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Wastewater

An Arab Perspective

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Economic and Social Commission for Western Asia

Wastewater

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Preface

This World Water Day booklet builds on the Arab Chapter included in the *2017 World Water Development Report, Wastewater: the untapped resource*. The World Water Development Report is published annually by the World Water Assessment Programme of the United Nations Educational, Scientific and Cultural Organization (UNESCO/WWAP) with the substantive support of other United Nations organizations through UN-Water. The Arab Chapter (Chapter 10) of the 2017 World Water Development Report was contributed by the United Nations Economic and Social Commission for Western Asia (ESCWA).

The subject of the annual World Water Development Report is aligned with the World Water Day theme selected for each year by UN-Water. The theme of World Water Day 2017 is on wastewater, under the slogan "Why Waste Water?"

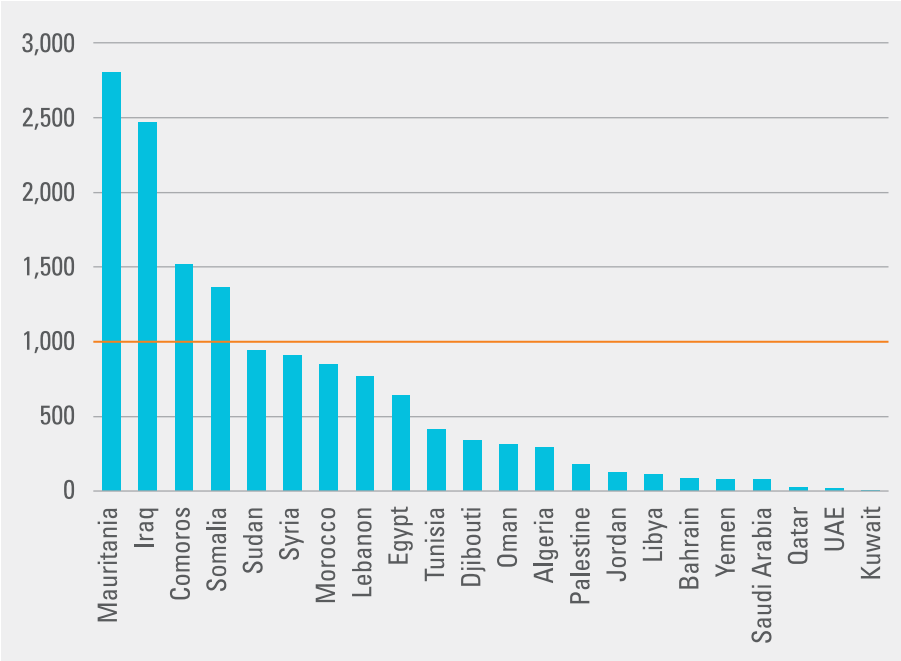
The aim of this booklet is to showcase how wastewater is being increasingly viewed as a water resource by Arab States to help overcome water scarcity constraints. The purpose is to foster discussion on knowledge gained on the use of treated wastewater based on regional experiences. In doing so, it seeks to support efforts to achieve the sustainable and integrated management of water resources in the Arab region.

The terminology adopted in the *2017 World Water Development Report* refers to "use" of treated wastewater and the "reuse" of untreated wastewater as a means to emphasize the opportunities that wastewater presents as an untapped resource. In view of ensuring consistency between the terminology used in the Arab Chapter of the 2017 World Water Development Report and this booklet, the same terminology is used and reference to the "reuse of treated wastewater" is avoided.

I. Regional context

The Arab region is the driest in the world, with 18 out 22 Arab States falling below the water poverty line of 1,000 m3 per capita per year (FAO, AQUASTAT, 2016). Population growth, increasing average yearly temperatures and reductions in precipitation in many parts of the Arab region are further increasing strains on scarce freshwater resources (RICCAR, 2015).

Figure 1. Total renewable water resources (m3/capita/year)



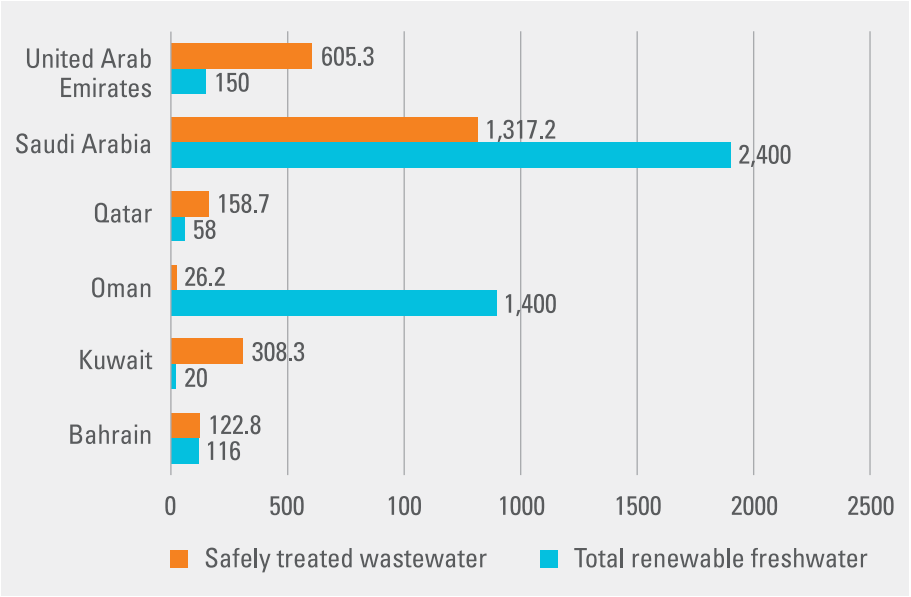
Source: FAO, 2016, Aquastat data for 2014.

These pressures are being accompanied by increasing urbanization, particularly towards coastal areas. Meanwhile, migration and refugee movements caused by conflict and unrest have created new formal and informal human settlements in various parts of the region. In addition to increasing pressure on existing water supply and sanitation infrastructure, this is increasing water consumption in different locations as well as associated wastewater volumes.

Surface and groundwater quality are in turn being affected in areas where wastewater treatment is unavailable or insufficient.

In tandem, desalination capacity has expanded from Morocco and Algeria to Saudi Arabia and Kuwait to meet growing demand for water, as have groundwater withdrawals in the Mashreq and Maghreb for domestic and agricultural purposes. Agricultural drainage water is often used several times along a river course. Investments in non-conventional water resources, such as water harvesting and the safe use of treated wastewater, has also increased. Indeed, safely treated wastewater exceeds renewable freshwater resource volumes in Kuwait, the United Arab Emirates, Qatar and Bahrain and represents the equivalent of 55% of the renewable freshwater resources available in Saudi Arabia.

Figure 2. Safely treated wastewater relative to renewable freshwater resources in selected Arab States (MCM/year)



Sources: LAS/UNESCWA/ACWUA, 2016a, *MDG+ Initiative Report 2016*; FAO 2016, Aquastat data for 2014.

Safely treated wastewater has thus become a means for increasing water availability in face of growing water scarcity. Wastewater management has in turn become a core component of water resource management planning as well as environmental policy-making in the Arab region.

Monitoring sanitation and wastewater treatment

The 17 Sustainable Development Goals (SDGs) included in the 2030 Agenda for Sustainable Development adopted in September 2015, replace the Millennium Development Gaols (MDGs). SDG6 specifically aims to "Ensure availability and sustainable management of water and sanitation for all". Three targets for monitoring achievement towards this dedicated water goal directly relate to wastewater:

- **Target 6.2** aims to "achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying attention to the needs of women and girls in vulnerable situations";

- **Target 6.3** aims to "improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and sustainably increasing recycling and safe reuse globally";

- **Target 6.a** seeks to "expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies."

A global set of Indicators has been formulated and are under review to support monitoring and reporting towards the SDG targets (United Nations Statistical Commission, 2016). The indicators related to SDG 6.3 will monitor the proportion of wastewater safely treated (6.3.1) and the proportion of bodies of water with good ambient water quality (6.3.2).

Well before the formulation of the SDGs, the Arab Ministerial Water Council (AMWC) adopted a regional set of indicators for monitoring access to water, sanitation and wastewater services under the MDG+ Initiative. Launched in 2010, this initiative established a regional monitoring framework for reporting on country-level data collected by National Monitoring Teams comprised of water-related ministries, utilities and statistical offices. The initiative was implemented on behalf of the AMWC by the United Nations Economic and Social Commission for Western Asia (ESCWA) in partnership with the Arab Countries Water Utilities Association (ACWUA) and the League of Arab States with funding provided by the Swedish International Development Cooperation Agency (Sida).

The initiative includes a more elaborate set of indicators than what is being pursued at the global level for SDG6, and particularly with respect to the wastewater targets. 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. Arab States then report on the quantity of safely treated wastewater that is used and for what purpose, i.e., for agriculture, groundwater recharge or other uses. Safely treated wastewater is considered wastewater that is treated at the secondary or tertiary level based on national standards.

The initiative is aligned with the regional perspective that safely treated wastewater can play an important role as a reliable resource for overcoming water scarcity constraints. The data reported under the initiative, and the process of collecting it, also successfully engaged national and local water actors in dialogue and exchange on the findings. In doing so it has built the capacity of a range of national actors in data collection methods and the presentation of findings that can inform investment and decision-making on wastewater management. Some findings and analysis based on the wastewater data collected through the MDG+ Initiative are elaborated below.

Connectivity to sewage networks

Access to improved sanitation is largely prevalent in the Arab region, with 92% of the urban population in North Africa and 96% of the urban population in Western Asia having access to improved sanitation in 2015 (JMP, 2015). Access in rural areas is slightly lower, reaching only 86% in North Africa and 89% in Western Asia (JMP, 2015).

However, connections to sewerage networks and wastewater treatment facilities remain limited in 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. Proportion of population connected to a sanitation system in selected Arab States, in percentage (2013)

Arab State	Sewage network		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	23	13	77
Iraq	40	0	57	100
Jordan	59	n/a	41	n/a
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/UNESCWA/ACWUA, 2016, *MDG+ Initiative Report 2016.*
Notes: *Data for Libya are for the year 2012. n/a signifies not applicable.

Table 1 summaries the proportion of population connected to a piped sewage 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.

Wastewater treatment and use

While access to sanitation is high in most Arab States, with the exception of the region's least developed countries (LDCs), wastewater collection, transfer and treatment remains more limited and disbursed. Table 2 presents the volume of wastewater collected and treated per country. The data shows that of the total volume of wastewater collected in 17 out of 22 Arab States, 10% underwent primary treatment, 45% secondary treatment and 23% tertiary treatment in the year 2013. It is noted, however, that as these figures do not include data from the Comoros, Djibouti, Lebanon, Somalia and the Syrian Arab Republic, the amount of wastewater collected that only undergoes primary treatment in the region is likely much higher.

As shown in table 3, half (51%) of the wastewater collected in 17 Arab States is safely treated at the secondary or tertiary treatment level. Of this amount, one-fourth (24%) is used, which represents close to half (47%) of the collected wastewater that is safely treated.

GCC member States use 90% to 100% of their safely treated wastewater. Jordan is the leader for safely treated wastewater use in the rest of the region, reporting that 100% of its safely treated wastewater was used in 2013. These efforts contribute to off-setting water scarcity constraints, although significant potential exists for expanding safely treated wastewater use in many parts of the region.

Table 2. Volume of wastewater collected and treated by level of treatment (MCM per year), 2013

Arab State	Volume of collected wastewater	Primary treatment	Secondary treatment	Tertiary treatment
GCC				
Bahrain	122.8	0	0	122.8
Kuwait	NA	NA	58.0	250.3
Oman	26.2	0	0	26.2
Qatar	176.8	0	0	158.7
Saudi Arabia	1,317.2	0	580.2	736.9
UAE	615.7	0.3	11.7	593.6
Mashreq				
Egypt	3,030.4	724.3	2,054.8	57.1
Iraq	620.4	0	415.7	0
Jordan	130.8	0	130.8	0
Palestine	30.8	20.7	0.45	0
Maghreb				
Algeria	1,570.4	0	275.2	0
Libya*	291.1	0	45.8	0
Morocco	144.2	38.2	0.1	6.1
Tunisia	235	0	222	6.6
LDCs				
Mauritania	0.65	0	0.65	0
Sudan	18	18	0	0
Yemen	159.4	58.13	42.24	22.02
TOTAL	8,489.9	858.6	3,837.6	1,980.3

Source: LAS/UNESCWA/ACWUA, 2016. *MDG+ Initiative Report 2016.*
Notes: *Data for Libya are for the year 2012. NA: Not available.

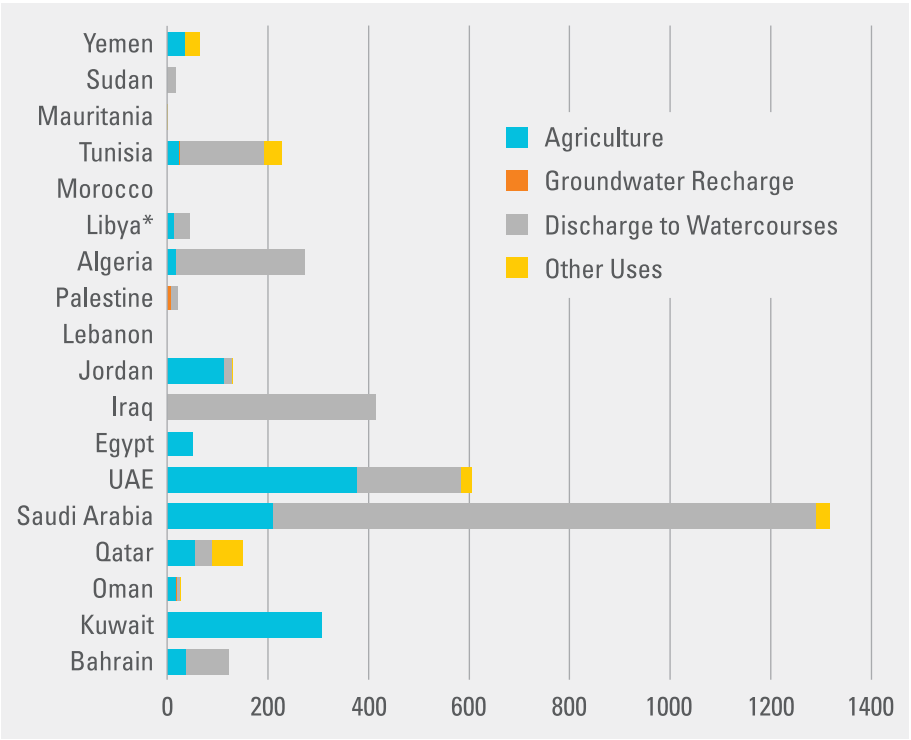
Table 3. Safely treated wastewater use, 2013

Arab State	Volume of safely treated wastewater (MCM/year)	Safely treated wastewater as a share of total collected wastewater (%)	Volume of safely treated wastewater used (MCM/year)	Treated wastewater use as share of safely treated wastewater (%)
GCC				
Bahrain	122.8	100	38.1	31
Kuwait	308.3	NA	308.3	100
Oman	26.2	100	20.4	78
Qatar	158.7	90	115.9	73
Saudi Arabia	1,317.2	100	237.1	18
UAE	605.3	98	397.2	66
Mashreq				
Egypt	2,111.9	67	50.2	2
Iraq	415.7	67	0	0
Jordan	130.8	100	113.3	87
Palestine	0.5	1	0.5	100
Maghreb				
Algeria	275.2	18	19.3	7
Libya*	45.8	16	14.7	32
Morocco	6.2	4	NA	NA
Tunisia	228.6	97	60.0	26
LDCs				
Mauritania	0.7	100	0.1	18
Sudan	0	0	0	0
Yemen	64.3	40	36.0	56
TOTAL	5,818.1	51	1,411.1	24

Source: LAS/UNESCWA/ACWUA, 2016. *MDG+ Initiative Report 2016.*
Notes: *Data for Libya are for the year 2012. NA: Not available.

As can be seen in Figure 3, about two-thirds of safely treated wastewater in the Arab region is discharged to surface water. This includes all the wastewater collected and treated in Iraq. Approximately one-fourth is used for irrigation and groundwater recharge. This can be attributed to the fixed capacities of countries to store treated wastewater and because treated wastewater use in the Arab region has been traditionally focused on the agriculture and landscape irrigation (Al-Anzi et al, 2011).

Figure 3. Use of safely treated wastewater by type (MCM/year)



Source: LAS/UNESCWA/ACWUA, 2016. *MDG+ Initiative Report 2016.*

II. Challenges

Among the main challenges related to the delivery of satisfactory water, sanitation and wastewater treatment services in the Arab region are insufficient investment and weak institutional capacity. (UNESCWA, 2013). Other challenges include the difficulties to ensure cost recovery, meet additional needs caused by displaced populations, respond changing climate conditions and flooding, as well as control water pollution caused by domestic and industrial effluent.

Insufficient Investment in face of changing regional context

Strategies and plans are generally made at the national and sector levels to secure funding and financing for wastewater treatment. However, wastewater master plans can become quickly outdated in face of regional dynamics and changing demographic trends, such as in the case of Lebanon (Box 1).

Despite investments in secondary treatment plants, many facilities are also overloaded and produce effluent below the expected quality due to changing population pressures and the time lag between the design and

Box 1. National Strategy for the Wastewater Sector in Lebanon

In 2012, the population of Lebanon was estimated at 4.3 million. Out of an estimated 310 MCM of wastewater produced annually, an estimated 250 MCM came from domestic sources and 60 MCM from industry (MEW, 2012).

It is estimated that only 8% of the wastewater generated in Lebanon is treated. About 11% of the population uses safely managed wastewater systems in the governorates of North and South Lebanon, compared to only 7% and 3% in Greater Beirut and the Bekaa, respectively (Karnib, 2016). Most collected wastewater is discharged into surface waters and the Mediterranean Sea. On-site septic tanks contaminate groundwater resources, such as the Jeita Springs that supply water to Greater Beirut

Box 1. National Strategy for the Wastewater Sector in Lebanon (Cont.)

(BGR, 2013). The harmful impacts of inadequate wastewater collection, transfer and treatment increase health and environmental risks.

The 2012 National Strategy for the Wastewater Sector (MEW, 2012) includes five strategic pillars: 1) an integrated and prioritized investment programme for wastewater collection, treatment and use; 2) legal, regulatory and policy measures to set and regulate standards; 3) institutional measures to define responsibilities and to create capacity for service delivery; 4) financial measures for viability and affordable services; and 5) measures to optimize private sector participation in the wastewater sector. The implementation cost was estimated at US$3.1 billion for work planned between 2012 and 2020. Unfortunately, the implementation of the strategy was disrupted due to a lack of funding and the instability resulting from political uncertainty and ongoing regional conflicts.

construction (UNESCWA, 2013). Increasing urbanization and concentration along coastal zones is a particular challenge for water and wastewater managers serving cities along the Mediterranean coast. Insufficient investment results in wastewater simply being collected, filtered and discharged into surface waters or the sea. Investment decisions are also often made with little regard for the hot and arid environment that characterize the Arab region. Local climate conditions should be considered when deciding between investments in aerobic and anaerobic wastewater treatment options.

Cost recovery and policy coherence

Water supply and sanitation are generally considered public goods in the region. This influences the way that wastewater is managed in several countries. When wastewater service provision is the responsibility of government institutions, there is little opportunity for the private sector engagement. This can stymie operational efficiency and cost recovery efforts, which reduce the attractiveness of the sector to outside investors.

Cost recovery of investment in the safe use of treated wastewater can also be difficult when freshwater resources are under priced and do not reflect the cost of water supply. This is particularly so in the agricultural sector. The challenge is multiplied when countries are unable to control groundwater abstractions, although some efforts have been made to adopt fee structures and measures to regulate permitting processes and pumping costs, such as in Saudi Arabia. Vested interests can also impede the operationalization of policy directives. These institutional and policy challenges result in the insufficient allocation of public budgets towards wastewater treatment and use and stymies private investment in the sector.

Limited institutional capacity and coordination constraints

The institutional capacity to manage, operate and maintain secondary and tertiary wastewater facilities lags behind in some Arab countries. Human resources and technical capacity also tend to be more advanced in the area of water supply than in wastewater treatment and reuse. This constrains investment opportunities and lengthens the time required to render the plants operational.

An additional dimension is the need for improved coordination and coherence between national and local actors responsible for wastewater management in some countries. For instance, in Lebanon there is a need to improve coordination between national and municipal actors responsible for extending sewerage networks, as well water resource managers and water utilities responsible for operating wastewater facilities. Responsibilities for setting and regulating standards are also sometimes split across different national authorities, although some Arab States have recently established water regulatory authorities to address this challenge.

Serving displaced populations

Provision of water, sanitation and wastewater treatment for refugees in camps, informal settlements and host communities in Arab States has become a serious challenge. Specialized plans have been developed to respond to the pressures on water resources and services caused by the influx of Syrian refugees in Jordan and Lebanon.

Early on in the crisis, a Jordan National Resilience Plan 2014-2016 was drafted with a set of specific objectives to expand and improve wastewater

sewage networks in host communities (MOPIC, 2014). Jordan now hosts over 700,000 registered refugees from Iraq and Syria, with 90% living outside of camps (UNHCR, 2016). Meanwhile water infrastructure in Lebanon is struggling to serve the 1.5 million refugees that represent the equivalent of one third of the Lebanese population (UNOCHA, 2016). It is estimated that about 39% of refugees in Lebanon are connected to sewerage systems, while 60% are using on-site sanitation facilities and 1% are practicing open defecation. Wastewater collection systems are not able to serve these new communities, which has led to the introduction of decentralized wastewater treatment systems.

Conflict and the internal displacement of people in Iraq, Libya, Palestine, Somalia and Syria have also strained the operating capacity of wastewater facilities and damaged sewage networks.

Managing wastewater and stormwater from floods

Flooding has caused economic losses and environmental damage in local communities throughout the region. Infrastructure, property and protected areas have been affected, such as the Socotra Islands in Yemen during Cyclone Chapala in 2015. Oman has been hit repeatedly by cyclones, causing severe flooding along its eastern shores. Egypt, Lebanon, Palestine and Saudi Arabia also experienced significant flooding events in recent years, which can be largely attributable to insufficient storm water drainage systems and limited investment in artificial groundwater recharge schemes in face of climate variability and climate change.

Extreme rainfall events that cause flooding can render wastewater treatment plants inoperable. Overflow of wastewater storage capacities at collection points and treatment plants can significantly impact human health and the environment in the absence of disaster planning and response. These risks are increasing, with the likelihood that more frequent and intensive extreme rainfall events will be experienced in the region due to climate change (RICCAR, 2015).

Industrial effluents

Industrial wastewater management is costly and controversial in the region. Chemical and biological effluents from the textile and tannery industries in Egypt, Morocco and other Arab countries affect surface and

Photo Credit: Jordan Wastewatater Treatment Plant, ACWUA, 2016

groundwater supplies, but closing these small-scale businesses threatens traditional livelihoods. Clean production centres and initiatives in Egypt and Morocco have sought to help tanneries that are clustered together to pursue joint investments in collective wastewater treatment systems to reduce untreated effluent flows. However, more financial and technical assistance is needed through public and private sector arrangements to support their operation.

On a larger scale, brine released from desalination plants includes chemical residues that negatively affect coastal ecosystems when not fully removed. Oily water brought to the surface during the extraction of oil and gas results in produced water that is sometimes reinjected to extract additional energy resources or released into the surrounding areas in the absences of an effective treatment policy, this can contaminate aquifer systems and degrade land resources.

III. Responses

In 2011, the Arab Ministerial Water Council adopted the Arab Strategy for Water Security in the Arab Region to Meet the Challenges and Future Needs for Sustainable Development 2010-2030. The strategy calls for the expansion of treated wastewater use and reuse of agricultural drainage water as non-conventional water resources that can be developed to offset water deficits in the region (AMWC, 2011).

In tandem, the Council launched the MDG+ Initiative to monitor and report on water supply, sanitation and wastewater services in Arab states, based on a set of region-specific indicators that examine water and wastewater within the context of water scarce environments (UNESCWA, 2013). The MDG+ Initiative forms a key component of the Arab water strategy's action plan for implementation under the pillar related to improved sanitation and freshwater.

Institutional and policy frameworks

Policies for advancing safely treated wastewater use must be pursued within the institutional and policy frameworks of each country. At least 11 out of 22 Arab States have adopted legislation permitting the use of treated wastewater. These were issued by the national institutions responsible for the use and discharge of wastewater, be it the ministries responsible for the environment in Kuwait, Lebanon and Oman, the ministry of health in Iraq, the ministry of agriculture in Tunisia, the ministry of housing in Egypt, or the institutes responsible for standards in Jordan and Yemen (WHO, 2006).

Extreme water scarcity and poor energy endowments have led Jordan to be a leader in treated wastewater reuse. Wastewater treatment and reuse standards in Jordan are among the most developed in the region and include standards related to the discharge of wastewater into streams and wadis, as well as for groundwater recharge, landscaping and agricultural purposes. The Jordan Food and Drug Administration established a State Crop Monitoring Programme in cooperation with the Jordan Valley Authority and the National Centre for Agricultural Research and Extension to oversee safely treated wastewater use in agriculture. The programme helps to ensure that the quality of crops irrigated with treated wastewater is in line with the international health standard (Sobh,

Box 2. Water reuse in Tunisia

Water reuse has been a priority in Tunisia since the early 1980s, when Tunisia launched a nation-wide water reuse programme to increase the country's usable water resources. Most municipal wastewater receives secondary biological treatment through activated sludge, with some limited tertiary treatment also in place.

Restrictions on treated wastewater use to protect public health have received considerable attention and are in line with WHO recommendations (WHO, 2006).

Tunisian regulations allow for the use of secondary treated effluent on all crops except vegetables, whether eaten raw or cooked. Regional agricultural departments supervise the use of safely treated wastewater and collect charges from the farmers. Tunisian farmers pay for irrigation water on the basis of the volume of water required and the area to be irrigated.

While there is strong government support for treated wastewater use, farmers continue to prefer irrigation from groundwater due to social acceptance, regulations concerning crop choices, and other agronomic considerations. Farmers in the arid south have also expressed concerns about the long-term impacts of saline wastewater on their crop productivity and soils. In addition, farmers consider the health restrictions as an impediment to growing high-value crops such as vegetables. To address these challenges, Tunisian policy-makers have sought to improve the coordination and pursue demand-driven approaches to improve the planning of wastewater reclamation and irrigation projects with safely treated effluent.

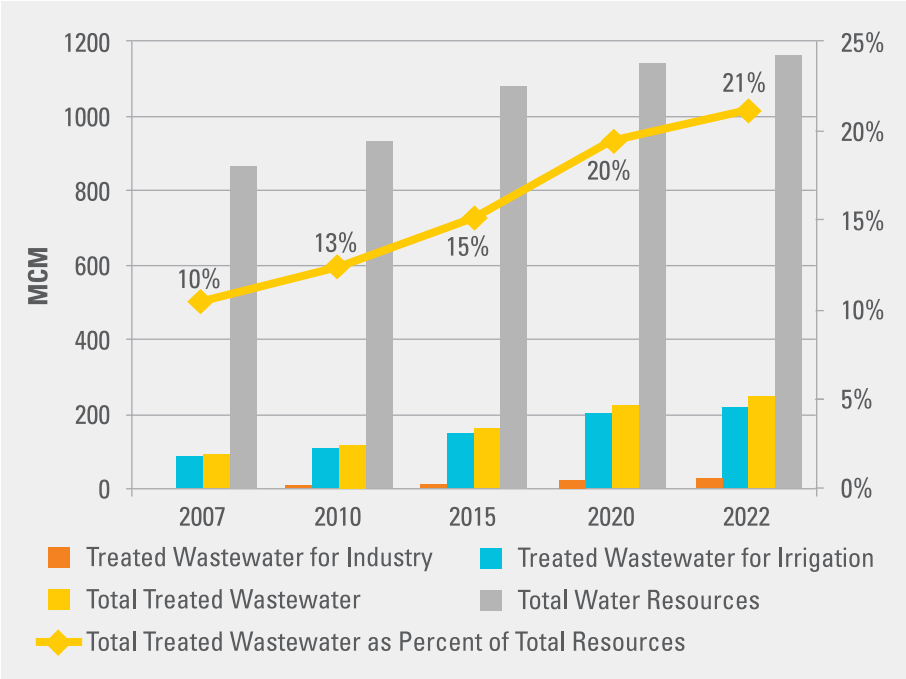
Contributed by Manzoor Qadir (UNU-INWEH) based on Qadir et al., 2010).and included in the Arab Region Chapter of the 2017 World Water Development Report: Wastewater-The Untapped Resource (WWAP, 2017).

2013). The increased use of treated wastewater use for irrigation has increased freshwater availability for other purposes, such as drinking.

Tunisia has worked for decades on wastewater reuse and adopted advanced safely treated wastewater use standards. It has worked with farmers and local institutions to encourage its use (see box 2).

Jordan and Tunisia have additionally incorporated wastewater reuse within their national water policies and plans. Jordan adopted the "Water Substitution and Reuse Policy" in February 2016, which formalizes treated wastewater use as a national policy and includes plans to set tariffs for the use of treated wastewater and blended treated wastewater (MWI, 2016a). This has been complemented by a decentralized wastewater management policy to serve smaller communities (MWI, 2016b). These efforts expand upon Jordan's 2008 National Water Strategy commitments, which aimed to double treated wastewater use as a share of total resources from 10% in 2007 to 21% by 2022 (see figure 4).

Figure 4. Past and projected treated wastewater usage as per Jordan's National Water Strategy, 2008-2022



Source: MWI, 2009, as presented in UNESCWA, 2015. Note: Total resources for the year 2022 are without the Red-Dead Sea conveyance project.

Investment planning and balancing budgets

Donor coordination and investment planning in the wastewater sector in response to new population pressures is also well developed in Jordan.

The Jordan Response Plan for the Syrian Crisis 2016–2018 dedicates significant resources to expanding wastewater collection and treatment in host communities in Jordan. The incorporation of energy efficiency and local air pollution measures in wastewater treatment plants have also been planned, as well as efforts to ensure gender-sensitive sanitation facilities in schools and healthcare clinics (MOPIC, 2016).

Efforts to overcome cost recovery challenges in the wastewater sector need to be balanced with public policies aimed at the public good. Some countries, such as Tunisia, have been able to charge sufficient rates to cover the operation and maintenance costs of wastewater facilities, while ensuring high rates of access to sanitation and wastewater treatment services. Public sector reform in Egypt led to the establishment of the Holding Company for Water and Wastewater (HCWW) to increase the financial independence of the service provider, while maintaining it as a public company. The company has in turn prepared a national master plan for water and sanitation that extends to the year 2037, and includes wastewater management as a core component of its operations.

Engaging the private sector

The provision of public services in Arab States is generally managed by government-owned institutions and authorities. Nevertheless, many states

Box 3. Private sector engagement in Kuwait

The Sulaibiya Wastewater Treatment Plant was first project in Kuwait 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 provided 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.

Source: Biygautane, 2016.

in the region have initiated public sector reforms that are simplifying existing regulations and opening up the water and wastewater sectors to external investment. In Kuwait (box 3) and Egypt (box 4), projects awarded to private companies to manage wastewater collection networks and treatment plants. These public- private partnership (PPP) are supported by legal and regulatory frameworks overseen by the Authority for Partnership Projects in Kuwait and PPP Central Units in Egypt.

Box 4. Private sector engagement in Egypt

The first successful PPP initiative in Egypt was launched with the New Cairo Wastewater Treatment Plant, which started operations in March 2012. The 250,000 m3/day plant is overseen by the HCWCC under the Ministry of Housing, Utilities and Urban Development (MHUUD) of Egypt. A loan provided by a group of four Egyptian banks covered most of the engineering, procurement and construction expenses.

The project contract was awarded to Orasqualia (a joint venture between Orascom and Aqualia), which is in charge of the operation and maintenance of the plan for under a 20 year contract. Authorities plans to replicate the New Cairo Treatment Plant model to other wastewater treatment projects. Four new projects are in the pipeline and aim to upgrade existing wastewater treatment plants and construct two additional plants.

Source: water-technology.com. "New Cairo Wastewater Treatment Plant," Egypt

Improving connectivity to wastewater networks for reuse

Many Arab States are pursuing infrastructure works to expand sewage collection networks. In Oman, the government is set to implement a wastewater management plan for the expansion and rehabilitation of the existing sewerage networks and the wastewater treatment capacities (box 5). This could increase the cost efficiency of safely treated wastewater use as all collected wastewater in Oman is tertiary treated.

Egypt has been pursuing an aggressive wastewater collection and treatment programme in rural areas, with the government allocating US$2 billion for sanitation and wastewater projects. During the period extending from 2005 to 2015, over the 27 rural governorates were covered by the project and the length of the sewage network almost doubled. This has helped to improve water quality along the Nile River, along which most of

Box 5. Improving connectivity in Oman

Oman is implementing the Muscat Wastewater Master Plan, which was initiated in 2013. The plan aims to connect 80% of the population of Muscat to sewerage networks, advanced sewage treatment plants, treated effluent networks and outfall systems. The aim of the initiative is to improve on the current wastewater collection system, which is largely decentralized and organized around individual household disposal in sceptic tanks followed by the suction and transport of the sludge via public tankers to centralized treatment plants. Water effluent will be treated to the advanced standard levels and with the aim of achieving total reuse.

The plan is funded by the Government of the Sultanate of Oman and implemented by Haya Water, the publically owned Oman Wastewater Services Company. Haya Water builds and operates wastewater networks, pumping stations and sewage treatment plans in Muscat and throughout the country, with the exception of the southern region of Dhofar.

Sources: Water World, 2012. Wastewater Network and Treatment Plant contracts to be awarded in Oman, early 2013; Al Asmi, S, 2016.

Egypt's rural population is concentrated. The use of agricultural drainage water for irrigation remains the main source of wastewater reuse in Egypt.

Decentralized wastewater management approaches

Decentralized wastewater collection and treatment systems are emerging as a more cost effective solution for the sustainable management of wastewater, and is particularly appropriate for use in small communities (Massoud et al, 2008), as well as rural, remote and mountainous areas that are difficult to connect to centralized sewage network.

Studies have found that decentralized systems also encourage the use of treated wastewater (Sustain Water MED, 2015; Bakir, 2001). Pilot projects in Egypt, Jordan and Morocco have demonstrated the economic feasibility of decentralized systems and the additional benefits generated by increased engagement of local communities in the sustainable operation and management of decentralized wastewater management systems (Sustain Water MED, 2015a, b, c). The application of this approach improved awareness and increased social acceptability of the use of safely treated effluents Egypt and Morocco (Sustain Water MED, 2015a, c), and was also witnessed in Jordan (box 6).

Box 6. Decentralized wastewater systems in Jordan

The Ministry of Water and Irrigation of Jordan initiated a pilot project to test a Clustered Decentralized Wastewater Treatment and Reuse System in Maghareeb, which is located in the Lower Jordan River watershed. The project began in 2012 and led to the establishment of the National Implementation Committee for Effective Decentralized Wastewater Management. The Committee engages and integrates relevant institutions and local stakeholders in efforts aimed at applying appropriate technologies that take into consideration the socio-economic issues.

A decentralized systems approach supported by a centralized management scheme was piloted to engage several communities in the project. This helped to secure the funds that otherwise would have been reserved for larger scale projects due to cost recovery concerns related to operation and maintenance. The pilots demonstrated the economic feasibility of tested decentralized treatment and reuse scheme when compared to centralized wastewater management arrangements and even more so when results were compared to tanker solutions.

Source: Afferden et al. 2014. The project was conducted by the Helmholtz Centre for Environmental Research UFZ with the support of the Government of Jordan.

Photo credit: Litani River constructed wetland, from Google earth, in Hawwa, 2016.

Ecosystem management

Off-network approaches are also being applied that draw on lessons learned from natural ecosystems. In Lebanon, the Litani River Authority successfully tested a constructed wetland for wastewater treatment to improve water quality along the river. Similar nature-based approaches to wastewater management have been adopted in some mountain communities in Lebanon that cannot be accesses by sewage networks (Hawwa, 2016).

Public sector investments in an environmentally sensitive wastewater treatment system around Riyadh resulted in the construction of the Wadi Hanifa Wetlands from redirected drainage and treated wastewater. The initiative received the Aga Khan Award for Architecture for the design of the new recreational spaces and the re-emergence of biodiversity in the area (AKDN, n.d.).

Produced water use by the oil industry

Efforts have been made to treat and use water produced during oil extraction. Oman tested the treatment and use of oil-containing wastewater for irrigation as an alternative to injecting the water back into aquifers, contaminating groundwater resources (JPEC, 1999). The de-oiling of produced water was also researched by Sultan Qaboos University in Oman (Pillay et al., 2010), which found that constructed wetlands could also be used to dispose of the treated produced water. Radioactivity in produced water from the oil sector was also research by Sultan Qaboos University in Oman (Pillay et al., 2010).

Artificial groundwater recharge

Treated wastewater is being used to support artificial groundwater recharge and water storage in the water-scarce Arab region. Bahrain used 7% of its safely treated wastewater volumes in 2012 for groundwater recharge (LAS/UNESCWA/ACWUA, 2015), while Oman allocated 6% of safely treated wastewater volumes for groundwater recharge in 2013 (LAS/UNESCWA/ACWUA, 2016). Meanwhile, some Arab states are redirecting storm water and treated wastewater into aquifers as a way to manage extreme rainfall events and increase water reserves, as was done by Egypt along its Red Sea Coast during flood events.

Wastewater treatment from a Nexus perspective

Addressing wastewater management challenges from a water-energy-food security nexus perspective increases the potential for advancing sustainability when compared to conventional wastewater treatment systems focused on collection, treatment and discharge alone. This allows for considering wastewater treatment and use from an integrated perspective that considers potential uses for treated wastewater for agriculture or the energy that can be generated during wastewater treatment processes to support other sectors.

For instance, anaerobic wastewater treatment processes have high applicability potential for the Arab region. The anaerobic digestion of wastewater provide a cross sectoral solution resulting in the production of treated wastewater, on-site generation of heat and electricity that could even be used for off-site electricity production as well as the production of soil conditioners and fertilizers.

The As-Samra Wastewater Treatment Plant is the largest in Jordan and serves 2.27 million people. Investments in new and appropriate technologies at the plant has allowed it to achieve 80% energy self-sufficiency by using recovered biogas for the on-site generation of heat and electricity. The sludge generated is also used as a soil conditioner and a fertilizer (UNESCWA, 2015). The Gabal El Asfar wastewater treatment facility on the east bank of the Nile River in Cairo has a processing capacity of more than 1.4 MCM/day, and includes a cogeneration plant fuelled by anaerobic sludge digestion that satisfies up to 65% of the power needed to run the facility (Badr, 2016).

Haya Water in Oman is composting excess sludge generated during wastewater treatment processes, which is used as a soil conditioner and fertilizer. Haya is also exploring ways to recover methane for on-site energy generation (Abu El Saud, 2016)

Modular biogas digesters are also being considered for generating and supplying energy to refugee camps and informal settlements in the Mashreq. However, awareness-raising within the local cultural context is needed before application of such approaches is pursued beyond the pilot phase.

IV. Conclusion

Sustainable wastewater management and the use of safely treated wastewater in the Arab region is expanding. The need to overcome the freshwater resource deficits that characterize much of the region has motivated much of this progress.

The allocation and opening of investments in secondary and tertiary treatment provides an important opportunity for expanding treated wastewater reuse in the region. Governments and private sector actors are investing in wastewater treatment and reuse and finding sustainable ways to ensure cost recovery and multiplier benefits from pursuing nexus approaches that incorporate energy and fertilizer production capacities in their bottom line.

Increased awareness about the benefits of decentralized and ecosystem based wastewater management systems have also expanded opportunities in rural and peri-urban areas that were previously not connected to wastewater treatment facilities. This responds to the equity factor that is pursued in the implementation of the 2030 Agenda for Sustainable Development as well as the Arab Water Security Action Plan.

Informing action through continued monitoring, reporting and exchange of lesson learned and experiences in wastewater treatment and use in the Arab region will support further progress in this area.

Photo Credit: Jordan Wastewatater Treatment Plant, ACWUA, 2016

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