Chapter 3

Water reuse policy and institutional development in MENA:
Case studies from Egypt, Jordan, Lebanon, Saudi Arabia and Tunisia

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Key messages

Egypt – Food and water security are the key drivers behind Egypt's pursual of 'new' water sources. Therefore, Egypt plans to optimize the use of treated agricultural and municipal wastewater to maintain its socio-economic development. However, due to increasing health and environmental concerns regarding water reuse safety, the country has maintained its centralized control over the different aspects of wastewater management and reuse. This has led to overlapping responsibilities and legal mandates, which challenges the full expansion of water reuse in Egypt.

Jordan – Jordan's institutional and policy landscape development shifted from decentralization (i.e., the leading role of municipalities in wastewater management) to a 'semi-centralized' institutional landscape where infrastructure development, operation and maintenance activities are delegated to regional institutions and state-owned companies. This institutional landscape has enabled Jordan to lead the MENA region in water reuse. However, it has created gaps in the decision-making process, which have slowed down the implementation of the current water reuse policy.

Lebanon – Despite massive investments in infrastructure development and successive institutional reforms, the wastewater sector in Lebanon appears to be dysfunctional, with a very low rate of operational WWTPs. The under-performance of the wastewater sector lies in conflicting and/or diluted administrative responsibilities and a weak operationalization of State institutions' legal mandates further exacerbated with the recent financial and political crisis.

Saudi Arabia – Saudi's experience in managing the water and wastewater sector (including water reuse) reflects a successful transformative shift toward the involvement of the private sector (and state-owned service providers) through an enabling policies and institutional reforms, while the government maintained its regulatory and monitoring role.

Tunisia – The water sector is highly regulated and institutionalized. However, the sector is characterized by competing interests between the existing institutions. This leads to a lack of coordination between the different institutions (e.g., National Sanitation Utility [ONAS] and The Ministry of Agriculture, Water Resources and Fisheries [MAHRP]), which causes a shortage in treated wastewater (TWW) reuse and availability to satisfy the agricultural sector's needs. On the other hand, overcoming these challenges has led to relatively flourishing water reuse arrangements for the irrigation of golf courses, where there is a collaboration between ONAS and the Ministry of Tourism.

3.1. Introduction

This chapter explores the policy and institutional landscape of wastewater treatment and reuse in Egypt, Jordan, Lebanon, Tunisia and Saudi Arabia. It aims to analyze the key elements that contribute to, or hinder, the development of water reuse policies and institutional arrangements in the selected countries. It does so by observing the different trajectories each country has followed in developing its water and sanitation sector over the years and focuses on addresses the following aspects:

- country-specific contextual constraints (e.g., population growth, agriculture expansion, water scarcity and dependency on transboundary water resources);
- institutional roles and responsibilities within the sector; and
- the historical development of water reuse governance and management modalities (e.g., from centralization to decentralization and privatization).

The selected countries are suffering from an increased water supply-demand gap and a rapidly increasing population that requires continuous socio-economic development. This growth leads to competition over the scarce water resources particularly between the agricultural and domestic sectors (Figure 3.1). In this context, governments have sought to reduce this gap by developing the reuse of TWW. However, this shift is problematic as different technical, social, economic, health and institutional problems often challenge the adoption of water reuse schemes.

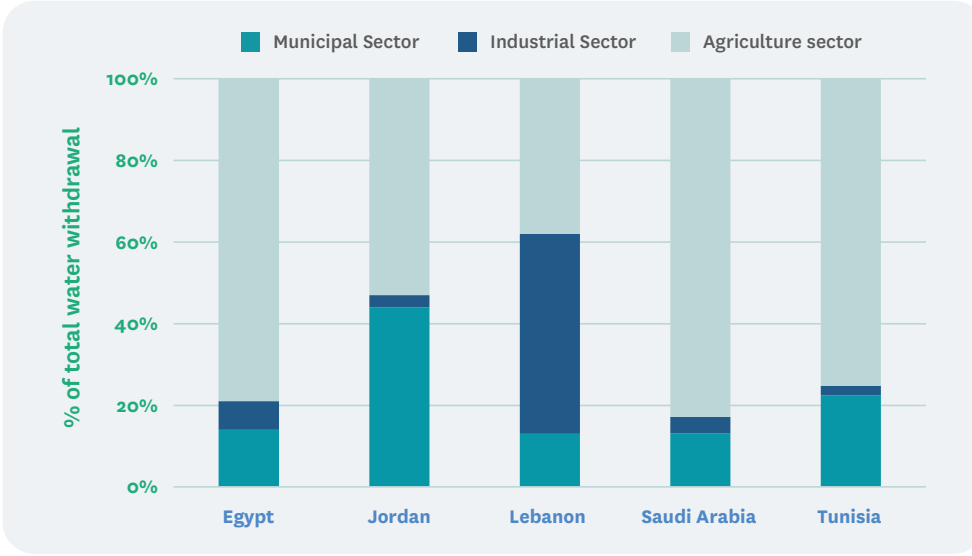


FIGURE 3.1 Water withdrawal by sector in the five countries in 2017 (FAO 2022a).

This chapter analyzes the key policy and institutional milestones as well as the bottlenecks that shaped this development throughout the years. It starts by identifying the most important policies and institutional reforms (milestones) that shaped the current water reuse

institutions and arrangements, then analyzes the current interactions and de facto functioning of the different governmental institutions that operate in the sector.

3.2. Egypt

3.2.1. Toward water reuse development

Egypt's annual per capita water share reached 800 m^3 in 2017 (FAO 2022a). This is below the 'stress' conditions threshold of 1,000 m^3 per person described by the Food and Agricultural Organization of the United Nations (FAO 2022b). This supply-demand gap is expected to increase with population growth, climate change impacts and the development of the GERD dam in Ethiopia, which would affect Egypt's annual share of the Nile River.

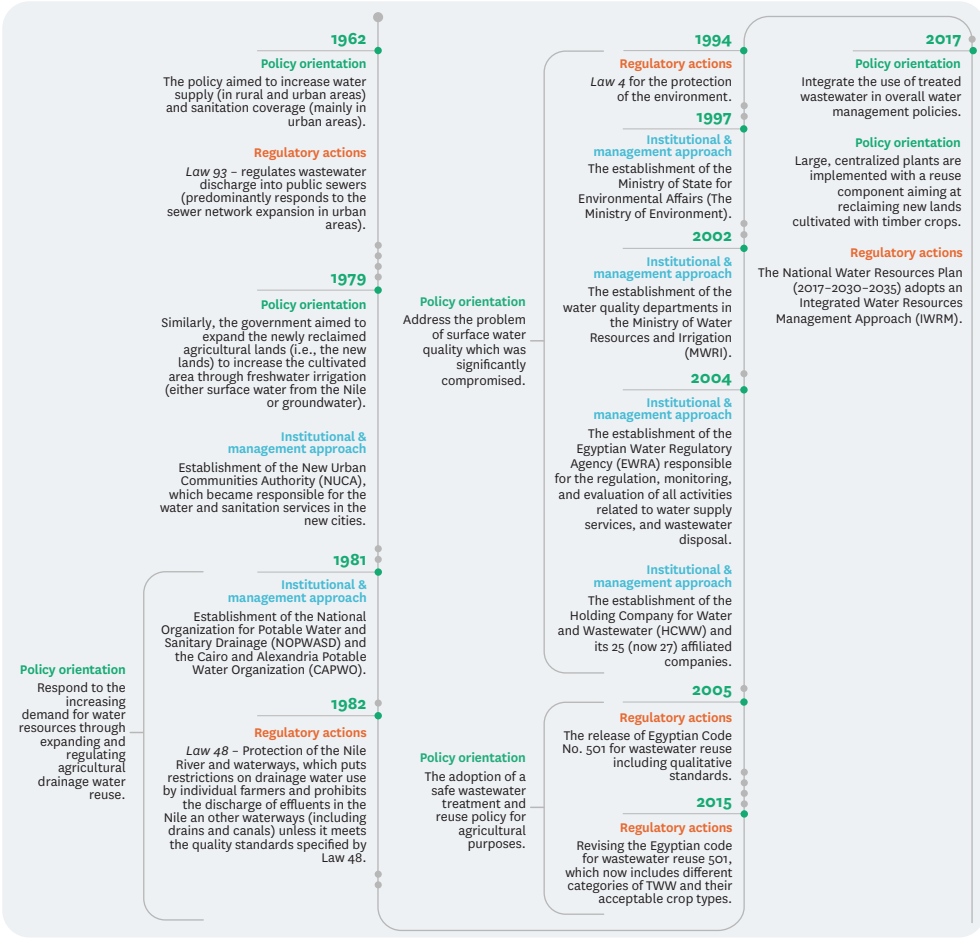
The Government of Egypt has reacted to the dwindling per capita water share by reallocating freshwater to priority uses (i.e., drinking water supply) while maximizing the share of drainage water reuse in the agricultural sector. The latter is the largest water consumer in Egypt and consumes around 76% of the country's water budget (Tawfik et al. 2021). This policy orientation includes public investments in large-scale water reuse projects both related to treated municipal wastewater and agricultural drainage water. It is one of the mitigation measures that Egypt adopts to maintain its socioeconomic development in a water-scarce context (IWMI 2019).

3.2.2. The historical development of water reuse: Policy and institutional milestones

Since the 1960s, Egypt's successive governments have worked to expand the agricultural area through desert land reclamation to achieve food self-sufficiency and create job opportunities (Molle et al. 2019). This agricultural expansion relied on freshwater sources (either surface water from the Nile or non-renewable groundwater). However, from the late 1970s to the early 1980s, there was a noticeable increase in drainage water reuse for irrigation (Molle et al. 2019). Many more farmers started to rely on agricultural drainage water as an important resource to reduce the supply-demand gap. Drainage water reuse enabled the country to meet its land reclamation objective.

However, the lack of comprehensive sanitation coverage (particularly in rural areas) and the low capacity of some WWTPs, led to the illegal discharge of untreated wastewater into the agricultural drainage system (Tawfik et al. 2021). Accordingly, beginning in the 1980s, the government started to regulate water reuse to prevent the pollution of the agricultural drains through a set of institutional and organizational actions. This included donor-driven reforms such as the establishment of the Egyptian Water Regulatory Authority (EWRA) and the Holding Company for Water and Wastewater (HCWW), Law 48, Code 501, environmental law) and mega infrastructure projects such as El Mahsama and Bar El Baqar treatment plants. To achieve the desired quality of wastewater treatment and safe reuse, a top-down, centralized governance approach was implemented, as reflected in the prominent role given to central state institutions in the different management activities of water reuse (Table 3.1).

TABLE 3.1 The historical development of wastewater treatment and reuse in Egypt.



3.2.3. Institutional roles, responsibilities and bottlenecks in water reuse

The water and wastewater sector's institutional landscape in Egypt is based on a form of institutional pluralism, where the various responsibilities are distributed among different organizations with overlapping mandates and limited coordination and/or communication channels. For instance, the state-owned HCWW was established to improve the sector's performance and meet the donor's prerequisites (World Bank 2016). However, the establishment of the HCWW in 2004 overlapped with the mandates of previously established institutions (particularly the National Organization For Potable Water and Sanitary Drainage, NOPWASD). This overlapping led to conflict and disagreement between the two institutions regarding new water and wastewater projects (e.g., Integrated Sanitation & Sewerage Infrastructure Project in 2016) (World Bank 2016; Tawfik et al. 2021). These overlaps are evident particularly in the operation and maintenance (Table 3.2).

Another example is the Egyptian Water Regulatory Authority (EWRA) whose role as a regulatory body started in 2004 but was challenged by the overlapping of its regulatory responsibil-

TABLE 3.2 Institutional mapping of the responsible institutions for wastewater management and reuse activities in Egypt.

Wastewater management (collection, treatment, discharge or transfer)		Water reuse (license, approval and allocation)			Codes and standards	Monitoring
Infrastructure development	Operation and maintenance	Industry	Agriculture	Urban (e.g., landscaping)		
Strategy and policy formulation: The Ministry of Water Resources and Irrigation (for all aspects related to water allocation)						
NOPWASD	HCWW (25 affiliated companies in the different governorates)				Cabinet	EWRA
Strategy and policy formulation: The Ministry of Housing Utilities and Urban Communities (for all aspects related to water and sanitation services in urban and rural communities)						
NOPWASD	CAPW (Cairo & Alexandria)				Parliament technical committees	Ministry of Environment
Strategy and policy formulation: The Ministry of Agriculture and Land Reclamation (for all aspects related to agricultural expansion)						
Hayah Karima project (National project to improve the livelihoods of rural communities in Egypt through infrastructural development projects in remote villages)	NUCA (new cities)					
	Suez Canal Authority (Suez Canal cities)					Ministry of Health

ities with other institutions such as the HCWW, relevant ministries and the cabinet (Ménard 2022). Overlaps in mandates diluted leadership and diluted responsibilities of monitoring and enforcement, hence affecting the performance of treatment.

These institutional bottlenecks compromise the sector's performance and result in the spread of 'informal' practices developed by local users (i.e., water users from different locations and sectors but mainly agricultural water users). For example, in the Nile Delta, informal drainage water reuse in agriculture (often mixed with raw wastewater) was estimated between 4 to 6 BCM/year (Reymond et al. 2014). Given the under-performing and low rate of treatment and the difficulty to enforce regulations on the ground, these water reuse quality standards remain overly ambitious (Reymond et al. 2014; see Section 1, Chapter 5).

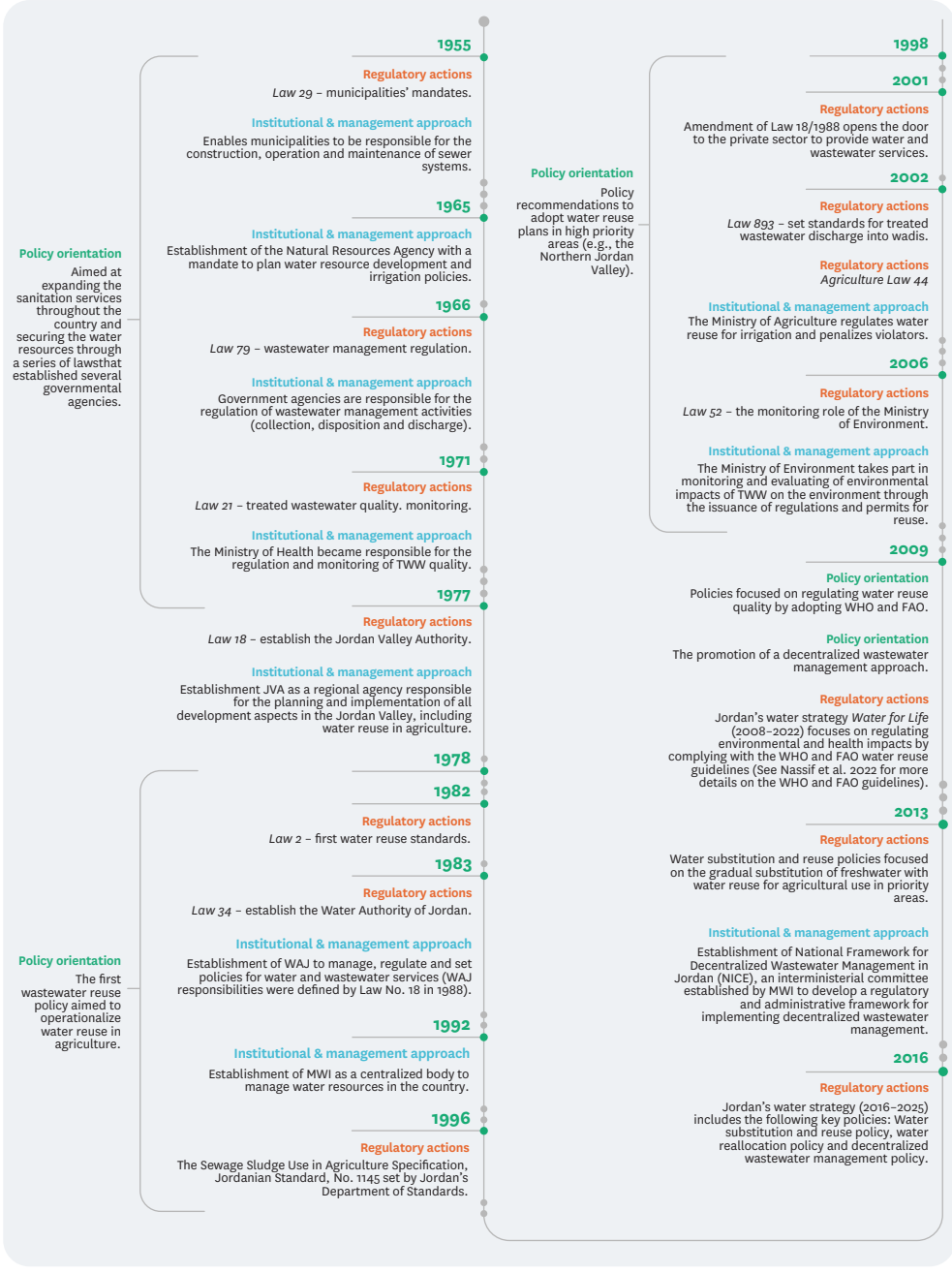
3.3. Jordan

3.3.1. Toward water reuse development

Jordan's annual per capita water share continues to decline and is now approximately 106 m^3 and places it as one of the most water-scarce countries in MENA and the world (Hussein 2018). Since the 1970s, Jordan has become one of the first MENA countries to consider reuse as part of its national water plan (Table 3.3) (see Chapter 5).

Jordan has increased the reallocation of water reuse toward the agricultural sector so it can serve as the primary water source for irrigation. This strategy enabled Jordan to partially adapt to its water scarcity by reallocating large volumes of freshwater to priority domestic needs (MWI 2001). This strategy relies on expanding the sanitation services in urban areas to generate 0.184 BCM of TWW annually (MWI 2016).

TABLE 3.3 The historical development of the water reuse sector in Jordan.



3.3.2. The historical development of water reuse: Policy and institutional milestones

Table 3.3 (above) shows the progressive inclusion of water reuse in the Jordanian water budget, particularly the one allocated for irrigation. In the 1950s, Jordan relied solely on freshwater resources (notably groundwater). By the late 1970s, Jordan started the shift toward large-scale water reuse in agriculture and to reallocate freshwater to urban areas (e.g., water reuse and reallocation scheme in the middle Jordan Valley) (Tawfik et al. forthcoming). Jordan established centralized governmental agencies – Jordan Valley Authority (JVA) and Water Authority of Jordan (WAJ) under the umbrella of the Ministry of Water and Irrigation (MWI) – to control, operate and regulate wastewater treatment and reuse activities.

Since the 1980s, Jordan has followed donor recommendations and has further expanded water reuse in agriculture and saved freshwater for domestic uses. The country has identified key priority areas to implement the reuse–reallocation plans (MWI 2001). This includes the involvement of the private sector to facilitate this expansion.

3.3.3. Institutional roles, responsibilities and bottlenecks in water reuse

Municipalities managed wastewater treatment and reuse activities in Jordan since the 1950s. However, this decentralized role of the municipalities was abolished in the late 1970s when the Government of Jordan established the JVA, WAJ and MWI.

Although MWI was the latest to be established in 1992, it became the central body entitled to set policies and strategies at the national level (Table 3.4). WAJ was created in 1983 and assumes a wide range of executive responsibilities related to the sector's operation and management. These responsibilities include regulating and monitoring water and sanitation services through government-owned water and wastewater utilities in Aqaba, Amman and Northern Governorate as well as recommending tariffs based on the cost of water services (UFZ 2022).

JVA is responsible for the 'socioeconomic development' of the Jordan Valley. This broad mandate includes water resources management and irrigation water allocation (either fresh-

TABLE 3.4 Institutional mapping of the Ministry of Water and Irrigation (MWI), the responsible institution for wastewater management and reuse activities in Jordan.

Wastewater management (collection, treatment, discharge or transfer)		Water reuse (license, approval and allocation)			Codes, standards and tariffs	Monitoring
Infrastructure development	Operation and maintenance	Industry	Agriculture	Urban (landscaping)		
WAJ (regulate the construction of the infrastructure development)	WAJ (by supervising the water utilities through its Program Management Unit PMU)		JVA (in the Jordan Valley)		Cabinet	MWI
					Jordan Standards and Meteorology Organization (JSMO)	The Ministry of Health
					WAJ (tariff recommendation)	WAJ

water or water reuse) (MWI 2016). Its overarching role often puts the JVA at a 'superior level relatively' to the acting ministries (directorates) in the Jordan Valley. More recently, the JVA delegated some of its mandates (mainly irrigation water allocation and some maintenance tasks regarding irrigation water distribution networks) to the newly established water user associations (WUAs) in the Jordan Valley (Mustafa et al. 2016).

3.4. Lebanon

3.4.1. Toward water reuse development

Lebanon, compared to its neighboring countries, is endowed with relatively plentiful water resources. However, in the past few decades, it is experiencing water shortages that are expected to worsen due to rapid urbanization, population growth, poor governance and climate change (MEW 2020). Reuse has been considered as part of the solution to water problems according to Lebanon's latest national water sector strategies (MEW 2010; 2020). If collected and distributed in organized projects, treated effluents could potentially irrigate some 5,000 ha of lands and reduce pressure on freshwater and groundwater pumping (Eid-Sabbagh et al. 2022). Only one small municipal reuse project (20 ha around Ablah WWTP) was implemented through an international fund while no state projects were planned. No institutional framework for reuse planning and management has been developed and there is a lack of official water reuse quality regulations. The delay in developing reuse can be explained by a dysfunctional wastewater sector where despite 30 years of massive investments in building sanitation infrastructure, less than 20% of treatment facilities are currently operational.[1]

3.4.2. The historical development of water reuse: Policy and institutional milestones

Water governance in modern Lebanon is shaped by a long path of successive political regimes including Arab, Ottoman, French and a complex political history after its independence in 1943. It is today characterized by legal pluralism, institutional overlaps and competition over administrative scales that recent donor-oriented reforms failed to resolve (Riachi 2013; Ghiotti and Riachi 2013; Eid-Sabbagh 2015; Nassif 2019; Allès, 2019). Although relatively recent, legal and institutional development in the sanitation sector follow the same path. The first regulation of wastewater disposal was issued in 1930s, under the French Mandate (1920–1943), along other legal texts establishing water as Property of the State. Since then, water and wastewater use were further regulated and their formal governance progressively centralized. The Ministry of Hydraulic and Electric Resources (MHER) was created in 1959 amidst a period of building state institutions to plan water resources development and coordinate the services of the progressively created 22 public offices responsible for drinking water services. In parallel, hundreds of municipalities (locally elected administrations) and irrigation committees were governing their own water systems with little state intervention (Allès 2019; Nassif 2019). Between the 1950s and the 1980s, while large State-led hydraulic irrigation

[1]This number is further reducing starting the end of 2019 and the bankruptcy of both the Lebanese government and the banking sector (Eid-Sabbagh et al. 2022).

systems were being planned to replace community-based systems (Nassif 2019), wastewater management was still not a state priority. In 1977, municipalities were tasked with a number of responsibilities related to sewerage and treatment management and given competencies to levy taxes in this regard (Mashayekhi et al. 2014). In the same period, two years after the beginning of a long war, the Council for Development and Reconstruction (CDR) was established to manage reconstructions funds and would become a central actor in the sanitation sector after the war.

Between 1975 and 1990, the Lebanese civil war weakened state institutions and paralyzed national hydraulic plans while water and sanitation services were governed locally by militias and/or municipalities and private initiatives. After the war, a large reconstruction program fueled by donors' investments brought back all hydraulic plans on the table. Public investment in sewage collection and treatment became increasingly important and both sectors underwent large institutional transformations. The Ministry of Environment was founded in 1993 and tasked with setting environmental laws and regulations including water pollution. In 1994, Decree 5343 organized the work of the Sanitation Department at the MHER, tasking it with planning and implementing sewerage networks and treatment plants, and approving municipalities' projects (Mashayekhi et al. 2014). A few years later, to comply with the World Bank's governance orientations, the water and sanitation sector were completely restructured (Riachi, 2013; Eid-Sabbagh 2015; Allès 2019).

Issued in 2000, Law 221 created four Regional Water Establishments (RWEs) as decentralized bodies working under the Ministry of Energy and Water,[2] merging the 22 local water offices and taking over the operation of drinking water, irrigation and sanitation services from municipalities and local committees. Later in 2002, the government issued Environmental Law 444

[2]The new name of the Ministry of Hydraulic and Electric Resources

TABLE 3.5 The historical development of the water reuse sector in Lebanon.

1974

Regulatory actions

Decree 8735 – Prohibits wastewater discharge into water bodies.

1976

Regulatory actions

Decree 8765 – Prohibits wastewater use in irrigation.

Institutional & management approach

Each municipality is mandated to assign a location for wastewater treatment.

1977

Institutional & management approach

Establishment of the Council for Development and Reconstruction (CDR) as an autonomous entity directly reporting to the council of Ministries, with the comprehensive task of planning, reconstruction and rehabilitation of the country.

1999

Regulatory actions

Water Master Plan (2000–2009) by the Ministry of Hydraulic and Electric Resources (MHER).

2000

Regulatory actions

Law 221 – creating the regional water establishments (RWEs).

Institutional & management approach

Creates four RWEs with administrative and regional autonomy, responsible for the implementation, operation and maintenance of water-related projects. The law was enacted in 2018.

2001

Regulatory actions

Law 337 – establishing the Ministry of Energy and Water (MEW).

Institutional & management approach

Transforms MHER to MEW.

2002

Regulatory actions

Law 444 – Environmental law.

Institutional & management approach

Environmental law to combat pollution, where the MEW and the Ministry of Environment have competencies in developing standards and imposing measures to monitor water quality in collaboration with relevant stakeholders.

2012

Regulatory actions

The National Water Sector Strategy (NWSS).

Regulatory actions

The National Strategy for the Wastewater Sector (NSWW).

2018

Policy orientation

The international conference in support of Lebanon's development and reforms in Paris (Paris IV - CEDRE) where the Lebanese government committed to implementing sectoral and multi-sectoral reforms that encouraged a large flow of soft loans and grants.

Regulatory actions

Water Code *(Code de L'Eau – Law 77)* – complements and/or operationalizes Law 221 (issued in 2000) by assigning the MEW the responsibility of developing sustainable strategies for water governance at a national level. It states that the RWEs should handle water and wastewater services within their regions and satisfy water demand through conventional and non-conventional sources (including TWW), also for RWEs to propose water and wastewater tariffs.

TABLE 3.6 Institutional mapping of the responsible institutions for wastewater management and reuse activities in Lebanon.

Wastewater management (collection, treatment, discharge or transfer)		Water reuse (license, approval and allocation)			Codes and standards	Monitoring
Infrastructure development	Operation and maintenance	Industry	Agricul-ture	Urban (e.g., landscaping)		
Strategy and policy formulation: The Ministry of Water and Energy						The Ministry of Water and Energy
The Council for Development and Re-construction (CDR)	The Council for Development and Reconstruction (CDR)				The Ministry of Water and Energy	
	Regional Water Establishments (RWEs)				The Ministry of Environment	
Strategy and policy formulation: The Council for Development and Reconstruction (CDR)						
	Municipalities					The Ministry of Environment

that introduced the 'Environmental Police' in charge of enforcing pollution control regulations. In 2004, a 'Code de l'Eau' was developed in collaboration with the Agençe Française de Développement (AFD) as a comprehensive law that governs both water and sanitation and establish new financial and governance mechanisms such as the 'Polluter-Payer' principle and the 'Water Police' responsible for enforcing pollution control regulations. This Code was only ratified in 2018 under donors' pressure on the eve of the 'Cedre' Conference, aiming at attracting loans from the international community (Nassif 2019).

3.4.3. Institutional roles, responsibilities and bottlenecks in water reuse

The under performance of the wastewater sector lies in conflicting and/or diluted administrative responsibilities and a weak operationalization of institutions' legal mandates (Machayekhi et al. 2014; Eid-Sabbagh et al. 2022). For instance, while the MEW's formal role is to lead and supervise planning, infrastructure projects and funds have been typically managed by the CDR since the end of the war with generally weak involvement from the lead ministry. The CDR has indeed been granted the responsibility to implement donors' funds by direct approval of the Prime Minister, and is seen as instrument to concentrate decision-making and the associated financial benefits in the hand of the different political elites[3] (Leenders 2004; Eid-Sabbagh 2015; Nassif 2019). The Ministry of Environment seems also marginalized in planning since not enabled to perform Environmental Impact Assessments for WWTPs as per its mandate.[4] As regularly reported in the literature, implementation of state infrastructure in Lebanon lacks transparency and is associated with large individual political and financial benefits (Leenders 2004; Farajallah et al. 2015; Ibrahim and Seoud 2016; The Monthly 2017).

The wastewater sector has other vexing issues such as inability of RWEs to recover costs in

[3]In the past decade, a national shift in political dynamics has put the MEW in a better position concerning planning and project implementation (Nassif 2019). The latest wastewater sector strategies (NWSS 2012; NWSSU 2021) were issued by the MEW, including a National Wastewater Master Plan (NWSS 2012). Recent interviews with MEW officials reveal that co-ordination with the CDR has been improving and that it is an important objective for the current Ministry and the upcoming update of the National Water Strategy.

[4]Interview conducted by the second author with an official at the MEW in September 2019.

order to operate the WWTPs as per its mandate. It was hoped, following the reform model and dominant market logic, that operations and maintenance could be financed via revenues from fees. However, 20 years after the reform, RWEs are still struggling to implement their mandate due to their weak political power on the ground. They are poorly staffed and subject to interference from the various political factions (World Bank 2010; NWSS 2012; Eid-Sabbagh 2015; Nassif 2019). Currently, among the country's 104 wastewater treatment plants, only 10 are managed by the RWEs and five are well operational. The rest are managed by the CDR, and many have been funded by international projects and managed by the municipalities (Eid-Sabbagh et al. 2022).

3.5. Saudi Arabia

3.5.1. Toward water reuse development

The average annual water use per capita in Saudi Arabia is around 278 m^3 in 2018 (GASTAT 2018). The country has no natural surface water sources and extremely low annual rainfall.[5] The high rate of population growth and the steadily increasing water demand of the agricultural sector which grows at an annual rate of 7% and consumes around 84% of total water requirements has intensified the pressure on the limited water resources (MEWA 2020).

Wastewater reuse in Saudi Arabia is an integral component of the *National Water Strategy 2030*, where wastewater reuse is expected to help the country save its non-renewable groundwater aquifers from the continuous depletion and reduce around 2% of the country's annual electricity consumption (Kajenthira et al. 2012). Water reuse would also attend to the growing water demand of the industrial sector, which is a major contributor to Saudi's economy (Alkhudhiri et al. 2019).

TWW is expected to have contributed to Saudi Arabia's water supply with 0.6 BCM (2% of total resources) in 2016 while increasing to 1.9 (15% of total resources) by 2020. In 2018, the Kingdom produced around 1.46 BCM of TWW of which 17% is reused for agricultural purposes (MEWA 2020).

Water reuse projects in Saudi Arabia have aimed at conserving the non-renewable groundwater, while maintaining sustainable agricultural development and food security, improving the living standards of farmers, and maximizing environmental and economic benefits. This is pursued through a national scale policy and institutional reforms that support the sector's privatization and services subsidization by the government (i.e., water and sanitation services), while maintaining the country's regulatory role (Ouda et al. 2014).

3.5.2. The historical development of water reuse: Policy and institutional milestones

Saudi Arabia's water sector development started at a later stage compared with other coun-

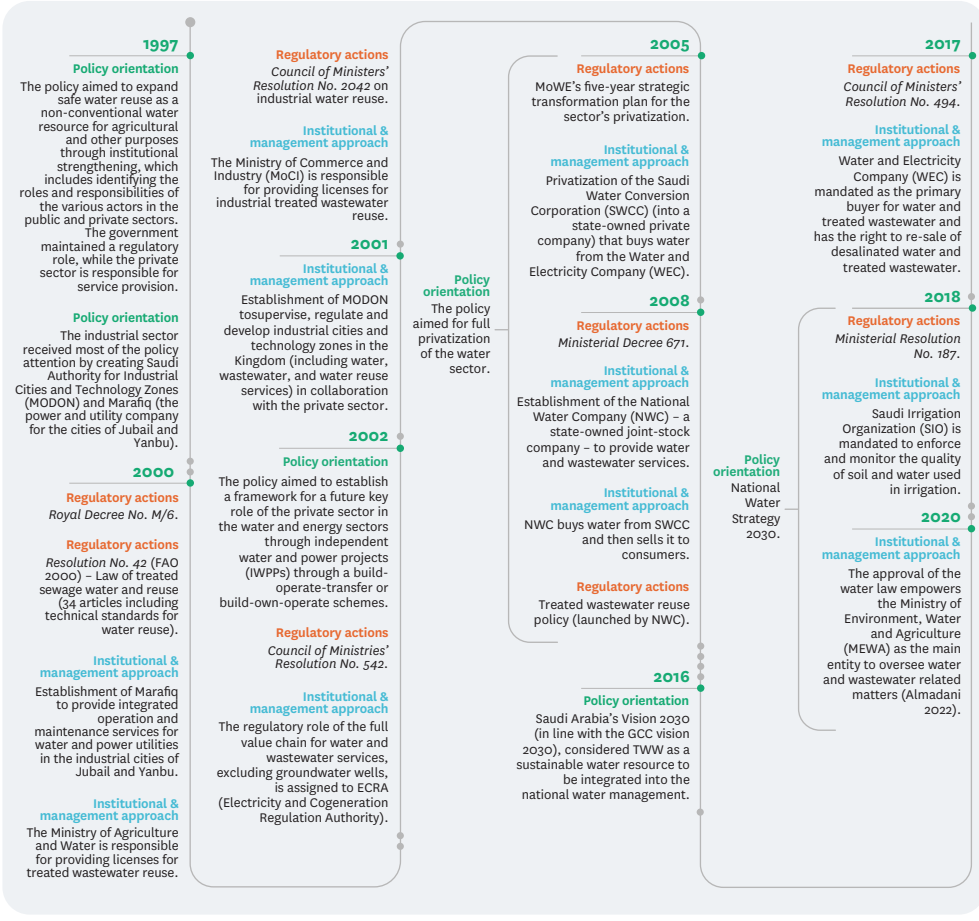
[5]Not exceeding 100 mm in most of the country except the south-western region (Al-Zahrani et al. 2011)

tries in the MENA region (Table 3.7). This can be explained by the Kingdom's recent agricultural development which came at a later stage than Egypt, Jordan and Tunisia. The country has historically depended on groundwater resources but in the 1950s it developed advanced seawater desalination capacities. Currently, Saudi Arabia generates 18% of the global desalinated water (Oxford Business Group 2018). However, the country's quest to expand the less-energy demanding safe water reuse started in the late 1990s with a policy objective that aims for greater involvement of the private sector in the provision of the services while maintaining the regulatory role of the governmental institutions.

3.5.3. Institutional roles, responsibilities and bottlenecks in water reuse

Saudi Arabia managed to integrate unconventional water resources (i.e., desalinated water and TWW) into its water sector plan, while minimizing the institutional overlaps and gaps between the existing agencies. This has been established by clearly allocating roles and responsibilities between the public and private sectors (Tables 3.7 and 3.8). This clear allocation of responsibilities helped as well to minimize the competition of interests between the various actors.

TABLE 3.7 The historical development of the water reuse in Saudi Arabia.



The Saudi case provides a successful example of privatization, while maintaining the regulatory and monitoring role of the governmental agencies to ensure the private sector's compliance with the national codes and standards. However, the well-established privatization does not mean a transformative shift toward a decentralized sector. On the contrary, the water sector in Saudi Arabia is a centralized one that employs the vast experience of the private sector to increase efficiency and reduce the cost-of-service provisions (including water supply, sanitation and water reuse).

These transformative changes are reflected in the institutional structure of Saudi Arabia's water sector, where the state-owned companies and private investors are playing a key role in the value chain of water reuse which starts with the IWPP contracts (build-own-operate or build-operate-transfer) followed by providing water for consumers through the state-owned companies (WEC, SWCC and NWC) (Biygautane 2017) (Table 3.8).

TABLE 3.8 Institutional mapping of the responsible institutions for wastewater management and reuse activities in Saudi Arabia.

Wastewater management (collection, treatment discharge or transfer)		Water reuse (license, approval and allocation)			Codes and standards	Monitoring
Infrastructure development	Operation and maintenance	Industry	Agriculture	Urban (e.g., landscaping)		
Strategy and policy formulation: MEWA (Ministry of Environment Water and Agriculture)						
Independent water and power projects (IWPPs). This includes NWC, WEC and SWCC in addition to Marafiq and MODON.		MoCI (Ministry of Commerce and Industry)	SIO (Saudi Irrigation Organization)	MEWA (Ministry of Environment Water and Agriculture)	ECRA (Electricity and Cogeneration Regulation Authority)	MEWA (Ministry of Environment, Water and Agriculture)
		MEWA (Ministry of Environment Water and Agriculture)				

3.6. Tunisia

3.6.1. Toward water reuse development

The annual per capita water share in Tunisia was estimated at around 440 m^3 in 2017 (FAO 2022a) and is expected to drop to 360 m^3 by 2030 (Chouchane et al. 2018). The increasing water stress and the variability of rainfall and drought periods, additionally to the limitation of conventional water resources, and the degradation of their quality to cover agricultural water needs, are the main drivers to use every 'single water drop,' including TWW.

Water reuse projects started early in the 1960s in the La Soukra region mainly to irrigate citrus trees. This major crop used to be irrigated with depleting shallow coastal aquifers, which resulted in seawater intrusion and salinization of groundwater and made it unsuitable for irrigating crops as sensitive as citrus trees. Hence, the main objective of wastewater reuse was the preservation of the groundwater resources from salinization and the preservation of citrus orchards, even before the promulgation of the overreaching national regulation *Water Law*,

so-called *The Water Code* established later in 1975 that regulates water reuse among other objectives.

3.6.2. The historical development of water reuse: Policy and institutional milestones

Tunisia presents a unique case where the implementation of the water reuse project in the La Soukra area preceded the institutional development of water reuse in the country. This is in contradiction to the other case studies, where implementation steps come after the regulatory and institutional ones. However, starting from the mid-1970s, Tunisia directed its policy orientation toward building the institutional capacity of water reuse by establishing the central governmental institution to manage the sanitation sector (i.e., ONAS). From the 1980s onward, the successive Tunisian governments issued a series of standards and laws to regulate the effluent and influent quality, and to comply with the national and international standards.

Since 2018, expanding water reuse has gained momentum and was promoted under the flagship of the *Strategic Study Eau 2050* accompanied by a *National Master Plan* for reuse, the so-called *Reuse 2050*.

3.6.3. Institutional roles, responsibilities and bottlenecks in water reuse

Water reuse started early in the 1960s in Tunisia (Table 3.9), but policy and institutional settings were only established in the 1990s (e.g., creation of ministries and national agencies). These institutions can be classified into producers, managers, users and distributors, controllers and consumers (of the irrigated products or services) (Table 3.10).

Within this 'value chain-like' structure, the Ministry of Agriculture and Hydraulic Resources and Fisheries (MARHP) plays a prominent role through its directorates and/or subsidiaries. MARHP's wide range of responsibilities includes water resources (mobilization and use) and agricultural production as well as urban (through the National Water Supply Utility, SONEDE) and rural drinking water (through the Department of Rural Engineering and Water Exploitation and the Water Users' Association so-called Agricultural Development Groups).

In the early 1990s, ONAS (established in 1974) and the National Agency of Environmental Protection (ANPE, established in 1988) were moved under the Ministry of Environment (ME) created at that time (ONAS also operates under the Ministry of Local Affairs, since it maintains its role as the main operator of sanitation services). Since then, all wastewater reuse projects have had to submit an Environmental Impact Study to be approved by ANPE. MARHP is the main manager, user and distributor of TWW. It intervenes only downstream of the treatment plant (the upstream being managed by ME) and it operates at various levels, mainly national and regional through its representative regional departments (the Regional Department for Agricultural Development, CRDA) located in the 24 governorates.

Together with the farmers' associations (i.e., GDA), the CRDA is managing TWW reuse and the irrigated areas including the operation and maintenance of the irrigation network, assuring

farmers' involvement and participation at local and regional levels. For this purpose, the Agricultural Extension and Training Agency (AVFA) and its representatives in the regions (Extension Territorial Service, CTV) is responsible for the dissemination of the good practices of water reuse in irrigation and to offer extension services to end-users. The Ministry of Health and its regional affiliated agencies and departments are the main bodies controlling and monitoring the quality of TWW and the quality of the irrigated environment and products.

In terms of governance and the agricultural water reuse, Tunisia has the required actors including the ministries, agencies, committees, and associations at the national, regional and local levels for a successful implementation. However, the relationships between the actors are still weak due to the lack of information sharing, which might reflect a certain mistrust. Currently, there are no mechanisms to reduce the existing overlap in missions and define the roles and responsibilities of each actor. The non-agricultural water reuse is facing weak governance caused by the lack of specific regulations (except the agricultural standards established in 1989, which are applied for water reuse in golf courses, recreational activities and aquifer recharge).

TABLE 3.9 The historical development of the water reuse sector in Tunisia.

Policy orientation

The policy aimed to replace irrigation using depleting groundwater resources with treated wastewater through water reuse projects and developing the government's institutional capacity (particularly laws, regulations and standards).

1965

Institutional & management approach

First water reuse project in La Soukra area.

1974

Regulatory actions

Law 1974 – established the National Sanitation Utility.

Institutional & management approach

Establishment of the National Sanitation Utility (ONAS) to manage the sanitation sector.

1975

Regulatory actions

Issuance of the *Water Code* prohibiting water pollution and the use of raw wastewater.

1985

Regulatory actions

Decree 85-56 – industrial effluent standards into the receiving environment.

1988

Institutional & management approach

Establishment of the National Institute for the Protection of the Aquatic Environment (ANPE).

1989

Regulatory actions

Establishment of the *NT 106.03* The standards of water quality dedicated to the reuse of reclaimed water in agriculture.

Regulatory actions

Establishment of the *NT 106.02* The standards of discharge of effluents in the receiving environment including sewer systems, water bodies and the marine environment.

1990

Regulatory actions

The first strategy for the mobilization of water resources includes the reuse of reclaimed water.

Policy orientation

The policy aimed to develop and build the capacity of state administrations to expand infrastructure building and improve pollution monitoring.

1991

Institutional & management approach

Establishment of the Ministry of Environment.

1992

Institutional & management approach

Modifying ANPE's mission to work under the supervision of the newly created Ministry of Environment.

1993

Regulatory actions

Amendment of *Law 1974*.

Institutional & management approach

ONAS started to monitor the physicochemical and microbiological quality of urban influents and effluent. Under this law amendment, ONAS became a key player under the Ministry of Environment, with its financial autonomy.

2000

Regulatory actions

Ten-year strategy for water resources mobilization.

Policy orientation

Policies geared towards revising the existing standards and providing a national strategy for water reuse in Tunisia.

2018

Regulatory actions

Revision of the standards of discharge of effluents in the receiving environment *(NT 106.02,1989)* and enacting of the *Decree No 2018-315* of 26 March 2018.

2019

Regulatory actions

Launching the Master Plan Reuse 2050 where wastewater reuse in agriculture and for other purposes was promoted (ongoing).

2020

Regulatory actions

Revision of the standards of reuse for agricultural irrigation and the integration of other purposes (ongoing).

Regulatory actions

New Water Code under discussion.

The lack of collaboration between many institutions, mainly from different sectors, is one of the major bottlenecks. For instance, there are no institutional arrangements between ONAS and the regional departments of MARHP, which means that there is no guarantee of the production and distribution of TWW that satisfies the agricultural water demand. Therefore, it was repeatedly suggested to create an independent multi-sectoral organization that would oversee water reuse to avoid redundancy and overlap of missions.

TABLE 3.10 Institutional mapping of the responsible institutions for wastewater management and reuse activities in Tunisia.

Wastewater management (collection, treatment, discharge or transfer)		Water reuse (license, approval and allocation)			Codes and standards	Monitoring
Infrastructure development	Operation and maintenance	Industry	Agriculture	Urban (e.g., landscaping)		
Strategy and policy formulation: MARHP						
Ministry of Equipment and Infrastructure	ONAS		MARHP through the Regional Departments for Agricultural Development (CRDA)		MARHP, ME, MH	The Ministry of Environment through ANPE and ONAS (practicing self-evaluation)
			Farmers' Association (GDA)			The Ministry of Health

3.7. Conclusion

The MENA region suffers from a lack of technological and infrastructural development, the absence of standards and regulations, and the weakness of institutional arrangements that govern these services (Ait-Mouheb et al. 2020; Mayaux and Ennabih 2020). 'Decentralization' and 'private sector participation' (e.g., public-private partnerships) are common policy recommendations. This is often not reflected in the actual policy orientation that informs the regulatory and institutional development of the sector. Where the top-down, centralized institutional set-up of the sector is dominating in most of the MENA countries in various forms. The policy and institutional development of water reuse in the five countries have shown the following key features that characterize wastewater management and reuse in MENA:

- Wastewater management and reuse are a second priority in the five countries where the increased pressure on water resources was the key driver to adopt water reuse as a new source of water and it was primarily directed toward the agricultural sector.
- Policy and institutional measures to regulate wastewater reuse often lag other water-related projects (i.e., supply management projects). Accordingly, an increased share of freshwater is turned into the system as untreated wastewater.
- The absence of independent regulatory agencies, the overlapping roles and responsibilities, and the absence of specialized institutions to monitor water reuse in the different sectors are key factors that lead to institutional weaknesses and thus hinder the governments' efforts to shift toward decentralization and private sector involvement (with Saudi Arabia as an exception).

- Institutional and policy reforms initiated by donors (e.g., in Egypt and Lebanon) do not achieve their goals of improving the sector's performance unless there is a country-driven reform based on needs assessment and long-term planning.
- There is a trend toward centralization and increased regulation of water quality and water flows. This is logical in a context of increased, competing demands for water, and weak/poor institutional capacity to handle water, sanitation and reuse services at a local level (e.g., the reduced role of municipalities as service providers in Lebanon after the establishment of RWEs, and the centralization of water and sanitation service provision in Egypt by the establishment of the HCWW).
- There is a lack or absence of policy enforcement and implementation, which creates a 'gray zone' that is often filled with informal (often illegal) reuse arrangements (Tawfik et al. 2021).

Finally, reviewing and analyzing the policy and institutional challenges/trajectories for the five countries resulted in the following recommendations that will help policy- and decision-makers in MENA overcome the policy and institutional bottlenecks in their countries by:

- Creating spaces for local stakeholders to participate in policy and institutional development that concern their localities.
- Creating an enabling environment to encourage private sector involvement. This includes clear roles and responsibilities for the various institutions in the sector, policy incentives, and long-term concession contracts.
- Entrenching the concepts of transparency and collaboration between the different institutions to develop a multi-sectoral water policy that is inclusive of their various needs.
- Ensuring that each policy item must have a corresponding institutional action to avoid overlapping of responsibilities.
- Understanding that the transition from centralized to decentralized water management is not a 'silver bullet' for the sector challenges. However, implementing this transition must go through phases to avoid institutional 'shocks' and to ensure the financial, regulatory and legal 'maturity' of the newly created autonomous entities.
- Recognizing the key role of donor-driven policies and institutional reforms in the sector's performance might hinder the sector's ability to set a clear vision that meets the country's needs and long-term planning goals.

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