ALTERNATIVE
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SOLUTIONS

POLICY PAPER

Water Management in Egypt

September 2019

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Alternative Policy Solutions is a non-partisan, public policy research project at The American University in Cairo. Using rigorous, in-depth research and a participatory process of consultations with a diverse range of stakeholders, we propose evidence-based policy solutions to some of the most difficult challenges facing Egypt. Our solutions are innovative, forward-looking and designed to support decision makers' efforts to introduce inclusive public policies.

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List of Acronyms

CAPOWO	Cairo and Alexandria Potable Water Organization
EWRA	Egyptian Water Regulatory Agency
FTC	Facing the Challenge
GOPW	General Organization for Potable Water
GOSSD	General Organization for Sewerage and Sanitary Drainage
IWRM	Integrated Water Resources Management
NOPWASD	National Organization for Potable Water and Sanitary Drainage
NWRP	National Water Resources Plan
O&M	Operating & Maintenance
WINE	Water in the National Economy
WUA	Water User Association

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1. Executive Summary

The Arab Republic of Egypt is facing major challenges regarding water resource management, with growing needs of a more urbanized population and the dependence on external water supply from the Nile River implying a deepening gap between water demand and supply. Two National Water Resources Plans (NWRP) for 2017 and 2037 have been proposed for sustainable water management at the national level, under demographic and economic scenarios. According to NWRP2017, a major challenge for Egypt is to move toward an adaptive strategy, in order to close the gap between depleting water resources and increasing water demands. Such challenge implies identifying not only the best pathway to sustainable water management, but also a way of introducing more-efficient ways of financing water infrastructure.

The purpose of this policy paper is to present a general evidence-based policy framework to accompany such plans. While special attention is paid to affordability and implementation issues, the performance of such policy instruments is explored according to the economic literature regarding criteria such as cost-effectiveness, monitoring, and the speed of policy implementation. A discussion of the assessment of NWRP measures is proposed, together with a road map for gradually implementing policies based on economic (market-based), regulatory, or participatory measures. The report focuses on demand-oriented policies suggested in the NWRP2037.

The main lesson from this analysis is that adaptation to water scarcity is a lengthy process. It requires improving an enabling environment for integrated water resource management, promoting significant changes in water user behavior, and investing in long-term water-related infrastructures. An optimal timing of policy implementation is essential to avoid policy failure through, for example, lack of awareness and lack of public acceptability of policy measures. In this regard, earmarking economic instruments such as water quotas and tariffs to actual improvements in access to adequate levels and quality of freshwater is recommended.

The paper proposes a policy framework for sustainable water management including agricultural usage, non-agricultural usage, and general propositions. For agricultural usage, the paper proposes adopting an efficient quota (permit) system where quotas are allocated according to the economic valuation of crops. For non-agricultural usage, the paper proposes an increased water pricing for industrial and residential usage. It also proposes earmarking revenues from water pricing for water infrastructure projects. Additionally, the paper proposes a cross subsidization mechanism where higher brackets of water consumption subsidize the connection fee and fixed part of the tariff. The paper acknowledges that there is a need to communicate to the general public the challenges of water scarcity facing the country. The adoption of economic instruments for water management is contingent on such communication campaign.

2. Introduction

2.1. Water Resources in Egypt

Desert land in Egypt occupies some 96 percent of total land, a figure close to some other MENA (Middle East North Africa) countries. In terms of water withdrawals, Egypt— with about 86 percent (67 billion cubic meters (BCM)), 2.5 percent (2 BCM), and 11.5 percent (9 BCM) for agriculture, industry, and domestic use respectively—is also in line with the MENA average. Egypt is almost entirely dependent on the Nile River for its water, which supplies about 56 BCM every year. Total renewable water resources amounted to 700 m^3/capita/year in 2014, with very low water produced internally: 0.50 BCM/year for surface and 1.30 BCM/year for groundwater (WWAP, 2015; FAO AQUASTAT, 2016). Water withdrawals in Egypt consist mostly of surface water, with a declining trend in the per capita renewable freshwater level because of population growth and of increasing water requirements per capita. This level was 2,460 m^3/capita/year in 1970 and is expected to reach 903 by the year 2025.

A major challenge is to provide freshwater to a growing population, as the Egyptian population is expected to reach 96.2 million in 2025 (it was 71.2 million in 2001), with an urban population of 43 percent in 2011. Such a demographic pressure will induce more competition for the resource, as domestic water demand is expected to increase by 93 percent between 2010 and 2030 and such additional domestic demand may represent 8 percent of the 2010 agricultural water demand (World Bank, 2018). On the availability side, the main threat is due to the Upper Nile projects upstream (for example, the Grand Renaissance Ethiopian Dam) and the declining supply of the Nile due to climate change (Eid, El-Marsafawy and Ouda, 2007).

There is an important distinction to make between economic sectors, in terms of net water consumption (that is, water lost through evaporation or se-

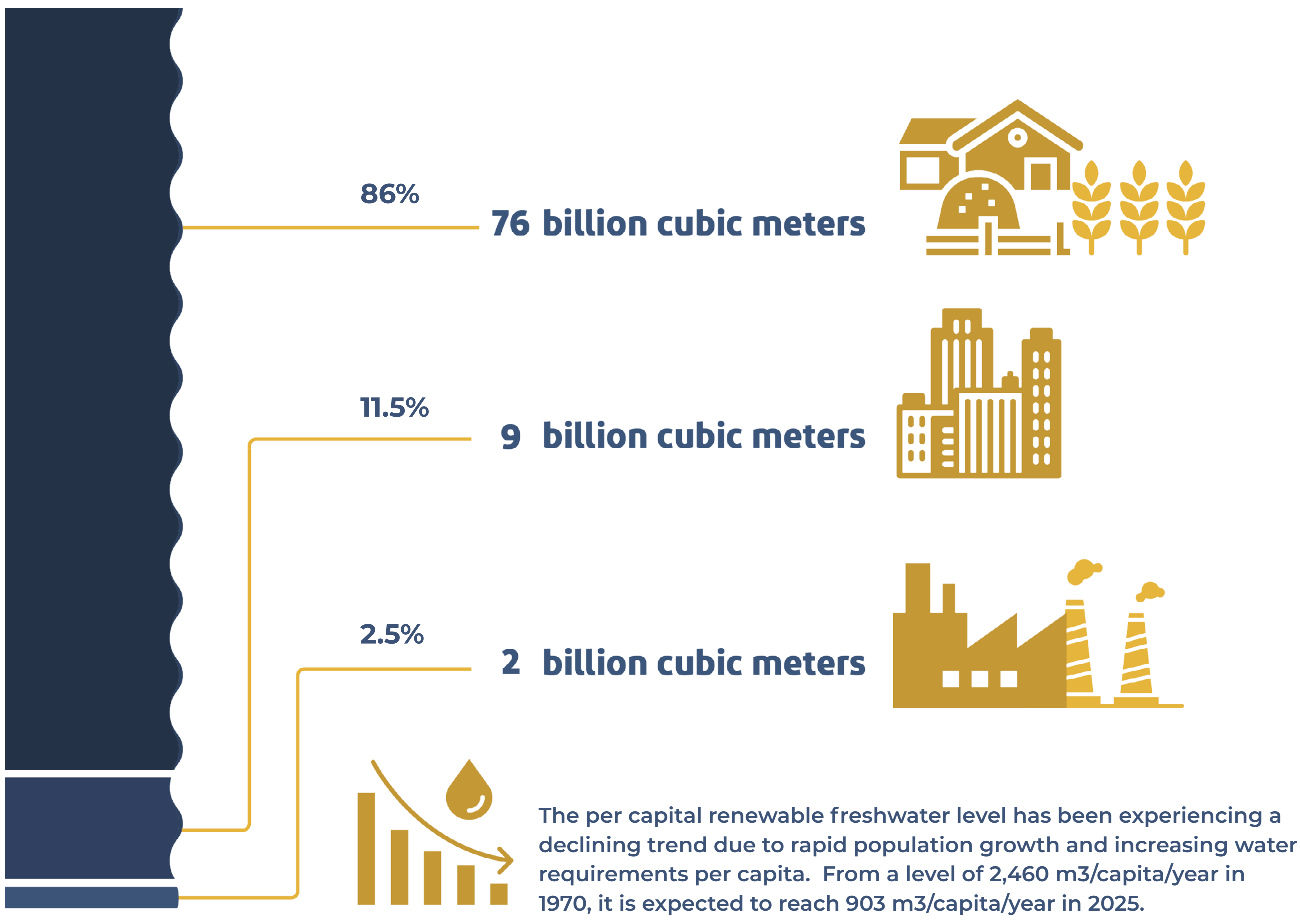

FIGURE (1): Distribution of Water According to Purpose of Use

vere quality deterioration), because not all water extracted for productive or consumption purposes is "lost" in the Egyptian hydrological system. The large agricultural demand for irrigation is partly met by agricultural drainage water: Egypt has the largest volume of reuse of agricultural drainage water (about 3 percent of water withdrawals) of all MENA countries. Surface and groundwater resources are under the Protection of the Nile from Pollution Law of 1982. The Ministry of Water Resources and Irrigation (MWRI) is responsible for providing water polluters with wastewater discharge licenses, and the Egyptian Ministry of Health is responsible for monitoring wastewater effluent emissions. Water-quality standards are defined from Executive Regulations for different types of water bodies.

In terms of the rural-urban distribution, the Greater Cairo area is MENA's largest agglomeration, about 18 million today, with a very high population density. Such urban development is largely due to its location along the Nile River, and the extension of residential developments between Cairo and Alexandria, the second-largest city in the country, is a continuous process, making it possible that the two cities will be merged in the future (SIWI, 2006). A high proportion of the population has access to safe water, hence a moderate (but increasing) water-quality threat, of about 53 percent (World Bank, 2017). However, while about 97 percent of the urban population and 70 percent of the rural population rely on piped water supply, sanitation services lag behind water supply, with 72 percent of urban and 11% of the rural population covered (National Planning Institute, 2008), and only 50 percent of the population connected to piped sewerage systems with adequate wastewater treatment (World Bank, 2017). Deteriorating water quality because of untreated sewage, industrial effluent emissions, and agricultural fertilizer runoff contribute to declining availability of safe freshwater. More precisely, the discharge of untreated or poorly treated municipal and industrial wastewater into the agricultural drains and sometimes into the irrigation canals leads to the deterioration of water quality in the agricultural drains, hence limiting reuse of water.

Regarding the economic valuation of water, Egypt has a level of total water productivity that is below the average for middle-income economies, and one of the lowest of MENA countries, with about USD 0.494/m^3 for agriculture and about USD 21/m^3 for industry (AWC, 2012). This suggests that a more "profitable" use of agricultural water may be possible by switching to high-value crops (World Bank, 2002; El-Gafy and El-Ganzori, 2012), or by reducing the importance of agricultural water use compared with industry and residential use. Such prospect, of course, has to account for the importance of agriculture in supplying jobs in rural areas (about 1 million are employed for cotton production during most of the year, and half a million in the textile industry) (MWRI, 2005), even though the share of agriculture in the Egyptian economy is declining.

In Egypt, water policies have focused on augmenting supply capacities before considering demand-management policies, and until the 1990s, investments in water supply projects were significant. Water resource management in Egypt was (and in many regards, still is) considered a cornerstone of national security and is part of the "social contract" with the Egyptian people, justifying the participation of the public budget (Mohamed and Jagannathan, 2009).

The purpose of this policy paper is to propose a set of policies that address water demand in both agricultural and non-agricultural usage. The paper proposes a set of market and valuation instruments that aim at improving the efficient usage of water resources. The paper starts off by giving an overview of water supply networks and management in Egypt. It then moves to analyze and assess the two main national water strategic plans. Before moving to the recommendation section, the paper presents the most relevant economic literature on the topic.

2.2. Resource Management in Egypt

This section discusses how water supply networks and management are organized in Egypt, distinguishing agriculture, industry, and municipalities.

FIGURE (2): The Impact of Agriculture on the Egyptian Economy

2.2.1. Agriculture

Agriculture represents about 14 percent of Egyptian GDP and 30 percent of total labor force. Water demands for agriculture amount to about 80 BCM/year (compared with the annual renewable flow of 55.5 BCM). Irrigated crops contribute mostly to local food production but also to exports with cotton and horticultural production, and to the prevention of salt-water intrusion in the Northern Delta thanks to rice production.

The two major agricultural regions in Egypt have very different biophysical features, which implies specific irrigation techniques and cropping patterns. In the Old Lands with the Nile Valley and the Nile Delta, surface water availability is increased by resource returning to the Nile from the Nile Valley, or to main irrigation canals where it is pumped back for reuse. Moreover, water percolating from the surface is recharging the shallow Nile aquifer and can also be recovered from the Nile Valley (and partly from the Nile Delta), (Gersfelt, 2007). In these Old Lands, agricultural water is applied with surface irrigation techniques, characterized by low efficiency, combined with water lifting systems (FAO Aquastat, Country report Egypt, 2016).

In the New Lands, the irrigation method is imposed on farmers by law: sprinkler and drip irrigation only, as pressurized irrigation (with very limited drainage) is more suited for the sandy soil of those areas. As a consequence, crops tend to be of higher value (tree crops, vegetables) than in the Old Lands (MWRI, 2005)[1].

Irrigation water management in Egypt is organized according to five levels: governorates (27), irrigation districts (300), main canals (between 400 and 600), secondary canals (between 4,000 and 5,000) and mesqas (tertiary canals, about 100,000). There are on average 150 farmers on each mesqa and between 40,000 and 80,000 farmers per irrigation district. Such fragmentation is not without problem, as

1 See El-Gafy and El-Ganzori (2012) for a presentation of economic values of irrigated crops in Egypt.

each mesqa generally has its own water user association (WUA), resulting in coordination issues. A pilot project to upscale WUAs to a higher level, for example, the secondary level where Branch Canal Water Boards could be formed with representatives of mesqas, has been initiated (MWRI, 2005).

Farmers are responsible for the mesqas, where they bear the cost of pumping and maintenance, while the irrigation system from the Nile River to the main canals and to the branch canals is operated and maintained by the Ministry of Water Resources and Irrigation (MWRI). The latter therefore invests in land reclamation and irrigation improvement, covers Operating & Maintenance (O&M) costs and rehabilitation costs of irrigation and drainage infrastructures. Pumping costs from the mesqa to the fields are paid by farmers. However, in recent projects as in Toshka with modern irrigation techniques as in the New Lands, farmers may be charged with a combination of area-based and volumetric charges (MWRI, 2005). The average cost of irrigation development is estimated at USD 800/ha for localized irrigation of orchards, USD 1,200/ha for localized irrigation of vegetables or field crops, USD 800/ha for sprinkler irrigation, and USD 1,800 /ha for stationary sprinkler (AWC, 2012).

2.2.2. Residential and industrial water users

Water tariffs for domestic use contributed only to between 10 and 25 percent of water supply and sanitation costs in Cairo, and 50 percent for water supply and 10 percent for sanitation costs in Alexandria (Mohamed and Jagannathan 2009).

Many developing and emerging countries such as Egypt have experienced some form of the following "vicious circle": water use is inefficient and the level of service is poor because of service fees and charges that are too low (water charges do not cover distribution and treatment costs); operating funds are therefore inadequate and this results in a decrease in urban and rural water users' willingness to pay for the service (World Bank, 2017). In the case of Egypt, inefficient water management resulted in significant water losses and network leaks in sewage and water distribution networks. Such challenges in water resource management were exacerbated by the fragmentation of water governance and the poor coordination level among water authorities at various levels. A first reform in 1981 was decided, to reduce the fragmentation of responsibilities (national, regional, local) for water provision and wastewater collection and treatment activities. With this 1981 reform, the Egyptian government decided to merge the two agencies in charge of water and sanitation, the General Organization for Potable Water (GOPW) and the General Organization for Sewerage and Sanitary Drainage (GOSSD), into a new entity, the National Organization for Potable Water and Sanitary Drainage (NOPWASD), and to promote autonomous water and wastewater companies in each Egyptian governorate. Until recently, water fees and charges were among the lowest in the MENA region: the average charge (including fixed fees) was USD 0.061/m^3 for water and 0.15/m^3 for wastewater (ACWUA, 2014). To illustrate the discrepancy with water production and distribution costs, over the same period the rate for Cairo urban water consumers in Egyptian pounds (LE; USD 1 averaged LE 7.05) was between LE 0.15/m^3 and 0.25/m^3, the average user fee was LE 0.2/m^3, while operation subsidy was LE 0.9/m^3, and the estimated capital and O&M costs were about LE 1.1/m^3.

2.2.3. Recent tariff increases

The Egyptian government decided on a series of water increases over the past decade and a half, to reduce the gap mentioned above and target cost recovery for municipal water utilities. A first decision occurred in November 2004 (in conjunction with sector privatization, see above), where water prices were increased from LE 0.12/m^3 to LE 0.23/m^3, resulting in strong reactions from the population and an increase in unpaid water bills (in locations such as Matariya, Al-Wayli, Al-Zawya and Al-Hamra). In response, the government agreed to modify this reform by maintaining water tariff increases but at the same time designing lower water rates for people living in poor areas. More recently (August 2017), the Egyptian government decided to raise water

Increase Water Pricing and Sewage Fees for Domestic Use, Starting from LE 0.45 up to LE 2.15 per m3

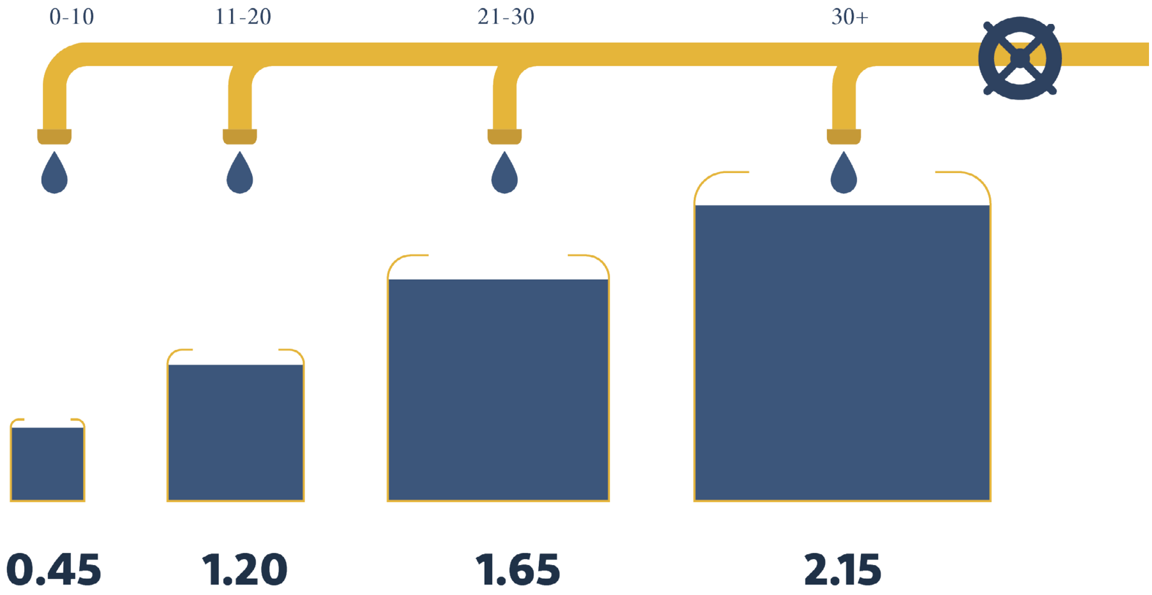

FIGURE (3): Water Tariffs According to Consumption

prices and sewage fees, as part of a general decade-long trend to drastically reduce public subsidies for fuel, food, and utilities such as water. The new tariff for domestic users was set from LE 0.45 (about USD 0.02) to LE 2.15 per m^3, with an increasing block rate structure: LE 0.45/m^3 between 0 and 10 m^3, LE 1.20/m^3 between 11 and 20 m^3, LE 1.65/m^3 between 21 and 30 m^3, and LE 2.15/m^3 above that level.

Sewage fees are computed as a fixed proportion of water rates, and they increased from 57 percent to between 63 and 73 percent of the water price. Water tariffs were also increased for industry and commercial users, with tariffs that now range between LE 2/m^3 and LE 6.95/m^3, depending on industry type and consumption level.

In June 2018, Egyptian Prime Minister Sherif Ismail approved measures to increase bills for piped drinking water by up to 46.5 percent, the second rise in less than one year. The cost of drinking water went up from LE 0.65/m^3 to LE 3.15/m^3 according to the consumption category. Also, sanitation fees were increased by 12 percent. Sewage fees are calculated on the water consumption bill, and they represent 75 percent of the water price. Water fees for industry and commercial users are set to range from LE 3/m^3 to LE 10/m^3, depending on industry category and consumption level.

3. Methodology

We present in this section the two NWRPs of Egypt as the government strategy toward water security of the country. We discuss the way the measures contained in these plans are evaluated and ranked, before proposing a critical assessment of the policy design, which requires a discussion about the economic properties of policy instruments, whether or not they are explicitly present in the NWRPs.

3.1. National Water Resources Plans (NWRP)

Recent measures such as the creation of a holding company and water tariff increases overlooked the fact that water management is an inter-sectoral issue, requiring a Water in the National Economy (WINE) approach. Integrated Water Resources Management (IWRM), focusing on water user categories, was not enough to achieve national objectives of sustainable water management. On top of that, water policy needed to address issues of securing water for people, industry, food production, and employment, while protecting vital ecosystems and cooperating with Nile Basin countries. A decisive political move regarding Egyptian water policy was therefore the first NWRP for the period 2003–2017.

3.1.1. NWRP2017

NWRP2017 was launched in 2005 and included 39 actions, with two scenarios: (1) business as usual; and (2) the recommended plan labeled FTC (Facing the Challenge). The NWRP was based on three pillars for horizon 2017: increase water use efficiency, protect water quality and control pollution, and increase water supply. The integrated approach of FTC assumed that all measures are effectively implemented, because failure of some of them may have severe consequences (for example, an insufficient improvement of water quality will mean that the increase in the reuse of water will be much less than expected, and therefore less water will be available

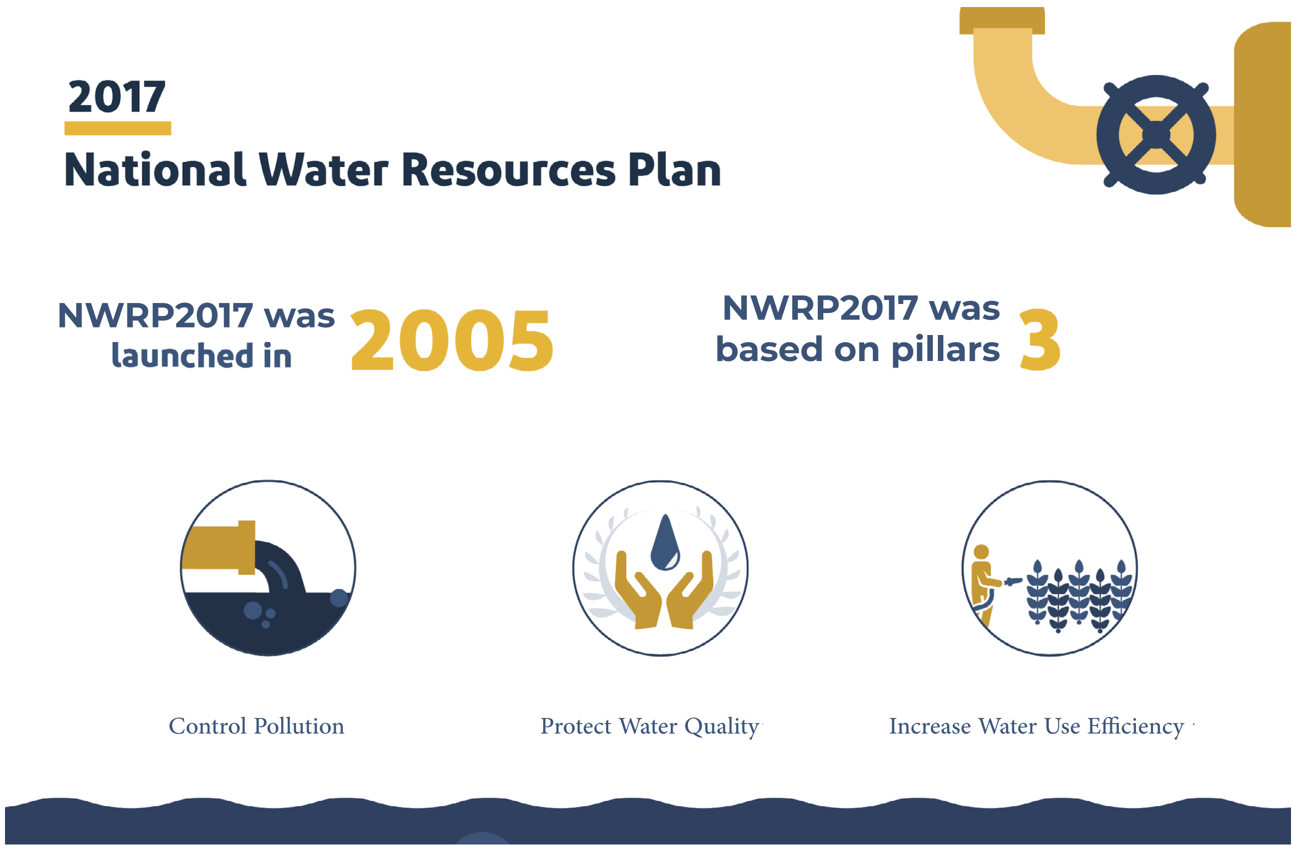

FIGURE (4): The 2017 National Water Resources Plan

for agriculture). A large part of the NWRP was dedicated to increasing available water for agricultural use (irrigation), to reach food security goals and secure farm income. Indeed, the main motivation was that the total cultivated area was expected to reach 4.053 million ha by the year 2017, and 4.830 million ha by the year 2030, requiring vast developments in irrigation capacities.

Water-saving techniques have therefore been promoted with explicit differences between Old and New Lands. In the New Lands, water-saving techniques included the promotion of modern irrigation systems in newly reclaimed land (sprinkler, drip irrigation systems) because gravity and flood irrigation are prohibited in these areas, and night irrigation. For the optimal use of resources, the NWRP specified (1) the reuse of drainage water and treated wastewater, with a plan to reuse an additional 3 BCM/year for irrigation of Al-Salam Canal (250,000 ha) and to feed the Nubaria Canal in the western Nile Delta; (2) desalination of brackish and seawater; and (3) international cooperation with countries upstream of Lake Nasser such as the Nile Basin Initiative (NBI projects, World Bank, 2009).

For the horizontal expansion projected by NWRP in 2007, an additional area of 1.85 million ha was expected to be reclaimed by 2030 (ARE, 2009), in particular through massive projects. Two of these projects are (1) the Al-Salam project east of the Delta and in North Sinai, using diverted water from the Damietta branch through the Al-Salam Canal; (2) the Toshka (New Valley) project near Lake Nasser, using water from the Sheikh Zaid Canal and groundwater pumping. These projects being in New Lands, new developments have to use sprinkler or localized irrigation instead of surface irrigation (see above).

New developments as the ones above represent an ambitious objective to develop new farm land with water resources that would be essentially primary freshwater (90 percent groundwater) and nonconventional sources (treated wastewater and agricultural drainage water). A strategic plan for the reuse of wastewater has been proposed (AbuZeid and Elrawady, 2014), which provides a scenario for reaching almost complete treatment of wastewater

FIGURE (5): The 2037 National Water Resources Plan

in Egypt by the year 2030. With a full cost recovery from users, it is estimated that farmers in the Old Lands could pay LE 8.75/m^3, while in the New Lands the water charges could reach LE 9.85/m^3.

3.1.2. NWRP2037

Labeled "Water Security for All," NWRP2037 was launched in June 2017 and included a series of updates from the previous NRWP2017, due to necessary corrections to predictions. In particular, the widening gap between water supply and demand had been underestimated because of greater uncertainty about climate change (less water inflow expected into Lake Nasser), a higher population growth than expected, a more-modest scope of demand-oriented interventions, and instability in the proportion of unaccounted-for water and in agricultural water efficiency. The most important message of such updated NWRP is that, with water availability per capita expected to drop by 35 percent in 2037 relative to 2015, demand-oriented and supply-driven policies are of modest scope and an adaptive strategy is required. This implies in particular that Egypt will have to live with water scarcity on a permanent basis, and that a more-efficient and equitable allocation of water resources is needed. The main lessons learned from the NRWP2017 were that water demands increased mostly because of population growth, water-quality issues still exisit with a poor state of rural sanitation, progress was slow in the modernization of irrigation systems, and cropping patterns were still favored profitable but water-intensive crops (sugarcane, cotton, etc.). Measures to address environment and system management have progressed less than "physical" (especially, supply-driven) program measures. For example, clear targets for water-quality improvements have not been set, and the necessary legal and regulatory framework changes have not all taken place. As a consequence, awareness regarding the issue of water scarcity and quality remains low and is not recognized as a societal issue by the overwhelming majority of the Egyptian population.

Building upon such lessons learned, NWRP2037 presents two scenarios (business as usual and 2037 strategy) with four objectives: improve enabling environment (for IWRM), enhance availability of freshwater, improve water quality, and enhance management of water resources. Nineteen outcomes are set under these objectives, with 61 measures that are screened according to three criteria: cost-effectiveness, public acceptability, and urgency.

NWRP2037 is based on the concept of IWRM, including a participatory approach for water development and management and the acknowledgement of the economic value of water. It is important to note that the economic dimension of the program measures refers only to investment and operating costs associated with each measure, as well as expected benefits according to experts. The policy instruments (whether economic and market-based, or regulatory or voluntary approaches) are not discussed at all. In that sense, most demand-oriented measures are more difficult to inform than supply-driven measures that are associated with physical infrastructure implying no or limited changes in economic agents' behavior, as opposed to demand-oriented policy options. The yearly average expenditures for the full program of measures are estimated at LE 44 billion, while investment is estimated at LE 492 billion over the period 2017–2030. Identified risks include a low acceptance of the common goal by water users, inadequate financial resources (as substantial investments are necessary), unexpected environmental and social impacts, limited public awareness and support, unanticipated water development projects upstream, unpredicted and stronger effects of climate change, continued rapid population growth, and the failure to account for innovation and research outcomes.

3.1.3. NWRP analysis

Both NWRPs are based upon the assumption that ranking policies in terms of diminishing returns is a consistent way of implementing a strategy toward water security. More precisely, to start with supply-driven interventions (the supply-management phase) is motivated by the fact that one should aim at obtaining more water first. Then, in a second, demand-management phase, one should focus on more-efficient use of water resources. The third, adaptive phase, in which recurrent water scarcity is the rule, is characterized by a decentralized policy where water users are encouraged to find solutions for water management by themselves. Actually, there are some pitfalls associated with such a way of ordering water policies.

First, according to the description in NWRP2017, the supply-management phase seems to be based solely on technical and physical solutions, while in the demand-management phase, and only there, water allocation to users implies dealing with water as an economic commodity. Moreover, a decentralized system of water allocation is advocated for in the last, adaptive phase, using for example the social learning capacity of water users. It is not at all obvious that economic considerations are not needed for public decision-making in the first phase, however. Consider, for example, cost-benefit or cost-efficiency analysis applied to public funding of large water infrastructures such as dams, water networks, and sanitation systems (see Whittington et al., 2008). The design of such supply-driven projects over a long period of time requires a scenario for future water use (and/or water-quality level) that can be used to prioritize project finance by weighing (mostly contemporary) costs with (future) benefits for society. This implies that demand-oriented policies that may impact future water use also need to be accounted for in the first, supply-driven phase. Furthermore, supply-driven interventions are highly dependent upon financial capabilities and opportunities for long-run investments that often require social, economic, and political stability, especially from international investors.

Second, implementing a demand-oriented water management phase when returns from a supply-driven policy are diminishing may miss the fact that water user behavior is slow to adapt to most policy instruments. Phasing in a demand-oriented policy initiated earlier has the advantage of diminishing the chance that the second phase will be rejected when water is considered in practice an economic commodity. Moreover, allocating water according to a strict ranking of economic valuation by water users is seldom acceptable by the population and would not account for local or national priorities such as food security, possible relationships between water volumes and water quality, etc. There are high-value agricultural crops that may exploit groundwater better than some industries, or even a leakage-ridden public water network for households that use only a tiny fraction of drinking water for actual drinking or cooking.

Third, the adaptive phase is presented, in governance terms, as a transfer of water allocation decisions to local stakeholders, whereas adaptation to permanent water scarcity may also imply centralized and top-down policies. Some of the latter may in fact be more efficient than decentralized water sharing systems, but the question of efficiency is debatable. Adaptation means in general that production and consumption systems need to be redesigned to cope with a new regime of water availability, and that diminishing the current level of water used for production and consumption purposes, with technologies unchanged, will not be sufficient.

Fourth, in the assessment of program measures of NWRP2037 described in NWRP2017, each measure has an objective and a set of indicators, but the objective of each measure does not originate from a comparison with expected social and economic benefits associated with the level of the indicator(s). A multicriteria analysis affects scores to each criterion and proposes a ranking of program measures, singling out in particular "no-regret" measures with both low cost and high public acceptability. In addition, each measure is associated with an estimate of the "present value" over the expected duration of the measure, a discounted indicator allowing direct comparison among costs of individual program measures. However, such indicator is not the net present value that would also include future social benefits from program measures. Such benefits are typically difficult to evaluate and are estimated according to expert (qualitative) values to construct the cost-effectiveness measures, in terms of water availability, water quality, and enhanced management of water use. Moreover, environmental and social impacts of program measures are not included, so that cost-effectiveness ratios are certainly biased in the direction of lower overall benefits from measure implementation. For supply-driven projects involving long-term investments, more comprehensive cost-benefit analyses can be conducted with the method of benefit transfer to be compared with costs of measures, in case such benefits are too difficult to evaluate (see Allen and Loomis, 2008; Johnston and Rosenberg 2010).

Fifth, no policy instruments are explicitly presented in the NWRP, either to curb water consumption or to control effluent emissions from agriculture, industry, or local communities (demand-oriented policies), or to enhance water availability (supply-driven policies) through subsidies or dedicated loan programs (low-interest rate loans, etc.) for investments in infrastructures. A range of policy instruments can be considered to associate with some of the program measures. When discussing the pros and cons of the latter, it is necessary, however, to make a move back to the economic properties of each set of policies and associated instruments. This is the purpose of the next section, and a more detailed discussion of the NWRP measures is proposed in the Analysis of Findings section below.

4. Literature Review

Most demand-oriented policies in the NWRPs discussed above and some supply-driven interventions (measures) have to do with the type of projects, program goals, or economic agents targeted by the policy, and as such, they are generally presented in the economic literature in terms of supply-side and demand-side policies. Another classification is based on economic properties of policies and their instruments, which can be applied in theory to a variety of economic agents and settings. While in principle both classifications can be applied separately to most policies, the discussion on economic properties of policies for water management is more relevant to demand-side policies than for supply-side ones. Many policies and their associated instruments are already in place, as discussed above, but it is interesting at this stage to review the properties of existing and possibly future policies, with reference to the economic literature.

4.1. Market-Based, Regulatory and Other Policies

Most policies for water management (and natural resources and the environment in general) can be classified according to the following categories: market-based policies (incentive-driven such as taxes, user charges, subsidies, tradable water rights); regulatory policies (often called command-and-control, such as standards and norms, bans, restrictions of use); and voluntary and participatory policies (including contracts, private standards, and information dissemination). OECD (2008) offers a full vision of the properties of these policies.

4.1.1. Market-based policies

Also denoted incentive-driven policies, market-based policies aim at modifying the behavior of economic agents through a change in the relative benefits of their actions (production, trade, or consumption). When water consumption of a household or effluent emissions of an industry are observed, a direct water charge or emission tax can be considered, with a possible modulation of charge/tax levels to accommodate local conditions (Skevasa, Stefanou, and Lansink, 2012). In agriculture, however, most farm operations imply nonpoint source emissions, and indirect instruments are used instead (tax on input or output levels, or on crop area). An advantage of such indirect policy is that monitoring costs are much lower than direct observation of water use (or effluent emissions, which in some cases are technically very difficult to observe accurately). Input tax policies may lead to changes in crop choice in favor of more input-saving outputs, as is the case of water-intensive crops that can be discouraged by a tax system favoring rain-fed crops and less-water-intensive ones through an irrigation water charge. An indirect water charge is sometimes applied by using a land tax system, for which monitoring costs are even lower than for inputs or outputs. Indirect tax systems can, however, be regressive for low-income farmers if their cropping practices are environmentally friendly but they operate large units of taxed land.

Jeuland (2012) discusses some examples of water tariff systems compared with water provision costs in MENA countries. He shows that in a vast majority of cases, domestic tariffs are far higher than irrigation tariffs, which themselves are below the marginal cost of supplying raw water. Moreover, in some countries that are highly dependent on groundwater, the water tariff is determined by the average pumping cost (Kuwait, Libya, Oman, Qatar, Saudi Arabia). In other countries, a proxy is used to approximate water consumption: in Egypt and Lebanon, some irrigation tariffs are proportional to annual land tax.

Another type of market-based policies concerns tradable permits or rights systems, mostly used in Australia, New Zealand, and in some US states for irrigation water management. When considered for irrigation water sharing, they have interesting theoretical properties in terms of cost-efficiency when water use is observed, and resource management effectiveness may be significant because such systems include a natural resource target as part of the policy (Shortle, 2012; Hadjigeorgalis, 2009). In situations of recurring water scarcity, a possible policy is to decouple water rights from land rights and to convert the former into tradable permits, through an initial allocation of volumes to land owners. In theory, trading water rights can lead to a better allocation of water resources among users, as most-efficient agents (usually, the ones with the highest willingness to pay for water) will buy from ones drawing less benefits from water use, with a price that will allow demand to match supply of trade rights. In this system, water rights are temporary by nature, but there exist other policies through which water rights may be permanent or even renewable on a regular basis to adjust for variations in overall available water.

Australia implemented an ambitious trading system of water rights, converted from land rights with initial allocations reflecting regional cropping patterns (Turral et al., 2005). In Spain, the former system coupled land and water rights, with an area-based fixed payment for water withdrawals (Garrido 1999), to be replaced more recently by a procedure modifying water rights in order to promote volumetric pricing. Quota allocation systems were implemented for communities and individual farmers with volumetric charges, and an annual revision of their quotas. Local communities that do not respect their quotas are imposed an overcharge. The performance of the system also increased because of more-efficient irrigation techniques (40 percent of irrigation systems use sprinklers or drip irrigation in the south of the country).

4.1.2. Regulatory policies

Often denoted command-and-control policies, regulatory policies include technical standards, production practices, technological requirements, input bans, and temporary restrictions. They often entail large monitoring costs to check compliance and are not flexible for producers or consumers, leaving them with a restricted set of possible actions. For this reason, they are not cost-effective and are not recommended in general by natural resource and environmental economists (Claassen and Ribaudo, 2016; Sterner and Coria, 2012). In practice, emission standards and water use restrictions can be effective for industrial plants where production is more easily monitored, but this is seldom the case in agriculture. Regulatory policies share the same poor properties as indirect charge/tax systems described above. Even when technological requirements (for example, irrigation methods) are easy to implement when investment is made, operation compliance can be costly to monitor in some cases. Temporary restrictions on water can be considered, for example, regulatory mechanisms such as a water extraction cap during the summer. Easy to implement, such policies have an immediate impact on farmer behavior.

Finally, a permanent ban on some inputs or production practices (for example, surface irrigation) is easier to monitor and implement than temporary ones or restrictions on agricultural practices. However, as in all regulatory policies, input restrictions allow farmers little flexibility in their production decisions, and it is important that policy makers provide farmers with alternative production options (modern irrigation techniques, etc.).

4.1.3. Voluntary and participatory policies

This third category includes voluntary approaches and contract-based arrangements, some of which are practice-based ("obligation of means") while some are results-based (no "obligation of outcomes"), as well as informal water markets. Such policies can be very flexible for the policy maker, as local resource management issues can be addressed directly through the specification of technologies or production or consumption practices. Contracts addressing water use from industry or agriculture may be designed between individual (or a collective of) farmers or industrialists, municipalities, and regional water authorities, to manage water at a river basin level. They can include cost-sharing arrangements between producers and local communities, while water authorities provide technical assistance and possibly infrastructure or operating subsidies.

Ostrom (1993) has demonstrated that, in some very specific settings, participation-based water allocation mechanisms can be efficient. On the other hand, such mechanisms correspond to an implicit system of water quotas, which impose a constraint on farm production capacities, and in particular those of the most efficient farmers, possibly leading to inefficient water allocation. As a consequence, heterogeneity in water valuation by users is a key aspect for the success of such policies. The performance of a selection of concerted watershed management has been analyzed by Blomquist, Dinar, and Kemper (2005), who conclude that, even though resource management has generally improved in their case studies, major problems remained in most cases. This is because such systems faced difficulties in rapidly adapting to new issues (including a rapid increase in water withdrawals). Moreover, they implied changes in the relative power of stakeholders, a potential source of conflict among water users. An example of conflict management in the Moroccan irrigation perimeter of Bitit is proposed by Abdellaoui (2009). He shows that, for conflict resolution in watershed management, it is essential to design a clear water allocation that all farmers integrate in their decisions, as well as a free water market to update water rights.

Voluntary approaches are not initiated by policy makers but by a group of farmers or by industries. This may result in poor environmental efficiency because such policies may result from mixed objectives of farmers and the industry for a better image (social corporate responsibility). Voluntary approaches sometimes lead to the provision of marketed food products from a partnership between farmers and the agrofood industry based on ecological labeling. In such case, the government may also be part of the policy, by accompanying producers with ecolabel certification. Voluntary approaches may include environmental agreements between a farmer cooperative and water authorities or local communities, to promote a reduction in water withdrawals through a change in cropping systems. They also include a policy to save on water in the industrial production process of an agrofood industry, to be labeled on consumer goods in stores. By transferring to the consumer market such information, environmental benefits can generate an additional value to the product, through a willingness of consumers to pay for more environmentally friendly products.

To conclude on this classification of policies, market-based instruments are known, at least in theory, to provide efficient outcomes in terms of water allocation among users (Sterner and Coria, 2012). However, their actual performance is conditional on properties such as transparency of payment mode, observation or verifiability of actual water use, and participation performance. This is particularly important in countries where institutions are weak and/or water users are not familiar with water charges, because market-based instruments can then be strongly opposed and ultimately fail (da Motta et al., 2004). On the other hand, non-market-based policies such as participatory approaches and informal water sharing rules are expected to be accepted more easily by water users.

While it may be claimed that water allocation based on concentration and stakeholder participation is preferable to market-based instruments, providing evidence about such relative benefits is sometimes difficult. This is because participatory and concerted water management experiences in some countries cannot be transposed to any other context, as they depend on specific local conditions (relative importance of stakeholders, role of general or local authorities, etc.). Moreover, there remain significant issues and uncertainties about the actual performance of such non-market-based policies, which may lead to limited environmental efficiency, inefficient resource allocation, and poor adaptation to climate change and local environmental conditions.

4.2. Water Pricing and Permits

The structure of water tariffs in itself is an important part of a water-pricing policy. As discussed in Abou-Ali and Thomas (2012), very few countries have sophisticated water tariffs for irrigation when they charge irrigation water, whereas municipal water tariffs, at least in large cities, generally have several consumption blocks with a different unit price for each. Jordan, for example, has developed an irrigation tariff on a volumetric basis and with an increasing block rate system. In many communities served by a public network, water tariffs are of the two-part type: a fixed charge (initially designed to cover access to the water network through covering capital costs) and a water fee more or less proportional to water consumption. The latter may be fixed (flat rate), or of the block rate type (increasing or decreasing), depending on a number of water consumption blocks. In the social tariff case, the first block is subsidized (or even free in some cases), and sometimes the fixed part of the tariff may be subsidized as well.

Jordan is one of the few countries to have generalized the system of increasing block rate tariffs, associated with a quota for irrigation (Jeuland, 2012). The Jordanian system of water tariffs includes charges for drilling boreholes for groundwater resource and for renewing withdrawal permits for well extension and maintenance. Irrigation tariffs are designed according to a volumetric formula with an increasing block rate system: below 150,000 m^3/year, from 151,000 to 200,000 m^3/year, and over 200,000 m^3/year.

When affordability is an issue for part of the population, special water tariffs have been designed in developing (and some developed) countries, with two underlying principles. The first one is indirect income redistribution: since part of the population can afford paying for water, this category of users can indirectly subsidize the poorer part of the population. The second is based on the principle of universal service provision: all households should have access to basic necessities including water, provided the cost of water provision is not far in excess of water valuation by users. Social water pricing is implicitly designed under these two principles: facilitating access of poor households to water, and when access is guaranteed, designing a pricing system that favors poor households versus more-well-off ones (with the possibility of an indirect transfer between both user categories, if service cost has to be fully covered).

Access to water networks is in general more costly for poor households' budgets than the actual consumption depending on a unit water fee or on a block rate. It is therefore possible in some situations to design a social water tariff by only subsidizing the fixed part of the tariff. More precisely, subsidized connections to the water networks or letting the fixed-charge component be free of charge are options of social pricing of water. Diakité, Semenov, and Thomas (2009) provide an example of social water pricing in Cote d'Ivoire, with a proposal of reform that accounts jointly for a subsidized connection fee and reduced rates for low-consumption blocks.

An essential aspect of social pricing of water is the fact that the economic vulnerability of households is often difficult to assess with accuracy. The construction of a social water tariff with a subsidized consumption block has therefore to evaluate first the relationship between water consumption at the household level, with household characteristics such as the number of household members and total household income. Failure to do so may lead to "leaking" (non-poor households may benefit from the social tariff) or under-targeting (some poor households may not benefit from the social tariff).

An alternative market instrument to water pricing is a water permit or quota system. This is a viable alternative when volumetric pricing is very difficult in its implementation, which is the case of water usage in agriculture, especially in the Old Land. In this case, permits are allocated through legislation to users or group of users. Users with the lower valuation of the water resource would then trade their excess in a market for permits. The complexity of implementation of a market of water could be, arguably, as difficult as a direct water-pricing system. However, initiating a permit (quota) system at a first stage is not as complicated.

5. Policy Options

In light of the NWRPs (and the 2030 strategic vision for wastewater, see AbuZeid and Elrawady, 2014), it is important to assess the potential for a variety of policies to accompany national strategies for water management in the future decades. The literature review applied to the various policies can now be used to address a major question in decision-making: can NWRP objectives be supported by actual policy instruments, such as the ones discussed in the preceding section, in the Egyptian context? In this section we match the NWRP measures, focusing on the more recent NWRP2037, and policy instruments discussed above in economic terms.

To be sustainable, given limited water availability, implementation of NWRP2037 targets needs to be accompanied by a series of water-saving measures. As demonstrated in some specific settings, a demand-side approach to better management of local resources through a switch in cropping systems and irrigation technologies can prove much more interesting (in terms of benefits-to-cost ratio) than supply-side policies of water supply infrastructure (dams, desalination, etc.). In Algeria, for example, a study showed that implementing more-efficient irrigation technologies, together with a change in cropping systems, could be less costly than a supply-driven policy based on desalination (Akli and Bedrani, 2011). Hence the focus of this section of the analysis will be exclusively on the demand-side measures of the NWRP.

Demand-oriented policies are concerned with the modification of water user (or polluter) behavior, using various policy instruments and often assuming an identical level of water availability in the future. These policies typically include modifying agricultural cropping profiles, reforming the water tariff for residential users, promoting more-efficient farm-level irrigation techniques, implementing a new form of payment for some irrigation water users, and implementing social tariffs for water. On the quality side, domestic and industrial effluent emissions can be associated with supply-side objectives, as they imply investments in wastewater collection and treatment plants.

5.1. Measures for Agricultural Usage

NWRP2017 measures include changes in crop patterns (replacement of sugarcane by sugar beet); reduction of rice cropping area and introduction of varieties with short crop cycle; cultivation of wheat and corn on terraces; development of modern irrigation techniques for horticulture; expansion of clover crop area; and improvement in irrigation efficiency to reach 80 percent (ARE, 2009). Increased water efficiency is also expected to be achieved with improvements of irrigation networks, laser land leveling, night irrigation to reduce tail end and evaporation losses, use of desalinated sea water, and reuse of drainage water. In the New Lands, located mostly outside the Nile's drainage basin, farmers are required by law to use sprinkler or drip irrigation, and metering water use at delivery point is in principle possible.

In the Old Lands, adoption of the Irrigation Improvement Project (IIP) was part of the 2005 NWRP, with a major change for farmers in these regions: the move from multiple pumping points along the mesqa by a system of collective pumping at a single point (Gersfelt, 2007). Such a "technical" change is not mundane at all, because continuous flow replacing the old rotational system will allow a more efficient use of water by providing farmers with more flexibility to irrigate according to plant requirements. However, it should be noted that each command area receives the same monthly amount of water than in the old rotational system, so that the supply constraint may move upstream to the distributary canals, with farmers possibly ready to draw water directly from such canals. An interesting point, however, is that the new system is compatible, in principle, with volumetric allocating of water (which was not used in 2004).

Given the weight of agriculture in total Egyptian water withdrawals, a policy for modifying the agricultural cropping profiles is expected to have a major impact, provided relative benefits (farmer profits) of alternative crops can be modified. In the NWRP2017, a new policy promoting both high-value crops and less-water-intensive ones is called for, to balance limited water supply and agricultural water demands (targeted crops are rice, sugarcane, corn, and berseem clover). A condition for this policy to succeed is that the differential in crop water requirements among subsidized crops is large enough. However, because agriculture in Egypt (as in the MENA region as a whole) employs a large share of the active population, the design of a crop-subsidy reform has to account for social consequences of a possible reduction in agricultural labor. As discussed in SIWI (2006), countries considering a "more employment per drop" policy for agriculture should examine the viability of such option in the long run, given ongoing urban transitions. Gohar and Ward (2011) identify improvements in national farm income from modifying agricultural water use patterns. They show that water trading across locations and seasons can increase such income by up to 28 percent.

Some farmers cover their irrigation needs by unofficial pumping of drainage water or digging wells for shallow groundwater (Rady and El-Din, 2018). Water pollution remains significant in the Nile Delta, due to agricultural drainage mixed with municipal and industrial wastewater, and groundwater contamination is also observed, due to wastewater and salt intrusion.

Measures included in NWRP2037 to address water use and management in agriculture include the following (see NWRP, 2017):

3.3.1 Control import, production, and use in agricultural of agrochemicals

3.3.2 Prevent water cage fish culture in all freshwater courses

4.1.3 Expand irrigation improvement projects for water delivery in branch canals based on participation and cost recovery

4.2.3 Convert on-farm systems in Old (and New) Lands into modernized systems through farmers' participation and cost recovery

4.3.4 Prohibit and enforce (traditional) surface irrigation in New Lands

4.3.5 Expand on Integrated Agro-Aquaculture (IAA), including water recycling systems

4.3.6 Expand on greenhouse cultivations, including hydroponics

4.3.7 Enhance decentralized participatory local/regional irrigation management schemes

4.7.1 Agree, promote, and enforce strategic cropping pattern according to available water-using economic instruments.

4.7.2 Promote cultivation of crops with low water consumption and salt tolerant varieties

4.7.3 Prohibit exporting crops of high water content

Market-based instruments using a permit system for managing water demand can be associated with measure 4.7.1 and possibly measure 4.7.2 through crop subsidies (also a market-based instrument). On the other hand, regulatory policies are better suited to measures involving restrictions of use or promotion of technologies, such as 3.3.1, 3.3.2, 4.3.4, 4.3.5, 4.3.6, 4.7.2, and 4.7.3. Finally, participatory approaches are relevant to consider in association with measures 4.1.3, 4.2.3, and 4.3.7.

5.2. Measures for Non-Agricultural Usage

As regards reforming the water tariff for residential users, recent increases have been decided (in some areas after the reforms in 2004–2006 and then in August 2017 and June 2018, see above). A specific feature is that residential tariffs remain fairly similar across Egypt, even though (or partly because) monitoring proposals for tariff reforms in the water and sanitation sector follow a single procedure involving the holding company, the National Water Regulatory Agency and the Ministry of Water Supply and Sanitation. A uniform tariff may not be relevant for water and sanitation services that are supplied as local services only, because of the local monopoly nature of water provision, with large fixed costs, almost constant marginal costs, and massive transportation and water-quality costs.

NWRP2017 has been an essential step toward the growing recognition of water scarcity as a key issue for Egypt. However, water management remains inefficient in municipalities and in industry, and there are high losses in the distribution network and a lack of public awareness (NWRP, 2017). Access to water is still inequitable, with water shortage and water-quality deterioration jeopardizing an equitable water access of sanitation. Domestic water networks in many areas are still characterized by leakages causing occasional mixings of pollutants from sewage, agriculture, and industry. Many users in rural areas are deprived of regular delivery of irrigation water and permanent drinking water as well. Despite previous efforts, no changes in behavior have been observed in actions toward water saving and quality (Rady and El-Adin, 2018). Demand-side policy options proposed in NWRP2037 include a rational use of groundwater for enhancing water availability; improvement of water quality by reducing agricultural pollution loads and improving drainage water quality; enhancement of water use management by allocating predetermined water quotas, implementing volumetric water allocation to agricultural land, and raising irrigation efficiency; improvement of drinking water supply systems; rationalization of water use by allocating water quotas by category of users; and regulation of cropping systems (crop patterns and land use).

Measures included in NWRP2037 addressing municipal and industrial water use include the following (NWRP, 2017):

4.3.8 Apply charges for operation and maintenance of water transmission systems

4.5.1 Promote water conservation by individuals through metering and appropriate tariffs to enable existing systems to serve future demands

4.5.2 Ban unlawful uses of drinking water (washing cars and flushing pavements) and control watering green areas with freshwater

4.5.3 Promote use of water-efficient appliances and fixtures to enable existing systems to serve future demands

4.6.1 Promote, regulate, and enforce water-saving technologies and practices in industry

Market-based instruments using pricing systems for managing water demand can be associated with measures 4.3.8 and 4.5.1. It is interesting to note that measures for promotion of technologies, such as 4.5.3 and 4.6.1, may be classified as belonging to regulatory policies but they can in fact be associated with market-based policies involving subsidies for adoption of new technologies. On the other hand, regulatory policies are better suited to measure 4.5.2 involving restrictions of use.

5.3. Challenges to Policy Options

Two dimensions of water management policies through market-based policies of water pricing are discussed here. These are acceptance and affordability of these instruments by Egyptian households and farmers on the one hand, and water consumption monitoring on the other. Best practices for water-demand management through these policies are discussed in the light of these two dimensions, as they are key determinants of the performance and success of such demand-oriented policies.

One of the most advocated (by economists and international organizations) policy instruments for residential water management is a volumetric tariff based on metered consumption. The justification is that such demand-side policy may send the right signals about the water resource to the final users, leaving them with flexibility to adjust to variations in tariff depending on their own consumption decisions. In contrast, a water tariff for large-scale surface irrigation with gravitation systems in agriculture is not recommended, because of monitoring costs and the low agricultural value of water in most cropping systems associated with such irrigation techniques. The situa-

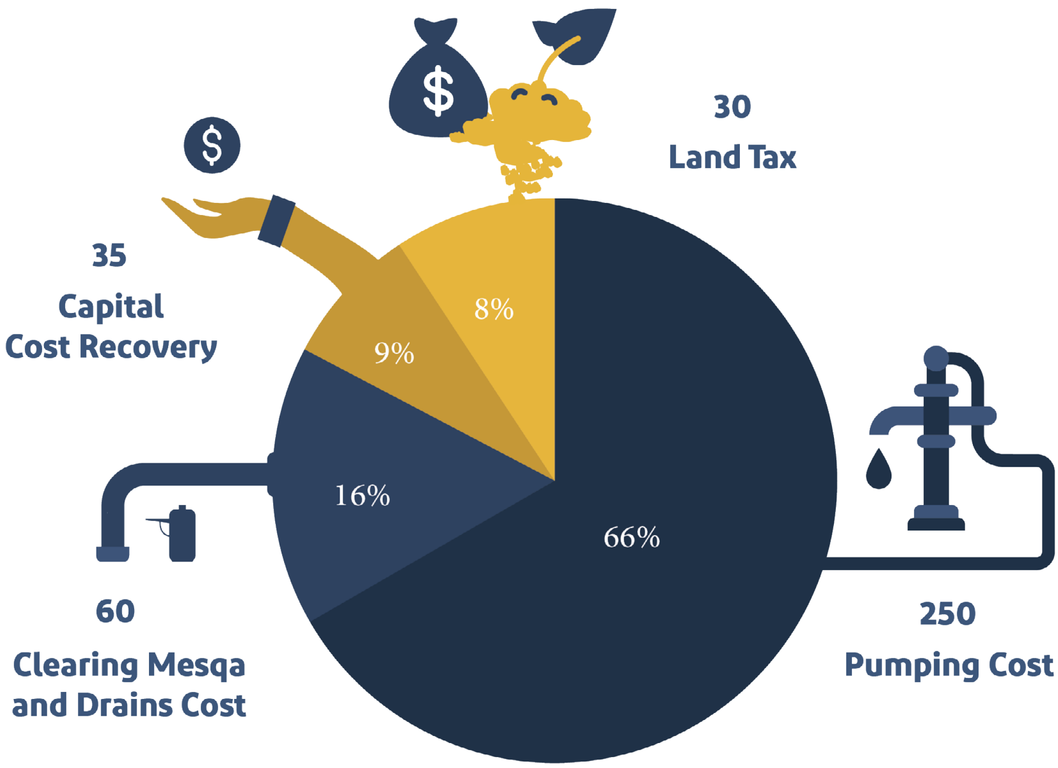

FIGURE (6): Irrigation Costs Incurred by Farmers in Exchange for Water from Irrigated Fields

tion is, however, very different in pressurized irrigated agriculture for which crops often have a much higher market value, resulting from adverse soil and climate conditions, and implying a much more-efficient irrigation technology (drip, sprinkler).

In Egypt, water rights to land owners in the Old Land (Nile Valley and Delta) and government land reclamation projects are not transferable, and the volume of water quota is determined by the MWRI. The actual water supply to farmers at the tail end of the canals is usually less than the allocated quantity, because of the operation of the canal system and the over-use by the upstream users. Gohar and Ward (2010) discuss the advantages and drawbacks of irrigation water-trading systems in the case of Egyptian agricultural water use, with the objective to increase its global efficiency. They analyze the natural resource and economic impacts of a water-trading scheme, at the catchment scale, and they also examine the role of restrictions of use that may be imposed by food security, technical and institutional constraints. They conclude that developing water markets among Egyptian farmers may result in more-efficient irrigation water use, raising farm income by between 6.3 and 7.9 percent.

5.3.1. Acceptance of market instrument policies

Affordability of water tariffs is a major concern for a large proportion of the Egyptian population if water prices are set at levels that would allow full cost recovery and/or full integration of the environmental impacts of withdrawals on total water resources. In the present water tariff context, in Egypt and also in many other developing and emerging countries, the marginal cost of accessing an additional unit of water is small, often a small proportion of household income. However, the picture changes radically when one integrates the full water tariff including connection charges. According to AWC (2012), the budget share of water and sanitation charges can reach 4 percent for the lowest income group.

A “vicious circle” or a “water poverty trap” is often found in poor communities where high connection fees keep a fraction of the population away from municipal water networks, even though the marginal price of water is small. This implies that such households have to resort to illegal water tapping, use unsafe water sources, or obtain water from tankers and private water vendors who charge prices at a much higher rate than the public water utility. In addition, such households do not have access to safe wastewater and sanitation facilities. In Egypt, water users who are not legally connected to the water network pay between LE 2 and LE 3 for 25 liters, about 300 times more than the water network price.

Acceptability of water pricing is also an issue in agriculture. A study on acceptability of water pricing and other conservation measures in Egyptian farming communities was conducted in 2003, at a time when multiple connection points for irrigation in the mesqas was the rule, and no water tariffs for irrigation were applied (Malashkhia, 2003). In most farmer interviews, water pricing was considered not acceptable. Affordability concerns were invoked by most farmers, although some recognized that cost recovery may be an interesting way of delivering a message about water scarcity. The main obstacles hindering the introduction of water pricing for irrigation included cultural acceptance, affordability, effectiveness of pricing for water conservation, and environmental limitations.

As regards cultural acceptance, a result of the study was that it was important to make a clear distinction, in messages about a water-pricing policy, between a charge for water resources and a fee for irrigation service (the latter being less opposed by respondents). Concerning affordability, farmers are not charged for water from irrigation canals, but they bear the cost of water conveyance (from the mesqa to their fields). Irrigation cost estimates are provided by MWRI (2002): pumping cost LE 250/year (67 percent); clearing mesqas and drains LE 60/year (16 percent); land tax LE 30/year (8 percent); and capital cost recovery LE 35/year (9 percent). When compared with an average production cost of LE 300/feddan (in 2002), irrigation represented about 12 percent of total farming costs on average. A concern with affordability of a water tariff is that a high water price may push low-income farmers away from rural areas, while reallocating water to big landowners and water users. If farmers have a low incentive to reduce water use, a water price increase can have a low impact on water use but a large effect on farmer’s income (Berbel and Gomez-Limon, 2000; Yang, 2003).

5.3.2. Monitoring water consumption

Water pricing is, in principle, a very cost-effective policy to achieve an optimal allocation of scarce water resources among users. To be effective, however, one needs to monitor accurately individual water withdrawal and consumption levels, evaluate social benefits from water use, and reach a consensus among consumers about the relevance of the pricing policy regarding equity and possible redistribution. In the vast majority of MENA and semi-arid countries, monitoring individual consumption for households and pressurized irrigation systems can be achieved with diminishing costs. On the other hand, monitoring consumption at the farm level with individual borewells or direct pumps from canals remains too costly (Hellegers and Perry, 2006; Lika, Galioto and Viaggi, 2017).

In the latter case, metering water use could be more costly than additional benefits from using a more precise measurement of water consumption. Such argument may be valid when water scarcity is low to medium, but is certainly questionable in situations where the marginal value of water is high. If a water-pricing policy is to be truly cost-effective, it has to be based on actual observations on water use, or at least on indirect measurement of farmer or consumer decisions, for those economic agents to associate their water bills with their own decisions. A related issue concerns the simplicity of the water tariff, to make sure that water users are informed about the impact of price changes on their water bill. In some cases, the water tariff can be sophisticated and such evaluation by a household may be difficult.

When applying water-pricing policies to water user categories, there is international evidence that pricing mechanisms can be quite effective at managing urban water demand because it is less costly to match water bills with actual water consumption and the economic benefits from water are higher for domestic or industrial use. Moreover, the higher population density implies that capital and operating costs are less difficult to recover than in less dense, rural areas. On the other hand, water pricing is subject to more important barriers when applied to irrigation. In this case, the cost of water to users would have to increase sometimes above the true cost of the distribution service for the water price to have a significant impact on irrigation demand. Another instrument would be needed, for example a water quota based on farm area. Perry (1996) estimates, for example, that to decrease water demand in Egypt by 15 percent, one would need to set a price policy leading to a loss of about 25 percent of farm income, which is of course politically unfeasible.

According to Hellegers and Perry (2006), the gap is often too big between water price and the value of irrigation water, implying that a huge increase in water price would be needed to balance supply and demand, with a substantial reduction in farmer welfare. Volumetric measurement at farm level is required for volumetric water charges (and tradable water rights), as well as a legal framework for volumetric water charges. In their case study (Kemry, Egypt), these authors noted that volumetric measurement was possible but there was not (at the time of the study) a legal framework to charge for water.

A very important point raised by the authors, highly relevant to the Egyptian case, concerns the charge basis of water prices, whether water extraction or water consumption is charged. When water return flows are partially recoverable, a volumetric water charge will not be able to account for crop-specific differences in field irrigation efficiency, and a volumetric water price would result in too heavy a taxation on some crops such as rice. Having in mind NWRP measures proposed for increasing water use efficiency, in most of the Old Lands, a water charge based on water use and not on water net consumption would not reflect the actual social cost of water abstraction. This is because drainage water is returned to the Nile River, whereas this is not true for New Lands where groundwater is used. In the latter case, farmers pay the full cost of groundwater abstraction.

The above analysis suggests that adopting a water-pricing system for agricultural usage is very difficult to implement, due not only to physical constraints related to implementation but also to potential negative impacts on the agricultural sector, especially small and poor farmers, and it would have limited impact on the efficient use of water resources.

6. Policy Recommendation and Implementation

This section gathers the various discussions above concerning the economic properties of policy instruments in water management, lessons learned both from the implementation of NWRP2017 and from the economic literature and best practices. First, the nature of policy implementation, whether gradual or immediate, which is an important dimension of policy propositions, is discussed. Second, a set of policy propositions to design and implement a consistent strategy based on economic policy instruments is presented. Lastly, general policy recommendations to guide decision makers toward water security in Egypt are presented.

6.1. Gradual or Immediate Implementation of Market Instrument Policies

A critical dimension of market-based policies, whether pricing or quota, is their implementation pace. There are two opposite strategies that can be used when implementing a water-pricing policy.

The first strategy starts from the assumption that water users will oppose implementation of water pricing, because of lack of familiarity with these instruments and the need to adapt and identify alternative ways of consuming or using water for production. Moreover, policy makers may not have information on the future (short-run and long-run) shifts in water use from various economic sectors, as a result of the policy. With such strategy, a first phase consists in performing an assessment of the sensitivity of water users to policy instruments (that is, elasticity of water demand with respect to water price). Second, a communication and awareness campaign has to disseminate information about the state of water scarcity (both at global and local levels), insisting upon the fact that each household, farm, or industrial plant can contribute to reduce total water withdrawal. It is important at this stage to involve local stakeholders and explain that supply-side policies should be accompanied by an effort in demand reduction. For example, public consciousness around water issues was raised through large-scale media campaigns in Tunisia and Australia. A very important aspect is also the need to associate, in the view of water users, their contributions through water bills with concrete projects that are relevant for their welfare. This means that revenues from water pricing have to be earmarked to cover water-related project costs.

Such gradual strategy was experienced in Brazil, with a pioneer implementation in the Paraíba do Sul river basin and the creation in 1997 of its River Basin Committee (CEIVAP). In 2000, negotiations started about a water charge methodology, according to the principle of stakeholder participation. In 2002, the river basin Water Agency was created and water tariffs were gradually implemented as follows. These principles were adopted during negotiation about water charges: (1) conceptual and operational simplicity (water charges are based on directly measurable parameters, for a clear understanding by users); (2) acceptability by all users, facilitated by participatory approach in the CEIVAP; (3) signaling (water charges are expected to act as signals about economic value of water resources, and the importance of sustainable use); (4) minimization of economic impacts, in terms of cost increases for water users (residential, industrial, agricultural). A trade-off was therefore implicit in the tariff policy, between the incentive nature of water tariffs and their economic impacts (signaling versus acceptability). Hence, water prices were set at very low levels during the initial implementation period (2003–2006), and were highly differentiated between categories of users. After 2006, a gradual increase in tariffs was planned.

According to da Motta (2004), the aim of the water policy was closer to revenue generation than to a more-efficient use of water resources. A consensus was, however, needed among stakeholders, and it was reached because of a clear revenue-raising approach, simple pricing rules, and a very low budget target. The policy also reached the objectives to get water users familiar with water pricing, and to learn more about the changes in user behavior. As a result, the gradual approach adopted by Brazil avoided failure of policy implementation because of weak regulatory framework and institutional capacity. Unfortunately, the expected implementation of higher water charges was postponed by critical issues debated among stakeholders regarding universality of uses being charged, institutional arrangements, and charge revenue allocation criteria.

The second strategy is based upon the assumption that gradual or piecemeal implementation of water policy is pointless, in particular when the objectives of water pricing are not clear from the onset, because water users will instead be used to water pricing as an additional tax and not significantly modify their behavior. This is the view of OECD (2017), discussing the fact that setting water charges at a low level first, hoping for gradual familiarity by water users, and then increasing water rates at a later stage did not prove as successful as expected. This second strategy is based on the idea that water-pricing policies need to be clearly recognized as revenue generating, for financing programs of general interest for water users in the basin. Such approach was used by the French Water Agencies since the 1990s, to justify a large increase in water taxes, accompanied by a parallel increase in subsidies for, for example, pollution abatement and water-saving technologies.

Morocco and Tunisia have considered volumetric pricing and have planned price increases as a signal on the resource scarcity, with price reforms in Tunisia allowing for a significant decrease in water use, due to a massive increase in average water price: a 400 percent increase in water price between 1990 and 2003 (Abou-Ali and Thomas, 2012).

According to OECD (2017), at least in an early stage of water pricing, water charges should in priority target large users and heavy polluters, in order to minimize transaction costs, the idea being that the marginal administrative and monitoring costs of charging and billing small water users are significant compared with revenues generated from their water bills. Furthermore, it is important to associate water charges with regulatory, monitoring, and enforcement policy instruments, as well as to verify consistency of the water policy with other sectoral policies (agriculture, energy, food, external trade, etc.). Finally, at least in a first stage, revenues should be earmarked to cover water-related expenditures so that water users can verify that their contribution as water charge payers is effective.

6.2. Policy Propositions for “Water for All” Egypt

The main policy propositions for a clear roadmap to accompany the strategic plan of Egypt regarding the “Water for All” objectives of NWRP2037 are presented in the sections below.

6.2.1. Policies for agricultural usage

• First, with satisfactory user awareness and an improved enabling environment, establish nationwide volumetric metering for agricultural usage in the Old Land. This needs to be implemented at the various distribution levels whenever feasible (governorates, irrigation districts, main canals, secondary canals and, if possible, mesqas).

• Second, establish a quota (permit) system, rather than a pricing market system, for water usage in agricultural Old Land. The quota allocations have to be set in accordance to the economic valuation of the crops. In other words, high-value crops should be allowed a higher quota level.

• For agriculture, reform the subsidy system and gradually substitute low-value and water-intensive crops with high-value crops. Subsidy policies and extension training for farmers are required for a transition period, to move away from low-value and water-intensive crops.

6.2.2. Policies for non-agricultural usage

• Increase water taxes and prices for large users and heavy polluters, especially for industrial usage.

• Earmark water-pricing revenues to water supply infrastructure projects. In other words, there must be a matching of necessary investments in supply-driven water infrastructures with water-pricing and pollution tax schemes. Priority must be given to reducing water leaks and losses, as well as reducing point source effluent emissions from local communities and industry. A simple system could start with emission taxes based on output indicators for firms and population numbers for municipalities.

• For residential usage, adopt social pricing schemes such that connection fees and fixed parts of water tariffs are subsidized by high-consumption blocks. In other words, the water-pricing policy subsidizes the first block of the tariff by adopting an increasing block rate water tariff.

6.3. General Policy Recommendations

As discussed in the sections above on literature review, policy options, and best practices, an increased role for market-based instruments such as water pricing and quotas requires first an assessment of users' behavior and their familiarity with market instruments. A clear strategic plan is also needed, targeting precise water-related programs to be funded from such water management policies, and a strong communication campaign with a participatory approach. This implies that a policy to assist affected users, especially in the agricultural sector, with training and subsidizing transitions toward less water-intensive technologies and water-saving devices, is also necessary. In regions or population categories where water users are not accustomed to water tariffs set at cost recovery level, gradual phasing-in of water pricing, with the possibility of social water tariffs, needs to be explored.

The particular position of Egypt benefiting from the Nile River from Uganda to the Mediterranean Sea implies that policy instruments should focus, in particular for irrigation, not just on water abstraction (water "use") but mostly on net consumption and drainage capacity. Given the weight of Egyptian agriculture in the economy, evapotranspiration of field crops is a large contributor to net water consumption, so that cropping patterns should be addressed by water policy. Moreover, given the large proportion of drainage from fields to canals and the Nile Delta, quality issues are essential to limit water loss because of poor quality. A consequence is that water pricing for irrigation, if implemented, must be implemented only in the New Lands. Subsidy policies and extension training for farmers are required for a transition period, to move away from low-value and water-intensive crops.

Furthermore, sectors other than water users should be integrated in the policy design as well, for example to ensure that solid waste management, particularly in rural areas, is sufficiently efficient to ensure that water quality is satisfactory. Policy makers must make it clear what the water-pricing policy is for: revenue generation, and/or to provide water users with incentives to modify their behavior for resource conservation purposes.

• First, develop an ambitious and comprehensive information and awareness campaign about water scarcity, letting water users know that infrastructures need to be upgraded. This campaign should promote the notion that, because water users benefit (or suffer) from different local conditions (origin of water resources, quality of raw water, etc.), it is natural that they are faced with possibly different water-pricing and tax levels, but that the policy aims at reducing inequalities among them.

• Second, fill information gaps about expected impacts of market-based policies (particularly water pricing); regulatory policies in terms of water-demand elasticity with respect to policy instruments; and expected impacts on household welfare, industry profits, and farmers' income.

7. Conclusion

A major challenge for Egypt is to move toward an adaptive strategy, in order to close the gap between depleting water resources and increasing water demands. Such challenge implies identifying not only the best pathway to sustainable water management, but also a pathway to more-efficient financing of water infrastructure. The National Water Resources Plans 2017 and 2037 were implemented (in 2005 and 2017 respectively) to prepare the way for sustainable water management in Egypt.

This report discusses the potential for accompanying the strategic NWRPs with a discussion about the relevance of policy instruments, which could be associated with program measures as planned in NWRP2017 and NWRP2018. While special attention is paid to affordability and implementation stages, the performance of such policy instruments is discussed according to major findings in the economic literature regarding criteria such as cost-effectiveness, monitoring, and the speed of policy implementation. A critical discussion about the assessment of NWRP measures is therefore proposed, together with a road map for gradually implementing policies based on economic (market-based), regulatory, or participatory measures.

The main lesson from this analysis is that adaptation to water scarcity is a lengthy process for improving an enabling environment for integrated water resource management, for promoting significant changes in water user behavior, and for investing in long-term water-related infrastructures. An optimal timing of policy implementation is essential to avoid policy failure through, for example, the public's lack of awareness and acceptance of policy measures. In this regard, earmarking economic instruments such as water tariffs and water taxes to actual improvements in access to adequate levels and quality of freshwater is recommended.

8. References

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