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Chapter 3
Existing and Recommended Water Policies in Egypt

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Abstract This chapter presents the 2017 state of water in Egypt. It provides information on the corresponding balance of water resources and uses in Egypt in light of the water scarcity situation. It provides views on the implementation of the water-energy-food nexus approach in Egypt. It also addresses the challenges facing Egypt's dependency on the transboundary water resource of the Nile, and the dependency of Egypt on the use of non-conventional water resources and reuse of agriculture drainage and wastewater. This chapter highlights the role of virtual water imports in achieving Egypt's food security. It touches upon the urban water tariff system. It reflects on existing water policies and provides recommendations for water policies that would achieve quick wins in the future.

Keywords Nile · Groundwater · Nubian Aquifer · Policy · Virtual Water · Reuse · Tariffs · Nexus

3.1 Introduction

Egypt's limited renewable water resources pose a restrictive challenge to its sustainable development. This challenge is exacerbated by the ever-increasing water demand and population growth. This requires additional water resources especially for the municipal, agriculture and industrial sectors. The increasing competition over the Nile River waters among upstream countries, in the absence of a commonly agreed river basin management vision, threatens the sustainability of the existing water uses of Egypt in the future.

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Table 3.1 2017 Estimated water balance for Egypt

Water resources	BCM/year	Water uses by sector	BCM/year
Use from primary water resources			
Nile River	55.5	Domestic	10.75
Non-renewable groundwater	2.1	Industry	5.4
Rainfall	1.30	Agriculture	61.6
Saline water desalination	0.35	Evaporation	2.5
Total	58.24		
Reuse from secondary water resources			
Nile Valley & Delta groundwater	7.5		
Agricultural drainage reuse	9.31		
Treated wastewater reuse	4.19		
Total	21		
Total water availability	80.25	Total uses	80.25

Modified from Egypt's Vision 2030, revised draft on the Water Resources Sector

According to the Egyptian Census, the population of Egyptians living in Egypt reached about 95 million people in 2017 with an average growth rate of about 2.56% in the previous 10 years (CAPMAS 2017).

The following table shows different water resources contributing to different water uses for Egypt as of 2017 (modified from Egypt's Vision 2030 Sustainable Development Strategy) (Table 3.1).

Urban water demand is rapidly increasing and posing pressures on water resources due to population growth and urbanization expansion where the urban population has increased from about 41 million people in 2006 to about 55 million people in 2017 (CAPMAS 2017). Sanitation services coverage remains a challenge. Although about 97% of the households are connected to national potable water networks, only about 56% of the households are connected to national sewage networks (CAPMAS 2017).

The impacts of climate change on the water sector in Egypt need assessment not only at the national level but also at the transboundary level where 97% of the renewable water resources of Egypt originate upstream in the Nile River basin.

From the institutional perspective, the water sector in Egypt is currently divided among two main Ministries: the Ministry of Water Resources and Irrigation, in charge of water resources planning and management, irrigation, and agriculture drainage, and the Ministry of Housing, Utilities and Urban Communities, in charge of domestic water supply and sanitation. Egypt has several water legislative frameworks and laws governing the water sector, mainly the 1984 Law 12 for Irrigation and Drainage, and the 1982 Law 48 for the Protection of the Nile and Waterways from Pollution. Current modifications to these laws are underway, and a New Law for Domestic Water has also been drafted.

3.2 Agricultural Water

The agriculture sector in 2017 used about 61.6 billion cubic meters (BCM) of water. However, a substantial amount of about 21 BCM/year came from recycled water in the form of agriculture drainage, treated wastewater, and return groundwater recharge.

(a) Surface water

About 39.2 BCM/year are withdrawn for agriculture purposes from fresh surface waters of the Nile River and its irrigation network of about 33,550 km in length, in addition to the effective rainfall in the amount of about 1.3 BCM/year.

(b) Groundwater

About 2.1 BCM/year are withdrawn from non-renewable groundwater aquifers for agriculture purposes. In addition, about 5.5 BCM/year are abstracted from return groundwater recharge within the Nile Valley and Delta aquifers.

(c) Reuse of agriculture drainage and treated wastewater

About 9.31 BCM/year of agriculture drainage is being reused in agriculture, in addition to about 4.19 BCM/year of treated wastewater which is directly or indirectly reused in agriculture.

Most of the Nile waters in Egypt are used and recycled several times. As shown in Fig. 3.1, the two regulators/barrages, Edfina barrage on the Rosetta

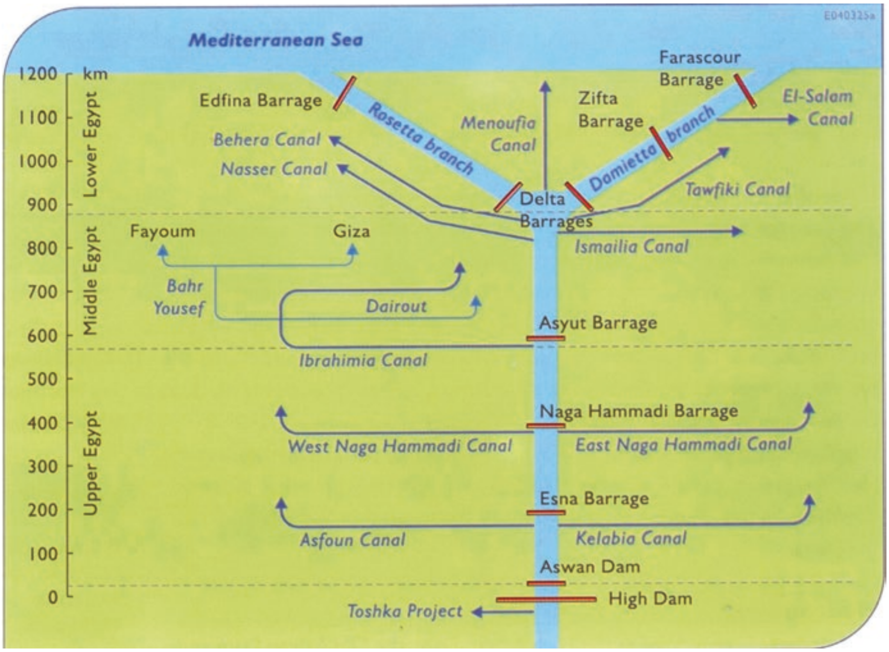

Fig. 3.1 Nile River dam/barrages system in Egypt. (Source: MWRI 2004)

branch of the Nile and the Faraskour barrage on the Damietta branch, provide full control on the tail ends of the Nile into the Mediterranean Sea whereby no freshwater is released from the Nile River except occasionally for environmental purposes. On the other hand, poor quality recycled agriculture drainage water, mixed in most cases with industrial and municipal wastewater, is discharged into the Mediterranean Sea.

Upper Egypt's agriculture drainage, in often cases still, finds its way to the Nile system and may be reused again downstream after mixing with fresh Nile water. Several agriculture drainage reuse pumping stations in the delta are located on agriculture drains to pump drainage water of good quality into irrigation canals for reuse to augment irrigation water, to meet tail end water demands. In cases where water qualities of these agriculture drains are affected by wastewater, and where their water quality is not meeting the set standards, reuse pumps are not operated. Unofficial reuse, where farmers at the tail ends of irrigation canals use their private mobile pumps on agriculture drains to irrigate their fields in the absence of adequate freshwater, also takes place (MWRI 2004).

(d) Cost Recovery

Irrigation water delivery costs are indirectly recovered through agriculture land taxes. However, this represents a partial cost recovery mechanism of the large-scale infrastructure used for irrigation water delivery. It has to be noted though that this infrastructure serves also for domestic, industrial, commercial, and other uses. On the other hand, irrigation costs at the farm level are mostly covered by the farmers or agriculture investors who cover their own costs of farm-level irrigation infrastructure, fuel for pumping, and other operation and maintenance costs. Costs of irrigation improvement mechanisms and agricultural drainage which are installed by the government are also recovered from the farmers in the form of installments.

(e) Institutional settings of irrigation organizations and farmers' participation

There are over 13,000 water users associations (WUAs) that are created so far in Egypt. However, these WUAs still do not cover the whole irrigation land. The new law, being discussed in parliament in 2018, aims among other things to set up WUAs as legal entities so that they can effectively take up their role in irrigation water management, including covering their own costs of canal and drainage maintenance at the farm level, and possibly farm irrigation improvement projects, and operation and maintenance costs of central pumps for irrigation rotation which serves more than one farmer.

(f) Irrigation efficiency

The Nile water system and its network of irrigation canals and agriculture drains in Egypt is considered one of the world's most efficient systems, with an overall water use efficiency, reaching over 75% in terms of water quantity. However, there is still room for improvement to increase the efficiency further at the local and farm level, and to improve the quality of water delivered, which is another aspect of water use efficiency. Irrigation improvement may add an additional 10–20% of freshwater availability. It will also provide for better distribution and more equity in allocating water quantity and quality among users, especially in the irrigation sector (AbuZeid 2011).

Reallocating any water savings that result from water efficiency programs has to be intelligently planned. Water savings from irrigation improvement projects, or domestic water supply networks rehabilitation, may not necessarily be reallocated to the same sector. With the ever-increasing demand in municipal water, a sector that has the highest priority in water allocation, it may be needed to reallocate Nile freshwater savings from the agriculture sector to the municipal water sector, and allocate the treated wastewater resulting from municipal water uses to agriculture expansion projects (AbuZeid 2009).

There is no detailed assessment of how much water has been saved from irrigation improvement projects, but so far, this has been contributing to the incremental increase in the supply of domestic water needed for urban expansion and the increasing population needs.

(g) State-of-the-art technology/Smart irrigation and innovations

A considerable area of desert reclamation projects for agriculture expansion is adopting modern irrigation schemes such as sprinkler and drip irrigation, and modern surface irrigation. Old agriculture lands in the Nile Valley and the Delta are being modernized. A little under 1 million acres have been modernized so far since the 1980s. Smart irrigation technologies are being implemented at experimental levels in few farms in Egypt.

(h) Food self-sufficiency vs food security (virtual water/food imports)

If Egypt would to be food self-sufficient, it would have to at least double its freshwater resources availability. That is why Egypt is adopting a food security strategy where it maintains a certain percentage (less than 100%) of food self-sufficiency in strategic crops and food products such as wheat, maize, table oil products, sugar, and rice. Egypt imports its remaining food needs and that is why it also has to maintain the availability of foreign currency needed to import its needs. Some of its high value cash crops exports contribute to the availability of this foreign currency. As per the Arab State of the Water Report 2015 (AbuZeid et al. 2019), Egypt was importing about 49 BCM/year of equivalent agricultural food products distributed as shown in Fig. 3.2, while exporting the equivalent of about 7 BCM/year in agricultural food products as shown in Figs. 3.2 and 3.3.

3.3 Domestic Water

Urban (Domestic) water is supplied at 10.75 BCM/year through surface water (about 8.4 BCM/year), groundwater recharge (about 2.0 BCM/year), and desalinated water (about 0.35 BCM/year in some coastal cities). Approximately 5.4 BCM/year is supplied to the industrial sector from surface water. Domestic water is the sector that has priority over other sectors in Egypt's water policies. In case of shortages, domestic water demand takes priority in satisfying demand over other sectors. The high dependency of Egypt on the one Nile River as the main source for renewable water resources requires long lengths of pipes to transfer domestic water to

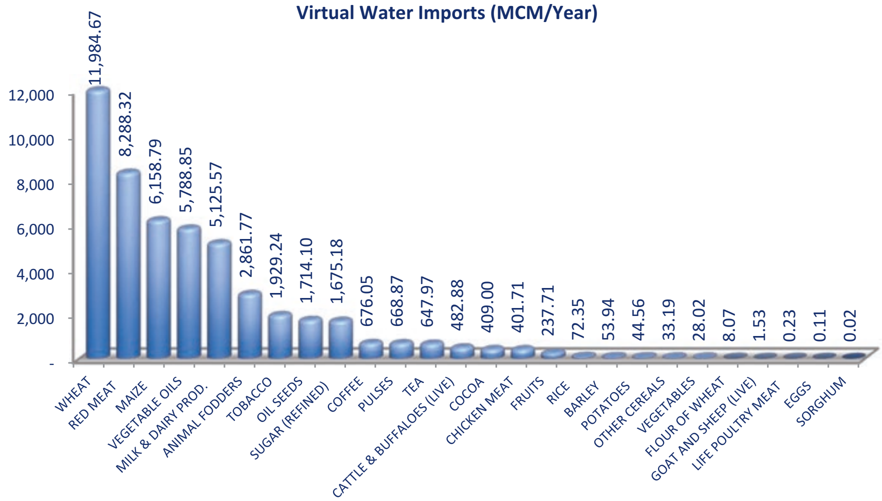

Fig. 3.2 Egypt's 2015 virtual water imports. (Source: AbuZeid 2017b)

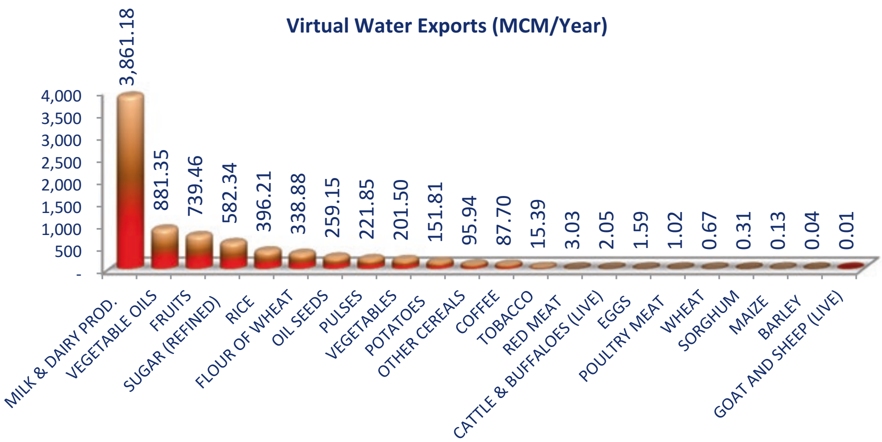

Fig. 3.3 Egypt's 2015 virtual water exports. (Source: AbuZeid 2017a, b)

urban centers of population and remote suburbs. The length of domestic water supply networks reached over 160,000 km as of 2015 (AbuZeid et al. 2019). These long transfers also require substantial amounts of energy for pumping. Sewage networks have also reached over 46,000 km in 2015 (AbuZeid et al. 2019).

(a) Desalination

All Red Sea tourism resorts in the South Sinai and the Red Sea governorates are already depending on sea water desalination for their water supply. All coastal cities are going to depend on desalination. Currently desalination provides about 0.35 BCM/year of domestic water. It is now the government strategy not to supply Nile water to coastal cities. Cities on the Mediterranean Sea and Red Sea coasts will depend mainly for their domestic water supply on sea water or brackish groundwater desalination.

(b) Wastewater treatment

As of 2015, annual produced municipal wastewater reached about 6.5 BCM. Industrial wastewater which is often collected using the same network has reached 4.2 BCM. 4.8 BCM of this total wastewater is being collected, and 4.25 BCM is treated annually.

(c) Wastewater reuse in the urban sector

As of 2015, 2.2 BCM/year of the treated wastewater is directly reused, and about 2 BCM/year is indirectly reused after disposal in agriculture drains.

(d) Urban water tariffs

The average domestic water tariff used to be about USD cents 7/m^3 and it used to be about USD cents 2/m^3 for the sanitation tariff. These tariffs did not meet the actual costs over the whole country, and some users were subsidized, either by cross-subsidy or by direct government subsidy. As of 2018, the Prime Minister's Decree No. 1012 for the year 2018 on the application of domestic water and sanitation tariffs for the fiscal year 2018/2019, household uses tariff for the first block from 1 to 10 m^3 was set at the equivalent of USD 3.75 cents/m^3. The second block from 11 to 20 m^3 was set at USD 9.22 cents/m^3 and the third block from 21 to 30 m^3 was set at USD 12.97 cents/m^3. The tariff for uses from 1 to 40 m^3 was set at USD 15.85 cents/m^3 and from 1 to more than 40 m^3 the tariff was set at USD 18.16 cents/m^3. Household sanitation tariff was set at 75% of the domestic water tariff.

Non-household uses were divided among several categories setting the tariff for "Services" at USD 19.02 cents/m^3, "Government" at USD 19.60 cents/m^3, "Commercial" at USD 20.75 cents/m^3, "Industrial" at USD 26.22 cents/m^3, "Tourism" at USD 26.51 cents/m^3, and "Others" at USD 34.58 cents/m^3, while "Sports and Social Clubs" at USD 57.64 cents/m^3. Sanitation tariff for these non-domestic uses was set at 98% of their water tariffs.

Drinking water tariff for border governorates such as "Sinai/Red Sea/Matrouh" was set at a flat rate of USD 74.93 cents/m^3 and the sanitation rate was set at 50% of the domestic water tariff. The higher rate in these coastal governorates reflects their anticipated dependencies on desalination as the main source for urban water.

(e) Public–private sector partnership and water utility management

There are new laws in place to promote public–private partnership (PPP) and to regulate the business. The private sector is now involved in wastewater treatment projects that treat and provide treated wastewater for reuse in the cities. However, it is still at a small scale. It is still not that attractive to the irrigation sector due to low or no cost attributed to alternative irrigation water supplies. Also the weak law enforcement and protection of direct water-related investments such as new agriculture developments in desert lands are affecting Egypt's competitiveness in that area (AbuZeid 2011).

3.4 Water-Energy-Food Nexus

Innovations in dealing with the water-energy-food nexus need to be encouraged, especially when it comes to desalination, wastewater treatment technologies, and groundwater pumping. Currently, solar energy is being used for pumping groundwater in remote areas in the desert for irrigation purposes. Although this is contributing to food production and saving on fossil energy consumption and carbon emissions, it may be detrimental to the fossil groundwater reserves that is being pumped, if strong regulations and control on pumping are not enforced. This has to be studied using a nexus approach. On the other hand, some irrigation improvement policies, which may be envisaged as saving water, may actually be consuming unnecessary energy and not achieving the targeted water savings goals. The Ministry of Water Resources and Irrigation has alternatively been implementing a combined policy of improving surface irrigation in the old lands (within the Nile Valley and the Delta), while reuse agriculture drainage generated from improved surface irrigation, as well as enforcing modern irrigation such as drip and sprinkler irrigation in the new desert reclamation lands. This demonstrates that, when approached from a nexus perspective, transforming surface irrigation to pressurized drip irrigation is not always the best solution. It is important to look at the overall water use efficiency than just focusing on the on-farm irrigation efficiency (AbuZeid 2017a, b).

3.5 Special Issues

(a) *International waters*

(i) *The Nile River Basin*

Egypt is one of the 11 riparian countries sharing the Nile River basin, with South Sudan becoming the 11th Nile River basin country. Egypt is the most downstream country on the Nile River, which makes it vulnerable to upstream activities, even with the existence of bilateral agreements that protect its historical rights to a certain amount of the Nile waters. Reduced water availability could potentially affect Egypt's competitiveness in regional and world markets, especially in agriculture (AbuZeid 2011).

The Nile River basin receives 1660 BCM of rainfall per year. Egypt's share from the Nile River basin's water is 55.5 BCM/year. This share is documented by the bilateral agreement between Sudan and Egypt to share the average annual river discharge of 84 BCM/year that used to flow at Aswan, Egypt, before the construction of the High Aswan Dam. Sudan's share of that amount is 18.5 BCM/year, and the remaining 10 BCM/year is an estimate of the evaporation and seepage losses from Lake Nasser upstream of the High Aswan Dam. The rest of the 1660 BCM/year of rainfall over the Nile basin is either used up within the Nile River basin by rain-fed agriculture, grazing land, natural vegetation, and forests, or it contributes to groundwater recharge, or it's lost to evaporation from ground and surface water bodies (AbuZeid 2009).

Whereas Egypt depends mainly on the Nile River waters, other Nile basin countries depend mainly on direct rainfall within and outside the Nile River basin. The Nile basin countries, almost all upstream of Egypt, receive about 7000 BCM/year of rainfall within their boundaries. One Nile basin country, Congo, has another major river that runs through its territory, namely, the Congo River. The Congo River discharges into the Atlantic Ocean about 1000 BCM/year. This is almost 20 times the annual abstractions from the Nile River in Egypt. There is no freshwater discharge from the Nile River into the Mediterranean, due to the full utilization of the released Nile flows from the High Aswan Dam. The Nile basin country of Ethiopia has over 12 river basins, other than the Nile River basin within its territories (AbuZeid 2010). Unlike upstream Nile basin countries, Egypt depends almost completely on the Nile River waters (Blue Water) as compared to upstream higher dependency on the Nile basin's direct rainfall waters (Green Water) (AbuZeid 2012). The overall efficiency of water use in Egypt is considered to be among the highest in the world mainly due to water recycling and reuse.

Significant volumes of water losses exist in the upstream countries of the Nile due to the large areas of swamps, especially in the Sudd area in Southern Sudan, and in the Baro-Akobo area in Ethiopia. Water saving projects that could be implemented in these areas to increase the yield of the River Nile are estimated at 18 BCM/year in the Sudd in Southern Sudan, and 12 BCM/year in the Baro-Akobo in Ethiopia. The Jongli Canal Project was estimated to increase the White Nile River flows in Sudan by 4 BCM/year in its first phase to be shared by Egypt and Sudan. Some 70% of this canal has already been jointly constructed by Egypt and Sudan until it was halted due to political unrest in Southern Sudan (AbuZeid 2009).

(ii) *The Nubian Sandstone Aquifer*

The Nubian Sandstone Aquifer System (NSAS) is a transboundary groundwater basin in the North Eastern Sahara of Africa. The international waters of this regional aquifer are non-renewable and shared between Chad, Egypt, Libya, and Sudan. The area occupied by the Aquifer System is 2.2 million square km; 828,000 km^2 in Egypt, 760,000 km^2 in Libya, 376,000 km^2 in Sudan, and 235,000 km^2 in Northern Chad (AbuZeid and ElRawady 2010).

Policies related to non-renewable groundwater have to take into consideration the cumulative withdrawals compared to the groundwater reserves, and strategies for planned drawdown within a certain time frame have to be put in place. Figure 3.4 shows Egypt's cumulative withdrawals from the Nubian Sandstone Aquifer System, since its groundwater development started from its Nubian and Post-Nubian subsystems (PNSAS) (AbuZeid 2018 and CEDARE 2014).

The four countries sharing the Nubian Sandstone Aquifer have agreed to a regional strategy not to exceed 1 meter of drawdown per year (CEDARE 2002).

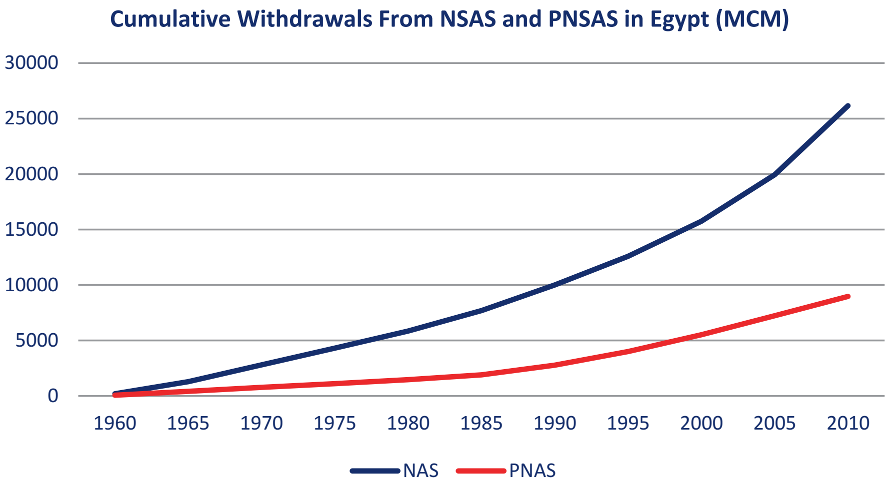

Fig. 3.4 Egypt's cumulative withdrawals from the Nubian Aquifer. (Source: CEDARE 2014)

(b) *Conflicts, negotiations, and agreements*

Egypt has water-related agreements with 5 of the 11 countries sharing the Nile basin. Egypt has initiated the Nile Basin Initiative (NBI), which was an umbrella framework that used to include 10 countries of the basin, with Eritrea being an observer. The NBI had two tracks: a joint projects development track and a legal framework development track. However, because of the unilateral signature of six countries on the Nile Cooperative Framework Agreement (CFA), before final agreement of all riparian countries on all articles, Egypt and Sudan withdrew from the NBI in 2010. The tensions in the relations between Egypt and Ethiopia (source of 85% of the Nile Waters running downstream) were exacerbated further in 2011 due to the unilateral decision of Ethiopia to build the Grand Ethiopian Renaissance Dam (GERD) on the Blue Nile, the largest tributary of the Nile supplying about 90% of Egypt's share of the Nile, with a storage capacity reservoir of exactly the same as Egypt's and Sudan's shares combined (74 BCM).

Studies have shown potential impacts on Egypt's and Sudan's shares from the Nile due to the accumulative effects of evaporation and seepages losses from the GERD. These accumulative effects would be much felt during the dry years and low flows of the Blue Nile. Figure 3.5 shows one of the several scenarios simulated in a study conducted by AbuZeid, K. at CEDARE.

A declaration of principles was signed in 2015 by the Heads of States of Ethiopia, Sudan, and Egypt on the GERD, mainly to agree on the rules of the first filling and the operation rules of the GERD before the first filling, and to oversee the environmental, socioeconomic, and hydrological Impact Assessment that is being

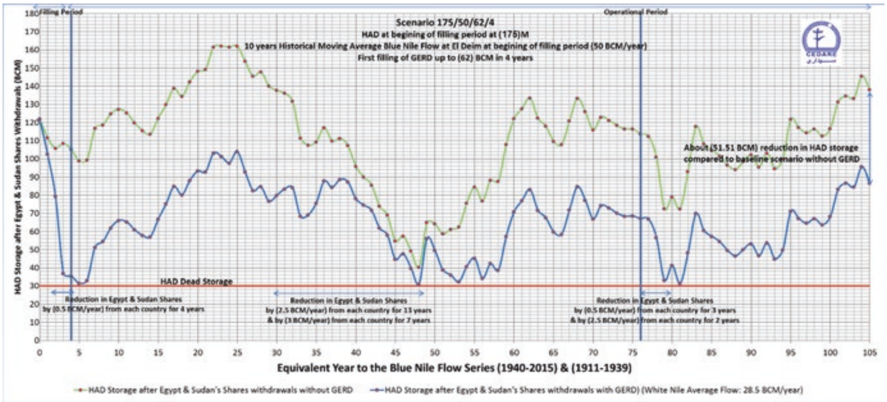

Fig. 3.5 Potential impacts of GERD on Egypt's and Sudan's Nile shares. (Source: AbuZeid 2017a, b)

conducted by an independent consultant that the three countries had agreed to hire. It is evident that this assessment should have been jointly conducted before the design and construction of the GERD, but the unilateral decision of Ethiopia prevented that from happening. It was announced in late 2018 by the Ethiopian government that due to delays, changes in the contractor, and in the design, it is supposed to be completed in 2022.

On the other hand, Egypt is part of the Joint Mechanism for the Studies of the Nubian Sandstone Aquifer with the three other riparian countries sharing the Nubian Sandstone Aquifer, namely, Libya, Sudan, and Chad.

(c) *Sustainability of non-renewable groundwater activities*

Non-renewable groundwater in most of Egypt's western desert, within the Nubian Sandstone Aquifer, which is also transboundary with Libya, Sudan, and Chad, is slowly being depleted. The aquifer is the only source of water and livelihood in the western deserts of Egypt covering the largest part of the country, almost 82%. The rate of depletion will be higher if this water is used for agriculture. The aquifer will last longer if this water is used for water bottling or used for municipal purposes. The quality of this groundwater is relatively high and requires minor treatment, therefore may be more appropriately used for human consumption. The return wastewater from municipal use of this non-renewable groundwater could be directed to agriculture after treatment, making this a far more efficient use of finite and non-renewable groundwater resources (AbuZeid and ElRawady 2010). According to the Holding Company for Water and Wastewater, 96.6% of the collected wastewater was safely treated in 2018. In 2017, about 350 MCM/year of treated wastewater was directly reused in agriculture, and about 3.5 BCM/year of treated wastewater was disposed into irrigation canals and agriculture drains where they were indirectly reused.

(d) *Property rights*

Groundwater users should have a license with specified allowed abstraction. The allowable pumping could be reduced based on the depletion situation of the groundwater aquifer. Egypt's lack of surface and renewable groundwater registered water rights reduces the ability to have a secure and stable future for agriculture land owners and water-dependent investments.

3.6 Conclusions

A quick win for Egypt is to implement a mix of policies that encourage conservation and use of non-conventional water resources, improve water allocation and water accounting, and jointly develop new Nile water resources. Egypt must plan now to use the appropriate type of water for the appropriate use at the appropriate location (AbuZeid 2009). Applying the fit-for-use water concept is going to result in reduced costs and efficient overall water use. Although there are some attempts to make use of treated wastewater for landscaping, and agriculture in some areas, and use of high value non-renewable groundwater for water bottling, which contribute to the concept, there is still no policy that is adopting the concept at the national level.

(a) Non-conventional water resources and geographical reallocation

Coastal cities on the Mediterranean and the Red Sea should be the first to consider desalination and start planning for it, if new water resources are to be sought. In the near future when Egypt will need to expand in desalination, proximity of seawater and brackish groundwater will play a role in reducing the cost of providing desalinated water. As it will be prohibitively expensive to convey desalinated water inland for long distances, inland governorates will therefore have to depend on Nile water, groundwater, and recycled water as the main sources for sustainable development in the future. This may require Nile water reallocation from some of the coastal governorates to inland governorates, which will be difficult to do in the future, if more Nile waters continue to be directed to coastal governorates away from the Nile River. With the existing limited share of Egypt from the Nile waters, no more internal Nile waters should be reallocated to coastal cities, as desalination would be the most appropriate resource for these appropriate locations (AbuZeid 2009). Desalination may appear to be the easy solution for providing new water resources; however, in some cases there are other priority options that are more cost effective for making more water resources available, especially agricultural water pricing, water conservation, and reuse of treated wastewater options. The following figure shows different incremental costs of supplying water for the city of Alexandria (AbuZeid et al. 2011) (Fig. 3.6).

(b) Facing the challenges: sectoral reallocation of water

Current depletion rates of renewable and non-renewable groundwater need to be addressed. There are weak monitoring and enforcement systems and low levels of awareness that result in illegal abstractions and over pumping of groundwater.

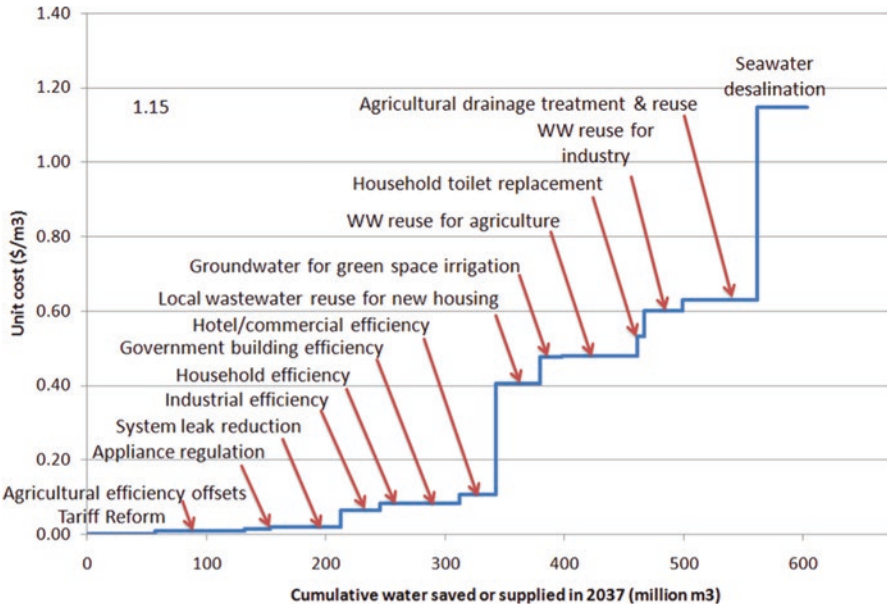

Fig. 3.6 Incremental cost for satisfying Alexandria future water demand. (Source: AbuZeid et al. 2011)

These may jeopardize the future of the existing investment in the agriculture sector and reduce significantly Egypt's competitiveness in the agriculture export marketing, and in achieving national food security. A reallocation of a different type of water resource may be needed to compensate for the depleted groundwater in the agriculture sector and to maintain the economic and social activities associated with the sector. However, reallocation of water away from the existing establishments in the agriculture sector is not recommended, due to the large socio-economic impact this might have on the country. A paradigm shift is needed to take the tough and wise decisions, and to get into innovative solutions at the technological, institutional, financial, and legislative levels, using non-conventional water resources such as treated wastewater, introducing models of public–private partnerships, and modifying the legislations that govern the way water is currently being managed to adapt to a more water-efficient and more competitive Egypt in 2030.

(c) Bridging the supply–demand gap

Water demand management, also known as water conservation, is a priority. There is room for reducing agriculture water losses by about 10% and domestic water losses by about 30%. A "Swap" in the type of water provided for agriculture represents another option of reallocation, whereby agriculture drainage water, or treated wastewater, rich in nutrients, may replace fresh Nile water for agriculture to free fresh Nile waters for drinking and domestic uses. This requires more attention to be given to the quality of agriculture drainage water, mainly by preventing the disposal of inappropriately treated or untreated wastewater into agriculture drains. It also requires raising the level of wastewater collection and treatment.

(d) Water quality improvement and reuse

Industrial wastewater treatment and recycling before disposal should be enforced to protect water quality. The modification of the wastewater reuse code that took place in 2015 to allow for reuse of treated wastewater in agriculture of food crops according to the level of treatment and the type of crop need to be embraced and fully implemented. This will contribute not only to food production but also to the improvement of water quality and the environment.

(e) Water security

Medium- to long-term measures include serious cooperation with the Nile basin countries to realize concrete win-win projects, such as those which provide more yield to the Nile waters, more hydropower, and more food for all, without affecting the existing uses in downstream countries such as Egypt.

(f) Institutional water reforms

A paradigm shift is needed in the way water is managed. Treated wastewater will need to be considered the renewable water resource for the future of agriculture (AbuZeid 2008). As wastewater increasingly becomes an important source, the domestic water and wastewater responsibilities (currently under the Ministry of Housing) may need to be brought together with the Water Resources planning responsibilities (currently under the Ministry of Water Resources and Irrigation). Every drop of water will need to be accounted for and measured, because "what is not measured cannot be managed" (AbuZeid 2009). Water should not be bought or sold as an economic good, but a cost-recovery model needs to be in place where the social, economic, and environmental value of water is considered. Water consumption and use needs to be measured. A mechanism for water equity needs to be established to avoid water conflicts and to ensure social cohesion. A model for equity needs to be established to define which sectors are to receive what portions of water, and how the rights of future generations (especially in regard to groundwater) are factored into such a model. One must also factor into the model ways of achieving equity among sectors and within sectors, and especially to ensure affordability for low-income sectors of the society through targeted subsidies or cross-subsidies. Partial or full "Volumetric Cost Recovery" (AbuZeid and ElRawady 2008) of water delivery services in all development sectors will need to be an acceptable practice in Egypt. Partial volumetric cost recovery which entails a subsidized payment for the service of providing water for municipal and even for irrigation use in volumetric terms will provide a sense of ownership and reduce over usage and wastage while recovering part of the costs. Water use tariffs to recover the costs of operation and maintenance as a function of the volume of water consumed are a socially sensitive and cost-effective tool for water efficiency, even if these tariffs are partially subsidized. However, this requires a strong metering and monitoring program for individual households and farmers, which is sometimes a challenge due to the vast number of apartment buildings and small holdings of farm land.

(g) Quick wins

Quick win measures for Egypt as it moves into a highly competitive market and into a green growth economy should include flagship programs for water awareness and policy advocacy, on issues such as irrigation efficiency improvement, wastewater reuse and recycling, domestic water demand management, water legislative reform, and enforcement.

Modification of the building codes is needed to enforce the use of water saving devices in new developments and retrofit these in older ones. Proper water accounting is needed, where water meters and other appropriate measuring devices are installed, and where water consumption is recorded and transparently communicated to the officials and to the consumers in all sectors. An Integrated Water Resources Management (IWRM) law needs to be formulated to encompass all scattered water-related legislations that may be contradicting. Water users associations need to be legally recognized and given an official role and mandate. The private sector's role in the water sector needs to be clearly defined and legally accepted. Continuous capacity building programs and investment in human resources in the water sector are needed.

A water-efficient Egypt by 2030 can increase the quantity and quality of water available for its people and for future economic growth by a mix of policies including water demand management and conservation, advanced use of non-conventional water resources especially treated wastewater, and desalinated water (when appropriate), implementation of the fit-for-use water allocation policy among sectors and regions, enforcement of a strong water accounting and monitoring system, and joint development of new Nile water resources in cooperation with the Nile basin countries, especially South Sudan, North Sudan, and Ethiopia.

These quick win policies are a mix of short-term actions and long-term initiatives that can start as soon as possible and continue throughout the next decade to ensure that the "Gift of the Nile" remains the gift that keeps on giving.

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