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WATER RESOURCES MANAGEMENT IN EGYPT

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Thirst for water will become one of the most pressing resource issues of the current Century.

The Egyptian water resources system is composed of many interacting components and intermingles with social, economic and environmental systems, which are also complex and uncertain. Fresh water resources include River Nile flow, precipitation and groundwater from both renewable and non-renewable aquifers. Egypt also practices the use of various types of marginal quality water, such as reuse of agricultural drainage water, reuse of treated domestic wastewater. In addition to the non-conventional water resources, desalination is being used to provide domestic water supply for some locations along the Mediterranean and the Red Sea coasts [3].

Egypt has reached a stage where the quantity of water is imposing limits on its economic development. The per capita share of water is continuously declining. The present share is below 1000 cm/capita/year (Sep. 2004), a figure that, according to international standards, is equal to the "water poverty limit" for a nation. This value might drop to 500 cm/capita/year in the year 2025, which would indicate "water scarcity". In terms of water quality, the few data available indicate that there exists a rapid degradation in surface and groundwater quality [1].

Nile River is the main source of water in Egypt and we should pay more attention to make use of each drop, and reduces loss to the minimum as we can.

In the present paper we introduce a brief study about the evaluation of the existing water resources in Egypt and also the main resources of losses and how to deal with it. Also we should give attention to other important resources of water.

INTRODUCTION & REVIEW

Major challenge facing Egypt now is the strong need for better development and management of the available limited resources of water, land and energy to meet the needs of a population growth.

Egypt has the great River Nile, which is the main water resources, is limited to **55.5 billion m^3 /year**. With the fast growth in the population and increasing consuming of water in different fields, such as agriculture, industry, domestic use etc, it is expected that Egypt will relay to some extent on the groundwater to develop the new projects such as East Eweinat [1].

As Martin Hvidt [5] notes, « there are two main ways one can match demand with supply: either by reducing demand or by increasing supply. In spite of the increasing scarcity of water, however, there are virtually no indications of attempts to reduce water demand in the three main water-consuming sectors ».

In Egypt, water planning started in 1933 when a policy was formulated to use the additional storage capacity made available by the second heightening of the old Aswan Dam and the Gabal El-Awlia Dam in Sudan. This plan introduced programs for land-reclamation, conversion of some basin irrigation to perennial irrigation, and increases in the areas under rice cultivation. This policy was first revised in 1974 and again in 1975 when a new plan was drafted to accommodate the extra volumes of water resulting from the construction of the Aswan High Dam [5].

The multi-year regulatory storage capacity provided by the Aswan High Dam gave stability to Egypt water resources by providing a reserve storage capacity during years in excess of requirements and providing supplemental resources during loan year.

Nowadays focusing and more efforts are running for water management and utilization of different available water resources.

Although all the previous attempts for planning water resources in Egypt, we still have to make more efforts to reach the required balance between the available water resources and the high growth population and water needs in consequent.

1 - State of Water Resources

1 –1 River Nile Basin, General Description

Water is one of the most valuable resources on earth, Egypt is fed by the River Nile, not only does Egypt share the Nile water with many countries but it also lies at the end of the Nile's route toward the sea (the ten countries of the basin are: - Egypt, Sudan, Ethiopia, Eritrea, Tanzania, the Democratic Congo, Uganda, Burundi, Rwanda, and Kenya)**.** This means that it receives the Nile after it has emptied much of its water along the way. In 1959 Egypt signed an agreement with Sudan. The agreement specifies that Egypt's share of the Nile water is 55.5 billion M^3 /year (table 1) [3].

Egypt can only release more than 55.5 billion M^3 /year of water if the flood is so great that will endanger the High Dam. This has happened, in 1998 (fig.1). Because droughts occur periodically, it is important to store water in Lake Nasser during the years of high Nile inflow.

1 - 2 Ground Water of Egypt

Ground water is the portion of the water beneath the surface of the earth that can be collected with the wells, tunnels, or drainage galleries, or that flows naturally to the earth’s surface via seeps or spring. Not all underground water pressure is greater than atmospheric pressure.

Table 1: Available Water Resources in Egypt

Water Sources	**Amount (**billion M^3 /year**)**	**Remarks**
River Nile [7]	55.5	As fixed by international treaty
Rain fall [7]	1	Of moisture in the delta
Water Reuse	**Amount (**billion M^3 /year**)**	**Remarks**
Ground water reuse [6]	4.8	
The agriculture drainage network returns [7]	4.5	
Recycling industrial water moves about [3]	6.5	
Reuse of sanitary treated drainage returns [3]	0.7	

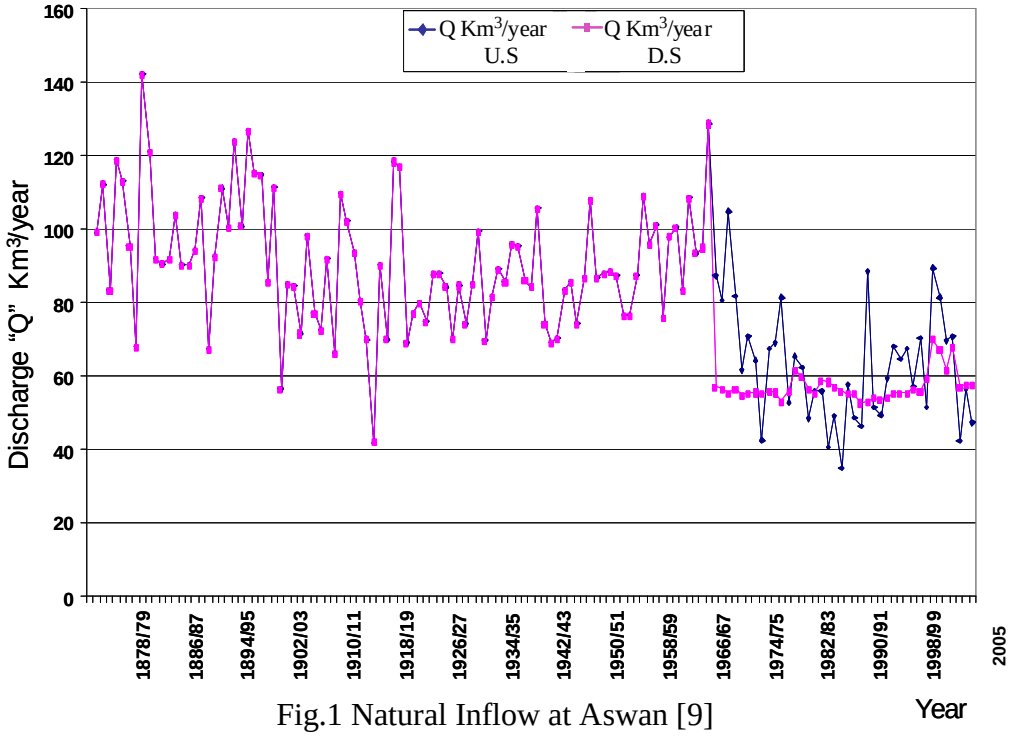

Fig.1 Natural Inflow at Aswan [9]

Groundwater is a vital resource of water that is used for countless purposes. It is used for public and domestic water supply systems, irrigation, industrial, commercial, mining and thermo-electric power production purposes. The amount of ground water in Egypt is 4.80 km^3 / year (table 1). In many cases and locations groundwater serves as the only reliable source of drinking and irrigation water. Unfortunately, this vital resource is vulnerable to contamination. Nowadays,

groundwater is being threatened by a vast array of pollutants from such diverse sources as sanitary landfills, soil treatment systems, septic tanks and subsurface disposal wells.

Origin of Groundwater: The age of groundwater may range from a few years or less to ten of thousands of years or even more. Old meteoric water often occurs in arid areas where most of the groundwater was formed during previous climatic periods with higher rainfall. In Egypt as example the groundwater age of Suze Rift Valley is more than 31,000 years (Munnich and vogel , 1962) [6].

1-3 Reuse of agriculture drainage water mixing with canal water

The total reused of agriculture drainage in Egypt 4.5 billion M^3/year) [7].

1 - 4 Rain Water

Egypt is a very arid country, where the average annual rainfall seldom exceeds 200 mm along the northern coast (table 1). The rainfall decline very rapidly from coastal to inland areas, and becomes almost nil south of Cairo. This meager rainfall occurs in the winter in the form of scattered showers, and can not be depended upon for extensive agricultural production. This amount (1 billion M^3 /year**)** cannot be considered a reliable source of water due to its spatial and temporal variability [3].

1 - 5 Reuse of Treated Waste Water

A new wastewater treatment plants come on steam in Cairo and other urban cities amounts of treated wastewater that could be available for agricultural activities (table 1):

1 – Reuse of treated agriculture water water.
2 - Reuse of treated domestic water. “Treated domestic wastewater in 2001/02 was estimated at 2.97 km^3/ year [2].
3 - Reuse of treated industrial water [4].

1 - 6 Desalination of Sea Water

The use of non-conventional water sources has been practiced for a long time in Egypt. An additional option is desalinization which is being applied in several areas (some costal towns, islands, remote industries sites) the desalination capacity in Egypt has grown to some 150,000 m^3/day [8].

2 - Water requirement

2-1 The Nile irrigation system

Water Infrastructure: Major control structures on the Nile in Egypt include the High and Old Aswan Dams, and a number of downstream barrages. The Old Aswan Dam was completed in 1902 with a storage volume of about 1 km^3. By increasing the height of the dam in 1933 the storage capacity was later increased to 5 km^3. The High Aswan Dam, upstream of the Old Dam was completed in 1968. Its reservoir has a large annual carry-over of 168 km^3. Downstream of Aswan, the water level of the Nile and the distribution of the Nile water are controlled by a number of barrages on the Nile, which have locks for navigation (fig. 2, table 2) [3].

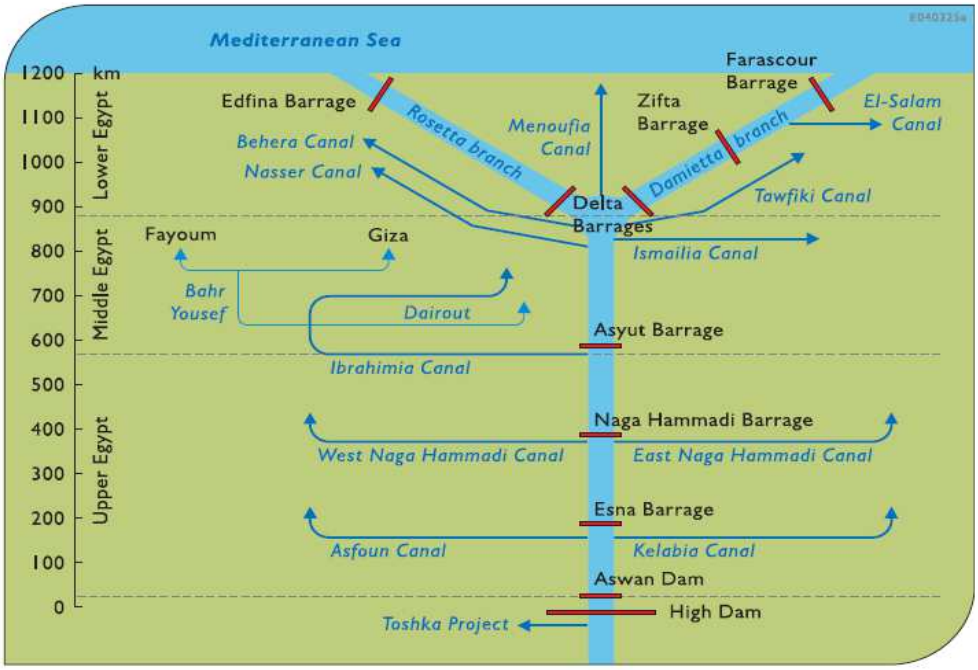

Fig. 2. Schematic diagram of major control structure on the Nile in Egypt [8]

Table 2: Approximate Canal and Open Drain Lengths (km) by Region [3]

Region	Function	Total	Region	Function	Total
Upper Egypt	Canals	6173	Middle Delta	Canals	5509
	Open Drains	1637		Open Drains	4283
Middle Egypt	Canals	7438	West Delta	Canals	3390
	Open Drains	3890		Open Drains	2837
East Delta	Canals	7253	*Totals*	Canals	*29763*
	Open Drains	4039		Open Drains	*16686*

Available water is reduced by evaporation. Total system loss to evaporation amounts to 2 billion m^3 annually [3]. Therefore, night watering by farmers can reduce evaporation and take advantage of less competition for water after dark.

Crop choice by farmers has a direct impact on water consumption. Crops vary considerably in their water requirements table 3.

Table 3: Crops water requirements [3]

Crop	Delta	Middle Egypt	Upper Egypt	
Sugar cane		7167	9109	m^3 \ fed
Rice	4961	4691	5395	m^3 \ fed
Cotton	2818	3541	3881	m^3 \ fed
Corn	2251	2310	2370	m^3 \ fed
Wheat	1608	1996	2195	m^3 \ fed

For example, the above table indicates the water consumption for several crops by regions (m^3 / fed). When government liberalized cropping decisions, rice production area almost doubled. This on-farm choice nearly replaced cotton and maize cropping in the summer because of rice's higher profitability. When Egyptian farmers fully irrigate more than 1 million fed of normal-duration rice [3], they use an amount equal to nearly one-fifth of all water delivered annually by the River 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 increased demand because the system was designed for only 40 percent rice cultivator [3].

2 – 2 Municipal Water Requirements

Municipal water requirements include water supply for major urban and rural villages. A part of that water comes from the Nile system, either through canals or direct intakes on the river; the other part comes from ground water sources. The average drinking water production was 5.3 Km^3/year [8]. A portion of that water is actually consumed and the rest returns back to the system, either through the sewage collection system or by seepage to the groundwater. There are regions like Alexandria, Suez Canal, and desert areas where the discharge cannot be recovered.

This water is delivered to the users through municipal distribution networks in urban areas and few villages. The major factor affecting the amount of diverted water for municipal use is the efficiency of these delivery networks. Studies showed that the average efficiency is as low as 50% [3], and even less in some areas. The other 50% of the diverted water is lost by leakage from the network [3]. Therefore, the government is paying great attention to the rehabilitation of municipal pipelines networks to improve its efficiency and reduce the conveyance losses. The cost of treating municipal water can be reduced significantly as the efficiency of the distribution network increases.

It is worth mentioning that municipal water requirements include water used to irrigate public gardens and parks. In addition, many small and medium size industries spread in cities and villages use this water for industrial production.

2 – 3 Industrial Water Requirements

There is no accurate estimate for the current industrial water requirement especially with the new government policy to encourage private sector participation in industrial investment. The private sector contribution to the industrial sector currently exceeds 50% of the total national industrial production where many new industries have been implemented and under production while others still under construction.

In 1990, the general authority for industry made a survey that covered 90% of the public sector major factories to estimate industrial needs and requirements. The study included 321 public sector factories representing the main activities of the industrial sector. The results of the study were used to estimate the water , A portion of that industrial wastewater goes directly to the sea as in the case of Alexandria's industrial sector. Water requirement for the industrial sector during the year 1995/96 was 7.5 Km^3/year.

A small portion of the diverted water for industrial requirement is consumed through evaporation during industrial processes while most of that water returns back to the system. The study of the Water Master Plan suggested that only about 6% of water abstracted by industry is consumed which means only 0.45 km^3 of water delivered to industry in year 1995/96 was lost. Thus, a huge volume of partially treated or untreated effluent is returning to the system creating major environmental problems.

2 – 4 Navigational Requirements

The river Nile main stem and part of the irrigation network are being used for navigation. The main navigation activity is the Nile touristic cruises between Aswan, and Luxor and the transportation of commodities between Upper and Lower Egypt.

Water demand specifically for navigation occurs only during the winter closure period (about 3 weeks in January and February), when the discharges to meet other non agriculture demands are too low to provide the minimum draft required by ships. Without extra releases from High Aswan Dam for navigation, ships suffer serious constraints in navigating the Nile during that period especially in Aswan-Luxor reach. The navigation water goes directly to the sea as fresh water. After changing the winter closer system to be divided the country into 5 regions instead of two regions only [3], there is no exclusive release of water from Lake Nasser for navigation. There only is a guaranteed minimum release of 60 million m^3 / day [8] which is also required for some municipal intakes along the Nile.

2 – 5 Hydropower Requirements

Since 1990, irrigation has had priority over hydropower in order to maximize the water availability for agriculture and new lands development. Thus, there are no special releases for hydropower at present, and releases for irrigation, municipal, industrial, and navigation purposes are used to pass through the turbines at the High Aswan Dam. The fluctuations in the amount of hydro-power generated has been overcome through the national electricity network where the thermal generation capacity, is sufficient to cover any reduction during low releases season.

3 - Egypt's National Water Balance

The Nile basin inside Egypt is a closed system. Thus inputs and outputs must be balanced. The release from High Aswan Dam is considered the only input to the system if we exclude the little amount of rainfall on the northern coast and the amount of deep groundwater from outside the basin which are insignificant inputs. The overall efficiency of the system is relatively high because of the recycling of water along the system. From the total amount of water used through the system about 12.97 Km^3 come from reused agricultural drainage, 4.8 Km^3 from groundwater abstraction from the renewable aquifer in Valley and Delta, and 0.7 Km^3 from reuse of treated domestic sewage (table 4).

Table 4: Nile water balance for 1995/96 [3]

Water balance	Km^3 / year
HAD release	55.50
Effective rainfall	1.00
Sea water intrusion	2.00
Total inflow	**58.50**
Consumptive use municipalities	0.91
Consumptive use industries	0.45
Consumptive use agriculture	40.82
Evaporation from water surface	3.00
Total use and evaporation	**45.18**
Navigation fresh water outflow	0.26
Fayoum terminal drainage	0.65
Delta terminal drainage	12.41
Total outflow	**13.32**
(Total use and evaporation) + Total outflow	**58.50**

4 - The future demands and availability at national level

Agricultural requirements include two main parts, the irrigation water for the existing cultivated lands (old and newly reclaimed lands) and the expected future horizontal expansion in cultivated land (new lands).The estimated area of the old agricultural land reached about 7.8 million fed [3]. The horizontal expansion plan for 1997 aims to reclaim some 3.4 million fed [3] to be added to the present agricultural land by year 2017. Future water requirements for different activities including agriculture, evaporation loss in the system, domestic water, industry and navigation as shown in (Figs. 3 & 4) [3].

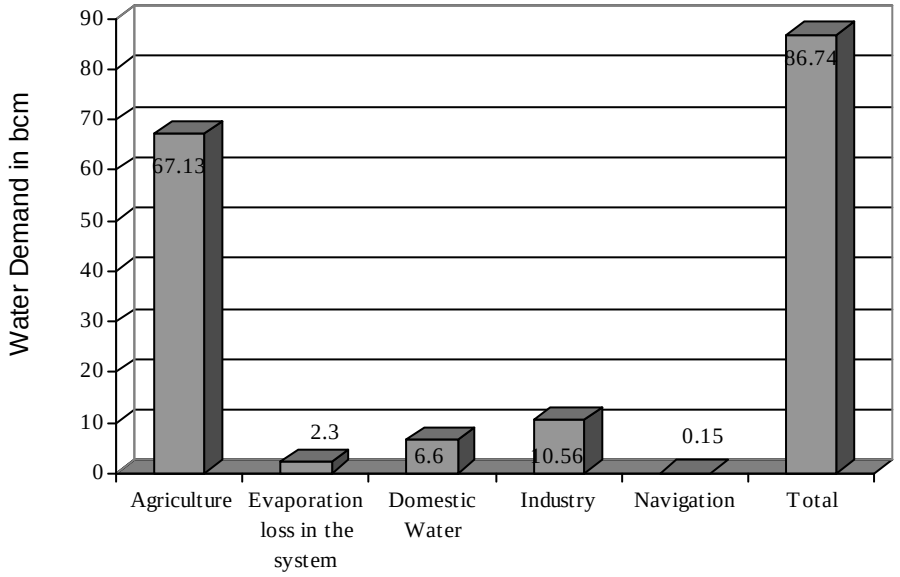

Fig. 3 Water Demand for the Year 2017 [3]

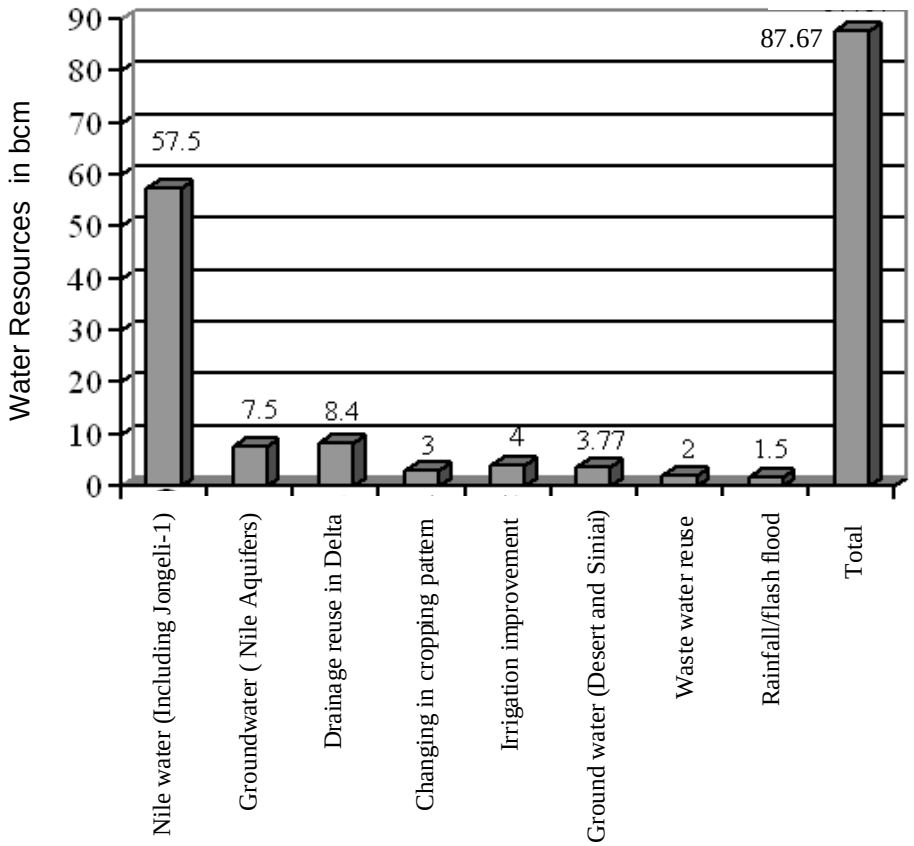

Fig. 4 Water Resources for the Year 2017 [3]

Currently there are an idea to offer new source of water through Condensing of Fog, In some countries they are thinking to take use of fog by condense it and use the result water for the irrigations of some kind of crop, we can use this source in the Costal cities.

CONCLUSION

A - Water management in Egypt is governed by three factors:

1. The degree of efficiency in domestic water management of hydrological and agricultural technology and application;
2. Egypt's ability to preserve its position as the principal riparian actor on the Nile;
3. Controlling the country's population growth. An additional crucial factor in Egyptian water planning is the « international aspect », due to the fact that the country's water resources lie outside the boundaries of Egypt. Consequently, any water planning has to be done in co-operation with the upstream riparian.

Many initiatives and discussions are taking place with the Nile countries aiming to have new agreements concerning water distribution.

B - Demand Oriented Measures for Water Conservation

Demand management tries to reduce and control water demands, as well as improve overall water use efficiency. Demand management allocates available water to competing user groups according to need.

Water is often considered a free good in many countries where a supply oriented approach attempts to serve water in quantities, relying on the assumption that the user will make proper use of it. This has been the case in Egypt for several decades. However, such a surplus bias system wastes considerable amounts of water, since the precious resource is then taken for granted and no incentive is made to conserve it. In contrast, a demand oriented approach assesses the real demand for water and tries to urge the users to conserve water and make better use of it.

Demand oriented measures that can be implemented in Egypt include the following:

1. Shifting to less water demanding crops, for instance, introducing cropping patterns with low water requirements (i.e. abandoning rice and sugarcanes for other cropping patterns).
2. Improving the efficiency of the existing public water supply system by reducing losses, detecting leakage and improving irrigation distribution and conveyance efficiency.

Water conservation measures need to be implemented and practiced by all water users and unnecessary or wasteful uses need to be reduced or eliminated where possible. A sound, reasonable, and effective water conservation culture can make the difference between adequate supplies and shortages.

3. Introducing implementation incentives for water conservation which might include various kinds of land or crop taxes, production charges, water pricing, or subsidies for water conservation.

While there are possible alternative energy sources for the future, the only alternative to water is water.

4. Finally, introducing public awareness campaigns aimed toward advocating a new water culture in a society based on the principle of conservation. The significance of water conservation in irrigation and domestic uses can be promoted through such public awareness campaigns.

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إدارة مصادر المياه فى مصر

المياه و توفير مصادر كافية و صالحة للاستخدام من اكثر القضايا الهامة التى تواجه مصر حاليا و مستقبلا، فى مصر يتواجد نهر النيل العظيم الذى كما قال المؤرخ اليونانى هيرودوت " مصر هبة النيل " حيث يقوم نهر النيل بامداد مصر بنسبة كبيرة من احتياجاتها المائية 55.5 مليار م^3. و لكن مع الزيادة السكانية المتطردة اصبح من الضرورى ان تعتمد مصر بنسبة اكبر على مصادر المياه الاخرى كالمياه الجوفية (4.8 مليار م^3) ومياه الامطار (1 مليار م^3)…. الخ، وايضا تحسين ادارتها لهذه الموارد كتقليل الفواقد فى المصادر المتاحة و خصوصا بالنسبة لنهر النيل كفاقد البخر الذى يبلغ 3 مليار م^3، و كذلك ايجاد مصادر اخرى بديلة.

تناولنا فى هذا البحث عرض لمصادر المياه المتاحة فى مصر و القاء الضوء على هيدرولوجية نهر النيل و كيفية ادارة و توفير المتطلبات المائية فى الفترة القادمة.