



Regional Report

Regional Process Commission

Region: Arab

Coordinator: League of Arab States (LAS)

**Pre-forum version
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Aknowledgement

The Arab regional report to the World Water Forum 8 is part of the regional process outcomes. It was developed after broad consultations on regional high priority topics involving all segments of society. The synthesis of contribution from government agencies, NGOs, CSOs, private sector, UN agencies and other international organizations was developed by an independant consultant, Prof. Safwat Abd El Dayem based on frame of ToRs set by the Regional Process Commission of the WWF 8. The report development was coordinated by Dr. Hammou Laamrani a Senior Expert at the Technical secretariat of the Arab Water Ministerial Council of the League of the Arab States. The report content is in essence based on contributiuns received from Ministries, Universities, UN agencies, regional NGOs, Private sector and CSOs and on key recommendations of the landmark events that took place since the start of the regional process. The laeague of Arab States would like to thank all organizations that implemented the events and that contributed sections used in the in the synthesis report.

1. Executive Summary

Twenty-two countries with many social, cultural, political and life-style in common and with mostly the same challenges located in North Africa and East Asia form the Arab region. The current report features the current water realities and prospects and links to the motto set for the forum “Sharing Water” that puts water in the heart of the SDGs/Development Agenda 2030 . The report intends to share the region’s experience dealing with water scarcity and best practices on issues of common interest with other regions worldwide.

Water scarcity in the Arab Region is one of the major and most critical development challenges. This challenge is expected to grow over time due to many pressing driving forces, including population growth, food demand, unsettled and politicized shared water resources, and climate change. About 40% of the Arab population are already living in conditions of absolute water scarcity. During the period 2005 to 2015 annual per capita freshwater availability in the region dropped by about 20%, from about 990 to 800 m³.

Transboundary water: The current water situation is exacerbated by the fact that more than half of total renewable water resources in Arab region originates from outside the region. Some countries rely almost exclusively on transboundary water resources originating from outside their borders. However, most shared resources lack comprehensive international agreements which threatens the region’s stability and imposes uncertainty on future water supplies.

Desalination has become one of the important sources for non-conventional fresh water supply. The region now accounts for more than half the world’s desalination capacity. It is estimated that desalinated water will account for 8.5 per cent of the region’s total water supply by 2025. Treated wastewater is another valuable non-conventional water resource subject to increase. However, development of both resources is associated with technological, financial, social and environmental challenges.

Water Allocation: The majority of water resources in the region are being used for agriculture (84%), while the municipal and the industrial sectors consume about (9%) and (7%) of the total water use, respectively. In the past 10 years, a clear trend of sectoral water competition is observed. The region's overall sectoral water allocation percentages have been shifting from the agricultural sector towards the municipal and industrial sectors.

Water Quality: The region’s deteriorated water quality has become equally disturbing feature over the past decades. Overexploitation and pollution of renewable and non-renewable water resources threaten their availability. Overexploitation and pollution have led not only to lower water quality and quantity, but also to ecosystem degradation. The cost of water’s environmental degradation may reach well beyond 1 per cent of a country’s GDP.

Climate change: The Arab region at-large is exposed to long-term climate change effects which will exacerbate the already precarious situation created by chronic water scarcity. By 2030 the effects of climate change is expected to reduce renewable water resources by another 20 per cent through declining precipitation, rising temperature, sea level rise and expanding seawater intrusion into coastal aquifers.

Nexus Water Energy Food: Since Arab countries use about 80% of their renewable water resources for agriculture, the nexus, energy, water and food security is an emerging clearly a vital one in the region. The scarcity of water puts natural limits on developing domestic food production. As the population has grown, locally produced food has declined and food imports have increased. Reliance on imports exposes Arab countries to volatility in international food prices.

Water under occupation: With the continued Israeli occupation of Palestine, the region is suffering from the only remaining occupation in modern history. Israel's aggression included forcible occupation of the Jordan River, its threat of the Litani River in Lebanon and Golan Heights, its exploitation of groundwater in the West Bank and the denial of the Gaza Strip rights from surface water and preventing the Arab population from drilling wells. Conflicts and instability in the Arab region continue to take their toll on economic, social and political life.

Regional Strategy: Seven Arab sectoral strategies related to Water, Environment and sustainable development, Food Security and Energy security developed by Arab countries under the auspices of the League of Arab States within the framework of sustainable development include putting water high on the political agenda of the region. The key guiding document remains The Arab Water Security Strategy 2030 and its action plan.

Water in SDGs: The challenges faced by many Arab countries in achieving their water-related MDGs will continue in the future in their efforts to meet the water related-SDGs. In fact, these challenges might be even more pressing due to many factors, the most important of which is limited financial resources in the face of increasing population, being compounded by other driving forces including the impacts of climate change, conflicts and instability that led to forced displacements and waves of refugees in several countries.

The MDG+ Initiative was launched as a response to concerns raised by Arab States regarding the insufficiency of the global indicator framework adopted to monitor progress in achieving the Millennium Development Goals (MDGs). These concerns particularly related inability of the Joint Monitoring Program (JMP) framework to report on accessibility, affordability and provision of safe and reliable drinking water services, as well as the collection, treatment and reuse of wastewater.

The MDG+ initiative includes a more elaborate set of indicators more reflective of the 2030 Agenda on Sustainable Development objectives than what is being pursued at the global level with the SDG6 indicators, and particularly with respect to the quality, reliability and affordability of water services and the wastewater targets.

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

Progress towards many of the solutions is already underway across the region. Regional cooperation emerged as the excellent opportunity for sharing knowledge and information, and best practices between the Arab countries. They help in promoting joint solutions towards achieving the SDGs. Regional cooperation can also help to make better use of the comparative advantages that each Arab country has, in terms of availability and use of resources (efficiency) and human securities.

Partnerships: Governments at the national level and the Arab Center ACSAD at the regional level are implementing several projects. The government institutions and local communities in the countries lead the implementation of the projects and activities. The region receives technical and financial assistance from international organizations which include among others ESCWA, GIZ, FAO, UNESCO, EU, CEDARE, SIDA and World Bank. Also, NGOs such as AWC, ACWUA and RAED are

quite active in implementing important regional activities and initiatives. However, the urgency of the current situation requires more intensified, accelerated and improved collective effort.

The actions taking place as presented in this report reflect partly the region's agenda for achieving the SDGs. Moreover, they are in-line and observing the thematic framework and the overarching theme of the 8th World Water Over. This was quite clear and obvious through the course of the Arab region's preparatory process and as finally expressed by the conclusions and recommendations of the 4th Arab Water Forum held in November 26-28, 2017.

The key message to the forum:

1. The Development Agenda 2030 offers a strategic framework countries should commit to and implement to secure a better water future. Other global agendas such as Sendai Framework for Disaster Risk Reduction and Paris agreement should be aligned to ensure water security for all.
2. The success in achieving SGD 6 calls for regional and international cooperation and solidarity to support countries in order to achieve the ambitious targets set by countries.
3. Newer challenges add hazards and complexity to water Scarcity challenges in the region. They require new models of inclusive and anticipatory governance, innovative financing mechanism and sustainable partnerships.
4. Transboundary water resources need to be put in the frame of regional development to share and optimize benefits of cooperation and mitigate potential tensions in the future
5. Innovation, Science and Technology transfer will certainly contribute to achieve SDG 6 targets and water security for all requires commitments. It calls for consistent commitments from both developing and developed countries.
6. Ecosystems health should be prioritized in development policies not only for the services they offer to communities but also as a buffer to climate change impacts and to make the economies climate proof.
7. Peace and stability are a key to sustainable water resources management and human securities. They call for regional and global engagement and commitment to prevent conflicts, end occupation, forced mass displacements and migration.
8. A better water future for the region and for the world needs pertinent policies, effective institutions with adequate capacities.
9. The emerging trend to put water in the heart of other sectors' policies and strategies in the some countries in region is key to achieve the SDG6 targets is to be sustained.
10. The forum is an opportunity to share and learn from other regions innovative governance mechanisms related to groundwater management.
11. International cooperation, commitment and solidarity is needed to bridge the capacity and knowledge gaps but also the necessary funds to deal with newly emerging international challenges such as mass migration and displacements and terrorism against water infrastructure in conflicts areas and countries.

2. Presentation

2.1. World Water Council

The World Water Council is a multi-stakeholder organization founded in 1996, with permanent headquarters in the city of Marseille, France, organized as a global network with 400 institutions willing to work for the future of water by expanding its actions, creating new synergies and proposing innovative solutions.

The Council unites institutions from approximately 70 countries and is composed by representatives of governments, academia, civil society, companies and NGOs, forming a significant spectrum of institutions related to the water theme.

The Council encourages debates and exchanges of experience and has as its mission to “promote awareness, build political commitment and trigger action on critical water issues at all levels, including the highest decision-making level, to facilitate the efficient conservation, protection, development, planning, management and use of water in all its dimensions on an environmentally sustainable basis for the benefit of all life on earth.”

2.2. The 8th World Water Forum

The World Water Forum, organized by the WWC, is the world’s largest multi-stakeholder platform, which brings together political leaders, practitioners and experts to share knowledge and experiences to learn from each other as well as to renew political commitments. It contributes to the dialogue of the decision-making process on water at the global level, seeking to achieve the rational and sustainable use of this resource.

Table 1 – Previous Fora, organized by the WWC.

Location	Year	N° of participants	Attending Authorities
Daegu-Gyeongbuk, South Korea	2015	40.000	10 Chiefs of State, 121 officials from 168 countries
Marseille, France	2012	35.000	15 Chiefs of State, 112 officials de 173 countries
Istanbul, Turkey	2009	30.000	250 officials de 182 countries e 1 st meeting from Chiefs of State
Mexico City	2006	27.500	270 officials from 140 countries
Kyoto, Japan	2003	25.000	Officials from 142 countries
Hague, Netherlands	2000	39.000	114 officials from 130 countries
Marrakesh, Morocco	1997	500	-



Figure 1 - World Water Forums

The 8th World Water Forum, co-organized by the World Water Council (WWC) and Brazil, will take place in Brasilia, Brazil from 18th to 23rd of March 2018. This is the first time the event will occur in the Southern Hemisphere. The 9th World Water Forum will take place in Republic of Senegal at 2021.

The International Steering Committee (ISC) is the Forum's highest decision-making authority and is composed of 24 members, 12 of whom are nominated by the World Water Council and 12 by the National Organizing Committee.

The Forum's contents are defined and implemented by five distinct commissions responsible, respectively, for:

- **the Thematic Process**, which discusses which themes the Forum will address;
- **the Regional Process**, which discusses the development, analysis and presentation of case based water issues by a regional point of view.
- **the Political Process**, which involves local, regional, national, and national governing bodies and parliamentarians, and has resulted in memoranda of understandings, cooperation treaties and agreements for the integrated water resource management;
- **the Sustainability Focus Group**, which discusses the adherence of public policies and actions to the principals of sustainable (economic, social and environmental) development in a cross-cutting perspective, participating in all the other processes; and
- **the Citizens' Forum**, which stimulates the participation of organized civil society in the discussions, exchanges of experience and all the Forum's other activities.

Discussions at the 8th World Water Forum are organized by the following themes:

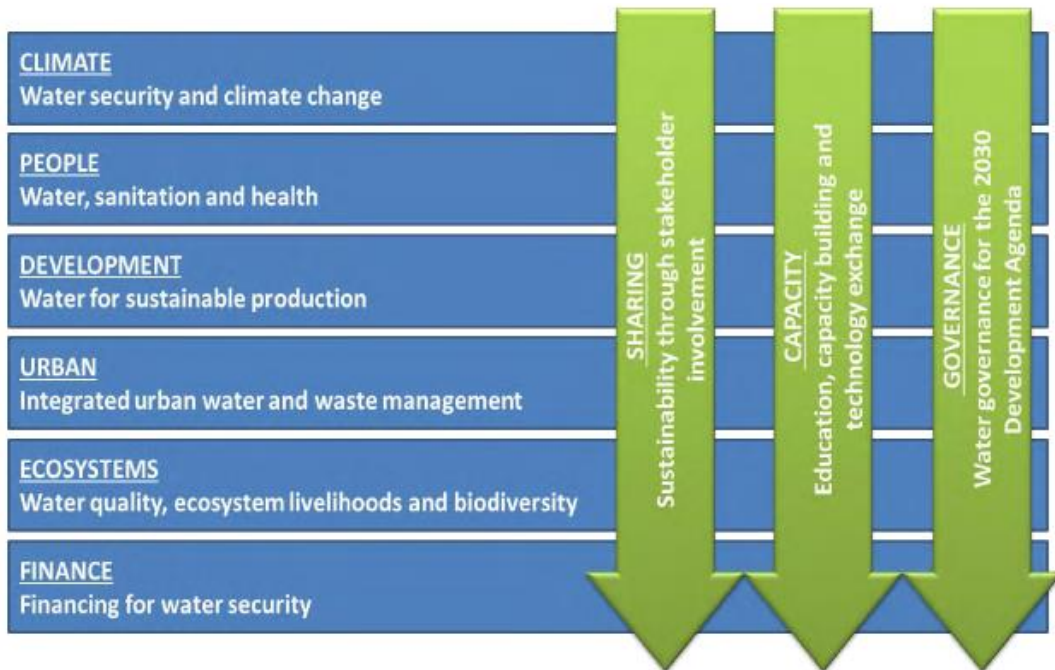


Figure 2 – Thematic Framework

2.3. Regional Process

The Regional Process has as its core the development, analysis and presentation of case based water issues by a regional point of view. Guided by the six main themes and three crosscutting issues of the Thematic Framework, the Regional Process incorporated local and regional perspectives throughout its own preparatory process as well as other processes and events related to the 8th Forum.

The Regional Process was supported by the Regional Process Commission (RPC) led by the Chair and the Vice-Chair, reporting to the ISC. The RPC mobilized water experts, politicians, high-level government officials, water users, NGOs, the private sector, media and civil society.

The structure of the Regional Process was primarily based on six larger geographic areas, or Regions, and these six Regions: Africa, Americas, Arab, Asia-Pacific, Europe and Mediterranean. Africa, Americas and Asia-Pacific were also divided into sub-Regions.

One Coordinator was nominated for each Region and Sub-Region and their work was aligned with the overall guidelines produced by the RPC. They organized stakeholders, promoted preparatory meetings, recruited consultants and build regional sessions proposals. They were advised by focal points for each theme.

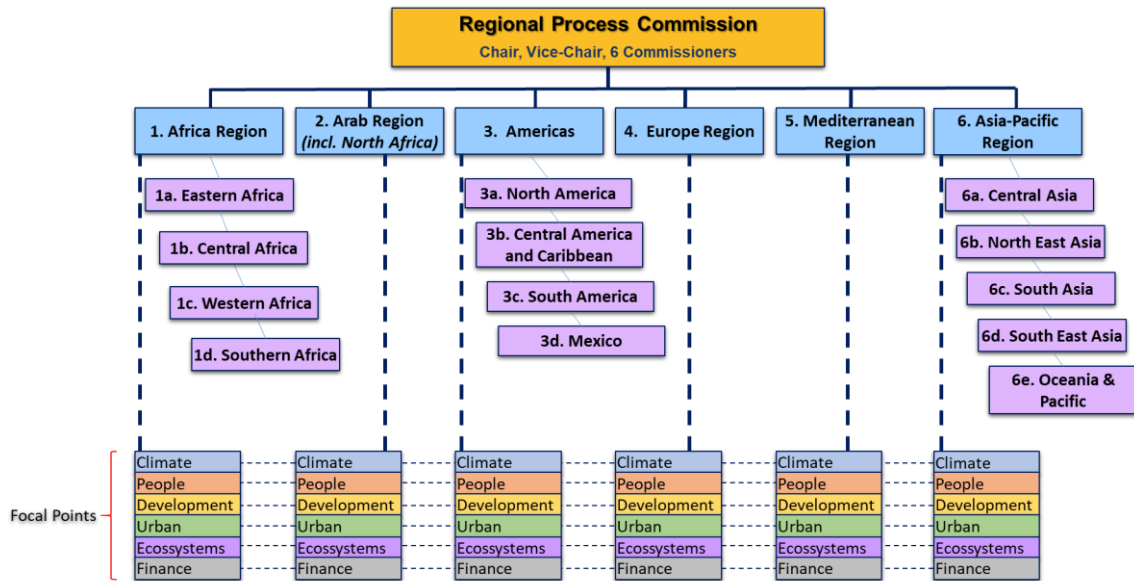


Figure 3: Organizational Structure of the Regional Process.

2.4. Arab Region

2.4.1. Culture

The Arab region extends over North Africa and West Asia (Figure 4). It consists of twenty-two countries. They are Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Somalia, the Sudan, Syrian Arab Republic, Tunisia, United Arab Emirates and Yemen. Their language is Arabic which is the same everywhere in its proper linguistic form. The Arab countries are the home of the three main monotheistic religions, Islam, Christianity and Judaism. The prevailing religion is Islam.

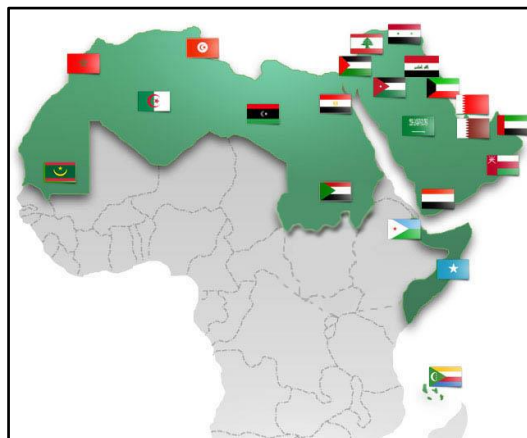


Figure 4. Map of the Arab Region and its 22 Arab Countries.

The region being at cross-roads of three continents (Asia, Africa and Europe), is strategically important to world trade, a reason for attracting the interest from the East and West along the history. Therefore, the Arab culture has influenced over years by other cultures but the original Arab culture still prevails driven by a realign background.

2.4.2. Demography

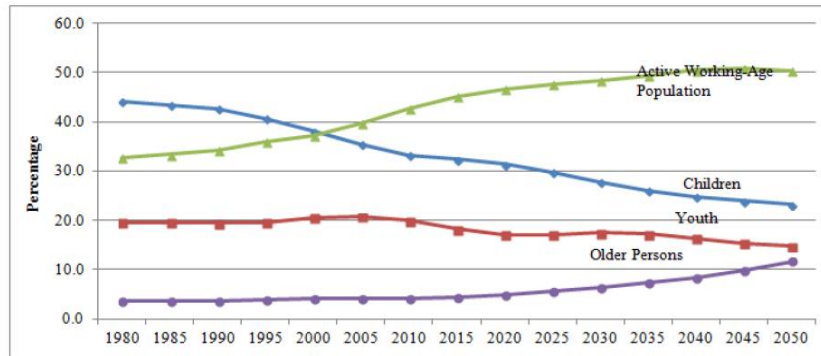
Demographic trends vary greatly between countries within the Arab region. In terms of population the total in 2016, reached 414.7 million of which 48.2 per cent are female compared with world 49.6 percent female. The average growth rate of population was 2.43 during the period 1982-2012 (UNESCWA, 2015). While some countries, such as Egypt, are highly populated, others, such as Comoros, Bahrain and Qatar, have very small populations. Variations in population size and growth rates are a direct consequence of the interplay between mortality and fertility as well as migration. The high level of inflows of labor migrants is responsible for the high population growth rates in countries of the Gulf Cooperation Council (GCC), for the period 1980-2012.

Variations also exist between countries of the region in terms of population distribution. While most countries are urbanized, the majority of the population in such countries as the Sudan and Yemen live in rural areas. The age structure of the population also differs between countries in the region. Most countries still find themselves in the early stages of demographic transition having youthful populations, while Lebanon and Tunisia are more advanced in this process, with a more pronounced ageing phenomenon (UNESCWA 2013, UN 2012).

As to the youth age group (15-24 years), its overall number increased from 32.6 million in 1980 to 69.4 million in 2010, and is projected to reach 85.3 million in 2030 and 89.0 million in 2050. In terms of proportions, youth formed 19.2 per cent of the total Arab population in 1980 and increased to reach a peak of 20.8 per cent in 2005. Youth as a proportion of the total population started to decrease after 2005, standing at 19.9 per cent in 2010.. The proportion of youth is anticipated to decline to varying extents in all countries of the region by 2050, except for Somalia, where it will increase around 20 per cent between 2015 and 2050.

The active working age population (25-64 years) is growing more rapidly than any other age group (Figure 5), almost tripling in size between 1980 and 2010, when it stood at 54.8 million (32.8 per cent) and 148.6 million (42.7 per cent), respectively, thereby adding a total of 93.8 million people to the overall population over a span of thirty years (UNESCWA 2013). Looking at the variations between Arab countries, it can be noted that the percentage of the adult working age group increased between 1980 and 2010 for all countries of the region, except for Somalia, with this increase being most prominent in some GCC countries due to their high levels of labor migration (UNESCWA, 2013)

Figure 5. Population of the Arab region by broad age groups (1980-2050)

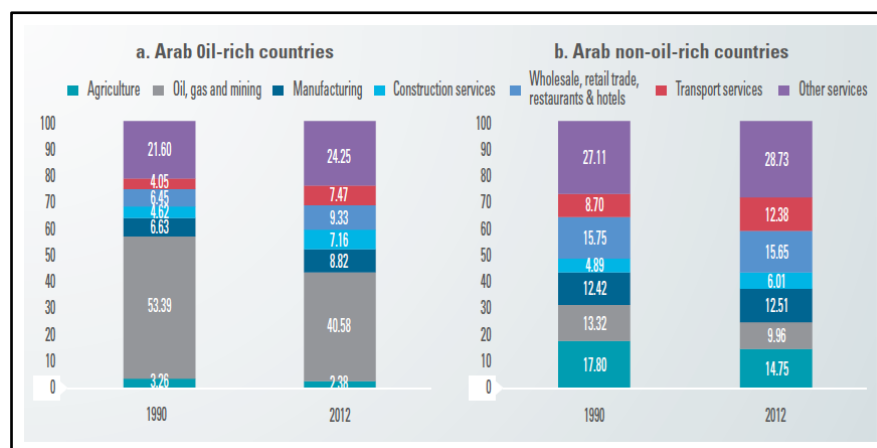


Source: UNESCWA, based on UN-DESA, 2012

2.4.3. Economy

The economic structure of the Arab countries (figure 6) has changed little since the 1990s (AMF, 2016). Despite some shifts, oil, gas and mining still comprise 41 per cent of GDP in the oil-rich countries and almost 10 per cent in the non-oil rich countries (figure 6). The emphasis on oil, gas and mining is important because these sectors generate little employment relative to other sectors (UNESCWA 2015). In Iraq, for example, petroleum accounts for more than half of GDP, but less than 1 per cent of employment. The service sector, a high employment but low productivity sector, comprises a large and growing share of GDP. Agriculture represents a small share of GDP, but is an important source of livelihoods for many of the rural poor. Manufacturing remains a very small part of most Arab economies. Moreover, within manufacturing sector, there is a greater emphasis on lower technology manufacturing than would seem to be warranted by the region's generally high level of education. Indeed, only 1.5 per cent of manufactured exports in the Arab region in 2008 were considered to fit into the high-technology category, compared to a global average of 17 per cent.

Figure 6. Economic Structure of Arab Countries (percentage share of Sector in GDP)



Source: UNESCWA, 2015

Gross Domestic Product (GDP) at Current Prices in Arab countries as a group decreased from about US\$ 2727 billion in 2014 to about US\$ 2429 billion in 2015, that is a contraction of 10.9% against a growth of about 0.5% that had been observed in 2014. Highest rates of decrease in GDP were recorded in major Arab oil exporters, particularly Kuwait, Iraq, and Qatar. GDP contracted also in Libya and Yemen due to current domestic conditions. As a result, GDP per capita at current prices decreased from about US\$ 7888 in 2014 to about US\$ 6872 in 2015, that is a contraction of about 12.9% against a contraction of about 2.2% that had been observed in 2014, (AMF 2016).

On Poverty, available data suggests that poverty rates have increased in a number of Arab countries during 2015 due to the deteriorating growth performance, lower remittances from Arab oil exporting countries, subdued global economic recovery and increasing influx of refugees due to domestic conditions in some Arab countries. Djibouti and Yemen continue to be the two countries with the highest rates of extreme poverty whereas lowest rates of poverty are observed in GCC countries. Within this context, Multidimensional Poverty Index (MPI) suggests that Somalia, the Sudan, Yemen, the Comoros, and Djibouti lag behind the rest of other countries for which data are available for this index. This suggests that there is unequal access to basic services and economic opportunities in these countries.

2.4.4. Conflicts and Migration

By 2015, the Arab region had overtaken South Asia as the least peaceful part of the world. Home to only 5 percent of the world's population, the Arab region has witnessed 17 percent of the world's conflicts between 1948 and 2014, and 45 percent of the world's terrorist attacks in 2014. In that same year, the region was home to 47 per cent of the world's internally displaced people and 57.5 per cent of all world refugees including Palestinian refugees displaced by one of the longest lasting territorial occupations in modern history (UNDR, 2017). Meanwhile conflicts have worsened in Iraq, Libya, Syria and Yemen.

Conflict and criminality have led to hundreds of thousands of fatalities and massive displacement. In 2015, about 7.6 million Syrians were internally displaced persons (ESCWA 2015, AMF 2016). The estimated net outflow from the Syrian Arab Republic was 4.2 million persons in 2010-2015. Most of these refugees went to Syria's neighboring countries, contributing to an unusually large influx of migrants to Turkey (net inflow of 1.6 million over five years), Lebanon (1.25 million) and Jordan (975 thousand). More than 2 million Somalis are displaced within or outside their country. These numbers are in addition to the 5.2 million Palestinian refugees due to the Israeli occupation.

The persistence of conflict in Syria, Iraq, and Yemen remains one of the main drivers of poverty regionally. In Syria, after five years of civil war it is estimated that 80 percent of the population lives in poverty, and life expectancy has been cut by 20 years.

With a total of 21 million migrants, GCC countries are hosting the largest number of migrants in the region. This category of migrants are work seeking opportunities. This represents 72 per cent

of the total number of migrants in the region and 47 per cent of the total GCC population, creating an imbalance in the overall population structure of the GCC countries.

The UN Arab Human Development Report (2016) warns that increasing levels of armed conflict are destroying the social fabric of the Arab region, causing massive loss of life not only among combatants, but also among civilians. Conflicts are also reversing hard-won economic development gains by destroying productive resources, capital and labor, within a larger territory neighboring countries where they are fought. Between 2000–2003 and 2010–2015, the number of armed conflicts and violent crises in the region have risen from 4 to 11, and many of them are becoming protracted in nature.

More information on key indicators on the state of development in the Arab region are reported by different institutions (UNESCWA 2015, AMF 2016, UNDP 2017). The Arab Human Development Report 2016 notes that, measured in terms of the Human Development Index¹ (HDI), all Arab countries increased their level of achievement between 1980 and 2010, driven mostly by gains in education and health, while income fell behind in comparison, notwithstanding great variations between different Arab countries. However, the report also indicates that the global financial and economic crisis in 2008–2009, coupled with political instability since 2011, have had a negative impact on human development in the region. Average annual growth in the HDI dropped by more than half between 2010 and 2014 relative to the growth between 2000 and 2010.

3. Regional Approach

3.1. Methodology

- The Arab region approach to make effective contribution to the World Water forum is based on partnership process in which the League of Arab States (LAS) takes the lead as the Regional Coordinator. LAS took care of organizing preparatory meetings attended by country representatives as well as representative of all relevant regional organizations involved in the water sector. Two preparatory meetings were organized in the following order:
 - First meeting on February 23, 2017 for initial interest and commitment were identified
 - Second meeting on November 16, 2017 was to follow-up and review the position of the region's involvement and learn the latest about the Forum organization

The preparatory meetings discussed the organizational matters as well as the different processes of the forum. Interest and commitment for participation by the Arab institutions in the different processes have been identified.

- Broader engagement of the Arab water community took place through two important regional events. The first event was the 4th Arab Water Week (AWA) 2017 organized by the Arab Countries Water Utilities Association (ACWUA) on 19 - 23 March 2017 under the slogan "*Managing Water Systems within Fragile Environments in the Arab Region*" at the Dead Sea, Jordan. The second was the 4th Arab Water Forum (AWF) organized by the Arab

¹ . The HDI measures human well-being capturing progress in three areas: *living a long and healthy life, being educated and knowledgeable, and enjoying a decent standard of living.*

Countries Water (AWC) under the slogan “*Sharing Water Sharing Destiny*” Both events provide the regional vision as related to the thematic framework of the 8th World Water Forum.

- The 4th AWF is the platform for presenting the outcome of the regional activities and program implemented during the past few years that relate to the thematic framework of the 8th WWF. The thematic sessions of the forum are organized by national and regional organizations. For this reason, it follows a route that begins a year ahead of the WWF just after the first preparatory meeting organized by the regional coordinator LAS. The course of actions taken by AWC followed the following course:
 - A Kick-off meeting on April 20, 2017, to identify the slogan and the themes the 4th Arab Water Form (AWF).
 - A follow up meeting to discuss the thematic framework and program contents
 - Organization of the 4th AWF on November 26-28, 2017, which was attended by about 350 participants).

The Linkage with the 8th World Water Forum and its thematic framework were the subject of a dedicated session convened by AWC, LAS and WWC. The proceedings of the 4th AWF and its recommendations are inputs to the regional report to the 8th WWF (see Annex 3.1).

- compilation and writing of the Arab region report to 8th WWF (this report) by a consultant who was involved throughout the whole preparatory process and who has experience with all previous World Water For a starting from the first in Morocco. .

3.2. Integration with other processes

The Arab Water Ministerial Council decision in July 2017 has set the role of the League of Arab States with a focus on regional process while inviting countries and organization to connect directly with thematic process and political process.

3.2.1. Thematic process

The role of the regional process coordinator was to communicate and update countries and organizations on the thematic process as it unfolds.

3.2.2. Political process

The outcomes of the regional process and the key messages were shared with all 22 countries as inputs to the PrepCom and the debates on the Ministerial declaration as a key outcome of the political process.

3.2.3. Citizens forum

The outcomes of the regional process were channelized through the attendance of a representative of the coordinating committee of the Citizen Forum at the Arab Water Forum 4.

3.3. Partnerships

Aside from representatives from the 22 countries, The regional process preparatory committee established by the Arab Water Ministerial Council includes 17 organizations from the region. The

Arab Water Forum 4 that was the culmination of the regional process was held in Cairo 26-28 November 2017 attended by more than 400 participants.

4. Water Overview in the Region

4.1. Diagnosis

4.1.1. Water Resources Availability

Water scarcity is considered one of the major and most critical challenges facing Arab countries. This challenge is expected to grow with time due to many pressing driving forces, including population growth, food demand, unsettled and politicized shared water resources, and climate change, forcing more countries into more expensive non-conventional water resources, such as desalination and treated wastewater, to augment their limited fresh water supplies. The large financial, economic, environmental, and social burdens to be borne cannot be overemphasized.

Nearly 90 per cent of the Arab region lies within countries classified as arid, semi-arid and dry sub-humid areas. Countries in the region, account for more than 5 per cent of the world's population, but less than 1 per cent of its freshwater resources. Arab region covers 10 per cent of the world's surface area but receive only 2.1 per cent of its average annual precipitation. Rainfall is low and variable, evaporation rates are high and droughts are frequent, all contributing to low water resource reliability and availability. The region's annual internal renewable water resources amount to only 6% of its average annual precipitation, against a world average of 38 (UNDP, 2013).

Some countries such as Egypt, Iraq and Sudan depend primarily on surface water, while Jordan, Morocco and Syria depend more heavily on groundwater. All Arab countries are increasingly using treated wastewater and desalinated water share is rising in the water budgets in Gulf Cooperation Council countries. Reuse of agricultural drainage water is practiced mainly in Egypt and Syria and at smaller rates in Saudi Arabia. The overall contribution of each water source in meeting the region's water requirements in 2016 is illustrated in Figure (7). The overall percentage contribution of these sources has not significantly changed since 2006, with a very small increase in desalinated water input, which is masked by the large volumes used from surface water and groundwater.

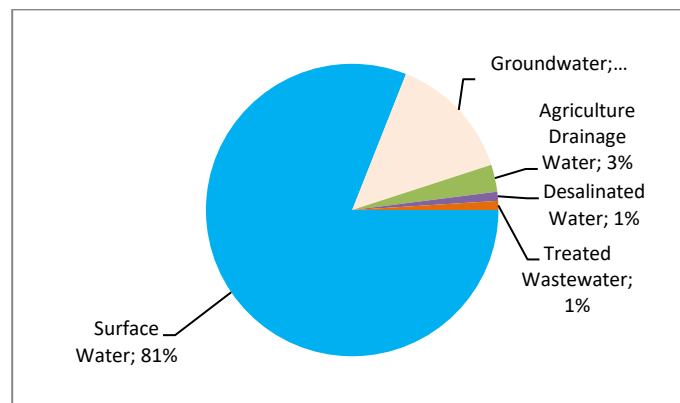


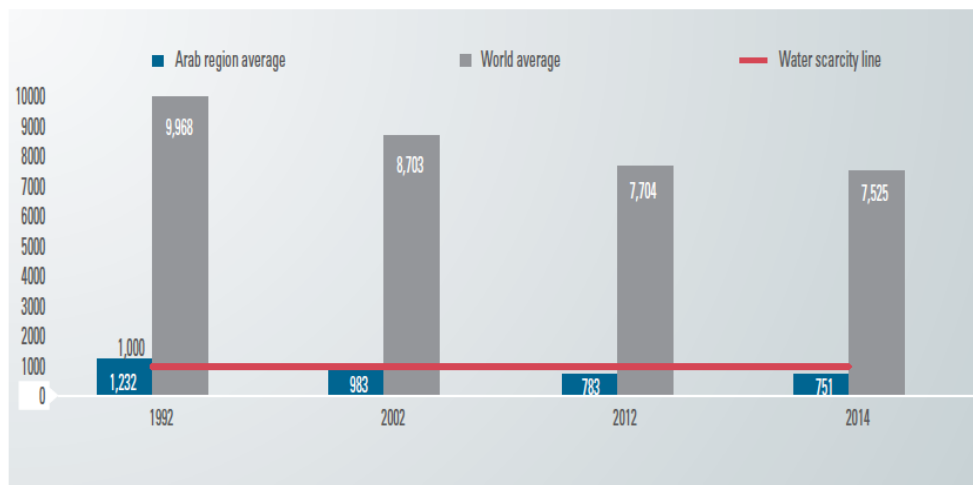
Figure 7. Water Resources in the in the Arab Region

Rapid population growth, since the mid-1970s, has caused a dramatic reduction in per capita renewable freshwater resources, currently reaching an alarming level below the water poverty line of 1,000 m³/capita/year. During the period 2005 to 2015 annual per capita freshwater availability in the region dropped by about 20%, from about 990 to 800 m³. The world average of 7,525 m³/capita/year was about 10 times more (figure 8). Moreover, the region experiences frequent drought cycles, which has been intensifying in recent years (Box 1).

Box 1. Intensification of Drought Cycles

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

Source: UNESCWA and UNEP, 2015



Source: Authors' calculations based on FAO, AQUASTAT and DESA, World Population Prospects.

Note: Regional values are divisions of total renewable water resources of all 22 Arab countries by the total population for corresponding years. The same methodology is applied to world averages.

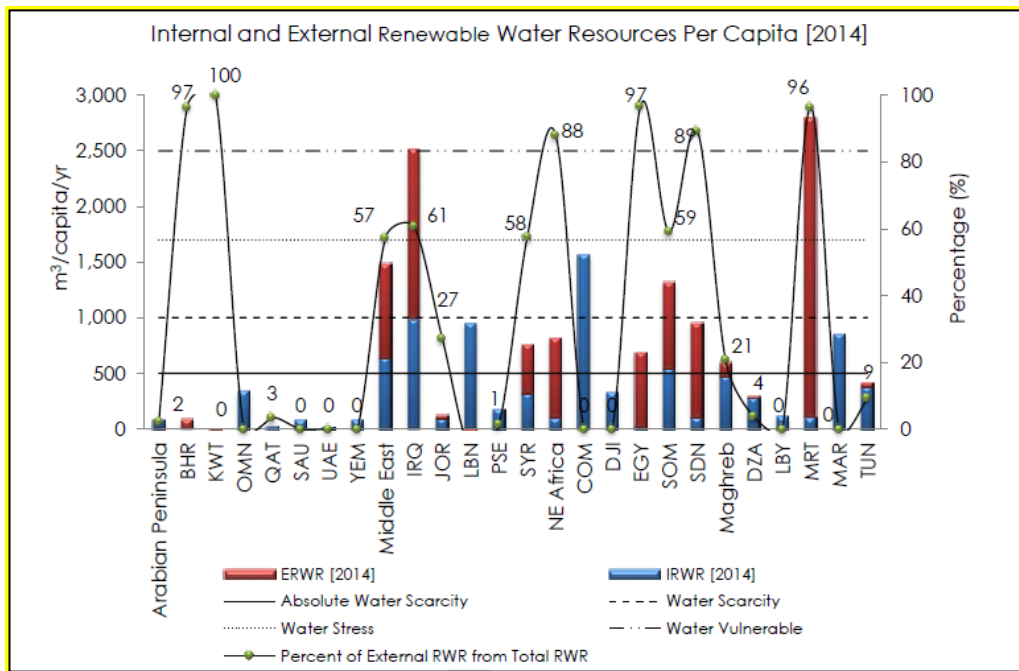
Source: UNESCWA, 2015.

Figure (8) Annual *per capita* renewable Water Resources (cubic meters)

In 2015, 16 of the 22 Arab countries fell below the water poverty line, and 13 are among the world's 19 most water-scarce nations (AFED, 2015). Annual per capita water availability in nine countries is already below 200 m³, much less than the amount designated as absolute water scarcity of 500 m³/capita/year (figure 8). This means that about 40% of the Arab population are already living in conditions of absolute water scarcity (ESCWA and UNEP, 2015). These trends in the reduction of per capita water availability are expected to continue as population growth

continues, and it is projected that by 2030, Iraq, Comoros, Mauritania and possibly Sudan could be the only Arab countries with an average above 1,000 m³/capita/year. However, it is estimated that by 2030, the effects of climate change will have reduced renewable water resources by another 20% (UNDP, 2013).

The current water situation is exacerbated by the fact that more than half of total renewable water resources in Arab region (about 174 billion m³/yr of a total of 315 billion m³/year) originates from outside the region, with two thirds crossing at least one international border (ESCWA and UNEP, 2013). This makes the water dependency ratio (for surface water) of some Arab countries extremely high (Table 2). Egypt, Iraq and Syria rely almost exclusively on transboundary water resources. Jordan and the State of Palestine depend almost entirely on the Jordan River, which is essentially controlled by Israel. For some countries the dependency ratio rises when shared groundwater aquifers are included. However, most shared resources lack comprehensive international agreements. This makes water availability and security in the Arab region has a political dimension as it is largely dependent on the effective management of transboundary water resources, between Arab States and between Arab and non-Arab States.



Source: Mohtar et al., 2017

Figure 9. Internal and external renewable water resources in the Arab region.

With stress on the region's water supply mounting, cooperation in managing shared water resources is imperative to ensure their sustainability in serving socioeconomic development. Competition over transboundary waters are at the heart of regional political conflicts. Inadequate governance of shared water resources and single side decisions of upstream countries to construct dams as in the case of the Euphrates and Nile rivers continues to threaten the region's stability and impose uncertainty on water resource planning in the downstream countries.

Table (2) Water dependency ratio in the Arab region (surface water only)

Country	Water dependency ratio (%)	Country	Water dependency ratio (%)
Kuwait	100.0	Qatar	3.4
Egypt	96.9	Palestine	3.0
Bahrain	96.6	Lebanon	0.8
Mauritania	96.5	Morocco	0.0
Sudan and South Sudan	76.9	Djibouti	0.0
Syria	72.4	Oman	0.0
Iraq	60.8	Yemen	0.0
Somalia	59.2	Saudi Arabia	0.0
Jordan	27.2	Libya	0.0
Tunisia	8.7	UAE	0.0
Algeria	3.6	Comoros	0.0

Note: The water dependency ratio refers to surface water only. Many of the countries with zero water dependency ratio share transboundary ground-water aquifers with other countries.

Source: UNDP, 2013 as cited from FAO, AQUASTAT data base 2013,

www.fao.org/nr/water/aquastat/data/query/index.html .

ion

SDG6

In the Arab region, water scarcity led some countries, mostly the GCC countries, to invest heavily in desalination, and the region now accounts for more than half the world's desalination capacity. Desalination offers exclusive sovereignty over produced water resources. The region is the largest desalination market in the world. It is estimated that the region requires a 6% increase per year of desalinated seawater to sustain their water supplies. Although desalinated water contributes only 1.8 per cent of the total supply of water in Arab countries, it is estimated that desalinated water will account for 8.5 per cent of the region's total water supply by 2025. The capacity of desalination plants increased by nearly 60 per cent between 2008 and 2013.

At the sub-regional level, the contribution of desalination has been increasing dramatically in the GCC countries in their overall water budget, particularly in meeting municipal water sector requirements (figure 10). Desalination contribution to the total water budget in the GCC countries increased from about 7% in mid 2005 (fulfilling 56% of municipal water demands) to more than 20% in 2016 (fulfilling 75% of municipal water demands). At country level, Qatar and Kuwait rely 100% on desalination for domestic and industrial use whereas Saudi Arabia (SA) reliance is nearly 60% of its water supply and has over 30 operating desalination plant. The United Arab Emirates relies on 70% desalinated water to supply the country. Arab countries in North Africa are also developing their desalination capacity along the Mediterranean and the Red Sea coasts

Figure 10. Desalination Plant in Bahrain



Source: GCC, 2014

4.1.2. N

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Two basic technologies have been widely used to separate salts from ocean water: thermal evaporation and membrane separation. In the last 10 years, reverse osmosis (RO) technology has come to dominate desalination markets, due mainly to its low investment and total water costs achieved by lowering the energy consumption to about 3 KWh/m³ (Ghafour et al., 2013). However, the technology is still energy-intensive and consequently has a large carbon footprint. In addition, it has some negative effects that include damage to aquatic ecosystems. Brine and heat from desalination plants have potentially detrimental environmental impacts that contribute to the deterioration of marine ecosystems and can be costly to manage.

Costs of desalination vary between \$ 0.50 and \$ 1.50 for cubic meter of desalinated water. Although cost is falling, the lowest price is still more than double the average cost of groundwater. To remain a viable option, renewable energy has to be used to meet at least part of desalination power requirements. The coupling of solar energy with desalination technologies is seen as having the potential to offer a sustainable route for increasing the supplies of desalinated water.

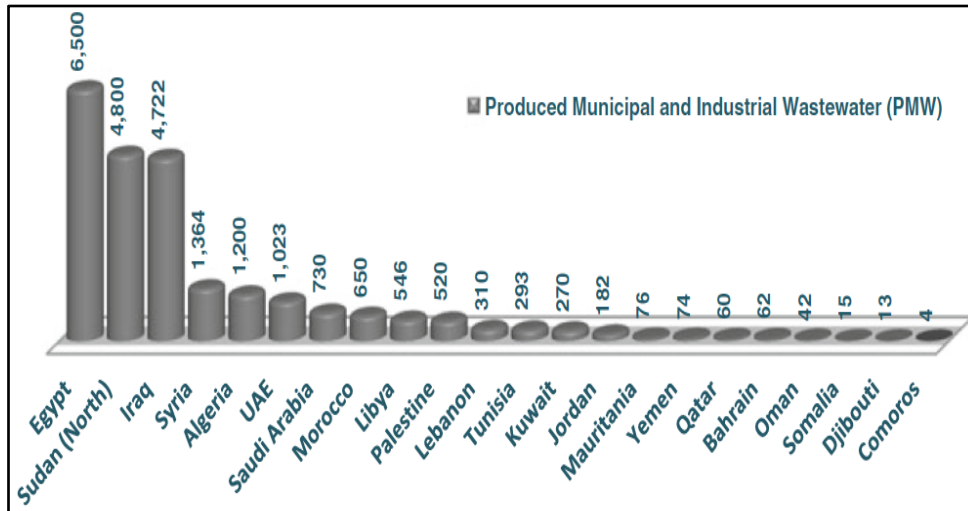
The MENA region needs to localize knowledge. Currently, there are not enough qualified staff to operate modern desalination technologies, including solar desalination plants. This is why, it is important to invest in training, knowledge transfer and capacity building. By designing incentives for the private sector in local businesses, governments can attract domestic investments in manufacturing key components and cultivating local innovations to attain economic sustainability.

B. Wastewater treatment and reuse

SDG6.3.1, SDG6.3.2, SDG6.5.1

Treated wastewater became a valuable resource in the Arab region to meet a substantial share of rising water demand from urbanization and population growth (UNDP, 2013; AWC, 2017). It lacks the uncertainties of fresh surface water resources and can fill-in part of the growing gap of water availability. Several countries have started to direct their treated wastewater to food production. Municipal and industrial wastewater reached 23 billion cubic meters per year in the region (figure 11). A small portion of this amount is treated and a smaller amount of about 1.6 billion cubic meters per year is reused due to many factors that prevent the expansion of water reuse, including social barriers, technical obstacles, energy barrier and institutional and political constraints. Regulations are needed to protect human health and the environment. All this together reflects the level of urgent need for water, as well as the level of knowledge, research and development in the area of wastewater treatment and reuse (Saleh, 2017).

Figure 11. Produced municipal and Industrial Wastewater in the Arab Region.



Source: Abou-Zeid et al, 2014

4.1.3. Water Uses

The majority of water resources in the region are being used for agriculture (84%), while the municipal and the industrial sectors consume about 9% and 7% of the total water use, respectively. In the past 10 years, a clear trend of sectoral water competition is observed. Total uses of water are estimated at about 245 billion cubic meters per annum. The relatively high share of water used for agriculture in Arab countries is explained by the fact that the dominant method of irrigation is traditional surface irrigation that overuses water (AMF 2016, ESCWA, 2015). However, the region's overall sectoral water utilization percentages have been shifting from the agricultural sector towards the municipal and industrial sectors, where the agricultural sector used to utilize in the past 88% of the total water consumption, followed by the municipal sector at 7% and then by the industrial sector at 5%.

4.1.4. Water Quality

The increasing water scarcity is not the only characteristic of the region but the region's deteriorated water quality has become equally distinguishing features over the past decades. Overexploitation and pollution of water resources threaten their availability. Using groundwater resources beyond their natural replenishment rates is rapidly depleting aquifer reserves and degrading water quality due to seawater intrusion. Groundwater resources in most Arab countries are also threatened by pollution from agricultural, industrial and domestic activities. Overexploitation and pollution have led not only to lower water quality and quantity, but also to ecosystem degradation. Such environmental damage incurs both economic and social costs. The cost of water's environmental degradation may reach well beyond 1 per cent of a country's GDP, as in Jordan and Morocco (World Bank, 2007).

Inadequate sewerage coverage and services has also led to alarming degradation of water quality in surface and underground water resources. Disposal of untreated or partially treated sewage

water in agricultural drains constraint the possibilities of beneficial reuse of agricultural drainage water in irrigation and thus loss of opportunity for increasing water use efficiency. In recent years, it has become increasingly apparent that more focus needs to be shifted to integrated water resources management in order to sustainably manage available water resources in terms of quantity and quality.

4.1.5. Climate Change

Climate change, bringing greater climate variability and more frequent and severe droughts and floods, will exacerbate the already precarious situation created by chronic water scarcity. In the Arab region, climate change is manifesting as more severe droughts, storms and flooding. The Forum for Environment and Development report on climate change in the Arab region (2009) states that Arab countries are among the most vulnerable to climate change's effects. Hardly any other region will be hit as hard by climate change as the Arab region, which will further aggravate water scarcity.

The Arab region at-large is exposed to long-term climate change effects which will be particularly challenging in the already water scarce areas which have limited capacity to cope with additional shocks and stressors. The Arab region is home to 5 of the top 10 countries at risk from the impacts of climate change (Box 2). Many other Arab countries are considered extremely or highly vulnerable. By 2030 the effects of climate change will have reduced renewable water resources by another 20 per cent through declining precipitation, rising water demand as temperatures mount and expanding seawater intrusion into coastal aquifers as sea levels rise and groundwater overexploitation continues.

Box 2. Arab countries at risk from the impacts of climate change

Djibouti, ranked as the most exposed to the impact of climate change, is regularly subjected to tropical storms from the Indian Ocean and will be more vulnerable to inland flooding as sea levels rise. Egypt ranks as the region's second most exposed country. With the vast bulk of its population concentrated in the Nile Valley and Delta, it is at high risk of inland flooding. The Nile's flow will also be uncertain because of unreliable rainfall. Iraq, Morocco and Somalia, the next most vulnerable, are at high risk of coastal flooding and exposure to extreme temperatures. The Gulf countries of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates are expected to suffer severe consequences of climate change. Bahrain, with its relatively small land mass, is in danger of inundation as sea levels rise. Qatar is especially susceptible to inland flooding. Bahrain, Qatar, Kuwait and Yemen are considered to be "extremely" vulnerable. Jordan, Lebanon, Libya, Oman, Saudi Arabia, Tunisia and the United Arab Emirates are rated "highly" vulnerable.

Source: UNDP, 2013

Climate change has disproportionate consequences for the developing world. Women, poor and marginalized communities are especially at risk. For food and nutrition security, climate extremes and climate change will act as a risk multiplier in the region, exacerbating the already existing social and economic vulnerabilities. Even small changes in precipitation or temperatures can lead to large changes in evaporation, runoff and recharge in arid areas. It has been identified that

climate change adaptation in the water sector in the MENA region is still very limited. The progress is often hampered by a low level of capacity in the responsible institutions and authorities (GIZ, 2017).

To reduce vulnerability to climate change, Arab countries are attempting to enhance their adaptive capacity and consider the impacts of climate change in their water resource planning. But national plans and regional investment portfolios do not yet reflect a sense of urgency on these vital matters. Key capacities for adaptive governance for climate induced water scarcity are underdeveloped. Attention needs to focus on good governance, human resources development, institutional structures, public finance and natural resource management. And Arab countries need to foster regional cooperation on adapting to climate change.

4.1.6. Agriculture and Food Security

Agriculture is one of the most important sectors in Arab countries in terms of products needed for food consumption, and raw material needed as inputs for manufacturing. Both rain-fed and irrigated agriculture offers jobs to around 20% of total Arab workforce. It generates a significant share of GDP. Agricultural Output at current prices in 2015 grew to about US\$ 142 billion in Arab countries, a modest 1.3% increase over 2014 while it had grown at an average of 7.2% during 2005-15. As such, it accounted for about 5.8% of total GDP of Arab countries in 2015, down from 6.1% in 2005. (AMF 2016).

It is often argued that middle East and North Africa region is potentially one of the most food insecure regions in the world particularly when cereals and meat are concerned (Table 3). This characterization is based on the region's heavy reliance on food imports (IFPRI 2010a, World Bank 2009b). Using imports as an indicator of food insecurity, the Arab countries appear highly insecure as it has the largest food deficit of any region in the world in terms of cereal imports as a proportion of domestic consumption. Most Arab countries import at least 50 % of food calories they consume (with a heavy consumption and import reliance on wheat). As a result, they are the world's largest net importer of cereal.

Table 3: Food Self Sufficiency (%) in the Arab Countries

Commodity groups	2014	2015	2016
Grain Group	44.68	45.04	43.23
Sugar (refined)	31.7	34.23	28.34
oils and greases (wholesale)	27.56	37.48	32.29
legumes(wholesale)	56.81	53.79	50.6
White meat	71.33	69.72	66.63
Meat wholesale	75.47	72.41	72.44
Dairy products	72.18	71.65	76.11
Red meat	80.35	75.47	79.71
Fruits (including dates) (wholesale)	99.27	98.06	95
Table eggs	93.41	93.9	94.77
potato	99.02	98.96	96.53
vegetables (wholesale)	102.64	102.05	96.59
Fish	100.44	101.47	103.72

Source: AOAD, 2016b

Since Arab countries use about 80% of their renewable water resources for agriculture, the nexus of food security² and water security is clearly a vital one in the region. The scarcity of water places natural limits on developing domestic food production. As the population has grown, locally produced food has declined and food imports have increased (Table 5). Reliance on imports exposes Arab countries to volatility in international food prices, as they found during the 2007-2008 global food crisis. The escalating food import bill (\$30 billion in 2008 for main food commodities) has caused large trade deficits and strained public budgets where subsidies are provided. It is estimated that the food import bill for the region will reach nearly \$100 billion by 2030. (ESCWA, 2015)

Table 4. Value of exports, imports and the trade balance of major food commodities in 2015 and 2016 (Billion USD)

Statement	Exports		Imports	
	2015	2016	2015	2016
Grain Group (wholesale)	0.82	0.49	21.94	17.15
Potato	0.35	0.23	0.51	0.52
Legumes(wholesale)	0.27	0.31	1.34	1.4
Vegetables(wholesale)	2.83	2.62	1.35	3.75
Fruits (wholesale)	3.5	3.27	3.66	5.86
Sugar (refined)	1.35	1.51	5.24	5.61
Vegetable oil	1.87	2.06	4.65	5.96
Meat (wholesale)	0.47	0.58	8.77	7.56
Fish	2.91	2.71	2	2.25
Table eggs	0.12	0.1	0.4	0.62
Dairy products	2.14	2.65	7.34	7.77
Total	16.6	16.5	57.2	58.5

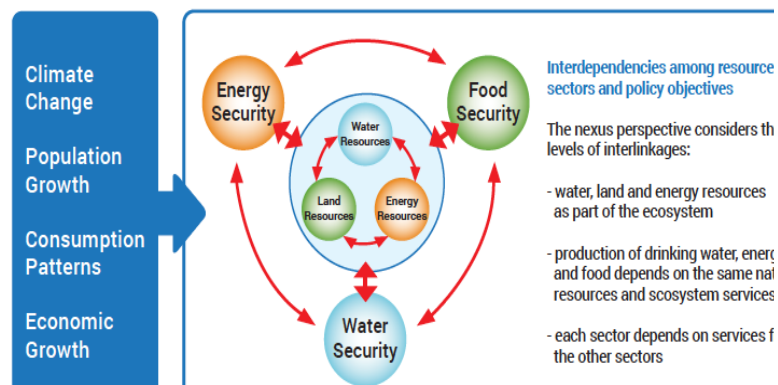
Source: AOAD, Yearbook of Agricultural Statistics, different volumes.

The chances of maximizing food self-sufficiency and supporting the region's farmers depend on reversing the trend of degradation of available agricultural and water resources (table 6), and in using them efficiently and productively. Water and irrigation efficiency, promoting water reuse in agriculture and reducing food loss and waste along the value chain have therefore become policy priorities. The overall goal for countries in the region is to secure sustained agricultural growth, reduce poverty and improve food security, as agreed at the Arab Economic Summit in Kuwait in 2009. This overall goal places diverse drivers onto water. A water/food security strategy cannot be pursued in isolation of drivers of other outcomes that will similarly depend on water, and clearly agriculture is not about food security alone, but also jobs, employment, income and export earnings from agriculture.

² "Food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life." www.fao.org/wfs/index_en.htm

4.1.7. The Water-Food-Energy Nexus

Water security, energy security and food security are inextricably linked in the Arab region, perhaps more than in any other region in the world. These interlinkages are intensifying in the region as demand for resources is increasing with population growth, consumption patterns are changing, and low efficiencies would be further compounded by the impacts of climate change (figure 12).



Source: GIZ, 2017

Figure 12. Water-Energy-Food Nexus

Generally, the region is known to be energy intensive, water scarce, food deficient, and one of the world's most economically and environmentally vulnerable regions to climate change. The current water-energy-food-climate policy landscape in the Arab region is complex and fragmented. The sectors have been developed independently of each other. Countries in the region don't yet advocate nexus explicitly. There is a strong need to mainstream nexus in countries' development planning and to use it as a framework towards better linkage across sectoral policies and institutions which necessitates adoption of an integrated nexus approach (AFED, 2016; GIZ, 2017).

The strong interdependency between energy, water and food needs to give way to an approach that reduces spill-over effects or externalities and trade-offs and builds synergies across sectors. This has been well recognized in the Arab Strategic Framework for Sustainable Development (ASFSD), adopted by the League of Arab States in 2013, aiming at addressing the key challenges faced by the Arab States in achieving sustainable development during the period 2016-2030.

National and regional efforts to address climate change offer an unprecedented opportunity for the needed institutional reform in order to mainstream the nexus thinking in policy development and Implementation.. Now, the water, energy and food nexus is at the center of global policy, development, and the research agenda, a testimony to the key role that the nexus approach has to play to meet the rapidly growing demand for water, energy and food in an increasingly resource-constrained world. It can be understood as a central way for approaching the Sustainable Development Goals.

4.1.8. Policies and Institutions

Despite the evident water scarcity, achieving food self-sufficiency at any cost was the prevailing policy goal during the 1960s and 1970s. The costs of this policy were high. Beginning from the 1980s it was realized that policies must shift from managing supply to managing sustainable demand. Allocating water among sectors has been seen as a macroeconomic decision and policy choice. But the implications of such contested decisions go far beyond economics, especially where strong advocacy groups represent sectors.

The Arab Water Security Strategy (AWSS) in the Arab Region to Meet the Challenges and Future Needs for Sustainable Development (2010-2030), and its associated action plan, are key policy documents adopted by the Arab Ministerial Water Council of the League of Arab States in 2011 and 2014 respectively. However, it should be understood that key political, environmental and social drivers of water policy lie outside the sector. Energy, global trade, agricultural policy, fiscal policy, food security, self-sufficiency and urbanization with its associated changes in demography and land use directly influence the political choices.

Other Arab major sectoral strategies developed within the institutional structure of the League of Arab States that influence the region collective policies towards water and food security within a safe and healthy environment include:

- The Arab Water Security Strategy – Action Plan (AWSS) (2010-2030)
- The Arab Plan of Action to deal with Climate Change (APACC)
- The Arab Strategy for Disaster Risk Reduction 2020 (ASDRR).

It is important to note that in general there has been weak or lack of real coordination in the Arab region in terms of policies and strategies for water, agricultural land, and energy. Moreover, climate change policies are still being addressed as an add-on policy issue rather than a core challenge for development in the region. Climate change policies need to be coordinated within the triple context of water security, energy security and food security (Al Zubari, 2017).

Several countries, such as Bahrain, Djibouti, Egypt, Jordan, Lebanon, Libya, the State of Palestine, Saudi Arabia, Syria, Tunisia and Yemen, have national water policies, plans or strategies that incorporate many IWRM elements, and thus effective water governance. Several have striven to improve accountability and stakeholder involvement in water decisions. A series of capacity-building IWRM initiatives have been undertaken to help formulate and monitor water policy and evaluate the water system. Other countries have focused on privatization by establishing new companies, such as the Water and Electricity Company in Saudi Arabia. But these efforts are not yet reaching their intended goals (UNDP, 2013; ESCWA, 2016).

The adoption of the Arab Strategic Framework for Sustainable Development (ASFSD) creates unprecedented opportunities for fundamental policy changes in various economic, institutional, environmental technological, and social systems in the Arab region. Furthermore, the adoption of the SDGs (2015-2030) by the all the Arab countries calls for a review of all Arab strategies to include the SDGs with careful consideration of indicators to fit with the Arab socio-economic conditions.

4.1.9. Water under Occupation and Water Terrorism

In the last few decades, an unfortunate trend can be observed as states, societies and illegitimate groups have demonstrated a growing tendency to use water as a force of destruction rather than a resource of nourishing human society and environment. While some treat water infrastructure as a target in violent conflict, others use water as an instrument of violence. Sometimes, it is difficult to decipher whether water is a target or an instrument of violence, as the two aspects of destructive perception of water is interchangeable. Militants groups in Iraq and Syria targeted their water resources and water infrastructure (Annex 3.2). As such, the people of the Arab region in particular face an uncertain future. Millions are fleeing their homes to escape violence and millions more remain trapped by conflicts (UNESCWA, 2015).

Deprivation of water resources in occupied territories is a major issue requiring serious and immediate attention. The Israeli occupation of the State of Palestine provides a sad and shameful example. Practices in occupied Palestine and the Syrian Golan heights violate these international conventions (Box 3). Israel did not stop at converting the Jordan river and deprive the right of other riparian countries, but went far to exploit water resources in occupied territories.

International conventions state that it is illegitimate for military occupiers to exploit and invest in natural resources within occupied territories while denying the States owning these resources the

right to such investment. Israeli never stopped its aggression despite the many international projects for dividing the Jordan River, the most famous of these projects is the American Envoy Johnston's project, which gave the countries water quotas according to the distribution of lands that contribute to the river's catchment in the following proportions: Jordan 50% (including Palestine West Bank), Lebanon 9%, Syria 2% and Israel 39% (figures 13 and 14).

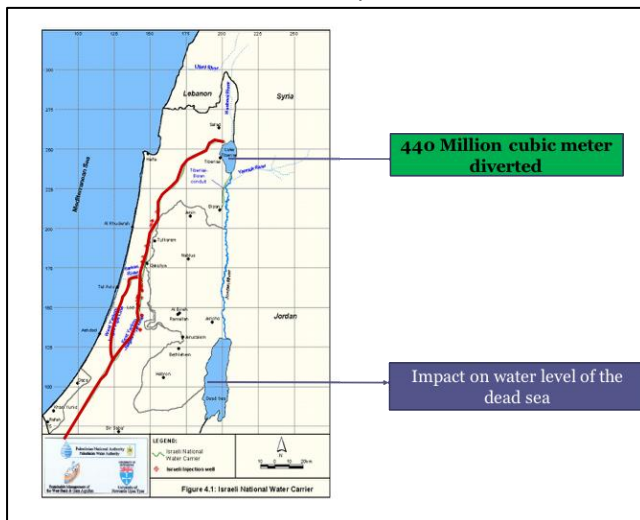


Figure 13. Israeli National Water Carrier

Box 3. Israeli Illegal Control on Water in the West Bank

Prior to 1967, Israel had developed the water resources to which it had access and established a national water carrier, Mekorot, that conveyed water from existing shared sources of supply to the various centers of demand from agricultural, municipal and industrial customers. Following the 1967 War, Israel took control of water resources, and developed wells, throughout the West Bank, together with a water supply network serving settlements that linked into the Mekorot network. Palestinian water rights in the West Bank were abrogated, including from the Jordan river. The amount that Mekorot supplies to the settlements is unofficially estimated at some 75 MCM, of which 44 MCM is produced from wells controlled by Israel or settlers within the West Bank.

Israel's military chief declared after the 1967 war that all West Bank water resources belonged to Israel. Palestinian waters were placed under the direct control of Tsahal (the Israeli Army) and the management of the Israeli government through the Water Delegation Office. In 1967–1968, several military orders were issued establishing the occupation's authority over all water exploration and well-drilling works. Military decision number 158 forbids Palestinians from owning a hydraulic system or drilling a well without a permit from Tsahal. Even with a permit, they cannot exceed 60 meters in depth, whereas settlers can reach depths ranging between 500 and 600 meters.

Israel illegally exploits almost 85% of West Bank water resources and continues to prevent the Arab population from drilling wells. In Gaza, more than 96% of water resources did not meet WHO health standards regarding nitrate concentrations in 2013 and 2014.

Source: World Bank, 2009; UNDP, 201.

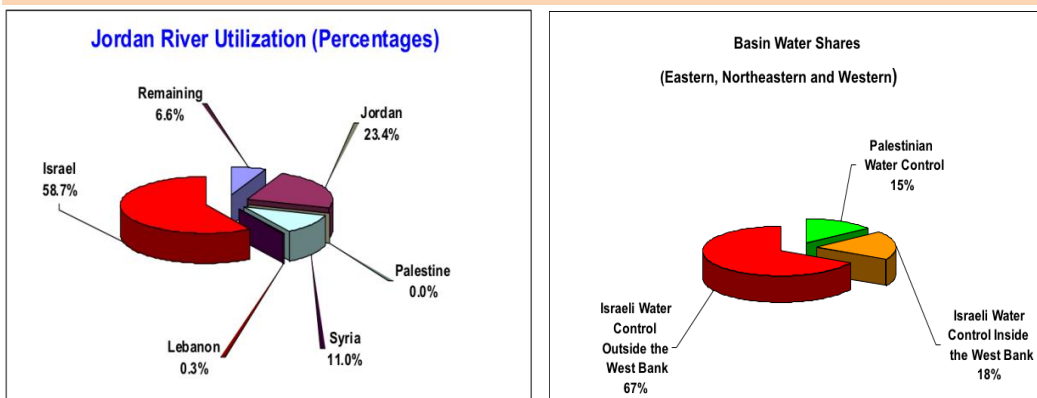


Figure 14. Israeli Domination on shared Water Resources.

Israel's aggression is manifested in forcible occupation of the Jordan River, its threat of the Litani River in Lebanon, its exploitation of groundwater in the West Bank and the denial of the Gaza Strip from surface water. This situation has led to the deterioration of economic and social development in Palestine and all Arab countries affected with the Israeli occupation (Lebanon, Jordan, and Syria) and contributes to the weakening of their capacity to achieve the objectives of sustainable development. The future generations, especially in Jordan and Palestine, will be the

poorest in terms of water and the most threatening in terms of food security, which will increase poverty rates and this will be a major cause and a major motivation in the national and regional instability.

4.1.10. Funding Water in the Arab States.

Funding the Arab region's chronic water problems to achieve the Arab Water Security Strategy as well as the SDGs entail high investment needs and growing costs to maintain, develop and expand water and sanitation services. The water sector, predominantly publicly owned with little private sector involvement, has a funding gap. Water investments absorb large amounts of public funds that could be used more efficiently elsewhere, without generating optimum economic returns.

The funding requirements of sustainable development and resource gaps can be estimated in various ways and depend on the particulars of each case. UNDP (2013) reported that the Islamic Development Bank estimates that Arab countries may need to invest up to \$200 billion in water-related infrastructure over the next 10 years to satisfy growing demand. UNESCWA (2015) estimates that \$3.6 trillion will be required for selected Arab countries to achieve sustained economic growth between 2015 and 2030. Resources will also be needed to repair past and ongoing environmental and conflict-related damage. The cost of environmental degradation in the region has been estimated at 5 per cent of GDP (World Bank, 2007).

While domestic public finance remains the central resource, all sources, including foreign direct investment, remittances and public-private partnerships, need to be mobilized to bridge the financing gap. Official development assistance will remain a significant source of funding for some Arab countries, especially in a highly volatile and unpredictable political environment that limits economic opportunities and deters private investment. Global sources of financing, such as climate finance, need to be tapped more consistently (UNDP, 2013; UNESCWA, 2015).

4.1.11. Moving from Water MDGs to Water SDGs

As discussed above, the challenges faced by many Arab countries in achieving their water-related MDGs will continue in the future in their efforts to meet the water related-SDGs (figure 15). In fact, these challenges might be even more pressing due to many factors, the most important of which is limited financial resources in the face of increasing population, being compounded by other driving forces including low cost recovery, and impacts of climate change. The most challenging factor is conflicts and instability in several countries which is putting the region under unprecedented pressure.

The 2030 Agenda for Sustainable Development includes a dedicated goal on water and sanitation (SDG 6) that sets out to "ensure availability and sustainable management of water and sanitation for all." SDG 6 expands the MDG focus on drinking water and sanitation to cover the entire water cycle, including the management of water, wastewater and ecosystem resources. With water at the very core of sustainable development, SDG 6 does not only have strong linkages to all of the other SDGs, it also underpins them; meeting SDG 6 would go a long way towards achieving much of the 2030 Agenda. SDG 6 contains six targets on outcomes across the entire water cycle, and two targets on the means of implementing the outcome targets (Box 6). In addition, water-related

issues are mentioned in many other goals across the 2030 Agenda, including target 11.5 on water-related disasters.



Figure 15. From Water MDGs to Water SDGs

The MDG+ Initiative was launched at the request of the Arab Ministerial Water Council (AMWC) in 2010 with the aim of “Establishing a Regional Mechanism for Improved Monitoring and Reporting on Access to Water Supply and Sanitation Services in the Arab Region.” The initiative was a response to concerns raised by Arab States regarding the insufficiency of the global indicator framework adopted to monitor progress in achieving the Millennium Development Goals. These concerns particularly related inability of the Joint Monitoring Program (JMP) framework to report on accessibility, affordability and provision of safe and reliable drinking water services, as well as the collection, treatment and reuse of wastewater. The MDG+ Initiative was operationalized through country-level data collection and consolidation by National Monitoring Teams comprised of water-related ministries, utilities and statistical offices and led by a National Focal Point³. Data was then consolidated into regional reports issued under the auspices of the AMWC.

This regional monitoring mechanism created by Arab States was based on a set of regional specific indicators vetted and adopted by the AMWC for monitoring access to water, sanitation and wastewater services. Formulated well before consultations on the Sustainable Development Goals (SDGs) began, the MDG+ Initiative established a regional monitoring framework for reporting on a set of 10 indicators and data points that build upon the data collected under the JMP, but which focus on issues of primary concern to water scarce regions. Many of these indicators are now included within the targets included under SDG6, although some still go beyond what is being monitored

MDG+ Indicators & Data Points	
Water Supply	Sanitation & Wastewater
Quantity Supplied	Quantity Collected
Consumption Rate	Treated Quantity
Continuity of Supply	Treatment Type
Water Quality	Reuse Utilization & Type
Tariff Structure	Tariff Structure
Affordability	Affordability

³ The initiative was implemented on behalf of the AMWC by the United Nations Economic and Social Commission for Western Asia (ESCWA), the Arab Countries Water Utilities Association (ACWUA) and the League of Arab States Secretariat, who provided training and technical assistance to Arab States on a harmonized methodology for each regional indicator. Funding for the initiative was provided by the Swedish International Development Cooperation Agency (SIDA)

today (Figure 16). For instance, the MDG+ indicators monitor the proportion of safely treated wastewater as called for in SDG 6.3, but also report on the percentage and volumes of wastewater treated at the primary, secondary and tertiary levels as well as the amount of safely treated wastewater that is reused and for what purpose, i.e., for agriculture, landscaping, groundwater recharge, etc.

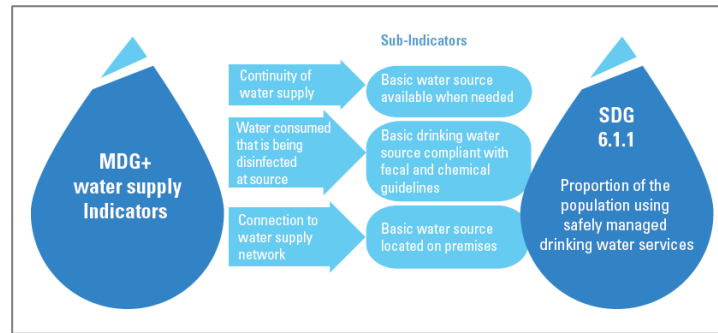


Figure 16. Illustration of how the MDG+ Indicators feed into SDG 6.1.1

The MDG+ initiative thus includes a more elaborate set of indicators more reflective of the 2030 Agenda on Sustainable Development objectives than what is being pursued at the global level with the SDG6 indicators, and particularly with respect to the quality, reliability and affordability of water services and the wastewater targets. However, it should be noted that the JMP is now providing case studies and thematic assessments to help fill in these gaps. This is illustrated below with respect to SDG 6.1.1.

4.2. Assessment

Proceeding from the diagnostic analysis of water in the Arab region (section 4.1.), this section will focus on the experiences, achievements, examples and further challenges facing sustainable management of water and water services. It is therefore important to consider the content here as continuation and inseparable part of the preceding section. It rather summarizes actions that took place at the national and regional levels and their relevance to the SDGs and links to the thematic framework of the 8th World Water Forum.

4.2.1. The SDGs Goals on the Arab Agenda

Two important documents were published by regional organizations regarding the implementation of the SDGs in the Arab region (figure 17). In 2015 the UN-Economic and Social Commission for Western Asia (ESCWA) in cooperation with other UN organizations and the League of Arab States published its report *“Arab Sustainable Development Goals”*. The report provides a review of the then current situation in the Arab countries in relation to sustainable development. It uses regional and global benchmarks to help in examining progress over the past two decades, trends, and remaining gaps and opportunities. It provides national stakeholders with evidence-based information to be used for establishing targets, designing policies and monitoring/reporting progress.

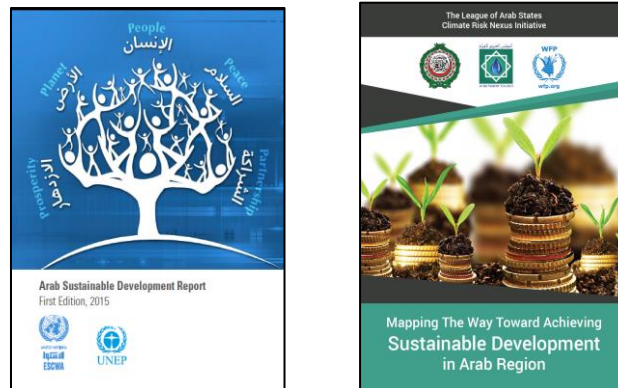


Figure 17. Recently Published Documents on SDGs in the Arab Region

In 2016, the League of Arab States (LAS), published the report *“Mapping the Way towards Achieving Sustainable Development in Arab Countries”*. This report was prepared in cooperation with AWC and WFP within the framework of the LAS Climate Risk Nexus Initiative addressing Food Security, Water Scarcity and Social Vulnerability (LAS/CRN) launched in November 2015. The Climate Risk Nexus (CRN) Initiative by the League of Arab States (LAS) has been proposed to develop capacities of LAS and Member States to enact decisions and policies that better manage and reduce the growing complexity of risks that could severely affect the achievements of the required sustainable development goals, at the meantime support the resilience of people and countries. The initiative is still in the stage of development



4.2.2. SDGs in the Heart of the Political debate

The 2030 Sustainable Development Agenda is now shaping the global development discourse and increasingly determining development financing. The commitment by LAS member countries and the mandate given to LAS by the LAS Summit, to develop the Arab regional report on SDGs for the High Level Political Forum (HLPF) in 2018, make it all the more important to develop comprehensive integrated policy responses to the wider scope of the SDGs.

The SDGs were present in all presentations and debates during the 4th Arab Water Forum (AWF) organized by AWC on 26-28 November 2017. Keynote speakers and dignitaries including the Secretary General of LAS, ministers, politicians, legislators, and decision-makers expressed the regional commitment towards the UN-SDGs. All stakeholders reaffirmed their commitment to keep the momentum towards achieving the SDGs as related to water in order to enhance implementation of the entire SDGs and achieve water security in the region.

A High Level Dialogue on Water in Sustainable Development was organized by AWC and LAS within the framework of the 4th AWF, with the aim to assess the progress made so far by the Arab countries collectively and individually with respect to SDG6 and give recommendations for the way forward. The session gave the overarching message that strong partnership is needed

between governments, civil society, private sector, development partners, International community and development funds to achieve SDGs in the region (Box 3).

In the following part of this section of the regional report, examples of experiences, and

Box 3. Conclusion and Recommendation of the AWF4 High Level Dialogue on SDGs

- The SDGs indicators should be customized to fit the conditions in the Arab Region. It is important to review and modify some UN-SDGs indicators that are not adequate for the Arab conditions and needs.
- All 17 SDGs should be considered while implementing all SDGs not only SDG6.
- It is of great importance to consider and address social justice while moving towards the achievement of the SDGs through engaging all members of the civil society.
- Large partnership is the key for success and achieving SDGs. Moving forward in an integrated approach is important in achieving the SDGs.
- SDGs should be mainstreamed in government policies and development plans and the government officials should deal with the SDGs as a national priority and consider them from both developmental and political background.
- Collaboration and cooperation of all line ministries are very important for achieving the SDGs at the national level.
- Coordinating and integrating the initiatives and efforts at national and regional level are very important to achieve the SDGs according to the UN base line.
- Scaling up the support of the Arab financing institutions is a key to help in achieving the SDGs. The Arab investment funds should adopt a policy of “supporting Arab countries to implement SDGs”.
- Considering, strengthening and enforcing laws and legislations that allow the implementation of integrated water resources management.
- Encouraging Public and private sector partnership is very important in order to cover countries’ main requirements and needs for achieving the SDGs.
- Private sector engagement in the water sector investments are crucial for financing the sustainable development activities on both country and regional levels.
- LAS Sustainable Development Department should seek and facilitate finances from the Arab Funds to development projects and programs.

Source: 4th Arab Water Forum, AWC 2018

achievements responding to the many of the water related challenges in the Arab region will be presented. They will be discussed within the context of the 8th WWF thematic framework and their relationship with the UN-SDGs and particularly SDG6 targets.

4.2.3. Implementation of Arab Water Security Strategy

The Arab Countries were never mobilized to jointly work on the water challenges than it does until the Arab Water Security Strategy-AWSS (LAS, 2013) and its Action Plan (LAS, 2014) were launched and empowered by the establishment of the Arab Water Ministers Council (AWMC) within the institutional framework of the League of Arab States. The dynamics of changes in the water sector are boosted at both of the regional and national levels. The endorsement of the Arab

Economic and Social Development Summit to these initiatives brought water to the forefront of the political agenda.

The AWSS action plan stands on 6 pillars and include projects for promoting IWRM in the Arab States. The AWSS and its action plan, although they were set long before, observes all the 8th WWF thematic Framework and its cross cutting themes as well as many of the SDGs targets, e.g. SDGs 1, 2, 6,7,8,9,12,13,15. The main pillars of the AWSS' action plans are:

1. Developing access to updated information on the state of water resources in Arab countries.
2. Improving the application of IWRM principles:
3. Strengthening the scientific, technological and industrial base:
4. Increased funding of water projects:
5. Enhanced vulnerability assessment and adaptation to climate change variables:
6. Working to establish means to protect Arab water rights from shared international water

Commitment to address water at the regional level are also undertaken by several non-governmental organizations that promote good governance, best practices and innovation in the water sector to support the implementation of the AWSS. Examples of such organizations include the Arab Water Council (AWC), the Arab Countries Water Utilities Association (ACWUA) and Arab Network for Environment and Development (RAED). Their institutional framework extends to cover all segments of the Arab society and engage and integrate all water stakeholders in making water truly the business of every one. They also build partnerships with regional and international organizations and financial institutions.

At the national level, government are taking further initiatives to reform their water sector and increase their capacity to address many interlinked challenges caused by water scarcity and climate change. Many of the Arab countries recently updated their water strategies and adopted new approaches and scaled up their investments in water infrastructure.

Progress towards many of the solutions is already underway in different directions across the region within and outside the AWSS action plan. Several regional, international and bi-lateral financial institutions and UN-Agencies and development partners have mobilized financial and technical resources to support the implementation of the AWSS action plan. These institutions include among other ESCWA, GIZ, FAO, UNDP, EU, CEDARE, SIDA and World Bank. However, the urgency of the current situation requires more intensified, accelerated and improved collective effort.

Regional cooperation emerged as an excellent opportunity for sharing knowledge and information, and best practices between the Arab countries. They help in promoting joint solutions so that they become economically viable. Regional cooperation can also help to make better use of the comparative advantages that each Arab country has, in terms of availability and use of resources (efficiency) and human securities. A good example for sharing of knowledge and best practices are the Policy Briefs on Nexus (Al Zubari, 2016) and the policy briefs published by AWC on use of non-conventional water (AWC, 2016), which were endorsed by AWMC and received widespread recognition within the Arab region's and among concerned constituencies.



Regional Report Arab Region Regional Process Commission

The Arab Center ACSAD is pursuing the implementation of the AWSS action plan projects and initiatives, with technical and financial support from different regional and international institutions. The government institutions and local communities in the target countries lead the implementation of the projects and activities (Table 5).

Table 5. Activities and a sample of Projects Implemented within the framework of the Arab Water Security Strategy

Pillars	Objectives	Contributors ⁴	Accomplishments
1. Developing access to updated information on the state of water resources in Arab countries. SDG6: Target 6.4	a. Building a database for climatic and hydrological data in the Arab countries, drawing on the data available and t data provided by institutions and competent authorities in the Arab countries.	ACSAD	<ul style="list-style-type: none"> ✓ Audit of Arab climatic data, ✓ check daily climate data for maximum and minimum temperature and precipitation, ✓ Construct indicators of extreme weather events, ✓ Test homogeneity of time series of precipitation and heat data, ✓ Continuous updating, revision and validation of the climate data and restoration of the daily, monthly and annual Arab climatic data to end with time series of the Arab climate data. ✓ Revision and comparison of the results of the mathematical model ACSAD_RegCM4.5 for the Arab region with the historical Arab climate data.
	b. Building database on Water resources availability and uses in the Arab states	CEDARE, ACSAD, AWC	<ul style="list-style-type: none"> ✓ Collecting data from Arab States, processing and analyzing and publishing tri-annual reports.
2. Improving the application of IWRM principles SDG2: Target 2.4 SDG6: Targets 6.4, 6.5,	promoting food and water security in the Arab region (FAO initiative)	ACSAD, FAO, ESCWA, SOW-VU,	<ul style="list-style-type: none"> ✓ Project for Enhancing Water and Food Security through Capacity Building and Cooperation in the Arab States ✓ Project for Irrigation Efficiency in the Arab countries ✓ Project for Participatory Approach to the Establishment of a Regional Economic Model for Water Management in the Jordan River Basin. ✓ Project for Modernization of the water

⁴ Contributors supported one or more of the projects under each pillar with technical or financial support, while National institutions and local communities in the target countries took lead in implementing the activities/projects.

Source: ACSAD explanatory note on follow-up the implementation of the AWSS Executive action plan presented to Ministerial Council for Water on July 6, 2017

			<ul style="list-style-type: none"> study of the Iraqi Hammad Basin. ✓ Project for Rainwater Harvesting in the State of Palestine ✓ Project for optimal investment of surface water resources - Water harvesting and management of investment in the area of Al-Hager in the state of Tamanrasset in Algeria ✓ Project for Sustainable Agricultural Development in the North-West Coast of the Arab Republic of Egypt (Kasaba Basin / Bagosh). ✓ Project of the mountain lakes in the Syrian coast ✓ Project for Rainwater harvesting in the town of Maqneh, Baalbeck - Hermel, Lebanon.
<p>3. Strengthening the scientific, technological and industrial base</p> <p>SDG6, Targets 6.4, 6.5, 6.A, SDG2, Target 2.4</p>			<ul style="list-style-type: none"> ✓ establishment of a mathematical model of groundwater in the basin of Asi / Syria ✓ Project for preparing a mathematical model for the Euphrates basin in the Syrian Arab Republic. ✓ Project for the study on the expansion of wheat cultivation using groundwater in the Nile and Northern Nile states in the Republic of Sudan - Water studies
<p>4. Increased funding of water projects:</p>	<p>Raising funds from regional and international institutions</p>	<p>SIDA</p>	<ul style="list-style-type: none"> ✓ The Swedish International Cooperation Agency was the funding body to several of the projects list in this table.
<p>5. Enhanced vulnerability assessment and adaptation to climate change variables:</p> <p>SDG6 Targets 6.4, 6.A</p>	<p>Adapting to climate change</p>	<p>ACSAD, ESCWA, SMHI, UNEP/ROWA, FAO, SIDA</p>	<ul style="list-style-type: none"> ✓ Project of the study of climate change and its effects on water resources in Arab countries ✓ Project for assessing the sensitivity of water resources to climatic changes in the Arab region and their economic and social effects ✓ Project for assessing the sensitivity of water resources to climatic changes in the Arab region and their economic and social effects ✓ Project of study of the sensitivity of the agricultural sector to climate change in

			the Republic of Lebanon.
6. Working to establish means to protect Arab water rights from shared international water SDG6 Targets 6.5,6.A	Ensuring fair, equitable and sustainable benefits from shared water resources	-----	----

Typical examples of other regional projects implemented that have strong linkage with the AWSS and its action are the World Bank “Regional Coordination on Improved Water Resources Management and Capacity Building Program-RCIWRC” (World Bank, 2016) coordinated by AWC, the “FAO-Regional Initiative on Water Scarcity” (FAO, 2015) and the GIZ Project on “Mainstreaming the Water-Energy-Food Security Nexus into Sectoral Policies and Institutions in the Arab Region, ACCWaM” (GIZ, 2017).

4.2.4. Sharing Information and Knowledge

SDG6; Targets 6.4 & SDG12, Target 12.8

Building data-base of information on the state of water resources in the Arab countries that is continuously updated and published is seen as the first step towards developing sound policy and effective plans. Regional cooperation effort has been launched by CEDARE and AWC to publish the “Arab State of Water report” series in cooperation with LAS/ACSAD and support from all Arab governments. The series started in 2012 and the third edition is about to be published in 2018. The report depends on data provided by focal points in each country who regularly update information about conventional and non-conventional water resources in their blue, green, gray form as well as water withdrawals and uses by different use sectors. Meanwhile, ACSAD under the umbrella of the AWSS-Action Plan built an Arab climate data-base that is updated, checked, tested, and shared.

The FAO Water Scarcity Initiative relates to extend the use of remote sensing as key technology to monitor cropland changes, evapotranspiration (ET) and crop water productivity (Box 5). The Initiative has disseminated the use of advanced Satellite-based information systems for monitoring and evaluation of Water Accounting, Water Productivity and Drought among professional staff from the Ministries of Agriculture, Water Resources and Environment of the Region, and has stimulated their capacities in water governance through different trainings and meetings. Cropland Reference Geospatial Data Collection is being implemented for the focal countries (Algeria, Egypt, Jordan, Lebanon, Morocco, Tunisia, West Bank and Gaza)

Also within the framework of the RCIWRC project mapping of irrigated areas and crop water requirement was carried out for Azraq basin in Jordan using remote sensing data of Landsat 8 and daily weather records (Al Bakri, 2015). The output map was refined and used to delineate (digitize) precise boundaries of irrigated farms using high resolution images as background for the

digitizing process. The output map included 7 major classes that included trees (olives and fruits), vegetables, Alfalfa and barley.

Box 5. Use of remote sensing for monitoring croplands, with estimation of Crop Water productivity (CWP) and Evapotranspiration/Water Consumption (ET) in the Arab countries

SDG2: target 2.4

SDG6: target 6.4 and target 6.5

The main objective was to provide the following data products at 30 m resolution:

- Use satellite crop monitoring methods and ground validation
- Estimation of Crop Water Productivity (CWP), using remote sensing techniques
- Estimation of actual evapotranspiration (ET) using remote sensing techniques

The suggested plan has been worked closely with the Ministry of Agriculture and the Remote sensing agencies of the country for carrying out the following activities:

- Acquisition of the Landsat images to be used for the interpretation
- Preliminary interpretation of the images to generate crop maps
- Organization of a training on “Ground truth data collection” for the teams that will be involved in the field survey. Organization of the field survey to calibrate and validate the interpreted maps using georeferenced field observations
- Conduct of the field survey
- Finalization of the maps using the field observations
- Validation of the results by national agencies

A capacity building programs are being implemented focusing on the concepts of WP, agro-meteorological modeling yields and results interpretation.

Source: FAO-RNE, Cairo

4.2.5. Reporting on Water Supply, Sanitation and Wastewater in the Arab Region

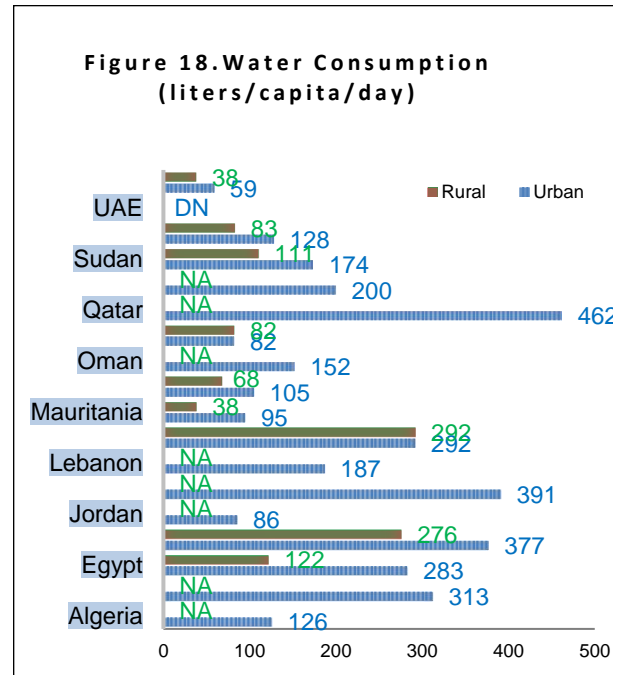
The section below provides an analysis on how the monitoring framework, data files and results of indicators generated and disseminated under the MDG+ Initiative could serve as a basis for informing several of the water-related SDG6 targets (Las et al, 2016b) as being measured by the JMP or the Integrated Monitoring Initiative for SDG6 (GEMI) put forth by SDG6 custodian agencies (see section 4.1.13). The data below is taken from the *MDG+ Initiative 2016 Report*, which was issued in 2016 under the auspices of the Arab Ministerial Water Council by ESCWA, ACWUA and the League of Arab States.

A. Water Consumption

This indicator supports SDG 6.1 and 6.4

This indicator can inform water supply and demand management policies related to water consumption levels, rates and behaviors. It can also be used to inform discussion on water scarcity in the Arab region, as differentiated from freshwater resource scarcity.

Over the Arab region, water consumed from piped water networks greatly varies from one country to the other and between rural and urban areas within the same country (Figure 18). Some Arab countries do not report on water consumption in rural areas as served populations are nearly fully accounted for in urban figures.



B. Continuity of water supply

This indicator supports SDG 6.1 and 6.4, although not reflected in the global indicator framework.

The reliability and regularity of water services is a necessary component of understanding access to water services in water scarce regions. Data on water supply intermittency can support integrated decision-making on water resources management and service provision. It can also inform policy formulation and regulations on water storage and water quality testing at the household level. (Figure 19)

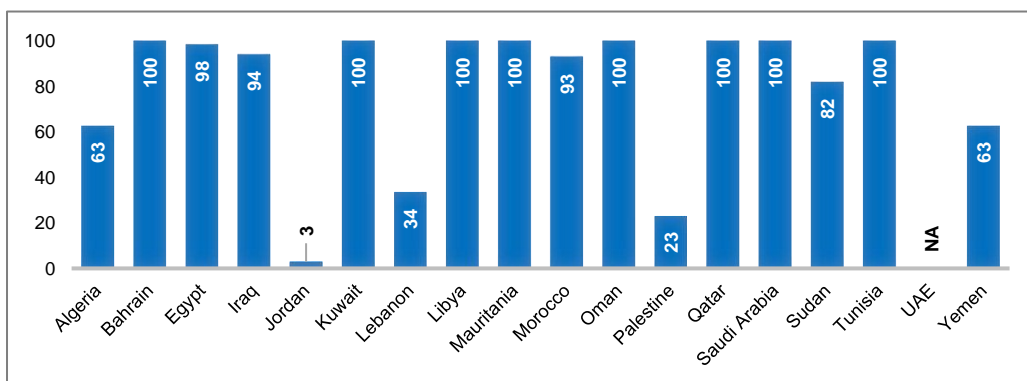


Figure 19: Proportion of the population connected to piped water network receiving their water daily (percent)

Intermittencies in piped water supply is a major issue facing many countries in the Arab region (figure 20) and is largely linked to water scarcity, water-energy production costs or ongoing conflicts (LAS et al 2016b).

In the case of Jordan, most of the population receives its water supply no more than once per week. Other countries with considerable water supply intermittencies include Palestine, Lebanon, Sudan and Yemen.

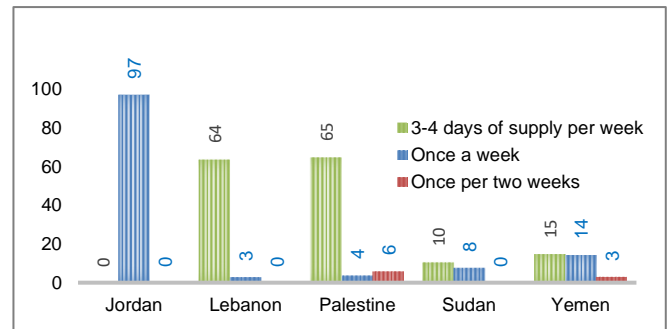


Figure 20 Proportion of the population receiving intermittent water supply (percent)

C. Water quality

This indicator supports SDG 6.1, 6.4 and 6.6.

Accurate quality estimate should focus on the water quality at the point of consumption, nevertheless since such data remains scarce and is difficult to obtain, water quality data at the point of delivery is provided by water utilities and used as a proxy for quality of water supplied (LAS et al, 2016b). Results show that the majority of the people connected to piped water network in the Arab region are supplied with water that has been disinfected at the source (LAS et al, 2016 a), (figure 21)

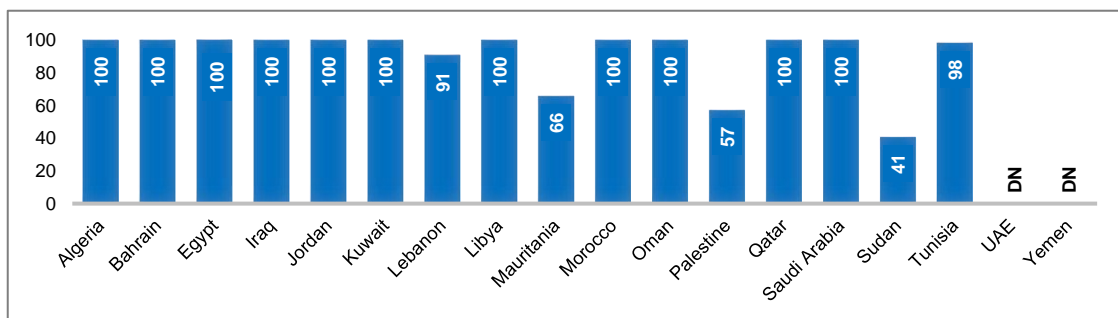


Figure 21. Proportion of the population connected to piped water network receiving water that has been disinfected at the source (percent)

D. Water Supply: Tariff structure

This indicator supports SDG 6.1.

Data on this indicator can help to clarify the affordability of water services for consumers.

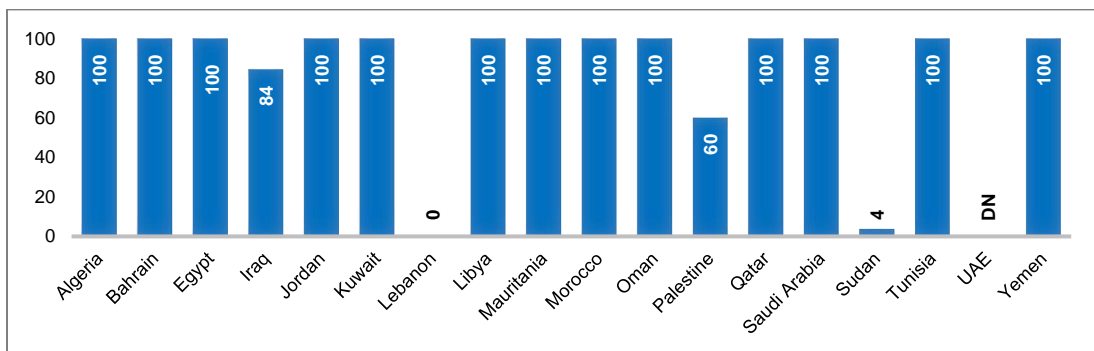


Figure 22. Proportion of the population connected to piped water network billed a volumetric tariff (percent)

Most people who are connected to piped water network in the Arab region pay for water services based on a volumetric tariff rate (Figure 22).

E. Inequalities

Furthermore, consumer field surveys were conducted in eight Arab States in collaboration with the Arab NGO Network for Environment and Development (RAED) to complement information gathered in unified questionnaire for a better analysis of the obstacles facing water supply and sanitation services delivery in remote rural areas of the region's least developed countries and countries affected by conflict.

F. Water Supply: Using Tanker trucks and bottled water

The JMP considered tanker trucks and bottled water as unimproved source types, due to the lack of data on accessibility, availability and quality of water supplied by this type of source. Nonetheless, Arab States were cognizant of the importance of monitoring and reporting of this type of water source due of their important contribution to the volume of water supply in the region. Such indicators can further inform the understanding on access to drinking water services in terms of volumes supplied but also the resource quality and affordability.

Results have shown that in Mauritania for example, nearly 40 per cent of the urban population relied on water tankers for water supply in 2011, which is significant and was similarly observed to a lesser extent in Somalia, the Sudan and Yemen. Even in more developed countries, tanker trucks remain an important source of water; for example, 14 per cent of Algerians relied on water tankers in rural areas in 2011 (UNESCWA, 2013). It is also well known that a significant proportion of the populations in Jordan, Lebanon and Palestine also depend on tanker trucks for the delivery of water. Trends in increased reliance on tanker trucks as the main water source is noted in countries such as Algeria, Jordan, Sudan and Yemen over the period extending from 1990 to 2010.

Similar to the Arab region, other parts of the world are reporting on this type of water source, and hence the increasingly available data on this type of water source has instigated the JMP to consider tanker trucks and bottled water as improved to be further classified based on the JMP ladder approach as either: limited", "basic" and "safely managed" (WHO/UNICEF, 2016).

G. Wastewater: Connection to sanitation system

This indicator supports SDG 6.2, but covers connection to piped and trucked sanitation systems and networks.

Table 6. Proportion of the population connected to a sanitation system in selected Arab states, in percentage (2013)

Country	Sewerage systems		On-site sanitation facilities	
	Urban (%)	Rural (%)	Urban (%)	Rural (%)
GCC				
Bahrain	87	n/a	13	n/a
Kuwait	100	n/a	0	n/a
Oman	20	n/a	80	n/a
Qatar	94	n/a	6	n/a
Saudi Arabia	54	47	n/a	n/a
Mashreq				
Egypt	87	13	23	77
Iraq*	40	0	57	100
Jordan	59	n/a	41	n/a
Lebanon				
Palestine	24	2	76	98
Maghreb				
Algeria	85	n/a	15	n/a
Libya*	56	47	44	53
Morocco	88	1	12	99
Tunisia	89	10	11	90
LDCs				
Mauritania	1	0	99	100
Yemen	36	29	64	71

Sources: LAS et al, 2016b

As shown in Table 6, while access to sanitation is high in most Arab States, with the exception of the region's least developed countries (LDCs), connections to sewerage networks and wastewater treatment facilities remain limited and disbursed across many parts of the region. Sewage network coverage is generally available in larger urban centers, while septic tanks and cesspits remain common in rural areas and in the region's least developed countries (UNESCWA, 2013). Off-network sanitation systems complicate the collection and treatment of wastewater and reduce the ability to manage sustainably wastewater as a resource in most areas. Table 1 summaries the proportion of population connected to a piped sewerage network or on-site sanitation system, based on national reports prepared by Arab countries under the MDG+ Initiative. With the exception of Bahrain, Kuwait and Qatar, the table shows that the proportion of population using on-site sanitation facilities in rural areas is considerably high. This presents a challenge for pursuing centralized approaches for advancing wastewater reuse (UNESCWA, 2017)

H. Percentage of collected wastewater that receives any type of treatment

This indicator supports SDG 6.2, 6.3 and 6.6.

The proportion of the annual collected wastewater volume by piped sewer networks receiving treatment prior to discharge (percent) informs the quantity of wastewater collected and treated, which in turn can be used to assess the quantity that is safely used for other purposes in water scarce regions, or released to water related ecosystems as treated or untreated wastewater.

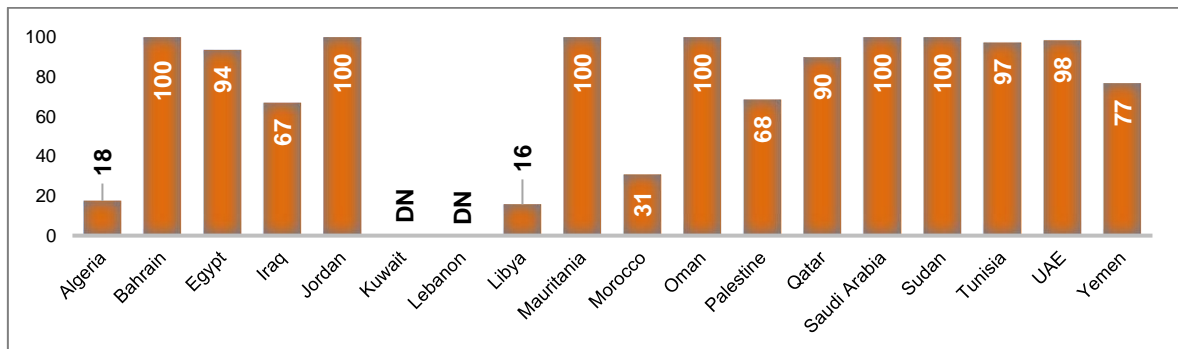


Figure 23. Proportion of the annual collected wastewater volume by piped sewer networks receiving any type of treatment prior to discharge (percent)

Figure 23 reflects the current situation of this indicator in the region. However, one should be careful in interpreting these figures, the reason for high percentages of treated wastewater volumes in some countries may be attributed to the initial limited collection rates. This is the case of Sudan and Palestine and Oman. In Algeria, Libya and Morocco, volumes of wastewater treated do not exceed the third of what is actually collected (UNESCWA, 2013). Untreated wastewater poses public health hazards linked to human exposure to hazardous chemical and organic contaminants. Furthermore, wastewater as an additional water resource complementing limited fresh water in the Arab countries is underexploited.

I. Waste Water Treatment by type

This indicator supports SDG 6.2, 6.3, 6.4 and 6.6.

This indicator supports analysis on the level of wastewater treatment provided by Arab States, this can support monitoring and reporting on the proportion of untreated wastewater in the region, and particularly what share is treated at the primary level, which remains harmful for the environment, or treated at the secondary or tertiary level, and can thus be safely used for other purposes to reduce water scarcity (LAS et al, 2013).

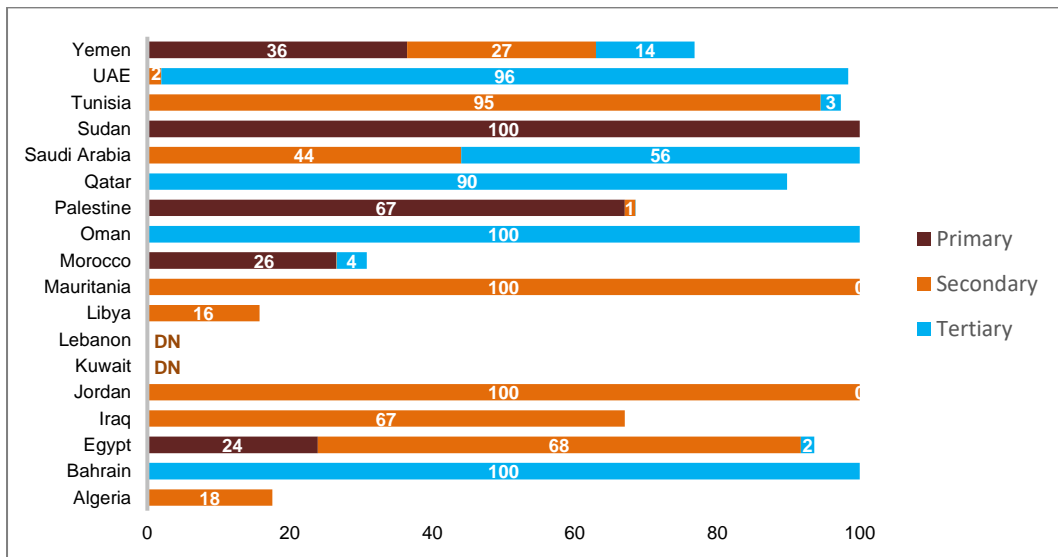


Figure 24. Proportion of the annually collected wastewater volume by piped sewer networks that are receiving primary, secondary and tertiary treatment (percent)

Wastewater treatment and the level of treatment vary widely throughout the Arab region. While tertiary treatment is prevalent in the Gulf, none is available in Algeria, Iraq, Jordan, Libya, Mauritania, Palestine and the Sudan. In the Sudan, collected wastewater is only primary treated. No data is officially provided on wastewater treatment levels in Kuwait and Lebanon.

J. Treated Wastewater Reuse

This indicator supports SDG 6.3, 6.4 and 6.5.

This indicator informs analysis on the use of safely treated wastewater, and the volume that is being used for subsequent purposes. This indicator is particularly useful in water scarce environments, and can also be used to inform SDG 6.a, which aims to support increased capacity building in this area.

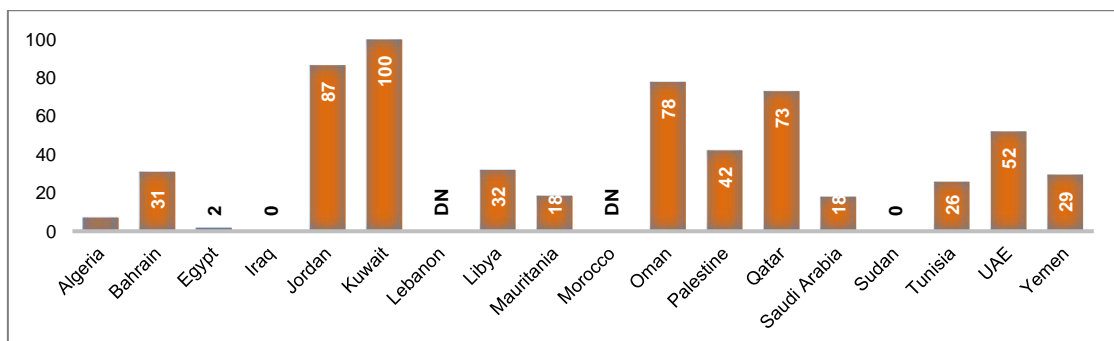


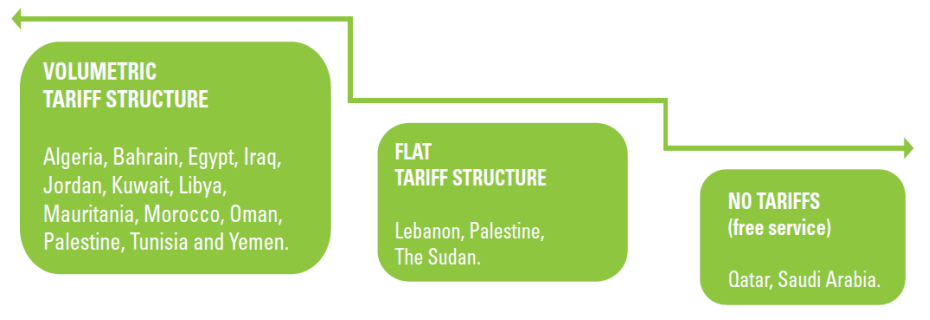
Figure 25. Proportion of the annually treated wastewater volume that is being used (percent)

Only Palestine and Oman report using treated wastewater for groundwater recharge in 2013, although other Arab countries have considered doing so (Figure 25). Most treated wastewater in the region is used for irrigation, and primarily for agriculture or landscaping.

K. Sanitation and Wastewater: Tariff Structure

This indicator supports SDG 6.3, 6.4 and 6.5.

The tariff structure impacts the financial sustainability of sanitation services. Knowledge of tariffs and the tariff structure informs the identification of policy options available for improving access to sanitation and wastewater treatment services, which can in turn support safe wastewater reuse, recycling and efforts to reduce water scarcity.



I. Lessons Learned

A. Wastewater Treatment

The provision of public services in Arab States is generally managed by government-owned institutions and authorities. Nevertheless, many states in the region have initiated public sector reforms that are simplifying existing regulations and opening up the water and wastewater sectors to external investment (UNESCWA, 2017). An example of a successful private sector engagement is demonstrated through the Sulaibiya Wastewater Treatment Plant in Kuwait which is the project in the country to qualify as a public-private partnership (PPP) and built-operate-transfer (BOT) investment. The facility is the largest sewage treatment plant in the Arab region and aims to demonstrate the leadership that the Arab region can provide with respect to the treatment and use of wastewater as a water resource. The plant uses state of the art treatment technologies, which are based on reverse osmosis and ultrafiltration to purify wastewater to potable water quality standards for non-potable uses such as agriculture, industry and aquifer recharge. The private sector arrangement is based on a 30 year concession owned by a consortium comprised of the Kuwait Kharafi Group and General Electric. A consortium of Kuwaiti banks financed the project. It is estimated that the plan will produce US\$11 billion dollars in savings to the public budget as compared to expenditures that would have been made if the facility was built and managed through a centralized government approach.

B. Technology Transfer

The As-Samra wastewater treatment plant (WWTP) project in Jordan is exemplary in that 80 per cent of the energy required for its operations is generated by the plant itself (UNESCWA, 2017b). It is also an excellent example of technology transfer at work and innovative financing, and addresses the water and energy in several ways. The plant is the largest of its kind in Jordan and can treat up to 267,000 m³ of wastewater a day, more than 70 per cent of the total treated throughout the country. The sludge produced as part of the treatment process is used to produce biogas, which is stored in tanks with a combined capacity of 18,000 m³. It is subsequently treated to remove hydrogen sulfide (H₂S) and used in 10 biogas generators to produce electricity, which helps to power the plant. In addition, hydraulic energy is generated at the plant inlet (using Pelton turbines) and outlet (using Francis turbines). Combined, the two sources of renewable energy generate 230,000 kWh a day. The plant also produces 133 million m³ of high quality treated water a year, which is used for agriculture and represents 10 per cent of the country's water consumption. Water pollution has been drastically reduced as a result and has helped to transform the once heavily polluted Jordan River into one of the cleanest rivers in the country. Completed in 2008, the plant is being expanded in order to increase water-line and sludge-line capacities by 37 per cent and 80 per cent respectively, thereby catering to the wastewater treatment requirements of the 3.5 million people living in Greater Amman and the surrounding areas. The As-Samra project sets an example for the region. It employs technology that can be integrated into new and existing wastewater plants.

4.2.6. Egypt's 2030 Strategic Vision for Treated Wastewater Reuse: A Case Study.

As of 2011, the nationally produced wastewater amounted to about 7 BCM, of which about 3.7 BCM were untreated, 2.4 BCM were secondary treated, 0.9 BCM were primary treated, and only 0.068 BCM were tertiary treated. Out of all the 3.368 BCM of treated wastewater, only 0.271 BCM were reused directly for Agriculture, while the remaining amount was disposed to the national agricultural drainage network.

According to population projections, the total national amount of produced wastewater in 2030 will be about 11.673 BCM. Assuming that all primary treatment plants will be upgraded to secondary, the total expected amounts to be secondary treated at the national level in 2030 is 11.606 BCM which is almost the whole produced amount, as the small remaining margin represents the current amount of 67.7 MCM that is subject to tertiary treatment and will be maintained through 2030. The situation in 2011 was considered as the baseline for developing the strategic future vision.

The vision will be to maintain the tertiary treatment level of 2011 until 2030 without expansion due to the extreme financial burden at the expense of under-served areas, and creates social inequality. As for Secondary treatment, it was safe to assume that all current primary treatment facilities should be upgraded to secondary level in 2030 to ensure that all wastewater is equally treated over the country to a reasonable level by 2030.

The strategic vision provides two options for future reuse plans geographically categorized. The first category consists of all governorates (administrative units) with a desert front and/or a future agricultural expansion area where the secondary treated wastewater will be used directly for agriculture. The other category consists of governorates without land available for agricultural expansion plans because they exploited their agricultural land potential. In this case, the secondary treated wastewater will be directed to the main drainage to be conveyed to agricultural expansion in North Sinai in the North-East or Hammam area and others areas in the North-West.

According to this strategic vision, 5.82 BCM will be used directly in agricultural expansion areas, while 5.53 BCM will be disposed into drains for downstream use. According to the Ministry of Agriculture and Land Reclamation, 1.4 Million feddans will be reclaimed for cultivation, according to the 2030 Sustainable Agriculture Strategy with a total average annual water requirements of about 5.42 BCM. According to this strategy, these water requirements can be satisfied by the secondary treated wastewater produced in 2030. The Strategic Vision estimates an additional 1.45 Million feddans that could be reclaimed based on the remaining potential of secondary treated wastewater of 0.4 BCM from desert front governorates and 5.53 BCM from delta governorates at an estimated water requirement of about 4100 CM /feddan/year.

The implementation cost of the proposed strategic vision requires a total budget of about 15.05 Billion Euro over the next 19 years, divided into an investment cost of about 8.57 billion Euro, and an operational and maintenance cost of about 6.48 Billion Euro. This would roughly mean that an annual total budget of about 0.79 Billion Euro would be needed, an investment budget of about 0.45 Billion Euro and about 0.34 Billion Euro of recurrent costs would be needed for O&M. Financial analysis, shows that based full cost recovery strategy, treated wastewater could be offered to agriculture developers at the downstream end of the drainage system at an investment cost of 0.85 €/m³, in addition to an O&M cost of 0.025 €/m³. Whereas treated wastewater could be offered to agriculture developers in the desert fronts governorates for direct reuse at an investment cost of 0.95 €/m³ and an O&M cost of 0.035 €/m³.

4.2.7. Improving Water Resources Management

SDG2, target 2.4, target 2.A, target 2.B
SDG6; target 6.4, target 6.5, target 6.A

As the supply side management has reached its technical and financial limits, several Arab countries have started to make a more effective shift in their water policies to demand management and conservation, with economic tools being increasingly used to materialize this shift. Water subsidies have been reformed in several Arab countries from general to more targeted serving two objectives: enhancing water use efficiency and increasing cost recovery. Furthermore, resilience to the immense water challenges in the region can be considerably enhanced through international and regional cooperation and capacity building (target 6.A) and by improving water governance, particularly stakeholders and local community's involvement.

One of the main battle fields to combat water scarcity in the Arab region is to improve water use efficiency through adopting and practicing integrated Water Resources Management (targets 6.5). Within this context, there were many initiatives made at both national and regional levels. One of these initiative was *"the Regional Water Scarcity Initiative (WSI)"* in the Arab region launched by

FAO (FAO, 2013). The initiative aims at assisting the countries of the region in developing and strengthening their water policies and facilitating the implementation of related plans and programs through adopting best practices that contribute to water use efficiency (target 6.4), improved agricultural productivity and food security in a sustainable manner in the region (target 2.4). In this regard, a Regional Collaborative Strategy has been formulated to seek structured mechanisms to address water scarcity beyond the national level and provide an agricultural water lens to the 'Arab Water Security Strategy' (2010-30).

To innovate the process of finding sustainable and strategic options to water scarcity and food security problems, the FAO *Regional Water Scarcity Initiative (WSI)* promoted the option of the use of the *Food Supply Cost Curve (FSCC)* method (Box 6) to perform two major inter-related investigations: (i) the costs of alternative investments (or combination of them) to achieve selected national food supply targets; (ii) the water required to be consumed for each alternative investments (or combination of them).

Box 6. Assessing tradeoffs of increasing Food Supply under Water Scarcity through the Food Supply Cost Curve (FCC) Approach in the Arab countries:

(Morocco, Tunisia, Jordan, Egypt, Oman and Yemen)

SDG2: target 2.3, target 2.4, target 2.A, target 2.B and target 2.C & SDG6: target 6.4

The FSCC analysis would visualize and quantify the various tradeoffs, i.e., costs of 'financial investments' vs costs of 'water investments' for each 'investment' scenario. With this information, policy makers can take decisions on a more evidence-based and strategic ground when confronting tradeoffs between 'food security' and 'water security'

A complete assessment of the opportunity cost of water for these pilot Arab countries was somewhat complex. By comparing the FSCC with both the international reference price for the selected crops at hand and the forecasted domestic consumption curves, it was possible to select the economically viable supply options, determining also the optimal amount of imports for these focal countries.

The FSCC approach is ensuring a process of selection of efficient options for the expansion of national production that is graphically depicted, easy to understand and to use for high level decision makers. This approach should be scaled up to the rest of the Arab countries.

Source: FAO-RNE, Cairo

Given the fact that number of Arab countries suffers absolute water scarcity with per capita share less than 500 cubic meters, Jordan offer a success story in managing to live with less than 100 m³ per capita per year, and move towards achieving sustainable development (Box 7).

Box 7. Jordan manages the impossible: A Case Study

Given that extreme and further aggravating water scarcity, Jordan needs to reduce future water allocations in all sectors, including energy and food. In the past five years, Jordan's water resources have come under additional pressure from the large influx of Syrian refugees and their water demands. In response to the pressing water scarcity, Jordan is exploring all supply and demand management options, and is ahead of most Arab countries in terms of adding nonconventional water to its conventional water resources, in particular reusing wastewater. Also it is beginning to desalinate seawater at small scale. Both of these non-conventional water resources are more energy-intensive than conventional resources. At the same time, Jordan has a very progressive "Energy Efficiency and Renewable Energy Policy" for the water sector. Also in response to the pressing water scarcity, drip irrigation dominates in Jordan. Cereals (which generally have low economic water use efficiency) are hardly grown under irrigation. Irrigation is mostly limited to (relatively high value) fruit and vegetables. The severe water scarcity also puts water security at risk, in particular among the large refugee population, with knock-on effects for water security of the rest of the population.

Source: GIZ, 2017

4.2.8. Recent IWRM Projects

SDG2; target 2.4, target 2.4

SDG4, target 4. Target 5, target 6, target 6.A, target 6.b

Projects to improve IWRM has been widely implemented within and outside the action plan of AWSS. Improving the application of IWRM is one of the 6 pillars of the AWSS and fits with the 8th WWF thematic framework. Within this context, ACSAD works with FAO on implementing number of projects that include Capacity, building, irrigation efficiency, participatory approach in water management, rainwater harvesting and investment in water resources in different Arab river basins (see table 8). These projects made impact particularly on local communities and engaged women and youth in their implementation. The following are example of projects implemented during the past few years.

Rainwater harvesting
(targets 6.4, 6.a and 6.b)

Water harvesting is seen as a practice that improves water availability (target 4.4) in water scarce conditions. It improves life of small communities and poor people (target 6.b) living in extreme water scarce conditions in desert areas. Several water harvesting projects have been implemented in the Arab countries (ACSAD 2017). Example of such projects are implemented by ACSAD in the State of Palestine, Algeria and Egypt within the framework of AWSS action plan.

The water harvesting project in Palestine is implemented within the water harvesting strategy followed by the Ministry of Agriculture in cooperation with the Palestinian Water Authority, with support from ACSAD. The objectives of the project are to address the problems resulting from the lack of water facing the agricultural sector (target 2.3, and 6.4), mainly due to the control of the

Zionist occupation authorities on most of the water resources (Box 3), and as a adaptive measure to climate change that have led in recent years to lower annual rainfall rates.

In Algeria, the aim of the project in the area of Al-Hager (figure 27) was to collect and store winter water in the wadis by establishing a number of rainwater harvesting technologies (target 2a) including soil barriers to reduce flow velocity, reduce soil erosion and increase the proportion of recharge aquifer recharge. Increasing the storage capacity of water-bearing aquifers undoubtedly provides a permanent water source that meets the needs of the local population of drinking water (target 6a), water for livestock, irrigation and rangeland development. Overall aim was helping to improve living standards and promote social stability in the area (target 6b). The project was implemented by the Arab Center - ACSAD, the Agriculture Development Department in the Saharawi regions – Ouargla, Algeria (ACSAD, 2017).



Source: ACSAD, 2017

Figure 26. Al-Hager Area Water Harvesting Project in Algeria

Outside the projects implemented by ACSAD many countries promote water harvesting. in Saudi Arabia, the Prince Sultan Center for Environmental, Water and Desert Research at King Saud University adopted a project for harvesting and storing rain water and floods under the name "King Fahd Project to harvest and store rainwater and floods in the Kingdom" (Figure 27). The aim of the project is to Increasing water resources taking advantage of the rainwater through storage in the shallow aquifers , to reducing the risk of flash floods, to revive and rehabilitate abandoned villages socially and economically to reduce migration to crowded cities due to lack of water, to achieve sustainable agriculture in traditional agricultural areas located on the borders of valleys, to secure strategic reserve of water around the cities and villages and relieve pressure on the non-renewable deep groundwater, which contributes to rational use of water (target 6.4, 6b,).



(a) Storage basin at Darma Dam



(b) Artificial Recharge upstream Al-Hareek Retardation

Figure 27. King Fahd Project to harvest and store rainwater and floods in KSA

Improving water harvesting techniques requires a long-term government policy to support national research centers (target 2a) and extension services; adequate institutional structures; beneficiary organizations (associations, cooperatives); and training programs for farmers, pastoralists and extension staff (UNDP, 2013).

4.2.9. Adaptation to Climate Change

SDG2; target 2.4,
 SDG6; target 6.4, target 6.5
 SDG13, target 13.2, 13.3

A clear and common objective across the region is to build national and regional capacities to deal with different aspects of the climate change, adapt to the international climate regime, foster regional cooperation to adapt to the potential climate risks, and work closely with the international community to make use of the opportunities offered for climate finance, and climate friendly technology transfer.

Within this context, the “Adaptation to Climate Change in the Water Sector in the MENA Region” (ACCWaM) program is to be mentioned. The program was implemented by (LAS), (UNESCWA) and (ACSAD) over the period August 2011 – December 2017. The main objective of the project was to improve the capacity of water management institutions in the MENA region to adapt to climate change (targets 12.2 and 13.3). The ACCWaM program seeks to promote mainstreaming of climate adaptation in regional and national policies and strategies in the Arab region.

The (ACCWaM) program seeks to promote mainstreaming of climate adaptation in regional and national policies and strategies. The concepts of climate mainstreaming, climate proofing and international climate finance were introduced to Jordan, Lebanon, and Egypt during 2014.

Since September 2011, ACCWaM partnered with ACSAD and UNESCWA to develop an Arab climate knowledge hub through the “Regional Initiative for the Assessment of the Impact of

Climate Change on Water Resources and Socio-economic vulnerability in the Arab Region” (RICCAR). Progress made in in this regard included a climate impact and vulnerability assessments (target 11b) and developing an integrated climate mapping tool. Pilot Projects were implemented in Egypt and Jordan based on proposals by the national water ministries. Feasibility studies and planning processes are in progress in Egypt, Jordan and Lebanon. Achievements included also, capacity Building through in-depth information exchange about relevant common themes (e.g. climate proofing, knowledge hubs, climate funding), frameworks and regional approaches for climate adaptation and water management. Number of studies were conducted by ACCWaM including:

- a) A study with the title “Climate Change and Water in MENA: Mapping of Knowledge and Institutions” a thorough overview of the complex institutional and stakeholder landscape in the Arab Region, especially in Egypt, Jordan and Lebanon. <http://www.accwam.org/ckfinder/userfiles/files/ACCWaM%20Report%20Mapping%20of%20Knowledge%20and%20Institutions.pdf>
- b) A report on "Mainstreaming Climate Change Adaptation in National Policies, Strategies and Action Plans" assessed the state and further potential of climate mainstreaming in national water strategies in the three focus countries.

Other projects were implemented within the framework of the AWSS action plan “Pillar 5: Enhanced vulnerability assessment and adaptation to climate change” (targets 13.2 and 13.3). These included the following three Projects:

1. A Project on “study of climate change and its effects on water resources in Arab countries”. The project aims to analyze the impact of current and future climate change on fresh water resources in the Arab region. The project was implemented by ACSAD, (UNESCWA), the Institute for Meteorology and Hydrology of Sweden (SMHI) (GIZ), the United Nations Environment Program / Regional Office for West Asia (UNEP / ROWA), (FAO) and the Swedish International Cooperation Agency (SIDA) - the funding body.

Within the framework of this project, the following actions were carried out:

- Operating the regional climate model RCA4, using circumferential conditions of three global rotation models, EC-EARTH, CNRM, and GFDL-ESM, using the RCP8.5 high emissions scenario and the average emission scenario RCP4.5. These results were obtained for the whole Arab region with a resolution of 50 km.
 - In each case, the RCA4 model was run for the RCP4.5 medium emission scenario, the RCP8.5 high emission scenario and then the average mean mean for each of the three climate variables per scenario.
 - Use the two hydrographic models HYPE and VIC to estimate the variation in runoff and evaporation-transpiration up to 2100, using the results of climate models as inputs for hydrological models.
2. A Project on “assessing the sensitivity of water resources to climatic changes in the Arab region and their economic and social effects” was implemented by ACSAD within RICCAR initiative of ESCWA and GIZ-ACCWaM project. Project Objective are:
 - Analysis of the impacts of current and future climate change on freshwater resources in the Arab region.

- Assessing the impact of current and future climate change on economic and social aspects, and on environmental and human systems, through scientific and consultative methodologies to identify the most sensitive areas in the Arab region (Hotspot).
- Facilitate access to data and information relevant to climate change and its impacts, and strengthen Arab institutional capacities in climate change assessment.

The key achievements of the project were:

- Identification of the Arab climatic domain, using mathematical climatic models and recorded climate data.
- Vulnerability assessment, through three components: exposure, sensitivity, and adaptability (figure 28).
- Describe each component of vulnerability through a range of indicators.
- Study of water sectors, agriculture, population, biodiversity and environment, infrastructure and human communities.
- The Arab Center - ACSAD in the framework of the project to accomplish the following:
 - Develop sensitivity indicators for each of the studied sectors (65 indicators).
 - The mapping of each indicator using geographic information systems (Figure 28).

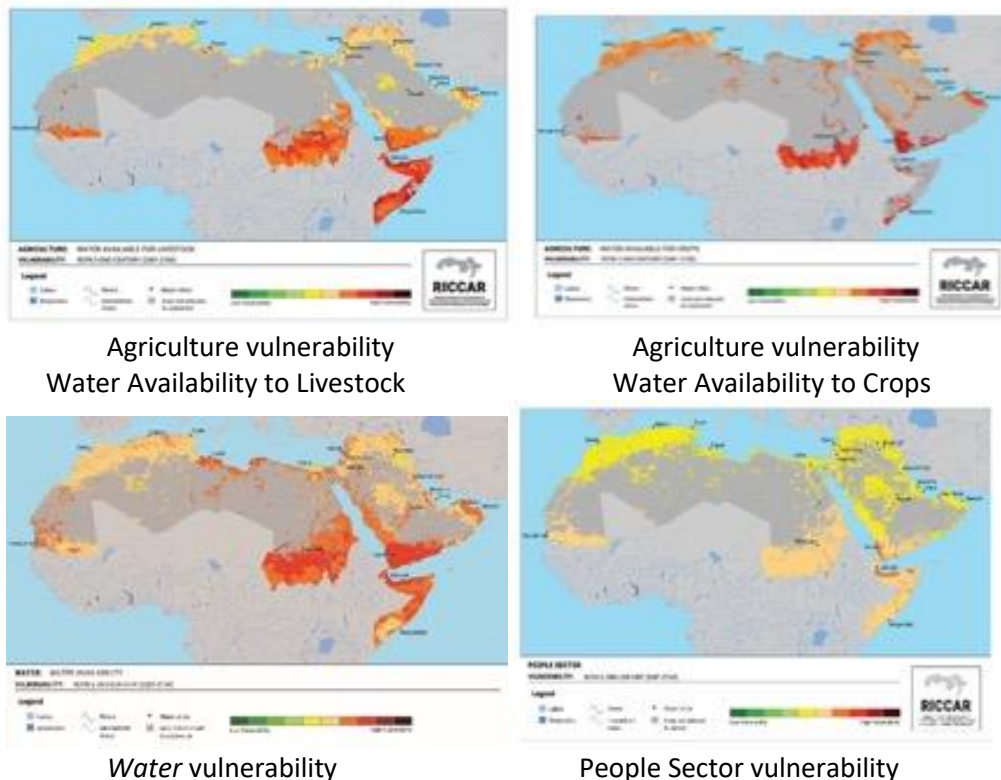


Figure 28. Models of vulnerability maps of the Arab Region developed within RICCAR Initiative (UNESCWA 2017)

3. A Project on “*assessing the impact of climate change on the productivity of some agricultural crops in the Arab region*”. The objective of the project is to assess the impact

of climate change on some agricultural crops in selected Arab regions. GIZ-ACCWaM programme,

4. The Arab Center - ACSAD, the Food and Agriculture Organization of the United Nations (FAO), United Nations Economic and Social Commission for Western Asia (ESCWA) and the German Agency for International Cooperation (GIZ) participated in its implementation.

The project studied the impact of climate change on major crops in selected countries during the two periods: mid-century (2045-2065), the end of the century (2080-2100) using the mathematical model Aquacrop, according to the RCP4.5 and RCP8.5 gas emissions. The study included the irrigated crops wheat, corn and cotton in the northern Delta in Egypt, rainfed wheat and barley in Karak governorate in Jordan and eggplant, maize, and potatoes in the Upper Asi basin in Lebanon

The most important achievements were:

- The results showed that CC will cause decline in productivity for the irrigated crops between 1 and 5 percent in the middle of the century, and between 6 and 27 percent at the end of the century for RCP8.5 and RCP4.5, respectively.
- The results of the project showed that rainfed crops are more sensitive to climate change than irrigated crops. It is expected that the rainfed wheat production in Jordan between 2 and 5 percent in the middle of the century and between 15 and 55 percent by the end of the century for RCP8.5 and RCP4.5 Respectively.
- The results of the study showed that the length of the growing season will be shortened by 18 days for irrigated wheat in Egypt and 32 days in the Upper Orontes basin in Lebanon. Despite the increase in air temperatures, it is expected that there will be a reduction in the actual water consumption of crops, due to the short duration of the growing period.
- The results of the project showed that there is likely to be a positive impact of the increase in atmospheric CO₂ concentration on plant production. This effect depends on the nature of the plant. Plants classified as C3, such as wheat and cotton, are more sensitive to increasing CO₂ concentration than C4 plants such as corn.
- Number of measures are proposed to adapt to the impact of climate change (Box 8).

Box 8. Recommended Measures to Adapt to Climate Change

- Modify sowing dates according to temperature and precipitation patterns.
- Use crop varieties which tolerates new climatic conditions.
- Application of conservation farming system (minimum tillage + soil cover + agricultural rotation).
- Application of rainwater harvesting technologies and supplementary irrigation.
- Change the fertilizer application rate.

Source: *assessing the impact of climate change on the productivity of some agricultural crops in the Arab region Project*

- Application of agricultural rotations.

4.2.10. Drought Impacts Mitigation

SDG2; target 2.4

SDG6; target 6.4, target 6.6, target 6.B
SDG15; target 15.3

Climatic variability is likely to induce more frequent and intense extreme weather events (such as droughts or floods), and less reliable water supplies, as well as less reliable agricultural productivity. More intense and more frequent drought further compromise availability and access to water. FAO is contributing to develop a Regional Drought Management System to address risk management and preparedness and response plans to mitigate the impact of drought (contribution of *FAO-RNE, Cairo*). The system will include the development of an early warning system and drought management guidelines. The implementation started with pilot countries with the following objectives:

- Consolidate an “Inter-Ministerial Group” (or Inter-Agency Team) for coordination of ‘risk/vulnerability’ assessment and the ‘preparedness plan’ (SDG target 2.4);
- Undertake a needs assessment across the major stakeholders to understand their requirements for a drought management system, the characteristics of existing systems and the nature of impacts from current and previous droughts;
- Establish a drought monitoring system using existing satellite data and the results from water modeling combined in a composite drought index that is tuned for the country conditions. The generated monthly drought maps will be at a resolution of 1km and will indicate the location and severity of current conditions, using 5 classes of drought;
- Develop an early warning system that will highlight likely 30-100 days future climate and water conditions. This will help decision-making and mitigation planning for areas at risk and support enhanced water planning (SDG target 12.8);
- Undertake a vulnerability assessment to understand the communities and parts of the economy most at risk from past, current and future droughts. This will help target future mitigation efforts;
- Further develop drought mitigation guidelines for Tunisia with the Inter-ministerial group, including definitions of roles, responsibilities, and resource mobilization for the various agencies and departments involved to ensure effective and efficient future management;
- Undertake climate change downscaling operations and analysis to understand the characteristics of future droughts such as their frequency, severity and likely affected areas in Tunisia. This will help support climate change adaptation strategies including as crop species and livestock selection, and water management practices, to build resilience for future conditions.

4.2.11. The Regional Coordination on Improved Water Resources Management and Capacity Building Program.

SDG2; target 2.4, target 2.A
SDG6; target 6.4, target 6.4
SDG13; target 13.2, target 6.4

This regional activity was a World Bank project financed by the Global Environment Facility (GEF) Trust Fund. The first phase of the project was with four countries – Jordan, Lebanon, Morocco and Centre Regional De Teledetection Des Etats D’Afrique Du Nord (CRETAN) for Tunisia. The Arab Water Council (AWC) played the role of the Regional Project Coordination and Management Office to coordinate project country activities and implement the regional integration and coordination activities. The project development objective was to improve water resources and

agricultural management and planning within and across beneficiary countries, based on quantitative and spatial-based decision making tools.

The project aimed at Improving Water Resources and Agricultural Management through providing, installation and implementation of Water Information System Platform (WISP) tools including remote sensing equipment, land surface models and land data assimilation systems that could be operated without relying on ground-based data and hence were not bound by geographical constraints and political boundaries. The WISP tools were applied to pertinent research issues in local and regional water resources (such as identifying drought and flood prone areas, estimating groundwater fluxes and evapotranspiration, monitoring climate change impacts and crop yield estimates).

The project outcomes included the following:

- Seven WISP tools were operational in total (including one in **Lebanon** and two each in **Jordan**, **Morocco** and Tunisia respectively), at project closure. The WISP tools included both: (i) common application areas in all countries (such as identification of flood and drought prone areas and related forecasting and monitoring, crop and irrigation mapping, climate change impact estimates to aid in water and agriculture management decisions. and (ii) addressing special country priorities, such as **Lebanon** using the project as the basis for developing disaster management programs and focusing on using the project data for forest fire and flood forecasting, **Morocco** using the data for guiding locust survey teams and **Tunisia** using the data to forecast floods and work on estimation of groundwater fluxes.
- Ten major water resources decisions were made in total on improved agricultural and land use management across beneficiary countries, based on the recommendations of the technical assistance activities at project closure. The decisions included:
 - Four water sector decisions in **Morocco**. (i) The real time monitoring data from the draught study was used by the Ministry of Agriculture and Marine Fisheries for conducting Morocco's compensation program for draught affected farmers. (2) Morocco's National Center for Combatting Locust launched a prevention plan in areas prone to locusts based on the conclusions of the locust study. (3). The Ministry of Water and Agriculture used the recommendations of the e climate change component study for implementing the national plan for climate adaptation. (4) The Ministry of Water and Agriculture used the water balance study for drawing a national water strategies plan.
 - Two decisions in **Jordan**. (1) An amendment to the groundwater law was enacted by Parliament following the recommendations of the Ministry of Water and Irrigation, based on the research results of the crop mapping component for selected pilot. (2) The Water Information System Platform installed through this project was used by the Ministry of Water and Irrigation for research studies on irrigation optimizations and water resource management.
 - Two decisions in **Lebanon**: (1) The Sustainable Management of Natural Resources and Early Warning Platform (SuNaR) developed for providing real time forecasting and monitoring information and maps showing hot spots for flood risk and forests fire prevention was launched in September 2014, by the Ministry of Agriculture for the National Response Plan. (2) The Ministry of Water and Energy started the

- process of standardizing, harmonizing and sharing policy in climatic and hydrological data.
- Two decisions in **Tunisia**: (1) The project outputs on climate change was used by the Ministry of Water and Agriculture in developing mitigation actions to adapt olive production to future changes. (2) The results of the simulations models for flood forecasting was used for the Floodplain Management Plan in October 2015.
 - Five regional and country project data portal to the end user agencies in the agriculture and water sectors to improve the existing development strategy, policy and planning was developed and operational at project closure, as per the revised target. This exceeded the original target of three.

The success of the project promoted the partners to move to a second phase that scale-up the activities in terms of the number of countries and variety of applications.

4.2.12. Recognizing the Water-Energy-Food Nexus

SDG2, SDG6, SDG7

The Water-Energy-Food nexus has been recently well recognized in the Arab Strategic Framework for Sustainable Development (ASFSD), adopted by the League of Arab States in 2013, aiming at addressing the key challenges faced by the Arab States in achieving sustainable development during the period 2015-2030. This new development has created unprecedented opportunities for fundamental policy changes in various economic, institutional, technological, and social systems, as well as boosting resource efficiency and productivity by addressing externalities across sectors.

The AFSD is promoting the nexus approach⁵ to water-energy-food sustainability in the Arab region, and encouraging the transition towards a green economy in order to address the interdependencies between water, energy and food to make the nexus work for the poor. Some Arab countries have already practiced the nexus approach and there are some good examples on the adoption of innovative solutions within the nexus. These include as examples: The Sahara Wind Power Project in Morocco; renewable energy for wastewater treatment and reclaimed water use in agriculture in Jordan; solar desalination in Saudi Arabia; an engineered wetland/aquaculture project in Egypt. These cases demonstrate the potential and benefits to be unlocked if technology and innovation are fully harnessed within the WEF nexus.

The series of policy briefs published by LAS with technical and financial support from GIZ offer an overview of the WEF nexus (Al Zubari, 2016). These policy briefs aim at providing a better understanding of the interdependencies of water, energy and food and their related challenges in the Arab region. Besides, it is intended to shed light on the risks and impacts posed by one sector on the others through articulating a framework for determining trade-offs and synergies that meet demand on resources without compromising sustainability. They offer an opportunity for sharing knowledge and experiences from cross the Arab countries.

It is worth to mention that the one of the targets in the Arab Region is: “By 2020, develop alternative and practical solutions for using non-conventional water resources with focus on the

⁵ The Water Energy Food Nexus approach is an integrated, holistic and pragmatic approach to address the supply risks of water, energy and food simultaneously and keep the resource base sustainable.

use of renewable energy in water desalination and water treatment for meeting the increasing water demand in the Arab Region”. RE-based freshwater generation should be seen as a valuable economic investment that reduces external, social, and environmental costs. In addition, if we use simple solar-driven small systems, it is simpler and less costly than conventional ones.

a. RE-Based Desalination

Renewable energy (RE), offers a sustainable and secure way to desalinate water. There is a great potential to develop solar desalination technologies especially in MENA region where the solar source is abundant and the installed photovoltaic (PV) costs are declining. Until recently, only small desalination plants in remote areas with no grid electricity and no skilled manpower used RE, but as R&D has intensified, several pilot desalination plants in the MENA region (figure 22) have operated successfully using mainly solar energy (SE).



Figure 29. Desalination for agriculture in Oman,
(Project funded by Agriculture and Fisheries Development Fund (RO unit
fed by solar PV at MEDRC facilities, North Al-Hail, Oman)

There are several ambitious projects in KSA and the UAE to develop large solar desalination plants, including a project in the area of Al-Khafji on SA’s eastern coast and one in the area of Ras Al-Khaima in the UAE. Both plants are set to become operational by 2020 and will be among the largest in the world (the initial phase of Al-Khafji solar desalination plant will produce 30,000 m³/day, and this capacity will double in the next few years). The Al-Khafji one will be a disassociated RO and PV system. RO will take energy from the grid and PV will be injected in the grid, compensating the energy load. A similar principle is behind a desalination plant that has recently been announced by Abengoa in Agadir (Morocco). The benefits are clear: not only does it cut costs, it also reduces carbon-dioxide emissions and fossil-fuel dependency.

A number of different technologies allow the exploitation of RE resources, providing energy as heat, power or even a combination of both. Possible combinations with desalination technologies are shown in Table 1 (El Kharraz 2015, Al-Karaghoulis et al., 2011 & IRENA 2012). RO coupled with solar PV is one of the most popular combinations in the MENA region. The main challenge of RE desalination is that desalination technologies generally work in steady-state conditions but RE sources are usually non-stationary.

In conclusion, policy makers need to consider the different choices for desalination based on locally available RE sources. In addition, solar desalination is a good example of the water-energy-food nexus implementation if combined with food production through greenhouses practices and other similar projects. As the demand for food, water and energy is expected to rise by 30–40 per cent by 2030, solar desalination is called to contribute significantly to SDG2 (food security), SDG6 (water) and SDG7 (energy). In addition, Most energy strategies within the Arab world have set goals of increasing the share of RE in the energy make-up.

b. Feasibility of Small Scale Solar Powered RO Desalination: A Case Study

Desalination of brackish and saline groundwater could play an important role in freshwater supply for areas that are remote from both seawater and freshwater resources. The main challenge is the required power to operate the desalination plants in areas where there is no power grid. Using sustainable and renewable energy source such as solar for operating a groundwater desalination system include a high recovery ratio, and high water output per unit of energy and land could be a solution.

A pilot solar powered reverse osmosis (RO) has been designed, constructed and operated in Abu Dhabi in 2010 to assess the feasibility of using solar energy to desalinate the brackish and saline groundwater in remote areas. Using solar power can help to overcome a series of desalination related problems, the most significant of which are those related to energy consumption and environmental pollution caused by the use of fossil fuels. The aim of this study is to demonstrate the feasibility of using of photovoltaic solar energy for powering RO system for the desalination of brackish and saline groundwater abstracted from the shallow aquifer system located in the western region of Abu Dhabi Emirate, with salinity ranges between 5,000 to 20,000 ppm. The design capacity of the system is 5 m³/hr with photovoltaic solar system of 45 kW hours. To minimize the cost, the system was operated during day time only to avoid using batteries for electricity storage. The produced fresh water stored in ground elevated tank to be used for 24 hrs. Also, a mathematical model was developed to calculate the required brackish groundwater and design of an RO system powered by photovoltaic energy (RO size and the number and configuration of the solar cells panels). The model was used as a tool for the design, optimization and costs.



Figure 30: Small scale solar powered RO desalination plant in Abu Dhabi.

c. Multi-Functional Wastewater Treatment

Treated wastewater is another non-conventional water resource that is increasingly, with the total quantity of treated wastewater in the Arab countries being more than 6 billion m³/year. Wastewater is becoming an important source of water, especially as its generated quantities are expected to further increase over time with increasing water consumption in the domestic sector. Out of about 60% of wastewater that is treated, about 15% are reused in agriculture, landscape irrigation and industrial cooling (World Bank et al. 2011). Wastewater processing and reuse can also generate environmental and ecological co-benefits, thus providing higher returns on investment (Abdrabo 2003). These co-benefits are related e.g. to the recycling of nutrients (and energy savings due to lower demand for mineral fertilizer), co-production of biogas and cleaner water bodies and improved human health.

Wastewater treatment and reuse is typical water-food nexus that could make difference. Energy represents both input requirement and output product with respect to wastewater treatment. Wastewater contains nearly five times the amount of energy needed for the wastewater treatment process – the majority in the untapped area of thermal energy. Capturing this energy it provides more than what is needed to operate the treatment plant, thus acts as a source of energy to other uses. The Waterleau: multi-functional wastewater treatment in Marrakesh, provides an excellent example for innovative application of the WEF nexus (Box 9).

Box 9. Waterleau: multi-functional wastewater treatment in Marrakech

Marrakesh, a rapidly growing city with over one million people faces resource challenges and environmental difficulties. In response to the growing challenge, the Waterleau multi-functional wastewater project implements nexus principles: while until 2008 untreated wastewater was discharged into the nearby wadis, Waterleau now has a wastewater treatment capacity of 236,000 m³ per day, employing biological water treatment technologies. After a tertiary treatment the water is reused in irrigation, in total 30 million m³ annually. The Waterleau plant also stabilizes the resulting sludge. After the processes of dewatering and drying, the sludge is digested in a solids reactor to produce biogas. About 22,500 m³ of biogas or ca. 135,000 kWh energy are recovered from the sludge per day. The output of the plant totals 1,6 MWe. Moreover, a solar drying facility for the sludge is under construction. So the Waterleau plant not only recycles water and nutrients (leading to savings in mineral fertilizer and hence energy required for the production of this mineral fertilizer), but it also generates energy (green electricity and heat), providing up to 45% of the plants energy needs. With that it reduces CO₂ emissions by about 60,000 tons per year. The maximum potential for reuse of urban wastewater in Morocco is estimated to about 700 million m³ per year if all wastewater was treated (currently only 25% of the wastewater is treated and only 11% is reused). Assuming similar biogas and energy production rates as in the Waterleau plant, from those 700 million m³ about 40 MWe could be generated. This energy recovery can contribute significantly to the country's renewable energy targets as well as the target of increased resource use efficiency. The solar drying technology moreover taps the region's almost unlimited solar energy potential (Morocco has an average solar radiation of more than 5 kWh per m² and day). Given the region's fast growing municipal water demand, this nexus approach to wastewater, sludge and solar energy can and should be replicated in other countries and contexts, in large cities as well as in a decentralized form in small villages.

Source: *Waterleau – protecting the 4 elements.*



d. Biological Wastewater Treatment

Another good nexus example is using engineered wetlands to treat polluted drainage water in Egypt, where reuse of drainage water for irrigation is an important practice to compensate for the deficit in fresh water availability. Population increase and intensive development with shortage of sanitation services made the agricultural drainage system receive loads of untreated sewage and domestic wastewater. Pollution of agricultural drains has seriously threatened the health of local people and the viability of economic activities such as fisheries, raising livestock, and farming. Two types of wetlands were used (Box 10). The first experience was the engineered wetland close to Lake Manzala. More recently, in-stream wetland has introduced in the more densely populated crop lands where there is no enough space for engineered wetland. In both cases wetlands proved to provide an economically and environmentally sound alternative to traditional wastewater treatment facilities, while using the treated wastewater for agriculture and aquaculture production.

Both the Waterleau and the Wetlands examples make a testing ground for the need to coordinate energy, water, and food policies, while reducing environmental footprint and improve resilience

Box. 10. Lake MANZALA engineered wetland, Egypt

Lake Manzala is an internationally registered important Bird refuge area by the Mediterranean Sea. Although Lake Manzala once supplied 30% of Egypt's fish from a varied catch, including highly valued marine species such as mullet and sea bass, recently 90% of the fish catch has consisted of four small but hardy species of tilapia. A constructed wetland project near the outlet of Lake Manzala, which was funded by GEF consists of intake structure, pump station, sedimentation basin, three free water surface cells, and reciprocating unit consisting of two subsurface flow cells. It succeeded at just one-quarter of the cost of conventional methods to remove 61% of the biological oxygen demand, 80% of suspended solids, 15% of total phosphorous, 51% total nitrogen, and 97% of total coliform bacteria.

In-stream wetland application has emerged as a practical and low-cost alternative to engineered wetlands in areas of high population and intensive agriculture such as the situation in the delta. A pilot in-stream wetland was constructed within Al-Bahwo drain reduced the contaminants by 24% for suspended solids, 58% for biological oxygen content, 50% for chemical oxygen content, 99% for coliform, 98% for fecal coliform. The in-stream wetland treatment systems allow sedimentation, filtration, biodegradation, nutrient plants uptake, and pathogens eradication processes.

The wetland treatment provides an economically and environmentally sound alternative to traditional wastewater treatment facilities. Their operation and maintenance costs are low with minimal energy requirements. Following treatment, the majority of the water is used for irrigation and agriculture, while some is diverted into basins designed for fish farming. They provide local livelihoods through support services and small-scale manufacturing ventures: plant harvesting and seedlings propagation for stocking the wetlands; production of fuel and animal feed pellets from harvested biomass; and harvesting of aquatic plants from the wetlands. The success of, has created global interest in the potential of this technology as a low-cost and low-maintenance alternative for treating wastewater.

to climate change at the national level.

e. Treated Wastewater Aquifer Recharge

With a population of over 1,300,000, the rapidly growing Abu Dhabi Emirate faces an increasing need for reusing its tertiary Treated Sewage Effluent (TSE) due to increasing demand for water supplies in different development sectors. In Abu Dhabi Emirate, the annual production of treated wastewater is about 285 million m³ in 2014 which is about 8% of the total Emirate water resources. Only about 55% of the treated wastewater is reused in wetlands, landscaping, and recreation areas. Recently, a new emirate strategy for assessing the alternative options for reusing the treated wastewater was developed including irrigation of agriculture crops and aquifer recharge (Box11).

Box 11. Feasibility of Using Treated Wastewater in Aquifer Recharge

Groundwater recharge with treated wastewater presents a wide spectrum of technical and health challenges that must be carefully evaluated. The lack of specific criteria and guidelines governing the artificial recharge of groundwater with treated wastewater called for a feasibility study to assess the aquifer suitability, risks, pretreatment requirements, environmental factors, purpose of groundwater recharge, sources of treated wastewater, recharge methods, location and economic parameters. The results of the cost benefits analysis indicated that the treated wastewater reuse would have a range of positive economic and environmental impacts. For the direct use in irrigation uses, the market value for tertiary treated wastewater is set between \$0.65 and \$1.1 /m³ without pumping and between \$0.95 and \$1.31 /m³ with pumping while the estimated operation and maintenance cost for producing and transmission of the wastewater to the demand centers is about \$0.16/m³ without pumping and \$0.16/m³ with pumping. Reusing treated wastewater will reduce nutrient concentration which may detriment agricultural crops fertilization, although the negative economic impact figures vary from different studies between \$-0.07/m³ and \$0.01/m³. The reuse will help to replace daily use of desalinated water of about 125,000 m³.

Source: A contribution by Dr. Mohamed Dawoud, ADEA.

f. Brackish Water for Agriculture

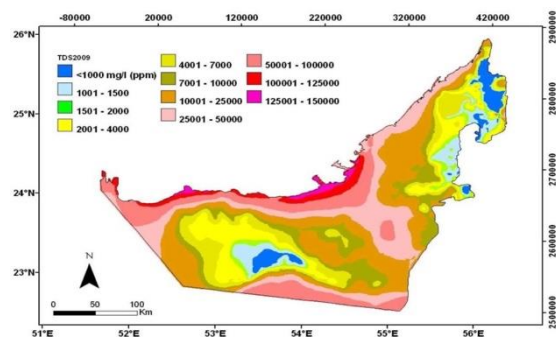
Non-conventional water resources are not limited to desalination and treated wastewater but extends to brackish water mainly from underground sources. Brackish groundwater does not have an exact definition, but it is typically defined as distastefully salty but less saline than seawater (35,000 milligrams per liter). Commonly it is of salinity between 1,000 to 10,000 ppm. It has potential for many economic uses that could close the gap between water supply and water demand. The use of brackish groundwater ranges from direct use for irrigation of salt tolerant plants, fish farming and aquaculture, industry for feeding or cooling power generating, oil and gas drilling, to domestics after treatment with RO desalination technology at much lower cost than sea water desalination. Brackish groundwater use allows the preservation of freshwater resources for other higher quality uses.

As such, brackish groundwater use is emerging as an established water management practice in Arab water-stressed countries. Brackish groundwater can be used directly for irrigation of salt tolerant plants after efficient planning and design of irrigation systems and frequency. However,

there are many challenges facing the direct use of brackish groundwater such as accumulation of salts on to the top of surface soils which renders the land non-usable for crop production. For this reason, AWC with support from UNESCO Office in Cairo published a dedicated policy brief for the sustainable use of brackish water in agriculture (LAS, 2017). Furthermore, FAO prepared guidelines for the same purpose (Box 12). The salinity also affects the groundwater wells materials and minimizes the wells and pumps lifetime which has economic implications. Currently, several countries in the Arab region have acknowledged the challenges associated with increasing groundwater salinity and have undertaken initiatives to use these valuable resources.

EGYPT: Recent studies indicating that brackish groundwater exists in all aquifer systems in Egypt. The sustainable annual yield in regions which are also the regions suitable for population redistribution is estimated at about 325 million cubic meters from all aquifer systems, with salinity ranging between 1,000 to 30,000 ppm, at the beginning of development, and is expected to increase with time, especially for the Pleistocene and the coastal aquifer systems. Using these resources is still limited due to: occurrence of brackish groundwater is in low demand areas; RO desalination for these resources in those areas is expensive with disposal of the brine challenges. The major utilization of brackish groundwater in the past was limited to hotels/resorts, Bedouins for small agricultural activities and as a drinking source for people and for cattle. During the last decade, medium to large farmers started to transfer their agricultural land in the northern part of the delta where land is not suitable for growing crops, to fish farms based on brackish groundwater (Attia et al., 2010).

UAE: In UAE due to over abstraction most of the groundwater aquafer system has been deteriorated and most of the aquifer potentiality which is about 650 billion cubic meters has become brackish to saline groundwater. At present the brackish groundwater use contributes with about 50% of the total water use in UAE. It is used directly for irrigation of frames and forests and for domestic sector after using membrane desalination technology (Dawoud, 2014).



Box 12: Guidelines and best practices for the use of brackish water in agriculture (Algeria, Egypt, Iraq, Jordan, KSA, Morocco, Tunisia and Yemen)

SDG2: target 2.3 and target 3.4

SDG6: target 6.3, target 6.4 and target 6.B

Within the framework of the FAO Regional Water Scarcity Initiative, and the Arab Water Security Strategy, FAO worked closely with the Arab Water Council and eight selected pilot countries from Arab Region namely: Algeria, Egypt, Iraq, Jordan, Kingdom of Saudi Arabia, Morocco, Tunisia and Yemen, to develop “Guidelines for Brackish Water Use for Agricultural Production”. This joint activity aimed at supporting Arab countries for developing their capacity on related fields while using brackish water. It was implemented on full partnership and high-level commitment with the concerned counties, through series of consultative meetings and regional workshops. The main outcome to enhance the use of brackish water in agriculture was highlighted as a need to have practical guidelines to determine at least water salinity limits, crops to be selected, and good agricultural practices, that are indispensable to have efficient, economical, and environmentally use of brackish water in agriculture production. These elaborated Guidelines and Best Practices are being tested in the focal countries, where the impact of the use of brackish water for agricultural production has many negative effects related to environmental, technical and social aspects. The presence of very diverse soil-plant-environment conditions in the Arab Region makes difficult to adopt standards that can be highly generalized. This explains why broad guidelines for average conditions have been suggested so far in the literature. Therefore, it is widely acknowledged that these new guidelines are very helpful for all the Arab Region.

Source: FAO-RNE, Cairo

5. Sessions

5.1. Ordinary sessions

5.1.1. Climate: Moving from climate vulnerability maps to policy action in adaptation to climate change

Global and regional climate and hydrological models as well as vulnerability maps showing the likelihood of distribution of hotspots to be hit hard by climate change impact on water, livelihoods and nature show that the knowledge base for policy action is sufficient to start action in adaptation to climate change in the region. The session will provide a platform to share with the world the current flagship projects countries and organizations are already implementing in water, agriculture and territorial development planning. A question to be also debated is about other regions’ experience in planning and acting in the realm of uncertainties of Climate change impacts and what experiences related to institutional innovations could be learned (worldwide) on proofing the water, cities, livelihoods and agriculture sectors through climate change adaptation mainstreaming in climate policies.

5.1.2. Development

Since 2014, a regional initiative led by the League of Arab States, regional organizations and donors joined efforts to promote an integrated approach for efficient use of depleted resources that are a threat for sustainable and secure supply of water, energy and food.

Several projects were conducted focusing on regional policies pinpoint the multiple challenges to be considered in planning similar experiences in other regions worldwide, The silo approach is entrenched in the institutional landscape in countries. NGOs and CSOs are often sectoral in their approach and so is the private sector.

Despite the fact that SDGs narrative stresses the necessity of an integrated approach to achieve SDGs, the reality of sectoral policies and strategies in countries requires several framework conditions to operationalize the WEF nexus approach and ensure coherence and integrated planning mechanisms.

The central question to debate in the session is: How WEF nexus is helping to achieve the Sectoral SDGs and how countries and stakeholders could use the Agenda 2030 to promote an integrated approach to ensure sustainability and efficiency of water, energy and land use and thus supply securities. How to optimize the two-ways benefits between SDGs (targets) and WEF Nexus approach.

5.1.3. **Urban** : Sustainability challenges need integrated solutions: Is the nexus Water, Energy, Food security the answer?

Since 2014, a regional initiative led by the League of Arab States, regional organizations and donors joined efforts to promote an integrated approach for efficient use of depleted resources that are a threat for sustainable and secure supply of water, energy and food. Several projects were conducted focusing on regional policies pinpoint the multiple challenges to be considered in planning similar experiences in other regions worldwide, The silo approach is entrenched in the institutional landscape in countries. NGOs and CSOs are often sectoral in their approach and so is the private sector. Despite the fact that SDGs narrative stresses the necessity of an integrated approach to achieve SDGs, the reality of sectoral policies and strategies in countries requires several framework conditions to operationalize the WEF nexus approach and ensure coherence and integrated planning mechanisms. The central question to debate in the session is: How WEF nexus is helping to achieve the Sectoral SDGs and how countries and stakeholders could use the Agenda 2030 to promote an integrated approach to ensure sustainability and efficiency of water, energy and land use and thus supply securities. How to optimize the two-ways benefits between SDGs (targets) and WEF Nexus approach.

5.1.4. **Ecosystems: Wetlands for mitigation, adaptation, nature and livelihoods in the Arab region**

Over years, several wetlands suffered the multiple anthropogenic and natural depletion. As a result, extreme events, the loss of ecosystem services and of biodiversity have raised awareness and engagement of countries in projects to protect wetlands. This is particularly relevant to the region where countries that experienced unrest where environment degradation was serious. This could be turned into a remarkable opportunity.

Wetlands could provide a double dividend investment for sustainable development. The issue for debate in the session is How to make wetlands a buffer to weather extreme events (floods) that are likely to increase with Climate change, while preserving biodiversity and ecosystem services in reconstruction and rehabilitation endeavor. How to put wetlands at the heart of nature friendly



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reconstruction efforts in countries that went through conflicts over the last five years. What innovative partnerships under SDG 17 could support countries in making wetlands resilient to internal (conflicts) and external shocks like climate change.

5.1.5. Finance: Role and frame conditions for the PPP in achieving SDGs

The results of recent experience in BOT and commercial contracts with private sector have had a mix of successful and failing experiences in countries in the region and worldwide. The central question to be debated in this session is about BOT and delegation/sub-contracting experiences. What's new and how the "truism" narrative and skepticism about the role of private sector in water supply and sanitation could be shared. The experience of Morocco, Gulf countries and Jordan (government and private sector) shed light on the frame conditions for working and sustainable PPPs to buffer the cost of universal access to water and sanitation as stipulated in SDG 6. A second layer of this question is about ways to make adaptation in the water sector a sustainable business case the way renewable energy has attracted huge investments.

5.2. High level Panel: Water related SDGs in crises prone regions: turning reconstruction into sustainable development

Several countries in the Arab and African regions as well as parts of other regions are entering a new era in water challenges, the post scarcity coupled with conflicts. Countries are facing the double challenge of dealing with protracted crises while striving to meet the basic needs and legitimate aspirations of their nations to sustainable development. Universal access to water and sanitation in countries facing entrenched turmoil needs more than innovation, solidarity and justice. The number of displaced is at its highest today with a total of refugees surpassing 65 Million people in 2015 According to UNHCR. One out of every 113 people on earth are facing such reality.

WWF 8 is a remarkable opportunity to show case that humanitarian aid in water supply and sanitation is not enough and cannot be a substitute to sustainable development. Resilience of countries hosting mass displacement due to human and natural crises need to share their experience and learn from each on how to conciliate crisis management and sustained action to achieve the 2030 development agenda. This debate will feed the progress of several global agendas including Paris agreement, Sendai Declaration and the UNHCR endeavor to develop and implement a Comprehensive Refugee Response Framework.

Purpose

The panel will discuss on what makes a and sanitation policy transition from reconstruction to sustainable development in water and sanitation sector within the frame of Sustainable Development Goals. The perspectives of both countries recovering from conflicts and countries hosting refugees will lead to an agenda for preparedness to be built for anticipation and mitigation of human tragedies in cases of conflicts.

The post-conflict time could be turned into an opportunity to adequately plan and implement sector and cross sectoral programmes for universal access to the right to water and sanitation within the 2030 vision in countries and regions.

Questions to be discussed

1. How to reconcile reconstruction and achievement of SDG6 in post conflict areas

2. What are the pillars of a preparedness strategy (regional and at country level) to ensure socio-economic and environmental resilience to shocks including forced migrations
3. What are the key drivers to ensure universal access to water and sanitation to the 65 Million refugees worldwide by 2030.
4. Sharing water also means sharing responsibility, how countries affected by mass migration could keep their aspirations and commitments to achieve SDG 6 and how reconstruction could be turned into an opportunity to plan and implement adequate policies to achieve the agenda 2030.

5.3. Special Session Transboundary water: Turning potential tensions into partnerships for regional development

The Arab region is not only the region facing scarcity the most, it also remains the only region worldwide that receives more than 66% of its renewable water from upstream countries. Thus, “Sharing Water” makes more sense to this region than any other region in the world. This water reality governed by custodian law far before the conventions and agreements were signed and for centuries, shared water narrative was on peace and cooperation rather than today’s media discourse on water war and water conflicts that luckily did not happen yet. This said, over the last decade, with “no water causes” of tension, water has come to focus as a risk factor in transboundary water.

Purpose:

The session purpose is to analyze the role of international and custodian law in preventing conflicts on transboundary water resources and how the water convention and its programme of work is supporting countries to achieve the SDG 6 indicator 6-5-2 and turn tensions into meaningful, just and equitable development partnerships as stipulated in SDG 17

Questions to be discussed:

Within the SDG indicator 6-5-2 framework:

- How a dialogue focusing on quantified benefits can facilitate transboundary water cooperation and unlock stagnating cooperation processes
 - How to build a negotiation around benefits of cooperation or cost of inaction?
 - How to optimize benefits for the conservation and development of transboundary basins: How can benefit approaches best facilitate agreeing on conservation projects and investments in transboundary basins?
 - How can the definition of development priorities in transboundary basins based on identified common benefits help prioritizing and financing development projects in basins ?
5. How do regional development priorities and regional economic integration initiatives relate to the generation of transboundary water cooperation benefits that help countries to achieve their ?

6. How can a dialogue on the benefits of cooperation help understanding and implementing international water law in the broad sense broadly?
7. How to make greater cooperation through successful communication efforts
8. How to move the agenda forward with the benefit approach to transboundary water resources in the frame of SDG6 Indicator 6-5-2 .

Scope

Transboundary waters are will shape The future of development worldwide. The session will be of direct benefit to other regions. The proposed panel will debate with the global audience “Best policy practices and bottlenecks” in moving from potential tension to development opportunities in shared basins in the Arab region and beyond.

Relevance

The focus on quantifying benefits of cooperation on shared waters, the session topic is of relevance to all regions as the intention is to debate the framework conditions to shift from tension to development cooperation within the Indicator 6-5-2

Impact and added value

Elaborating the framework conditions for a global shift from tension to cooperation in the context of shared basins. The speakers being a mix of executive policy makers, academia, NGOs and donor organizations will share their reflection on practical steps to boost the adoption of a benefit approach to transboundary and set the stage for countries to achieve progress on SDG 6 Indicator 6-5-2.

6. Final Remarks

6.1. Regional issues synthesis

The following issues and recommendations are the key outcome of the Forth Arab Water Forum that constitutes the culmination of the regional process in preparation of the World Water Forum 8. The regional forum is organized by the Arab Water Council in partnership with the League of Arab States and the Ministry of Water Resources and Irrigation in Egypt and attended by more than 400 participants from 22 Arab countries with all stakeholders represented.

6.1.1. At the Institutional and policy level

For the Arab States

- Arab countries have the primary responsibility for follow-up and review of the progress made in implementing the SDGs, which will require quality, accessible and timely data collection. Regional follow-up and review should be based on national-level analyses and contribute to follow-up, review and report at the global level. However, the development of regional monitoring mechanism is important for monitoring the overall regional progress.

- Investments in water, sanitation and hygiene programs should be encouraged by providing sufficient finance and an enabling regulatory environment and proper legislations to ensure maximum and long-term benefits that attract private sector through proper regulations and attractive incentives.

Inclusive Governance : All segments of society matter, state driven business alone cannot achieve SDG6

- There is a need for strong national alliances at several levels: people (including youth and gender), private, public, policy, governance and finance in order to design and implement national plans to achieve SDGs especially SDG 6 and to address water issues collectively.

Regional cooperation: No country can do it alone

- The Arab Water Ministerial Council offers the policy leadership to lead implementation of The "Arab Water Security Strategy 2030" and its action plan. The strategy needs to be updated to accommodate the SDGs requirements, recent new and emerging water challenges and mobilize funds to implement its action plan.
- The League of Arab states should facilitate and be more aggressive in approaching Arab Funds to support the Arab states, regional NGOs and CSOs in achieving the SDGs.
- Arab States to support systemic mechanisms for data sharing and generate regional updates similar to "State of the Arab Water Report".
- Cooperation between Water Ministerial Council and Other sectoral councils (Agriculture, Environment, Energy) is needed to support coherence in policies and strategies to achieve sustainability of the water resources and minimize the risks of Water insecurity, Food and Energy insecurity and support the countries and the region to achieve SDGs.
- Cooperation in transboundary water resources requires a common understanding on all countries commitments to optimize the benefits for all riparian countries and minimize the risks of potential tensions.

Development Partners

- Regional and international development partners are invited to continue and scale-up their valuable role in supporting the Arab countries in their endeavor in addressing the scarcity challenges and achieving the SDSGs.
- Development partners are invited to join the AWC and other regional organizations efforts and collaboration in projects and initiatives related to non-conventional water resources, recycled water, climate change and nexus programs.
- Further cooperation and knowledge transfer are needed in the Region through regional and international organizations and institutions based on acquired experience in the Arab Region and its needs.
- Capacity building and institutional development programs could be organized on regional and national scales and on the stakeholders/end-users needs.

6.1.2. At the Thematic Level

Shared Water

- Improving cooperation on shared water resources management between Arab states is a priority for water security in the region.
- The importance of fostering cooperation, integration, fund mobilization and data sharing in transboundary waters. Water needs to be considered as a collector not a sector.
- Importance of capacity development for Arab negotiators on management of shared water resources issues.
- Aside from International entities, regional organizations are called to play a vital role in developing dispute and conflict resolution mechanisms among riparian countries of shared basins.

Non-Conventional Water Resources

- Promoting the use of non-conventional water resources (NCWR) should receive concerted efforts by all stakeholders at national, regional and international levels to help the region to achieve one of the most important goals of the Arab Water Security Strategy 2010-2030.
- Desalination is the most promising sector to supply high quality water resource. Building up local and regional capacity and knowledge hubs in desalination technology development is highly recommended. International cooperation on such initiative will support the countries in need particularly the Arab LDCs.
- The Arab governments should encourage the Arab investors to participate in the desalination industry and grounding of the desalination technology.

Water-Energy-Food Nexus

- There is a need to attract the private sector investments beyond water projects and to have integrated investments projects to implement nexus approach.
- Trajectories for the adoption of a WEF nexus approach are to be formulated under the present institutional landscape and ongoing policies in the Arab region and in pilot countries where LAS, GIZ, ESCWA and FAO as well as regional organizations are implementing various initiatives in partnerships with countries and regional organizations.
- Leverage of systems efficiency and institutional reform is needed to adopt nexus approach in the region.
- Research and piloting is needed to develop cost effective technologies for renewable solar energy development as an entry point to pilot and scale up nexus projects.

Climate Change

- Arab countries should facilitate data exchange and knowledge sharing through existing and new knowledge hubs dedicated to water and climate change

- Adaptation measures to climate change are urgently needed. Proofing water investments against the impacts of climate change present genuine development opportunities.
- It is recommended to study the hydro-climatic changes under different scenarios to estimate future stream flow projections for the Nile, Jordan, Tigris and Euphrates basins.

Science and Technology

- Innovation and Development Research investments in water sector need to be strengthened at country and regional levels.
- Use of available technologies for monitoring, treatment and reuse of wastewater and drainage water, desalination should be prioritized in the countries and the region
- Use of remote sensing technologies in supporting solutions to reduce agricultural water productivity gaps is recommended.

6.2. Key messages

The key message to the forum:

1. The Development Agenda 2030 offers a strategic framework countries should commit to and implement to secure a better water future. Other global agendas such as Sendai Framework for Disaster Risk Reduction and Paris agreement should be aligned to ensure water security for all.
2. The success in achieving SGD 6 calls for regional and international cooperation and solidarity to support countries in order to achieve the ambitious targets set by countries.
3. Newer challenges add hazards and complexity to water Scarcity challenges in the region. They require new models of inclusive and anticipatory governance, innovative financing mechanism and sustainable partnerships.
4. Transboundary water resources need to be put in the frame of regional development to share and optimize benefits of cooperation and mitigate potential tensions in the future
5. Innovation, Science and Technology transfer will certainly contribute to achieve SDG 6 targets and water security for all requires commitments. It calls for consistent commitments from both developing and developed countries.
6. Ecosystems health should be prioritized in development policies not only for the services they offer to communities but also as a buffer to climate change impacts and to make the economies climate proof.
7. Peace and stability are a key to sustainable water resources management and human securities. They call for regional and global engagement and commitment to prevent conflicts, end occupation, forced mass displacements and migration.
8. A better water future for the region and for the world needs pertinent policies, effective institutions with adequate capacities.
9. The emerging trend to put water in the heart of other sectors' policies and strategies in the some countries in region is key to achieve the SDG6 targets is to be sustained.
10. The forum is an opportunity to share and learn from other regions innovative governance mechanisms related to groundwater management.
11. International cooperation, commitment and solidarity is needed to bridge the capacity and knowledge gaps but also the necessary funds to deal with newly emerging

international challenges such as mass migration and displacements and terrorism against water infrastructure in conflicts areas and countries.

6.3. Interregional relations carried out

Given the many similarities and opportunities for joint learning between the Arab Region and the Mediterranean regions, shared events were organized during the regional process of the WWF 8. A close coordination and cooperation in organizing specific sessions at the Arab Water Forum 4 and the Mediterranean water forum. The tangible outcome of the interregional cooperation is the identification of projects of common interest to be developed as a continuation of the regional process of the WWF8.

Concrete ideas around the need to connect and exchange between water knowledge hubs in the two regions particularly on issues related to shared waters, water and migration, water climate change as well as the nexus water energy and food security. Joint capacity building in the frame of SDGs were identified as opportunities to work across the two regions beyond the WWF8.

6.4. Annexes

6.4.1. Annex 1. Acronyms and abbreviations

AMF	Arab Monetary Fund
ACSAD	Arab Centre for the Study of Arid Zones and Dry Lands
ACWUA	Arab Countries Water and Utilities Association
AFED	Arab Forum for Environment and Development
APACC	Arab Plan of Action to deal with Climate Change
ASDRR	Arab Strategy for Disaster Risk Reduction.
ASFSD	Arab Strategic Framework for Sustainable Development
ASFSD	Arab Strategic Framework for Sustainable Development
AWC	Arab Water Council
AWF	Arab Water Forum
AWMC	Arab Water Ministers Council
AWSS	Arab Water Security Strategy
CEDARE	Centre for Environment & Development for the Arab Region & Europe
CRN	Climate Risk Nexus
ESCWA	Economic and Social Commission for Western Asia
FSCC	Food Supply Cost Curve
FAO	Food and Agriculture Organization of the United Nations
GCC	Gulf Cooperation Council
GEF	Global Environment Facility
GERD	Great Ethiopian Renaissance Dam
GIZ	German Agency for International Cooperation
IWS	Initiative on Water Scarcity
HDI	Human Development Index
HLPF	High Level Political Forum
ISC	International Steering Committee
IWRM	Integrated Water Resources Management
LAS	League of Arab States
MPI	Multidimensional Poverty Index
RCIWRC	Regional Coordination on Improved Water Resources Management and Capacity Building Program
SE	Solar Energy
SDGs	Sustainable Development Goals
UN	United Nations
UNEP	United Nation Environmental Program
UNDR	United Nations Development Report
UNCTAD	United Nations Conference on Trade and Development
WHO	World Health Organization
WISP	Water Information System Platform

6.4.2. Annex 2. References

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6.4.3. Annex 3, County reports

Water and Terrorism: Water Infrastructure Exploitation in Terror against Iraq by ISIS (Daesh)⁶

Introduction

In the last few decades, an unfortunate trend can be observed in the Middle East and indeed in some other parts of the world. States, societies and illegitimate groups have demonstrated a growing tendency to use water as a force of destruction rather than as a source of nourishing human society and environment. While some treat water infrastructure as a target in violent conflict, others use water as an instrument of violence. When water is treated as a target of violent conflicts, there is a deliberate effort to target the following:

- Water and sanitation infrastructure
- Supplementary infrastructure such as hydropower plants, electricity grids connected to any water-related activity.
- Contaminate water using chemicals, bacteria, or any other harmful substance.
- Drain natural and manmade water bodies
- Harm civilians by flooding towns, cutting off water supply, or drying up water bodies,.
- Disrupting supplies or flooding farms and industrial areas.

This paper reviewed the magnitude of material and moral losses caused by the terrorist Daesh on the Iraqi water system, which were estimated at more than 600 million US dollars as an initial estimation.

1- Recent History of Water Violent in Iraq

The destruction of water infrastructure has featured frequently in the conflicts in the Middle East. The wide occurrence of such destruction is explained by the wider scope of its consequences. In recent years, attacks on water infrastructure have increased, both in intensity and frequency.

In July 1981, Iraq experienced blackouts in its Kurdistan region when Iran targeted and bombed a hydroelectric station in the Kurdish region, destroying half of the turbines and 70% of all transformers. During the US-led invasion of 2003, the water infrastructure of Iraq was destroyed extensively. About 40% of Baghdad's water network was destroyed due to bombings, due to which half of the city lost water supply. In the aftermath of the war, water lines, wastewater treatment plants and pumping stations were damaged and looted, which further contributed to the deterioration of the water system in the country. In 2011, an explosion occurred at a water treatment plant in Baghdad which formed a chlorine gas cloud over the city and harmed hundreds of residents².

In April 2014, an oil pipeline running from Tikrit to Baiji oil refinery in Iraq burst and spilt oil in the Tigris. It was said to have caused by attacks by gunmen, but engineers also cited the aging,

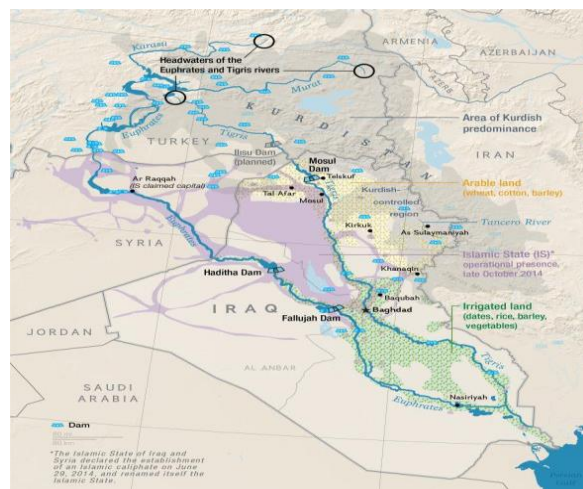
⁶ State commission of Dams and Reservoirs, Ministry of water Resources, Iraq.

rusting and corroded nature of the pipeline as a contributing factor. The oil spill spanned over 4 kms and travelled more than a 100 kms to reach Baghdad. The oil was set ablaze, reportedly by the emergency crew of the oil company, which led to air and water pollution in the region. Major water plants along the way had to be shut down, including three plants in Baghdad city. The spill had an adverse impact on the locals' health, drinking water supply, and irrigation. Whether the pipeline was burst specifically to pollute the Tigris could not be determined, but the damage, even if collateral, was serious. Contamination of water can prove to be deadlier than damage of infrastructure, as it has a direct impact on human health, local biodiversity and agriculture. Also, it can spread over large distances swiftly, and is difficult to control^{2,3}.

2- Daesh and Water Violent

The terrorist organization (Daesh), a non-state entity, used water more strategically and played it as a vital card for its benefit and ambitions. While it aimed to control oil and gas fields, the traditional key and coveted resources of the Middle East, it had also recognized the importance and vulnerability of water in the region. The aggressive and speedy use of water as a weapon, in both conventional and unconventional ways, was the Daesh strategy against Iraq^{4,3}. In this context, the following projects have been targets for Daesh. Fig 1 shows the the existence of Daesh in Iraq and Syria:-

Figure 1: The existence of Daesh in Iraq and Syria.



The list of water infrastructure targeted by the terrorists included series of major installations and critical threats to water and food security in Iraq, including:

- Mosul dam, the largest dam in Iraq, it can store 11 billion cubic meters of water, more than 50 percent of the revenues of the Tigris River from Turkey, which was completed in the mid-1980s. The dam was constructed for flood prevention, water storage and hydropower generation of 750 MW. The terrorist Daesh controlled the Mosul dam in 2015 for 45 days. The occupation of the dam led to heavy losses, the most important of which was the martyrdom, injury and escape of a number of dam staff, stopped operation and maintenance of the dam throughout the occupation period and the destruction of a number of water infrastructure of the dam.

Following are the photos before and after the emergency rehabilitation in the housing complex and Spillway Bridge of the dam.

Figure 2. the Mosul dam housing camp before and after the emergency rehabilitation.



Figure 3. Mosul dam spillway bridge before and after the emergency rehabilitation.



- Fallujah barrage: it is located in the Euphrates basin south of the city of Fallujah. It was constructed in 1985 to control the water of the Euphrates and in particular to secure the irrigation of major reclamation projects covering hundreds of thousands of Acres representing the food basket of the capital Baghdad and the province of Babylon as well as control the flow of the Euphrates River.

In 2014, Daesh (the terrorist organization), controlled the city of Falluja and its vital installations, including irrigation facilities. The organization advocated a number of operational procedures in the total representing the use of water in its criminal and sabotage activities, where they did the following

- use of stored water provided by the barrage to flood the areas outside its control.
- destruction of large parts of the gates of the barrage and its other facilities.
- Stopped all gates to prevent the discharge of stored water to barrage downstream.

Figure 4. Fallujah barrage before and after the emergency rehabilitation.



- Ramadi Barrage: it is located on the Euphrates River, north of Fallujah. It was constructed in the 1950s with a discharge equal to 3000 m³ /s, to control the Euphrates River southward, and divert the water to Habbaniyah Lake. Drinking water purification plants rely on the storage of this barrage to obtain the necessary water. In 2014, the terrorist organization (Daesh) occupied the barrage, caused great damage by destroying 10 gates out of 24 gates including its steel structure with a length of 96 meters, disrupting the technical and service work of the barrage. And the partial destruction of the barrage building.

Figure 5. Ramadi barrage before and after the emergency rehabilitation.



Al-Warar Regulator: it is located within the Ramadi system. The purposes of the regulator are to transmit water, avoids the risk of flooding, and raises the water level for irrigation purposes.

In 2014 the terrorist organization (Daesh) controlled the governorate, causing the completely collapsed of 8 gates with its steel structures at 10 meters altitude and 110 meters length. Collapse of the concrete pillars of the gates due to the regulator exposure to several terrorist bombings. Destroying the measuring station of water discharges on the Euphrates River and stealing specialized equipment used to monitor water imports.

Figure 6. Al-Warar barrage before and after the emergency rehabilitation.



- Adhaim Dam: It is located on the Adhaim River within the administrative borders of Diyala Governorate. The number of villages on the eastern bank of Adhaim river / Diyala Governorate is 16 villages and the area that irrigates from the river is 39,000 Acres and the same area is in the West Bank. The amount of storage is 1.5 billion m³, the date of completion 1999, the proposed electric power is 27 MW.

Damage caused by terrorist activities:-

- Damage to the building of the energy tunnel, irrigation tower and gates of the tunnel of conversion
- Damage to the building of the drinking water plant, housing complex, cars and vehicles, and generators and transformers.

3- Emergency Rehabilitation after liberation

The sabotage works that affected the water projects amounted to 70% of the entire water infrastructure, including Ramadi, Fallujah and the closure barrages. In mid-2015, after expelling

the militants of the terrorist organization (Daesh) from most of the areas it controlled, the Ministry of Water Resources / General Commission of Dams and Reservoirs started an emergency rehabilitation plan to repair the damage and re-operating these facilities.

The financial cost of rehabilitation of the damage to various water facilities reached 600 million US dollars, although there is still a lot of rehabilitation work to be done. , but because of the financial scarcity of Iraq, many of them have stopped.

Conclusions

Water has emerged as an important factor in violent conflicts in the Middle East, often with disastrous results for the environment, society and security of the region. There is a need to stop and prevent targeting of water infrastructure or use of water resources as a weapon in the future. The most ideal solution is to build peace, resolve conflicts, uphold dignity and human rights, deliver good governance and promote development in general sense. However, besides these general solutions to prevent all kinds of violence specific solutions at national, regional and international level are required to focus specifically on water resources and infrastructure. The best response to Daesh and similar non-state actors in the Middle East is establishing cooperation in the region. While the transboundary water bodies have aided Daesh in its use of water as a weapon for war and territorial expansion, the same water bodies can also enable riparian countries and their populations to establish an efficient preventive and curative mechanism against any destruction of and by water. Iraq has suffered from the sabotage of its water infrastructure and is still paying the price because of an intimidating terrorism, as until now trying to rehabilitate its water infrastructure.