

## NEED AND POTENTIAL FOR AQUIFER STORAGE RECOVERY IN EGYPT

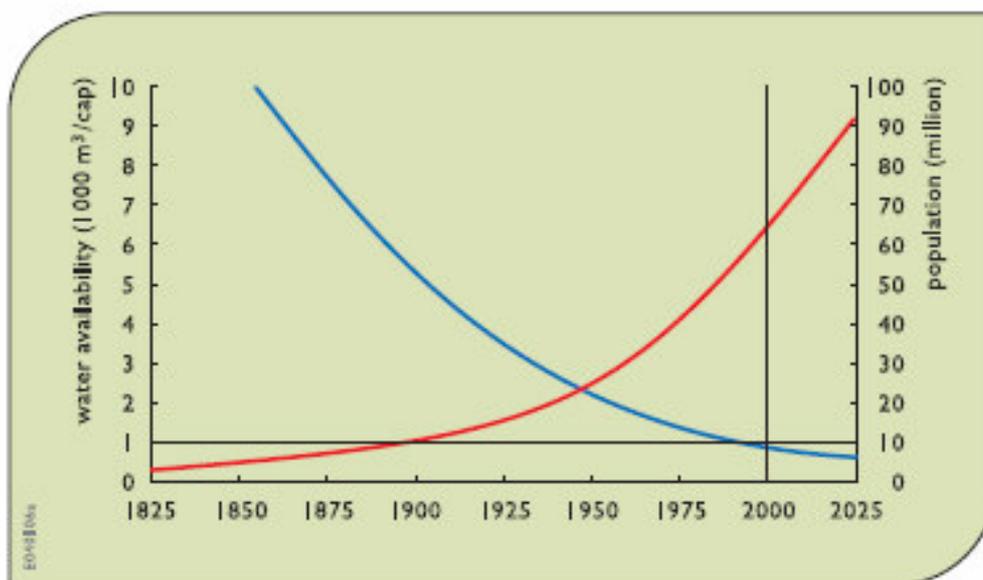
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### INTRODUCTION

The Middle East and North Africa regions not only have the world's lowest per capita availability of water resources but also the highest rate of reduction in these resources (El Fadel and Alameddine, 2005). Water scarcity is particularly increasing in those coastal zones, which are characterized by an arid climate (less than 100 mm rainfall per year), and a thriving tourism industry with a water demand that is seasonally fluctuating.

Egypt (with a current population of 78 million) is among those countries which are very vulnerable with regard to water scarcity (CIA, 2005). It is located furthest downstream in the Nile basin with an extremely arid climate. The annual share of Egypt from Nile water is 56 billion m<sup>3</sup>. The average per capita share is 711 m<sup>3</sup>/cap/a (Elarabawy *et al.*, 2000). Figure 1 shows increasing population with decreasing water availability in Egypt.

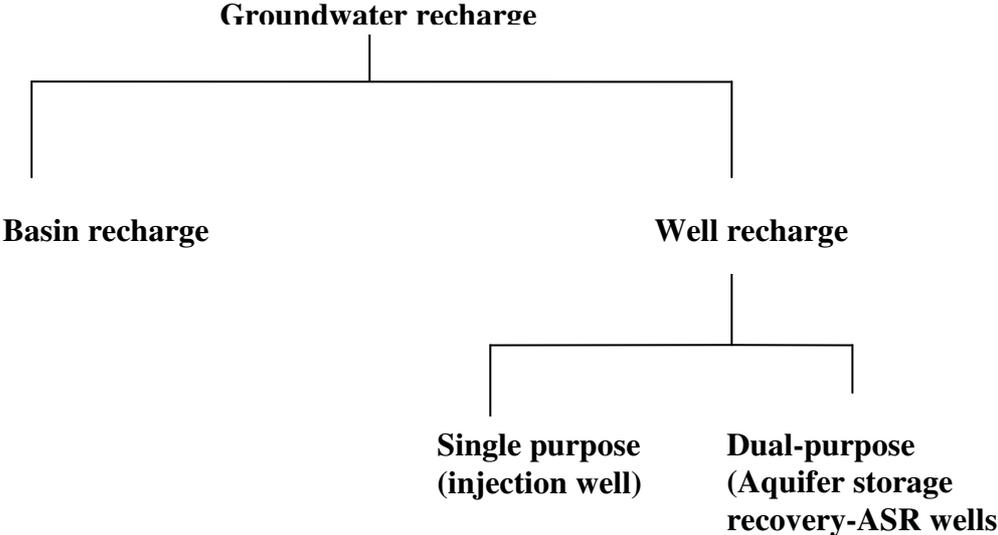


**Figure 1 Increasing population and decreasing water availability in Egypt**

The usual way to increase water supply is through conventional surface and groundwater abstraction. However, when such resources are limited, water can be sourced by non-conventional resources such as RO desalination of sea or brackish water, wastewater reuse and aquifer storage recovery (Lamei *et al.*, 2006a).

Aquifer storage recovery (ASR) technology proposed in this paper means not only injecting water into the ground but also to recover water for a beneficial use at the same location. Therefore, aquifer storage recovery is the storage of water in a suitable aquifer through a well or wells during times when water is available and recovery of the water from the same well during times when it is needed.

Figure 2 shows the different methods for groundwater recharge. Improvements in artificial recharge technology has reduced the cost of water supply facilities substantially, therefore future use of this technology is expected to accelerate (David, 1995).



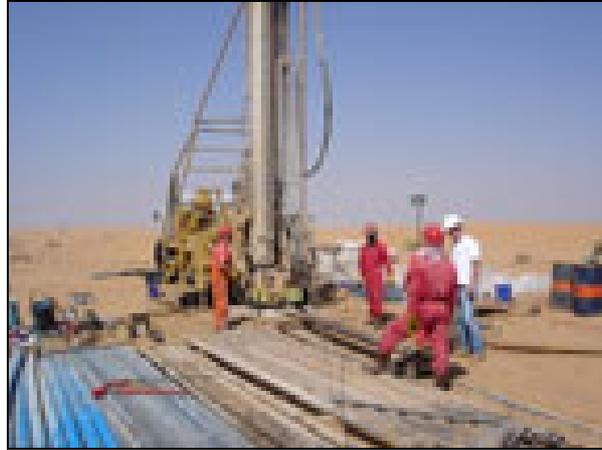
**Figure 2 Groundwater recharge**

ASR can be used for seasonal storage, long-term storage or even diurnal storage. The storage can contribute to improve water quality. ASR can be used for potable water storage as well as reclaimed water.

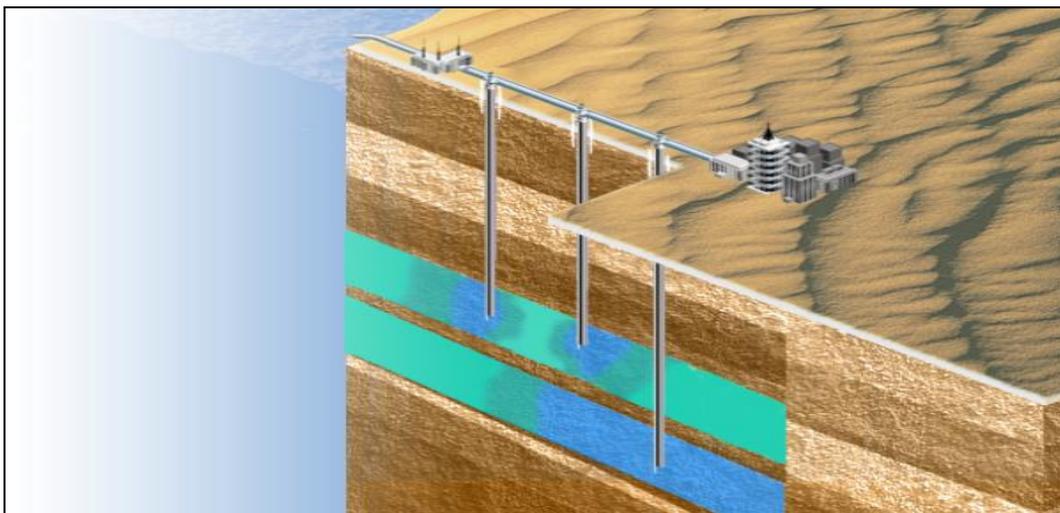
Figure 3 shows ASR well installation and Figure 4 shows a schematic of ASR system.

The recovery efficiency of stored water from wells is defined as the percentage of the water volume stored that is subsequently recovered while meeting a target water quality criterion in the recovered water. Recovery efficiency tends to improve with successive cycles. The residual water not recovered in one cycle becomes a transition or buffer zone of marginal quality surrounding the stored water in the next cycle.

As a general rule, treated drinking water can be stored and recovered from ASR wells without any need for further treatment other than disinfection following recovery.



**Figure 3** Aquifer storage recovery well installation (<http://www.water.slb.com>)



**Figure 4** ASR system schematic (Schlumberger water services)

## **ECONOMICS OF ASR**

When compared to surface storage reservoirs, aquifer storage is of low cost, since land requirements are minimal and the storage capacity is provided by nature for the relatively low cost of a few ASR wells. In addition, water transmission and treatment facilities can be operated more efficiently with ASR systems requiring less capacity and associated construction costs.

Experiments in the Gulf countries (combining desalination plants with ASR) confirm the technical and economic feasibility of the idea with total cost reductions from 10-20%.

## **ASR POTENTIAL IN EGYPT**

Aquifer storage recovery can be implemented in touristic cities characterized by varying seasonal demand. Most of these cities are in close proximity to the sea and depend mostly on desalination. These cities are mainly clustered on the North coast, South Sinai and the Red Sea.

The tourism industry requires huge quantities of water supply, with peak consumption during the peak season and excess capacity in the low season (Chartzoulakis *et al.*, 2001). In Sharm El Sheikh, water consumption may be as high as 500 l/d per bed (Hafez and El Manharawy, 2002). Depending on the occupancy rate (which varies from 65% to over 100%), water demand fluctuates over the year in this region.

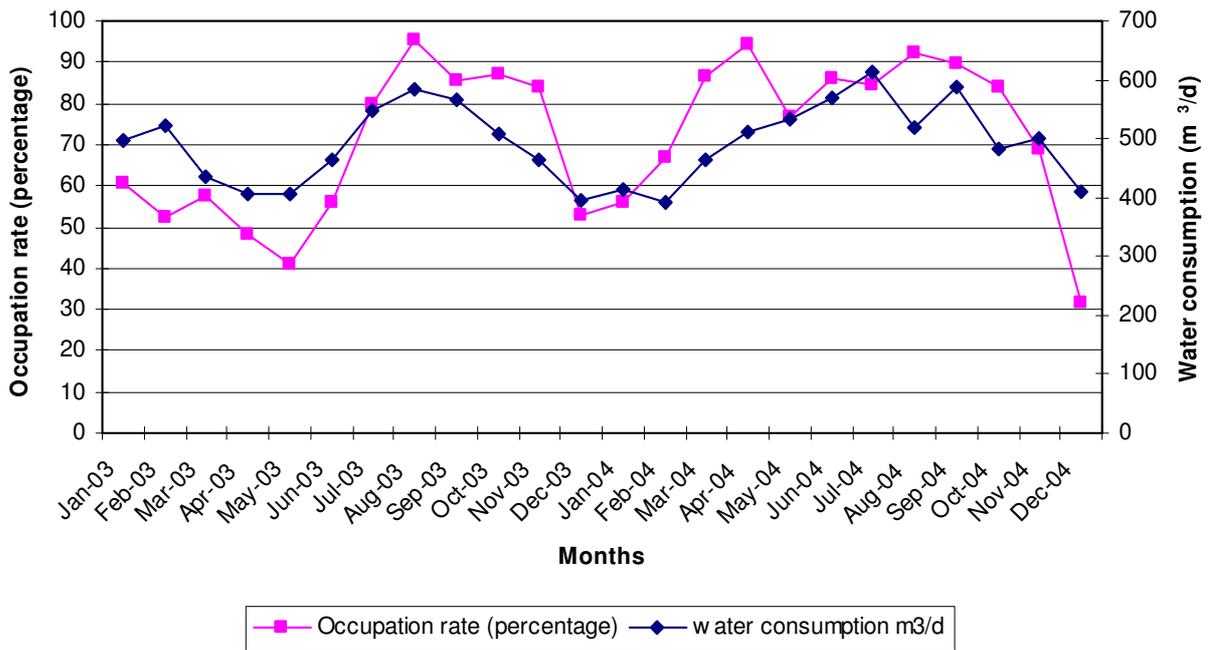
Figure 5 shows variations in water demand for a hotel in Sharm El Sheikh.

An ASR system enables a water utility to meet maximum day demands with water supply and treatment facilities sized to meet average demands. Usually treatment and piping facilities are much more costly than are ASR wells.

## **CONCLUSION**

Water scarcity is a problem that can constrain the economic development in arid coastal regions. Many of these regions depend primarily on tourism, a sector that does not seem to tolerate water shortage. The nature of development in these regions will put an increasing strain on available water resources and will require the development of new projects.

Aquifer storage recovery can achieve more efficient use of limited water supplies. It enables not only storing water in the ground but also to recover it for a beneficial use at the same location. Advances in the technology have reduced the costs leading to acceleration in future use.



**Figure 5** Water consumption and occupancy rates in a hotel in Sharm El Sheikh, Egypt (Lamei *et al.*, 2006b)

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