# PROSPECTS OF WATER CONSERVATION IN EGYPT (SPECIAL REFERENCE TO WASTEWATER REUSE)

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## ABSTRACT

Egypt has already made number of leading steps towards integrated management of drainage water as part of the available annual water budget for meeting the increasing demand on freshwater. The drainage research institute of the ministry of water resources and irrigation of Egypt had established a monitoring network of 140 sites on the main drains in the Nile Delta and Fayoum to monitoring the quantity and quality of drainage water in the main and branch drains with a monthly frequency. The monitoring program reveals that the drainage water quantity changes with time depending on water use policies and the management of the main supply system. It was found that the average water discharged annually to the sea is 12.5 billon cubic meter per year (bcm/y), and the volume of drainage water officially reused for irrigation has increased from 2.8 bcm/y (in 1985) to 5.2 bcm/y (in 2000) and expected to be 8.3 bcm/y by the year 2017. It is anticipated in the near future that both industrial and domestic wastewater will be increased thus reclamation and recycling should be considered as integrated components of water resource policy. Also, the reuse of treated greywater helps to ease the increasing burdens on global water supplies. Currently, there are two major uses for treated greywater, toilet flushing and irrigation.

**Keywords:** Water Reuse; Water Conservation; Greywater, Wastewater, Monitoring Drainage Program

## 1. INTRODUCTION

Renewable Freshwater Resources of 1000$m^3$ per capita per year is a benchmark below which most countries in the arid zone are likely to experience chronic water scarcity sufficient to impede development and harm human health [1]. It is expected in Egypt that by the year 2025 that the annual per capita renewable water will be less than 600$m^3$ [2].

In Egypt several additional factors contribute to the potential for water shortage, among the most serious is water pollution from a variety of industrial, municipal and agricultural sources. In Egypt domestic water use is about 7% of all water use and is expected to rise as the population grows and urbanization continues. Industrial water use is about 5% and is also expected to rise since the industrialization of Egypt is the

most promising option for development, while the agricultural water use comprises the largest share about 88% of all water use [3]. At the mean time the potential for developing other renewable sources for freshwater in Egypt is limited.

Water conservation and wastewater reuse are the only solutions of the water scarcity problem in Egypt. Water conservation involves preventing misuse of water, minimizing wastage and optimizing the benefits of water resources. The efficient use of municipal water supplies for industrial, commercial and domestic purposes is an important element. Prevention of water pollution, wastage in water distribution systems and collection of wastewater are also included [4].

Figure 1 shows the types of wastewater. Wastewater reuse includes domestic, industrial and agriculture wastewater. The reuse of agriculture wastewater should be encouraged to face the water scarcity problem in Egypt. Also encouraging the domestic wastewater reuse, specially the greywater, is very important to increase our water resources.

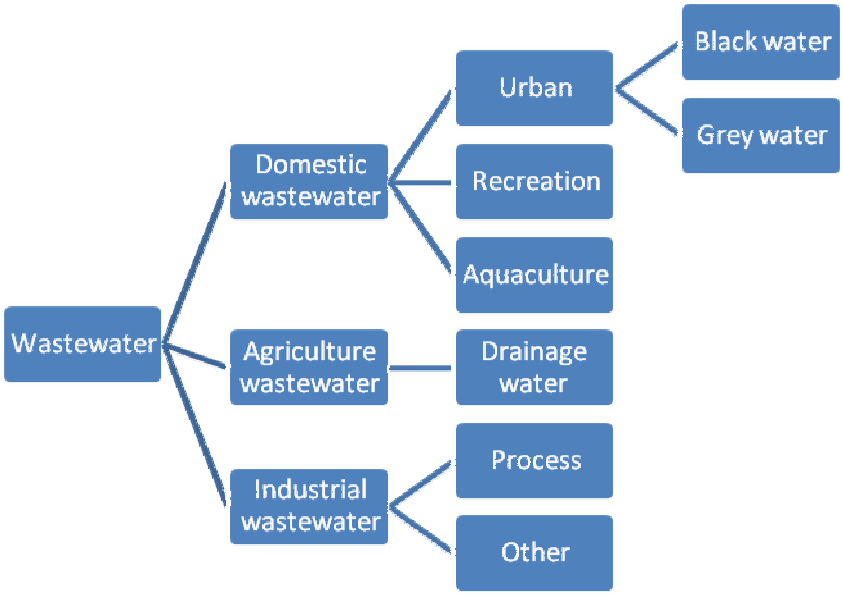


**Fig. 1 Types of wastewater**

## 2. WATER CONSERVATION

Water conservation entails a complex interconnected system that includes a variety of aspects ranging from consumer education to advanced technological equipment. Water conservation includes: Programs and techniques designed to curb domestic, agricultural and industrial water use, wastewater reduction, treatment and reuse; and supply- demand and replenishment- depletion relationships, energy consumption and environmental concerns. All aspects must be considered in relation to economic, social, religious, political, legal and aesthetic ties [5, 6].

To encourage the water conservation, the water utility should educate consumers to apply at the household level the three golden rules: reduce, repair and retrofit. Reduce is to cut out unnecessary water use. Repair is to stop water leakages. Retrofit means adapting or older, less efficient fixtures and applying the water saving devices [4].

The National community Water Conservation Program (NCWEP) in Egypt was established to address problems & Potable water loss. It did this through national and local activities. (NCWEP) implemented massive communication activities through their Water conservation strategy. [7], one of the main lessons learned was that the strategy of water conservation communication must be global and interactive and includes all consumers and all the factors concerned, such as religious, political and informal community leaders. The incorporation of imams in the environmental education system has been promoted in Egypt since 1988. For example, a national training seminar for mosque imams and preachers were organized by the institute of environmental studies and research and some active non-governmental organizations, since 1990.

## 3. WASTEWATER REUSE IN EGYPT

### 3.1 Agricultural Wastewater Reuse

Agricultural wastewater forms the largest amount of the wastewater in Egypt. It will obviously continue to be the largest during the next decades. Hence, the amount of agricultural drainage water continues to predominate to other uses, and consequently the biggest outflows. Table 1 indicates in / out flows for different activities for the year 1990 and the year 2000 [8].

It should be noted that; navigation will develop and water conservation will improve and this will lead to cut down the amount of bile water reaching to the sea to the minimum. Industry will receive more water share and accordingly the industrial wastewater will increase, probably will be doubled. Domestic wastewater also is liable to increase while agricultural wastewater will decrease as the result of adopting advanced irrigation technologies such as sprinkler or drip systems.

**Table 1 Inflow / Outflow (bcm/y)**

| Activity | 1990 | | 2000 | | Outlet To |
|---|---|---|---|---|---|
| | Inflow | Outflow | Inflow | Outflow | |
| Navigation | 1.8 | 1.8 | 0.3 | 0.3 | Sea |
| Industry | 4.6 | 3.9 | 7.9 | 6.1 | Drains |
| Domestic | 3.1 | 0.7 | 3.1 | 1.2 | Drains |
| Agriculture | 49.6 | 12.0 | 59.9 | 6.4 | Drains |

Egypt has already made number of leading steps towards integrated management of drainage water as part of the available annual water budget for meeting the increasing demands. These efforts include establishing quantity and quality monitoring networks, data bases and information systems; developing simulation models and developing guidelines for the safe use of such water in environmentally sound basis.

The Drainage Research institute of the ministry of water Resources and irrigation of Egypt was entrusted to carry out a long- term monitoring program to give answers to decision and policy makers about the quantity and quality of drainage water and its locations. Established a monitoring network of 140 measuring locations on the main drains in the Nile Delta and Fayoum in the early 1980's, providing daily measurements of drainage flow and bi-weekly salinity and other chemical components. Since then, the network has been continuously maintained and upgraded to furnish reliable measurements. The current monitoring network in the Nile Delta and Fayoum consists of 140 sites for monitoring the quantity and quality of drainage water in the main and branch drains with a monthly frequency. The number& parameters is increased to 31 parameters, including toxicological, microbiological, oxygen budget related and extended ions, metals and trace elements as well as the classic parameters.

The monitoring program reveals that the drainage water quantity changes with time, depending on water use policies and the management of the main supply system. The variations occur from month to month, season to season, and year to year. The average drainage water discharged annually to the sea is 12.5 bcm. The measured drain discharges to the sea are not entirely excess irrigation water. They include brackish groundwater, sea water and municipal and industrial discharges. The volume of drainage water officially reused for irrigation has increased from 2.8 bcm/y in 84/85 to 5.2 bcm/y in 99/2000, (In 2017 this is estimated to be 8.3 bcm/y) [9]. This water is pumped into irrigation canals and mixed with volumes of fresh water depending on the salinity of the drainage water reused.

Capturing drainage flow in main canals and mixing it with main canals water at centralized mixing pump stations is called the official reuse. This type of reuse is planned and managed by the ministry of water Resources and Irrigation with good records kept, direct pumping of nearby drainage water by individuals' farmers is called the unofficial reuse. It is impossible to measure this type of reuse because of its spontaneous and irresponsible nature.

The Ministry of water resources and irrigation is undertaking major projects for horizontal and expansion to divert considerable amounts of drainage water to newly reclaimed areas after blending with fresh water. Two major drainage reuse expansion projects have been Planned since early 1990's: El-salam canal project which mixes 2 bcm drainage water with 2 bcm fresh water to irrigate 220,000 acres west of Suez Canal and 400.000 acres in Sinai. The other is Umom project which reuses 1 bcm drainage water to irrigate after mixing with fresh water 500.000 acres in Nubaria.

This will bring the total drainage Water reused by the year 2017 to 8.3 bcm per year. The potential to increase this reused quantity beyond that depends on many factors among which are the quality of the drainage water, the location where this water is available, the salt balance of the Delta and the tolerated of the cultivated crops.

It is worth it here to mention that the growing interest in the rational use of treated wastewater in agriculture has led to include such increasing source in Egypt's water policy. The great Cairo sewage treatment plant has been in operation to produce about one billion $m^3$/y. It is anticipated that by the year 2025 1.5 to 2 bcm/y of treated wastewater will be available. The military plants industry is now producing compact units for industrial and sewage treatments.

A similar sewage treatment was built in Alexandria with the same capacity as that established in Cairo. For certain agricultural purposes in the western fringes of the Delta a wastewater treatment plant was built in Abu Rawash. However, it should be realized that there are various issues that impact a wastewater reuse scheme, such as institutional arrangements, regulatory aspects, market assessment and even global watershed management. Indeed, deriving useful applications from treated municipal and industrial wastewater, which is about 4-5 bcm/y coupled with the increasing demand pressure on water resource, has enhanced the emergence of wastewater reclamation, recycling and reuse as integrated components of water resource conservation policy.

## 3.2 Greywater Reuse

Greywater is usually defined as all wastewater produced in a household including kitchen, showers, sinks and laundry except toilets wastewater. Greywater has been used to promote sustainable development and resource conservation and also to solve the water scarcity problem such as groundwater recharge, landscaping, and plant irrigation. The greywater qualities are various depending on the household activities. The major contaminants in greywater can be divided into two types that are chemical and biological contaminants. These can contaminate into the environment and become not only environmental quality problem but also public health problem. The greywater should manage to minimize and eliminate the risks. The greywater management is considered control at the source, pipe systems, pre-treatment system, treatment system, and the end uses. A pipe system is needed to collect and transfer water to treatment system. Clogging from grease and oil may occur in the pipe system, so it must always be considered in greywater management. Grease and oil trap tank is general pre-treatment for grease and oil removal. Trickling filter, bioreactor, wetland system, and pond are set to minimized or eliminate some contaminants in greywater. After treatment the greywater is used for irrigation or brought back to nature, for example, discharge to surface water or percolation to groundwater [10].

Table 2 compares the breakdown of water consumption ratios in USA, UK and Germany. Strong similarity can be observed within the shown values. It can be seen

that water usage for toilet flushing is set out around 1/3 of all water consumption. Laundry operational water falls between 10 and 15%, while bath/shower consumptions reveal higher variation within 20 and 37%. By data analysis as shown above and considering the regional difference it can be summarized that water used for toilet flushing is not more than 30% of the total water consumption. Projecting this ratio on to the characteristic of generated wastewater, it can be stated that the amount of generated greywater is higher than blackwater. Thus it could be estimated that by toilet flushing alone, at least 30% of the total household water consumption might be saved by the greywater recycling activity [11].

In general, the greywater contains less total and faecal coliforms than blackwater. Solids content is also lower than that in raw sewage. One of the applications of the greywater reuse is to eliminate drinking water consumption for toilet flushing by installing on-site greywater recycling systems and thus supplying recycled greywater for this water consumption. The decreased amount of greywater then may be mixed together with the generated blackwater as in the conventional system and transported to a wastewater treatment plant; also there is a possibility to construct a greywater treatment plant at a lower cost and the generated greywater could be partially or fully recycled back to the system.

**Table 2 Water Consumption in Various Countries**

| **Water Usages** | **UK (%)** | **Germany (%)** | **USA (%)** |
|---|---|---|---|
| Toilet | 28.2 | 29 | 28 |
| Kitchen sink | 14.0 | --- | --- |
| Bath/ Shower/Hand basin | 28.2 | 37 | 20 |
| Laundry | 12.0 | 15 | 10 |
| Other (Garden tap, etc.) | 17.6 | 19 | 42 |

There are very few countries that have implemented specific legislation on greywater reuse. The World Health Organization (WHO) has produced documents to give guidance on the greywater recycling and drinking water quality [12].

The greywater can be preliminary treated to remove various wastewater constituents such as rags, floatable, grit and grease that might cause maintenance and operational problems with the treatment. Course filters are probably the most simple filtration unit being used in the greywater treatment. Also, sedimentation tanks can be used in the greywater treatment system, deposit of lower suspended solid concentrations of greywater. Rapid sand filters can be inserted as a tertiary treatment operation so that it can remove particles that generated as a by product of the secondary biological process. Disinfection process is normally used after rapid sand filtration.

## 4. CONCLUSIONS

1- Wastewater production is the only potential water source in Egypt which will increase as the population grows and the demand on fresh water increases.
2- The modest values of water reuse in Egypt are mainly due to the lake of cost effective and efficient treatment systems for wastewater.
3- Greywater has been reused in some countries and areas for many proposes like irrigation and toilet flushing. The awareness of greywater recycling varies across the world, with a noticeable intensity and understanding of the subject in areas encountering sustained pressures on the water supply.
4- The reuse of treated greywater helps to ease the increasing burdens on global water supplies. Currently, there are two major uses for treated greywater, toilet flushing and irrigation. To produce effluents of potable quality on a domestic scale would be expensive and inefficient, however, there is potential to treat greywater enough for use as a toilet flushing.

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