF. (2021a, February 1). Over 4 million people, including 1.5 million children are about to face imminent water shortage in Libya [EN/AR] - Libya. ReliefWeb. https://reliefweb.int/report/libya/over-4-million-people-including-15-million-children-are-about-face-imminent-water

UNICEF. (2021b, July). Water supply systems on the verge of collapse in Lebanon: over 71 per cent of people risk losing access to water. https://www.unicef.org/press-releases/water-supply-systems-verge-collapse-lebanon-over-71-cent-people-risk-losing-access

United Nations High Commissioner for Refugees. (2021). Lebanon. UNHCR. https://www.unhcr.org/lebanon.html#:%7E:text=Lebanon%20faces%20its%20worst%20socioeconomic,are%20living%20in%20extreme%20poverty.

Union for the Mediterranean Water Policy Framework For Actions 2030. (n.d.). https://ufmsecretariat.org/wp-content/uploads/2019/04/Policy-Framework-WEB_Nov2020.pdf

United Nations in Lebanon. (2021, May). World Bank Supports Small Scale Lebanese Farmers Reeling under the
Pressure of Lebanon's Multiple Crises.
https://lebanon.un.org/en/127314-world-bank-supports-small-scale-lebanese-farmers-reeling-under-pressure-lebanons-multiple

USAID. (2022, April). Agriculture and Food Security | Egypt | U.S. Agency for International. https://www.usaid.gov/egypt/agriculture-and-food-security#:%7E:text=Agriculture%20is%20a%20major%20component,Upper%20Egypt%20is%20agriculture%2Drelated.

USAID Water and Development Country Plan for Lebanon. (2017.). https://pdf.usaid.gov/pdf_docs/pbaah788.pdf

Varghese, M. (2021, November 22). After Years of War, Millions of Syrians Now Face Serious Water Crisis. VOA.
https://www.voanews.com/a/after-years-of-war-millions-of-syrians-now-face-serious-water-crisis-/6318836.html

Verner, D., Treguer, D., Redwood, J., Christensen, J., McDonnell, R., Elbert, C., Konishi, Y. 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

Waseem A.Geed. (2017). Water scarcity in Egypt : causes and consequences

Water for Agriculture in Jordan: Policy Strategies for Reducing Water Consumption in the Agricultural Sector.
(n.d.). https://old.ecopeaceme.org/wp-content/uploads/2021/04/13622989291%5E%5EJordan_Agricultural_Policy_Paper_English.pdf

Water Technology .(n.d). As-Samra Wastewater Treatment Plant, Jordan. https://www.water-technology.net/projects/as-samra-wastewater-treatment-plant-jordan/

Woertz, E. (2017, February 1). Agriculture and Development in the Wake of the Arab Spring. Open Edition Journals.
https://journals.openedition.org/poldev/2274

World Economic Form. (2021, September 18). The water crisis in Egypt, and the reasons behind it. https://www.weforum.org/agenda/2019/11/water-crisis-builds-in-egypt-as-dam-talks-falter-temperatures-rise

World Bank. (2008, September). Middle East and North Africa - Agriculture & Rural Development.

https://web.worldbank.org/archive/website01418/WEB/0__CO-48.HTM

World Bank. (2017, August). Water management in Israel: key innovations and lessons learned for water scarce countries.https://documents1.worldbank.org/curated/en/657531504204943236/pdf/Water-management-in-Israel-key-innovations-and-lessons-learned-for-water-scarce-countries.pdf

World Bank. (2018). Beyond Scarcity : Water Security in the Middle East and North Africa. MENA Development Report;. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/27659

World Bank Group. (2014a, September 4). Water: Tunisia's Other Development Challenge. World Bank. https://www.worldbank.org/en/news/feature/2014/09/04/water-tunisia-s-other-development-challenge

World Bank Group. (2014, October 1). Preserving Lebanon's Water before the Wells Run Dry. World Bank.
https://www.worldbank.org/en/news/feature/2014/09/30/preserving-lebanon-s-water-before-the-wells-run-dry

World Bank Group. 2016. Valuing Water Resources in Turkey : A Methodological Overview and Case Study. World Bank, Washington, DC. © World Bank.
https://openknowledge.worldbank.org/handle/10986/25291

World Bank Group. 2017. Managing Urban Water Scarcity in Morocco. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/29190

World Bank Group. (2018, August 31). Toward Water Security for Palestinians : West Bank and Gaza Water Supply, Sanitation, and Hygiene Poverty Diagnostic. World Bank.
https://openknowledge.worldbank.org/handle/10986/30316?show=full

Xu, X. Z., Xu, Y., Chen, S. C., Xu, S. G., & Zhang, H. W. (2010). Soil loss and conservation in the black soil region of
Northeast China: a retrospective study. Environmental Science & Policy, 13(8), 793–800.
https://doi.org/10.1016/j.envsci.2010.07.004

Yorke, V. (2013). Politics matter: Jordan's path to water security lies through political reforms and regional
cooperation.
Zafar, S. (2021, March 30). Water Scarcity in MENA. EcoMENA. https://www.ecomena.org/water-scarcity-in-mena/