The Egyptian Economy in the Twenty-first Century

The Hard Road to Inclusive Prosperity

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Khaled M. AbuZeid

The Present Situation

Introduction

Egypt is simply an elongated oasis in a desert, where 98 percent of the population is forced to live on only 4 percent of the land area within the Nile Valley. Egypt's increasing population is obliged to expand development into the remaining 96 percent of desert lands away from the renewable source of water provided by the Nile River. Egypt's limited renewable water resources represent a challenging limitation to its sustainable development. This challenge is exacerbated by the increasing water demand due to population growth and requirements for raising the standards of living, which requires additional water resources for the municipal, agriculture, industrial, and tourism sectors. The increasing upstream consumptive and non-consumptive water uses of the Nile River waters, based on unilateral decisions in the absence of a commonly agreed vision for managing the river basin, threatens peace, security, and the sustainability of the historical and existing water uses of Egypt into the future.

Per Capita Availability of Water

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

Figure 6.1 shows the population growth from 1970 to 2020 and the impact of that on the annual per capita share of renewable water resources in Egypt. It shows that starting in the late 1980s, the annual per capita share of renewable water resources in Egypt dropped below the water scarcity threshold of 1000 cubic meters per capita, falling to 570 m^3/person/year.

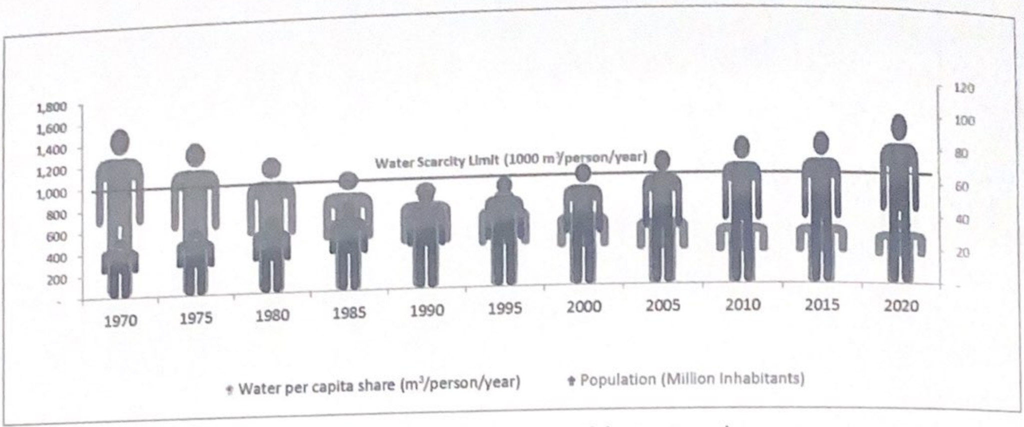

Figure 6.1. Egypt's decreased per capita renewable water share
Sources: CAPMAS 2017; AbuZeid 2021

Water Resources

Around 74 percent of Egypt's water resources are primary resources from the Nile River, rainfall, and non-renewable groundwater, while 26 percent are secondary resources from recycled groundwater recharge, reused agricultural drainage, and recycled treated wastewater. Renewable freshwater resources from the Nile River and the little rainfall available represent only 70 percent of Egypt's total water resources for 2017. The remaining 30 percent is obtained from non-renewable and non-conventional water resources. An estimated 97.7 percent of the renewable freshwater resources come from the Nile River.

Water Uses

An estimated 76.7 percent of water consumptive uses are directed to agriculture, 6.7 percent to industry, and 13.4 percent to municipalities. Non-consumptive uses include hydropower generation, navigation, and tourism. Three percent is lost through evaporation.

Water Balance

Table 6.1 shows the different water resources that contributed to water use in Egypt in 2017.

Urban water demand is expanding rapidly because of population growth and expanding urbanization, which put increasing pressure on water resources. CAPMAS 2017 estimates that the urban population has increased from about 41 million in 2006 to about 55 million in 2017.

Table 6.1. Estimated water balance for Egypt, 2017

Water resources	BCM/year
Primary water resources	
Nile River	55.50
Non-renewable groundwater	2.10
Rainfall	1.30
Desalination	0.35
Total	59.25
Secondary recycled water resources	BCM/year
Nile Valley and Delta groundwater	7.50
Agricultural drainage reuse	9.31
Treated wastewater reuse	4.19
Total	21.00
Total water availability	80.25

Water use by sector	BCM/year
Domestic	10.75
Industry	5.40
Agriculture	61.60
Evaporation	2.50
Total use	80.25

BCM = billion cubic meters

Source: Modified from Government of Egypt 2017

Sanitation services coverage remains a challenge. Although about 97 percent of households are connected to national potable water networks, only about 56 percent of households are connected to national sewage networks (CAPMAS 2017).

Another challenging factor is the impact of climate change on the water sector in Egypt. This needs to be assessed at the transboundary level, where 97 percent of the renewable water resources of Egypt originate. Unfortunately, local climate and hydrology information from the upstream Nile River basin is not accessible to Egypt, which makes it even more challenging.

Water management in Egypt is currently divided between two main ministries: (i) the Ministry of Water Resources and Irrigation, in charge of water resource planning and management, irrigation, and agriculture drainage, and (ii) the Ministry of Housing, Utilities, and Urban Communities, which is in charge of managing domestic water supply and sanitation. Egypt has several legislative frameworks and laws governing the water sector, most importantly Law No. 12/1984 for Irrigation and Drainage, and Law No. 48/1982 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.

The Challenge of Water Availability

The challenge facing water availability in Egypt has two principal aspects: (i) the increasing water demand for agriculture and domestic use, and (ii) the limited and transboundary nature of the supply of international water resources.

The Challenge of Agricultural Water Availability

Although agriculture is the major user of water in Egypt (table 6.2) and domestic (municipal) water uses are considered the second major user, through the reuse of agriculture drainage and treated wastewater, these sectors can in some sense also be considered providers of water. The limiting constraint on the expansion of Egyptian agriculture is water, not land.

Table 6.2. Crop water requirements (m^3/feddan)

Crop	Delta	Middle Egypt	Upper Egypt
Sugarcane		7167	9109
Rice	4961	4691	5395
Cotton	2818	3541	3881
Corn	2251	2310	2370
Wheat	1608	1996	2195

Source: Ashour et al. 2009

Table 6.2 indicates the water consumption for several crops by regions in cubic meters per feddan (m^3/feddan). When the government liberalized the cropping pattern, the area under rice almost doubled. This on-farm choice nearly replaced cotton and corn crops in the summer, because of rice's higher profitability.

This has an important effect on water requirements. When Egyptian farmers fully irrigate about one million feddans of normal-duration rice, they use an amount equal to nearly 10 percent of all water delivered annually by the Nile. Since the rice-growing season is shorter than cotton, it requires more water diversions per unit of time, and this concentrated demand further strains the system. The irrigation sector finds it difficult to provide enough flow to satisfy the increased demand, because the system was designed for a limited area of rice cultivation (El-Assuiti 2003). On the other hand, when the government banned exports of rice, the cultivation of rice fell drastically. In 2020, the government limited the rice cultivation area to 724,000 feddans.

Rice, which is a water-intensive crop, is profitable for the individual farmer, but would show a loss for society as a whole if not enough water is made available for other water needs. On the other hand, sugarcane is also a water-intensive crop, but many subsidiary industries and byproducts, and much employment, depend on the limited area of sugarcane that is being cultivated. Eliminating the difference between social and private profitability will constitute an important challenge for Egypt in the coming decades. Volumetric water accounting, fines penalizing excessive water use, and economic tools for promoting optimal cropping patterns are possible policies that could guide Egypt's future agriculture water management.

In 2017 the agriculture sector used about 61.6 billion cubic meters (BCM) of water. A substantial amount, about 21 BCM/year, came from recycled water in the form of agriculture drainage, treated wastewater, and return groundwater recharge (AbuZeid 2020).

Surface water

About 39.2 BCM/year are withdrawn for agricultural purposes from fresh surface waters of the Nile and its irrigation network of about 33,550 km^2, in addition to the effective rainfall of about 1.3 billion cubic meters a year.

Groundwater

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

Reuse of agriculture drainage and treated wastewater

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

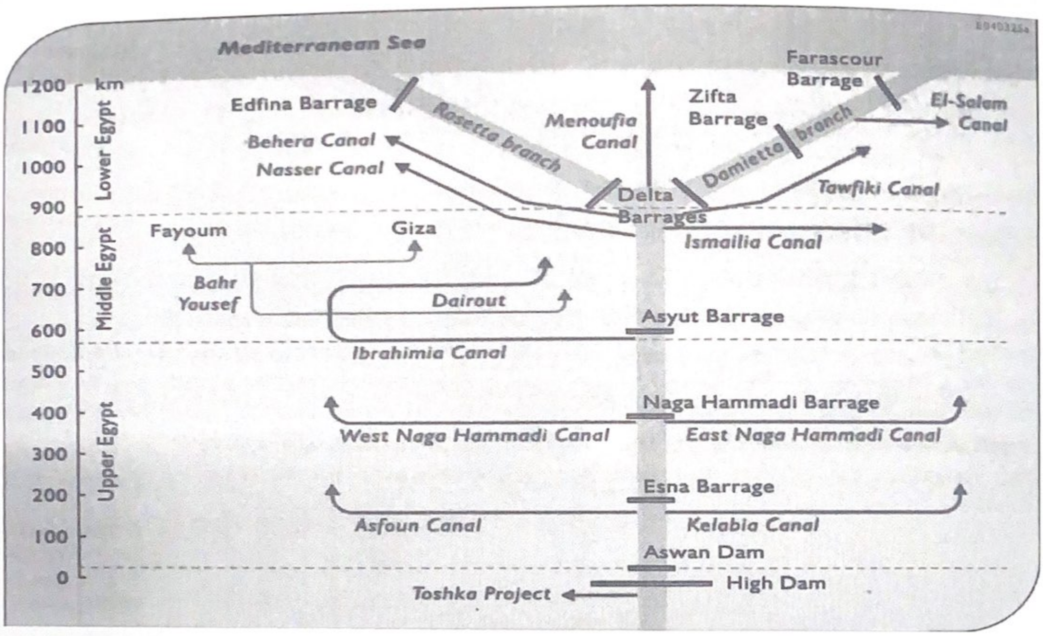

Figure 6.2. Nile River dam/barrage system in Egypt
Source: MWRI 2005

Most of the Nile waters in Egypt are used and recycled several times. As shown in figure 6.2, the two regulators/barrages, the Edfina barrage on the Rosetta branch of the Nile and the Faraskour barrage on the Damietta branch, provide full control on the tail ends of the Nile. No freshwater is released from the Nile to the Mediterranean, except on a few occasions, such as when pollution spills have occurred. On the other hand, poor-quality recycled agriculture drainage water, mixed in most cases with industrial and municipal wastewater, is discharged into the Mediterranean.

Upper Egypt's agriculture drainage 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 the water quality of these agriculture drains is affected by municipal or industrial wastewater so that their water quality does not meet the required standards, reuse pumps are not shut down. Unofficial reuse sometimes takes place, where farmers at the tail ends of irrigation canals are short of adequate fresh irrigation water, and therefore put their private mobile pumps on agriculture drains to irrigate their fields with agriculture drainage water (MWRI 2005).

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 of over 75 percent in terms of water quantity; the remaining percentage is the amount of drainage and wastewater that has been recycled several times. However, there is still room for increasing the efficiency at the local and farm level, which will mainly result in the improved quality of water delivered, which is another aspect of water use efficiency. Irrigation improvement may provide an additional 10–20 percent of freshwater availability of better quality than the reused water. 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).

The reallocation of any water savings that result from water efficiency programs has to be carefully planned. Water savings from irrigation improvement projects or from the rehabilitation of domestic water supply networks may not necessarily be reallocated to the same sector. With the ever-increasing demand for municipal water, the sector that has the highest priority in water allocation, it may be necessary 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 supply of domestic water needed for urban expansion and the increasing needs of the population.

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 agricultural lands in the Nile Valley and the Delta are being modernized—a little under one million acres have been modernized since the 1980s. Smart technologies are being used at experimental levels on some farms in Egypt.

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

For Egypt to be food self-sufficient, it would have to at least double its available freshwater resources. This challenge explains why Egypt has adopted a food security strategy where it maintains a certain percentage of food

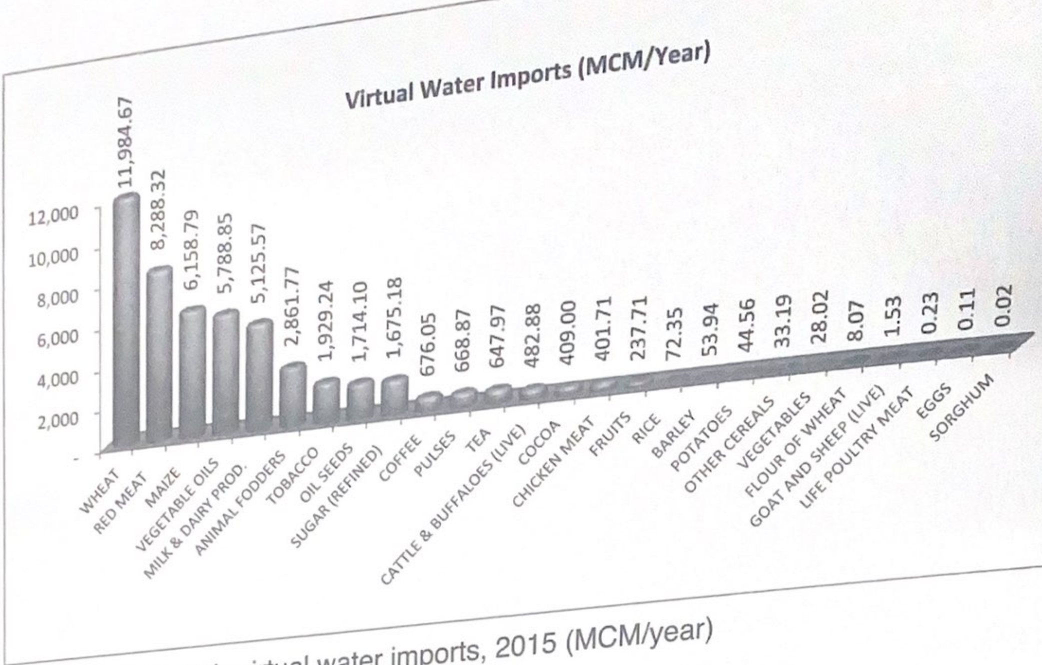

Figure 6.3. Egypt's virtual water imports, 2015 (MCM/year)
Source: AbuZeid 2017b

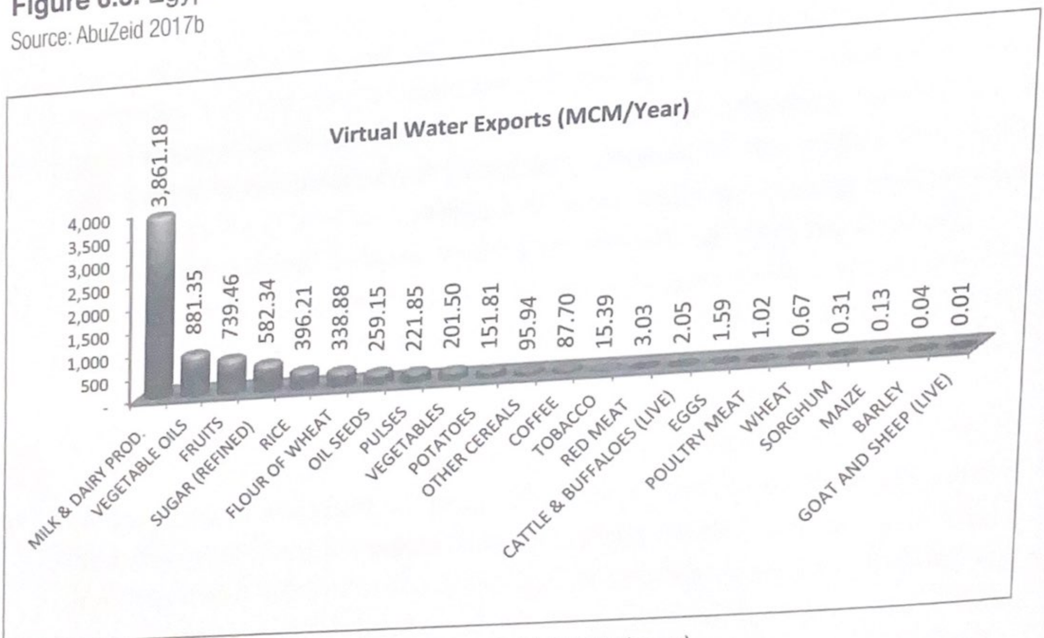

Figure 6.4. Egypt's virtual water exports, 2015 (MCM/year)
Source: AbuZeid 2017b

self-sufficiency in strategic crops and food products, such as wheat, corn, table oil products, sugar, and rice, but imports its remaining food needs. This strategy requires the country to have available the foreign currency needed to import its needs—food security for Egypt requires foreign exchange security.

Agriculture, especially through its high-value cash crops, contributes to earning this foreign exchange, including by the trade in "virtual water" (figs. 6.3, 6.4). Thus, for example, in 2015, Egypt imported about 49 BCM/year of virtual water embedded in agricultural food imports, while exporting the equivalent of about 7 BCM of virtual water embedded in agricultural food exports (AbuZeid 2018a, figs. 3 and 4).

The Challenge of Domestic Water Availability

Domestic needs and sources of supply

In 2017 urban (domestic) water was 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 has priority over other sectors in Egypt's water policies. In case of shortages, satisfying the domestic water demand comes first.

The high dependency of Egypt on the Nile as the main and almost single source for renewable water resources requires long lengths of pipes to transfer domestic water to urban centers of population and remote suburbs. The domestic water supply network stretched over 160,000 kilometers as of 2015 (AbuZeid 2018a) and provides another challenge. These long transfers also require substantial amounts of energy for pumping. Sewage networks reached over 46,000 kilometers in 2015 (AbuZeid 2018a).

Desalination

All Red Sea tourism resorts in the South Sinai and the Red Sea governorates depend on desalinated seawater for their water supply. All coastal cities are going to depend on desalination in the near future.

Currently, desalination provides about 0.35 BCM/year of domestic water. Owing to the inadequacy of Nile waters, the government will not supply the river's water to coastal cities. For their domestic water supply, cities on the Mediterranean and the Red Sea coasts will depend chiefly on the desalination of seawater or brackish groundwater. However, the desalination option is very expensive and cannot readily replace renewable freshwater provided by the Nile River. It requires huge investment and operating costs. The capital investment cost of desalination in Egypt in 2020 was estimated at approximately \$1100/m^3, while operation and maintenance costs were put at \$0.45/m^3.

Wastewater treatment

As of 2015, the annual production of municipal wastewater reached about 6.5 BCM. Industrial wastewater, which is often collected using the same network, reached 4.2 BCM. About 4.8 BCM of this total wastewater is collected, and 4.25 BCM is treated at different levels annually. Extending sewage collection infrastructure in villages remains a financial challenge. However, the government has identified this as a priority and is planning to reach full sanitation coverage by 2030.

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.

Urban water and wastewater tariffs

The average domestic water tariff used to be about US 7 cents/m^3, and about US 2 cents/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. Under the Prime Minister's Decree No. 1012 for the year 2018, domestic water and sanitation tariffs for the fiscal year 2018/19 were substantially revised. The tariff for household usage for the first tranche, from 1 to 10 m^3, was set at the equivalent of US 3.75 cents/m^3. The second tranche, from 11 to 20 m^3, was set at US 9.22 cents/m^3, and the third tranche, from 21 to 30 m^3, was set at US 12.97 cents/m^3. For higher amounts, the household tariff for usage from 1 to 40 m^3 was set at US 15.85 cents/m^3, and from 1 to more than 40 m^3 the tariff was set at US 18.16 cents/m^3. Household sanitation tariff was set at 75 percent of the domestic water tariff (Egyptian Prime Ministers' Decree no. 1012, 2018).

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

The drinking water tariff for border governorates, such as Sinai, Red Sea, and Matruh, was set at a flat rate of US 74.93 cents/m^3, and the sanitation rate was set at 50 percent of the domestic water tariff. The higher rate in these coastal governorates reflects their expected dependency on desalination as the main source for urban water.

Despite these revisions, there still remains some cross-subsidy between the different tariff categories, and full cost recovery in the urban water sector remains a challenge.

The Challenge of International Waters

The Nile River basin

Egypt is one of eleven riparian countries that share the Nile River basin. As the country farthest downstream, Egypt is vulnerable to upstream activities, even with existing bilateral agreements that protect its historical rights to a certain amount of Nile water. Reduced water availability could potentially affect Egypt's competitiveness in regional and world markets, especially in agriculture (AbuZeid 2011).

The Nile River basin receives about 1,660 BCM of rainfall per year. Egypt's share of the Nile River basin's water is 55.5 BCM per year. This share is not only documented by the 1959 bilateral agreement between Sudan and Egypt, but is also an acquired right through Egypt's continuous use of that share for over sixty years, with the majority of that share being used for thousands of years. The rest of the 1,660 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 is lost to evaporation from ground surface and surface water bodies (AbuZeid 2009).

Unlike the other Nile Basin countries, Egypt depends almost completely on the Nile River waters ("blue water") as compared with upstream countries' higher dependency on direct rainfall waters ("green water") (AbuZeid 2012). The Nile Basin countries upstream of Egypt receive about 7,000 BCM/year of rainfall within their boundaries; moreover, some of them receive additional water from rivers other than the Nile. The Nile Basin country of Ethiopia, for example, has more than twelve river basins, other than the Nile, within its territories (AbuZeid 2010).

The overall efficiency of water use in Egypt is considered to be among the highest in the world, mainly because of water recycling and reuse. Moreover, no fresh water is discharged from the Nile River into the Mediterranean, because the Nile flows released from the Aswan High Dam are fully utilized.

On the other hand, significant volumes of water loss exist in the upstream countries of the Nile because of the large areas of swamps, especially in the Sudd area in South 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, and 12 BCM/year in the Baro-Akobo. 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 percent of this canal had already been jointly constructed by Egypt and Sudan until it was halted due to political unrest in South Sudan (AbuZeid 2009).

The Nubian Sandstone Aquifer

The Nubian Sandstone Aquifer System (NSAS) is a transboundary groundwater basin in the northeastern Sahara. The international waters of this regional aquifer are non-renewable and are shared among Chad, Egypt, Libya, and Sudan. This situation presents another challenge. The area occupied by the NSAS is 2.2 million square kilometers: 828,000 square kilometers in Egypt, 760,000 square kilometers in Libya, 376,000 square kilometers in Sudan, and 235,000 square kilometers in northern Chad (AbuZeid and El-Rawady 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 timeframe have to be put in place. Figure 6.5 shows Egypt's cumulative withdrawals from the NSAS since the beginning of its groundwater development

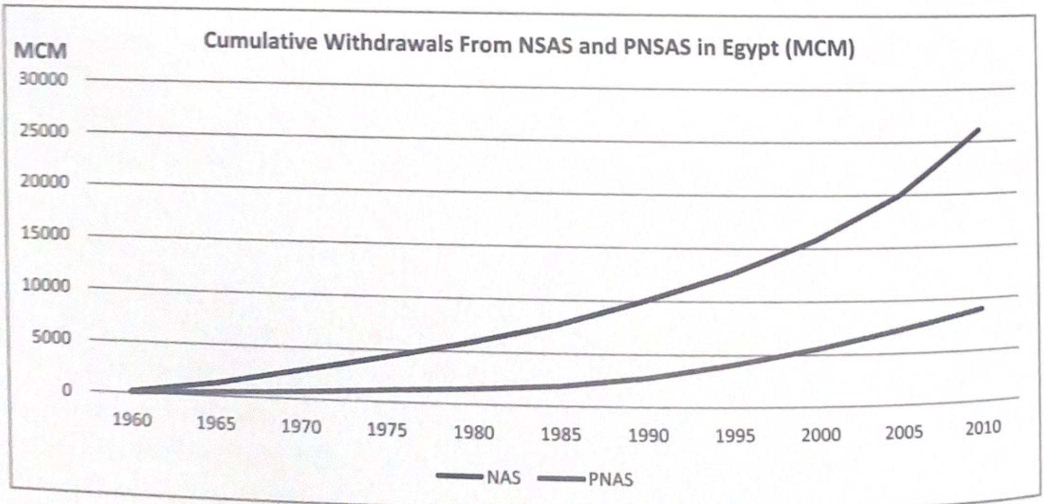

Figure 6.5. Egypt's cumulative withdrawals from the Nubian Aquifer and the post-Nubian sub-systems (MCM)
Sources: AbuZeid 2016; CEDARE 2014

from its Nubian and Post-Nubian sub-systems (PNSAS) (AbuZeid 2016; 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).

Conflicts, negotiations, and agreements

In 1999 Egypt initiated the Nile Basin Initiative (NBI), an umbrella framework that included ten countries of the basin, with Eritrea as an observer. The NBI had two tracks, a joint projects development track and a legal framework development track. However, because only six countries signed the Nile Cooperative Framework Agreement (CFA), without full consensus and 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 percent of the Nile waters for downstream countries) were exacerbated further in 2011 because of Ethiopia's unilateral decision to build the Grand Ethiopian Renaissance Dam (GERD) on the Blue Nile. This is the largest tributary of the Nile and supplies about 90 percent of Egypt's share of the Nile waters, with a storage reservoir of exactly the same capacity as Egypt's and Sudan's combined shares (74 BCM).

Studies have shown potential impact on Egypt's and Sudan's shares from the Nile due to the huge volume of water expected to be stored behind the GERD, in addition to the annual cumulative effects of evaporation and seepage losses from the GERD. These cumulative effects would be especially felt during dry years and low flows of the Blue Nile. Figure 6.6 shows one of the several scenarios simulated by a study conducted by Khaled AbuZeid at CEDARE.

A "Declaration of Principles" (DOP) was signed in 2015 by the heads of state of Ethiopia, Sudan, and Egypt on the GERD. The declaration aimed principally 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 would be 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 recently by the Ethiopian government that due to delays, changes in the contractor, and changes in the design, the dam is now supposed to be completed in 2023. Five years have passed since the DOP without a final agreement on the GERD. The United States and the World Bank hosted a series of meetings with the three countries during the last months of 2019 and two months into 2020 with the aim of reaching an agreement on the rules of first filling and annual operation of the GERD. Ethiopia did not attend the final meeting at the end of February 2020 at which the three countries were to sign an agreement. Egypt initialed the agreement, which the United States and the World Bank believed was a fair agreement that considered the concerns of all three countries. Unfortunately, the situation remains suspended without a fully signed agreement.

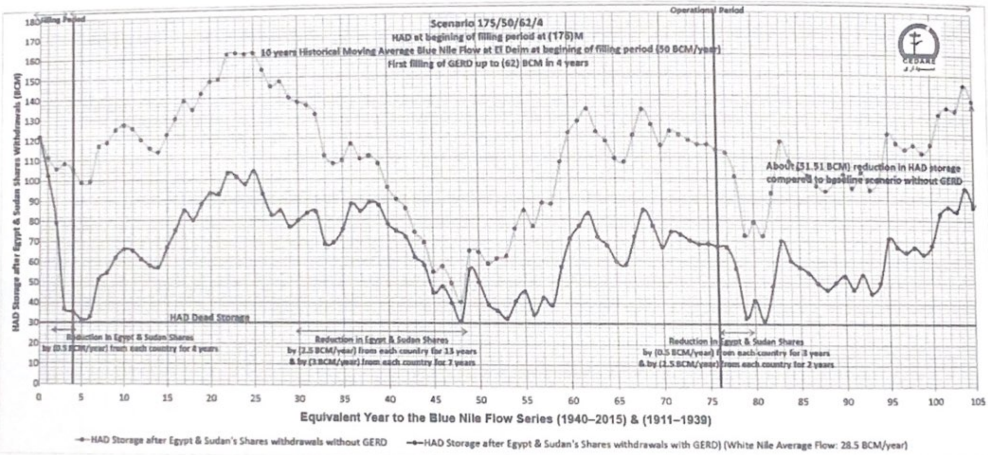

Figure 6.6. Potential impact of the GERD on Egypt's and Sudan's Nile shares
Source: AbuZeid 2017a, 2018b

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

Sustainability of non-renewable groundwater activities

The challenge of 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 that increased abstraction of water is depleting it. The aquifer is the only source of water and livelihood in the western deserts of Egypt, which cover almost 82 percent of the country. The rate of depletion will be even higher if this water is used for agriculture, but the aquifer will last longer if this water is used only for bottling or for municipal purposes. The quality of this groundwater is relatively high and requires only minor treatment; it may therefore 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 such a finite and non-renewable resource (AbuZeid and El-Rawady 2010). According to the Holding Company for Water and Wastewater, 96.6 percent 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 it was indirectly reused.

Summary

Egypt's water challenges can be summarized as follows.

1. *Increasing demand*. Because of population growth and density combined with the human-development requirement to improve the welfare of the population, and the need to expand horizontally away from the main source of renewable freshwater around the Nile Valley, increasing demand for water is a major and continuous challenge.
2. *Unilateral decisions by upstream Nile riparians*. Decisions to build infrastructure on the Nile River by upstream countries, without consultation, could make Egypt vulnerable not only to increased use by upstream countries, but also to unexamined consequences of water interventions that could have serious implications for Egypt's water security.
3. *Climate change impact and uncertainty*. Climate change will bring increased water demands, and also uncertainty about the renewability of the main source of Egypt's freshwater, the Nile. It is uncertain whether climate change will bring more or less precipitation in the upper Nile, both of which would affect the downstream flow.
4. *Multisectoral policies*. With water being a limiting factor to Egypt's development and with all sectors of its economy significantly affected, decisions concerning the management and allocation of water resources among different sectors could be challenging.

Recommended Water Policies to Meet Egypt's Water Challenges

In the next decade or two, Egypt needs 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 will result in reduced costs and efficient water use. Although there have been some attempts to contribute to the concept, such as using treated wastewater for landscaping and agriculture in some areas, and using high value non-renewable groundwater for water bottling, there is so far no national policy that would pursue the concept.

Non-conventional Water Resources and Geographical Reallocation

As recommended by AbuZeid (2011), coastal cities on the Mediterranean and the Red Sea have started looking to desalination as their new water resource. In the near future, when Egypt will need to expand desalination, proximity of seawater and brackish groundwater will help to reduce the cost of providing desalinated water. As it will be prohibitively expensive to transport desalinated water inland for long distances, inland governorates will have to continue to depend on Nile water, groundwater, and recycled water as the main sources for sustainable development in the future. This may require Nile water to be reallocated from some of the coastal governorates to inland governorates. The government decision to follow this policy was a step in the right direction.

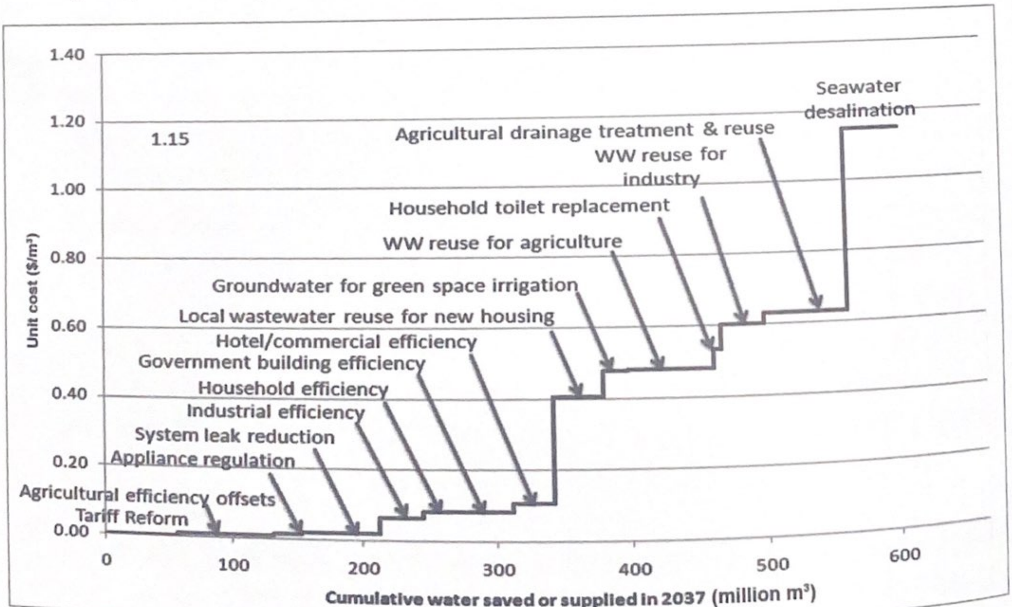

Figure 6.7. Incremental costs of satisfying Alexandria's future water demands
Source: AbuZeid et al. 2011

Because of Egypt's existing limited share of water from the Nile, no more internal Nile waters should be allocated to coastal cities, as desalination would be a more appropriate resource for these locations (AbuZeid 2009). However, although desalination may appear to be an easy solution, in some cases there are other options that are more cost-effective; these include agricultural water pricing, water conservation, and reuse of treated wastewater options. Figure 6.7 shows different incremental costs of supplying water for the city of Alexandria (AbuZeid et al. 2011).

Sectoral Water Reallocation

Current depletion rates of renewable and non-renewable groundwater need to be addressed. Weak monitoring and enforcement systems and low levels of awareness result in illegal abstractions and over-pumping of groundwater. These may jeopardize the future of the existing investment in the agriculture sector and significantly reduce Egypt's competitiveness in marketing agricultural exports 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, because of the large socioeconomic impact this might have on the country. A paradigm shift is needed to make the difficult decisions, and to develop innovative solutions at the technological, institutional, financial, and legislative levels. These decisions must examine the possibilities of using non-conventional water resources such as treated wastewater, introducing models of public–private partnerships (PPP), and modifying the legislation that governs the way water is managed.

Water Demand Management and Swap

Water demand management, also known as water conservation, is a priority. There is room for reducing agriculture water losses by about 10 percent and domestic water losses by about 30 percent.

A "swap" in the type of water provided for agriculture represents another option of reallocation, whereby agricultural drainage water, or treated wastewater, rich in nutrients, may replace fresh Nile water for agriculture, thus freeing fresh Nile water for drinking and domestic uses. This requires more attention to the quality of agricultural 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.

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 needs to be embraced and fully implemented. This would allow reuse of treated wastewater in the cultivation of food crops according to the level of treatment and the type of crop. Implementation of this practice will contribute not only to food production, but also to the improvement of water quality and the environment.

On the other hand, some irrigation improvement policies that may be envisaged as saving water may actually consume excessive amounts of energy and not even achieve the targeted goals of water savings. The Ministry of Water Resources and Irrigation has been implementing a combined policy of improving surface irrigation in the old lands (within the Nile Valley and the Delta), while reusing 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. Experience has shown that transforming all surface irrigation to pressurized drip irrigation is not always the best solution. However, it swaps some of the reuse of drainage water with freshwater, which improves water quality. It is important to look at the overall efficiency of water use, rather than just to focus on the on-farm irrigation efficiency (AbuZeid 2017b).

Water Security

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

Institutional Water Reforms

As wastewater increasingly becomes an important resource, efficient water management may require some institutional consolidation and restructuring. As AbuZeid (2020) has argued, the domestic water and wastewater responsibilities (currently under the Ministry of Housing) may need to be brought together with the responsibilities for planning water resources (currently under the Ministry of Water Resources and Irrigation). Every drop of water needs to be accounted for and measured, because "what is not measured cannot be managed" (AbuZeid 2009).

Water should not be bought or sold as simply a commercial good. A cost-recovery model needs to be in place where the social, economic, and environmental value of water is considered. Water consumption and use must 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 include in the model ways of achieving equity among sectors and within sectors, and especially ways to ensure affordability for low-income sectors of the society through targeted subsidies or cross-subsidies. As discussed in AbuZeid and El-Rawady (2008), partial or full "volumetric cost recovery" 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 overuse and waste, 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 they are partially subsidized. However, this requires a strong metering and monitoring program for individual households and farmers, which can sometimes be a challenge because of the vast number of apartment buildings and small holdings of farmland.

Other Recommendations

As it moves into a highly competitive market and into a green growth economy, Egypt 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.

Building codes need to be modified to enforce the use of water-saving devices in new developments and retrofit these in older ones. Accurate water accounting is needed; this requires water meters and other appropriate measuring devices to be installed, and water consumption to be 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, which may be inconsistent. Water-users associations must be legally recognized and given an official role and mandate. The private sector's role in the water sector must be clearly defined and legally accepted. Continuous capacity-building programs and investment in human resources in the water sector must be supported.

To sum up: A water-efficient Egypt can increase the quantity and quality of water available for its people and for future economic growth by a mix of policies that includes water-demand management and conservation; advanced use of non-conventional water resources, especially treated wastewater and desalinated water (when appropriate); implementation of a 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, Sudan, and Ethiopia. (These issues are discussed in more detail in AbuZeid 2008, 2018b.)

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