PROSPECTS OF WATER REUSE IN EGYPT

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ABSTRACT

In many locations where the available supply of fresh water has become inadequate to meet water needs, it is clear that the once-used water collected from communities and municipalities must be viewed not as a waste to be disposed off but as a resource that must be reused. Because of health and safety concerns, water reuse applications are mostly restricted to non-potable uses such as landscape and agriculture irrigation. Plans are proceeding slowly towards groundwater recharge for repelling saltwater intrusion and towards the reuse in non-potable industrial applications (e.g. boiler water and cooling towers…).

The ministry of water resources and irrigation in Egypt (MWRI) has over the past decades, thoroughly considered the issue of reusing drainage water through mixing it with fresh water. The criteria for mixing are based on the sustainability of the blend for irrigation of all crops. As a result, the volume of drainage water reused for irrigation has increased from 2.8 bcm in 84/85 to 5.2 bcm in 99/2000 and is planned to reach a value of 8.3 bcm per year by the year 2017. The reuse of domestic and industrial wastewater is estimated to be about 1.5 bcm/y by the year 2025, while the estimated reuse of drainage water will hardly exceed 10 bcm/y. The modest value of the reused wastewater in Egypt is mainly due to the lack of cost effective and efficient treatment systems.

Keywords: Water; Fresh; Domestic; Industrial; Drainage; Waste; Reuse

INTRODUCTION

Inadequate water supply and water quality deterioration represent serious contemporary concerns for many municipalities, industries, agriculture and the environment in various parts of the world. Water reuse has been dubbed as the greatest challenge of the 21st century as water supplies remain practically the same and water demands increase because of increasing population and per capita consumption. Water reuse accomplishes two fundamental functions [1]:

1. The treated effluent is used as a water resource for beneficial purposes.
2. The effluent is kept out of streams, lakes and beaches; thus reducing pollution of surface water and groundwater.

It was stated that 10 out of the 23 Middle East and North African countries (MENA) consume more than 100% of their annual renewable freshwater resources [2] MENA region with about 5% of the world's population has less than 1% of the world's renewable freshwater [3]. It is estimated that because of the population growth and increase in water demand, as a regional average, there will be a drop of almost 50% in annual per capita renewable water between 1995 and 2025 in the countries of MENA [4]. At the same time, pollution from domestic, industrial and agricultural sources is degrading the quality of these same water resources. If the present economic activities continue and agricultural practices are not radically updated, the future water shortage will surpass crisis proportion and may produce severe social, economic and political disruption and cause conflicts or even wars [5].

S. S. Al-Salem in his study on water reuse in the Eastern Mediterranean countries (EMR) has stated that many of these countries have very limited resources and the situation will worsen in the future as population grows and demand rises and water/wastewater reuse will become imperative [6]. By the year 2025, almost all countries of the region with the exception of only Iraq and Sudan will be unable to satisfy the food needs of their population [7]. Many of these countries will have to shift their economy from an agricultural based to industry and services based economy. It is expected that the high-income countries will depend on desalination while other countries will be forced to depend on water reuse and recycling. Thus reclaimed water will come to provide a substantial part of the available water resources in most EMR countries. In water stressed countries such as those in MENA and EMR regions, every drop of water must be counted and thus sustainable water management of water resources can only be achieved if the water resources and wastewater management policies come together in addressing the water cycle in a holistic manner [8].

Use of treated or untreated wastewater in landscaping and agriculture is common in many countries such as UAE, Oman, Bahrain, Egypt, Yemen, Jordan, Syria and Tunisia (FAO, 1997). Water resources management strategies in several countries, such as Jordan, consider wastewater as part of its water budget. (Jordan Ministry of Water and irrigation, 1998) [9].

TYPES OF WATER REUSE

Several trials had been made where wastewaters were successfully used during the last decades. Selected examples of historical development of water reuse in different countries are given in Table 1, [1].

Table 1. Historical development of water reuse in different countries

Year	Location	Water Reuse Application
1890-now	Mexico City, Mexico	Untreated or nominally treated wastewater from Mexico City is delivered to the valley of Mexico where it is used to irrigate about 90000 ha of agricultural land.
1912-1985	Golden Gate Park San Francisco, USA	Watering lawns and supplying ornamental lakes.
1962-now	La Soukra, Tunisia	Irrigation with reclaimed water for citrus plants and for groundwater recharge to reduce saltwater intrusion into groundwater.

Reuse of treated wastewater is already in practice in many countries. The supply of water is being augmented by domestic wastewater reuse in countries like Saudi Arabia, Kuwait, Tunisia, Jordan and Yemen. In water scarce countries of the Gulf, the contribution of wastewater reuse is substantial, especially since the cost of producing a unit of treated wastewater is estimated to be 8-18 percent of that of desalinated sea water and 24-40 percent of desalinized brackish water [10].

Water reclamation, recycling and reuse represent significant components of the hydraulic cycle in urban, industrial and agricultural areas. A conceptual overview of the cycling of water from surface and groundwater resources to water treatment faculties, irrigation, municipal and industrial applications and to water reclamation and reuse facilities is shown in Fig. 1 [11].

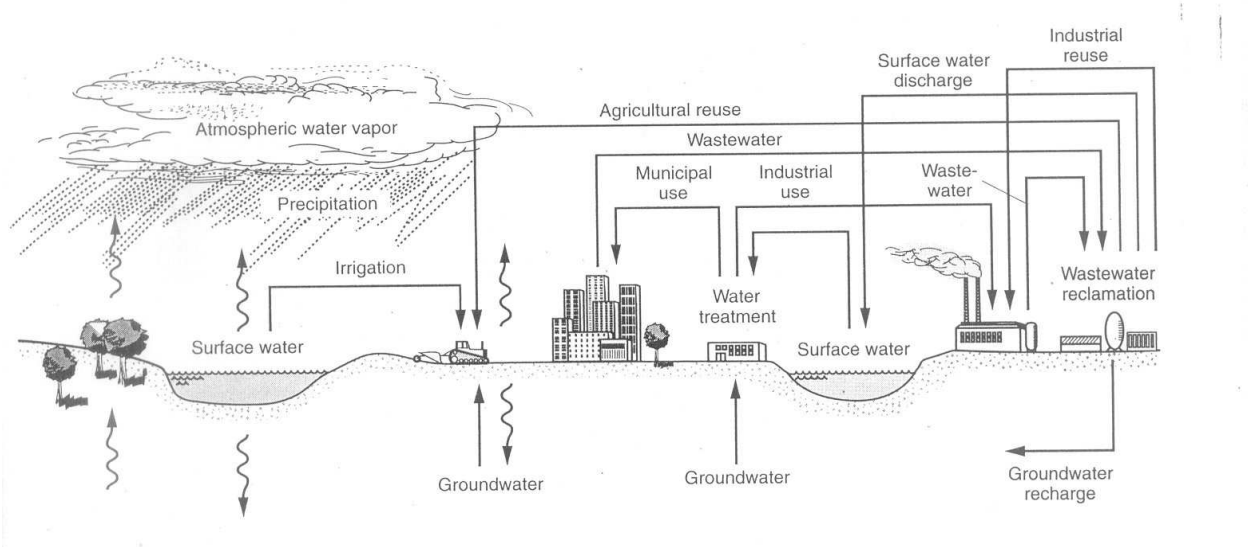

Figure 1. The role of engineered treatment, reclamation and reuse facilities in the cycling of water through the hydrologic cycle

The major pathways of water reuse include irrigation, industrial use, surface water replenishment and groundwater recharge. Water is a renewable resource within the hydraulic cycle. The water recycled by natural systems provides a clean and safe resource which is then deteriorated by different levels of pollution depending on how, and to what extent it is used. Once used, however, water can be reclaimed and used again for different beneficial uses. The quality of the once-used water and the specific type of reuse define the levels of subsequent treatment needed, as well as the associated treatment costs. The basic types of reuse for domestic and industrial wastewater are in Fig. 2 [12].

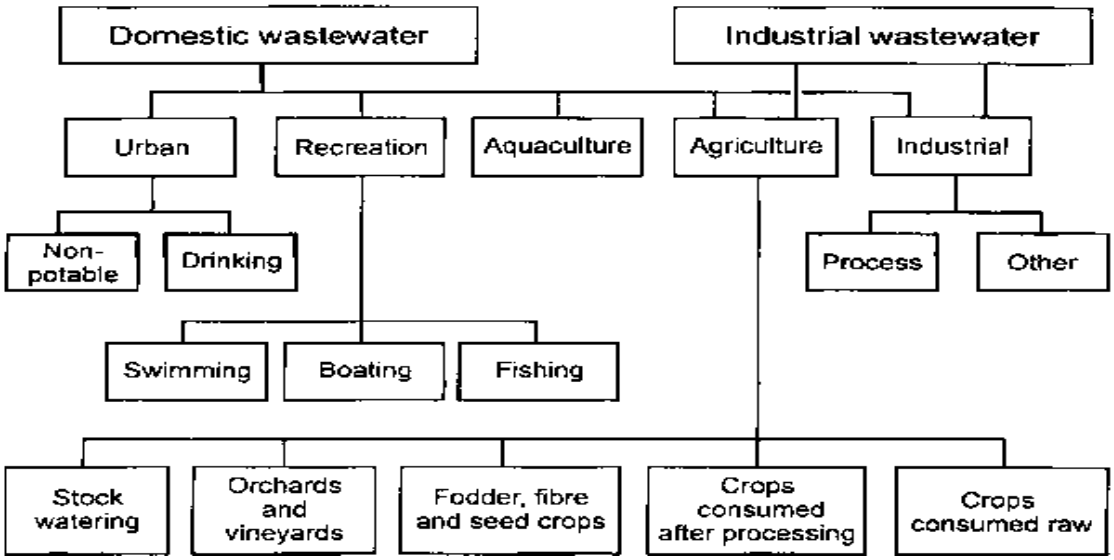

Figure 2. Types of wastewater use (After WHO, 1989)

CURRENT STATUS OF WATER REUSE IN EGYPT

Wastewater is widely recognized as a significant, growing and reliable water source. Wastewater production is the only potential water source in Egypt which will increase as the population grows and the demand on fresh water increases. According to MWRI, the available fresh water in Egypt in 1990 was 63.5 bcm from which the amount of water reuse was about 7 bcm/y. In the year 2025 – hoping that the share of Egypt from the River Nile water will remain the same – MWRI estimated the amount of available fresh water to be about 75 bcm [13, 14] from which 18 bcm of water will be reused. As a matter of fact the available fresh water covers all human activities and is divided between the different applications in Egypt according to the following: domestic~ 7%, industrial ~ 7% and the rest i.e. ~ 86% is for agriculture.

According to the MWRI estimates, the reused water from domestic and industrial applications will reach a value of 1.5 bcm/y in the year 2025, which is less than 20% of the share of domestic and industrial water used.

The total irrigation requirements for fresh water in Egypt in the year 1999 [15] was estimated to be 52.0 bcm/y under surface irrigation. At that time the seasonal water consumptive by crop land reached 29.9 bcm/y. Accordingly it may be concluded that the volume of drainage water – agricultural wastewater – is about 22 bcm/y, from which and according to [16] only 5.2 bcm was reused in the year 99/2000.

According to [16] the ministry of water resources and irrigation is undertaking major projects for horizontal and expansion to divert considerable amounts of drainage water reused by the year 2017 to be 8.3 bcm/y. The potential to increase this reused amount depends on many factors among which are the quality of the drainage water, the salt balance of the Delta and the tolerance of the cultivated crops. Accordingly one may assume that by the year 2025 the amount of reused drainage water will hardly exceed 10 bcm/y, which is again much less than the available drainage water for reuse.

It may be worthy here to mention that the introduction of new irrigation technologies such as sprinkler or drip may reduce the water irrigation demand by about 15 and 25% respectively. In other words according to the available data in 1999 the use of either sprinkler and/or drip irrigation systems can save 8 and 13 bcm/y [15], respectively. It is needless to say that the introduction of new irrigation technologies although will save a considerable amount of fresh water needed for irrigation it will at the same time lead to a decrease in the respective drainage water as a result.

PROSPECTS OF WATER REUSE IN EGYPT

By the year 2025 the population of Egypt is expected to be about 90 million, thus the available fresh water per capita will be about 600 m^3/y [17]. Under such circumstances every drop of water must count and sustainable management of water resources can only be achieved if the water resources and wastewater management policies come together in addressing the water cycle in a holistic manner. In order to do so certain measures ought to be taken in consideration. The most important of them are stated below:

- Higher quality water should not be used for a purpose that can tolerate a lower grade water. In such case fresh water should be minimally used as a transportation medium for excreta.
- The criteria for wastewater treatment intended for reuse in irrigation differ considerably from treatment systems developed in response of the adverse conditions caused by the discharge of raw effluents to water bodies, while it is intended that pathogens are removed to the maximum extent possible, some of the biodegradable organic matter and most of the nutrients available in the raw wastewater need to be maintained. In this respect it is advisable to follow the guides published in the FAO irrigation and drainage paper No. 47, 1985 [18].
- Water reuse standards must protect both public health and the environment and must be suitable for end reuse objectives and the method of application.
- Wastewater reuse projects should be designed as integral part of the overall wastewater network and water resources plan.

- Innovative low-cost domestic wastewater treatment units should be encouraged.
- Removal of the government subsidies on fertilizers and pesticides and ban on the use of some specific agricultural chemicals (herbicides and pesticides) should be considered.
- Efficient wastewater treatment processes should be used to maximize wastewater reuse opportunities.
- Development of industries not requiring much water is a must.
- The reuse of treated wastewater in industrial applications, such as boiler water and cooling towers, should be encouraged.
- Centralized wastewater management is costly, water intensive and reduces wastewater reuse opportunities, while decentralized wastewater management reduces water inputs, reduces environmental hazards in case of accidents, increases reuse opportunities and cost effectiveness and efficiency [19]. However it requires institutional reforms for effective operation.
- The EPA suggested guidelines for water reuse should be considered as a minimum required for reclaimed water for different urban reuses [20].
- Wastewater reuse projects at national level touch on the responsibilities of several ministries and government agencies. For adequate operation and minimization of administrative conflicts, the following ministries should be involved from the planning phase onwards:
    - Ministry of Water Resources and Irrigation
    - Ministry of Agriculture
    - Ministry of Public Health
    - Ministry of Housing and Public Works
    - Ministry of Environmental Affairs
    - Public Local Authorities
    - Ministry of Finance
- To complete the supply of basic sanitation services and to make progress on wastewater management and pollution control this requires major financial challenges.

CONCLUSION

1. Sustainable management of water resources and wastewater management policies should come together in addressing the water cycle.
2. Wastewater production is the only potential water source in Egypt which will increase as the population grows and the demand on fresh water increases.
3. The total volume of the agricultural wastewater in the year 1999 was about 22 bcm from which only 5.2 bcm were used.
4. The modest values of water reuse in Egypt are mainly due to the lack of cost effective and efficient treatment systems for wastewaters.
5. Adoption of new irrigation technologies – sprinkler and drip irrigation – will reduce the demand for water by about 15.5% and 25% respectively; on the other hand it will reduce the total volume of agricultural wastewater considerably.

RECOMMENDATIONS

All the items mentioned in the paragraph titled "Prospects of water reuse in Egypt" should be taken in consideration by who will be in charge of water reuse issues in Egypt.

REFERENCES

1. Metcalf and Eddy, Wastewater Engineering, Treatment and Reuse. McGraw-Hill, 4th edition, 2003.
2. Irrigation in the Near East in Figures, (FAO water report 9, 1997).
3. The World Bank press release No. 96/49/5. Washington DC, the World Bank Group, 1996.
4. Bakir, H.A. Water conservation, wastewater reuse and pollution control, Amman, WHO centre for environmental health activities.
5. K. Khosh-Chasm. Water-Conscious development and Eastern Mediterranean Health Journal, Vol. 6, No. 4, 2000.
6. S.S. Al-Salem, Overview of the water and wastewater reuse crisis in the Eastern Mediterranean region. Eastern Mediterranean health Journal, Vol. 7, No. 6, 2001.
7. Engelman R. et al. People in the Balance: Population and natural resources at the turn of the millennium. Washington DC, Population Action international, 2000.
8. Hamed Bakir, the 2nd Asian conference of water and wastewater management 8-9 May 2001, Tehran, Iran.
9. Hamed Bakir, Amman – Jordan, CEHA, March 2001, Amman – Jordan.
10. World Bank. From Scarcity to security, averting a water crisis in the Middle East and North Africa. World Bank, Washington DC, 1977.
11. Asano T. and A.D. Levine, Wastewater Reclamation, Recycling and Reuse. Water Science and Technology, Vol. 33, No. 10-11, 1996.
12. I. Hespanol, Wastewater as a resource, chapter 4. WHO/UNEP, 1997.
13. Abu Zeid, M. and Rady M.A. (1991) Egypt's resources management and policies. Comprehensive water management: Policy workshop. World Bank.
14. M. A. Keshk: About Land and water in Egypt. Univ. of El-Menia Press, 1994.
15. Ainer, N.G. et al: A new concept of rationalization of irrigation water use in Egypt. 3rd conference of "On-Farm Irrigation and agro climatology" January 25-27, 1999.
16. S. Abdel-Gawad: Agricultural drainage reuse policy in Egypt; conservation and challenges, MWRI. (Personal communication with Dr. Hesham Kandil), Sept. 2005.
17. Engelman R., and Le Roy P. Sustaining water: an update. Washington DC, Population Action International, 1995.
18. Ursula I. Blumenthal et al. Guidelines for the microbial quality of treated wastewater used in irrigation. Bulletin of WHO, 2000, 78 (9).
19. Hedberg T. (1999) Attitudes to traditional and alternative sanitary systems. Water Science and Technology 39 (5) 9-16.
20. US. EPA (1992a), Manual - Guidelines for water reuse EPA / 625 / R-92/004.U.S.