



Water conservation for reclamation projects in Egypt

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THE SCARCITY OF natural resources associated with population pressures has burdened Egypt's endeavours to carry out development plans. The Egyptian Government is accordingly integrating activities towards optimising benefits from its scarce resources. This is carried out through promoting water availability and allocating water savings to uses of best returns to water. In this regard, two approaches are adopted to increase water availability, the first might be caricatured as "externally-led" and the second "internally-led" measures. While the former involves attempts to augment water supply through collaboration with Nile Basin countries, the second technique implies a promotion of national water availability according to various measures and inducements. The current paper highlights actual and potential water resources in Egypt as well as efforts to promote their availability vis-à-vis water demand patterns. It also investigates the feasibility of land reclamation as an optimum water use alternative in the country's water strategy.

Conventional water resources in Egypt

The main water resource that Egypt has for long been depending on is the River Nile. After the construction of Aswan High Dam (AHD), Lake Nasser was created upstream of the dam and was, since then, used as a reservoir for long-term water storage. The country's annual abstraction from Lake Nasser is confined to 55.5 Km³ according to the 1959 agreement between Egypt and Sudan.

On the other hand, about 200 mm. of winter rainfall precipitates along Egypt's northern coast where a seasonal agricultural activity takes place depending on this limited water resource. The amount of rainfall gradually decreasing southwards leaves little chance for rain-fed agriculture beyond the coastal belt boundaries. Yet, flashfloods resulting from short storms on the Red Sea and South Sinai have not been totally harnessed for constructive exploitation.

The existence of groundwater in Egypt is either in deep or shallow aquifers. Groundwater aquifers in Western Desert and Sinai are mostly deep and non-renewable. Accordingly, these aquifers are deemed independent sources that would contribute to the country's water budget input. Conversely, the groundwater aquifer underlying the Nile catchment is not a separate source of water. Rather, it may be considered a closed underground reservoir that receives water mostly as seepage from the river, canals and excessive water of irrigated fields.

The limited availability of renewable fresh water is a major constraint on further agricultural development.

However, attempts are underway to promote water availability for development purposes through internal and external measures. Internally, various techniques are applied and projected within the Egyptian aquatic system for increasing water supplies and economising on water use, whereas the external approach implies implementing Upper Nile conservation projects in a framework of mutual co-operation among riparian countries.

Internal water conservation measures

In view of the water scarcity threat, conservation measures are undertaken at various levels within the Egyptian water system. A set of endeavours to economise on water is herein included to exemplify efforts set about by the Egyptian Government in this regard* (Chitale, 1997):

- Recycling 0.8 Km³ of treated municipal and industrial wastewater in the local waterway network and projecting a recycling rate of 3.4 Km³.
- Reusing drainage water at actual and projected rates of 4.5 Km³ and 7 Km³ respectively.
- Abstracting Nile aquifer groundwater to the extent of 3.8 Km³ at present and 5.8 Km³ in the year 2010.
- Stepping up deep groundwater abstraction from the current rate of 0.7 Km³ to 1.2 Km³.
- Desalinating 0.5 Km³ of sea and/or brackish water to be used in the domestic sector.
- Penalising excessive cultivation of high water consuming crops, namely; rice and sugar cane, for the purpose of saving 4.7 Km³ of irrigation water.

In addition to the aforementioned quantified measures of water conservation, Egyptian farmers are introduced with other courses of action to control fresh water consumption in agricultural, domestic and industrial sectors. These actions include (El Quosy et al., 1999):

- Promoting night water storage, particularly during the winter months, to avoid the spillage of fresh water flows to drains during the no-irrigation periods.
- Supplementing fresh water supplies at canal command level through drainage reuse schemes, groundwater development, rainfall harvest and/or desalination projects.
- Introducing short age varieties of crops, especially those characterised by high water consumption.

- Precise land levelling, using laser technologies, to prevent the formation of water ponds resulting from irrigation processes.
- Adopting irrigation improvement measures in old lands, including the use of raised mesqas, controlling losses from the distribution system, rehabilitating canals and structures, using modern irrigation systems in new lands, etc.
- Exhorting and educating farmers through Irrigation Advisory Services formed for the purpose of promoting the rational use of water for irrigation.
- Forming Water User Associations in new and old, improved and non-improved lands, for better water management and more efficient recovery of operation and maintenance costs.
- Adopting water saving techniques in the industrial sector, mainly through local recycling of water, promoting clean industries that result in no pollutants flowing into water streams, encouraging the use of machine cooling systems that use no additional supplies of fresh water, etc.
- Water losses in the domestic sector are controlled by rehabilitation of treatment plants and conveyance and distribution networks to control the attributed losses, which amount to 50 percent of the total water supply. On the other hand, household consumption is controlled through a metering system, according to which water use is regularly paid for.

Co-operation in the Nile Basin

Another means of promoting water availability in the Egyptian system is the implementation of projects to conserve water at the Upper Nile reaches. This necessity is emphasised by the fact that the actual Nile yield represents only seven percent of the total rainfall over the Nile Basin (ECP, 1999). Maximising the river's yield is therefore necessary for saving the vast amounts of precipitation that fall on the Nile Basin and are mostly lost through evaporation in large areas of swamps and marches. Minimising these losses for the advantage of all riparian countries is conceived through bilateral and regional programs of co-operation. Models of such programs are herein delineated:

- Egypt and Sudan are adopting a protocol according to which Sudan will undertake projects for saving water originally lost to swamps around tributaries of the River Nile.
- The co-operation between Egypt and Uganda crystallised into the construction of Owen Falls Dam, which provided Egypt with water and, simultaneously, accommodated Uganda with electricity.
- Six riparian countries (Egypt, Rwanda, Sudan, Tanzania, Uganda and the Democratic Republic of Congo) are effectively undertaking a co-operation program

under the name "Technical Co-operation for the Promotion of the Development and Environmental Protection of the Nile Basin (TECCONILE)" to strengthen sustainable development of the Nile Basin. In the same context, a Council Of Ministers of water affairs (COM) was formed with a technical committee to act as a steering committee for the co-operation framework.

An increase in Egypt's annual share of Nile water is estimated at some nine Km³ as a result of the implementation of Upper Nile conservation projects (Planning Sector, 1997).

Water demand patterns in Egypt

Estimating Egyptian water requirements necessitates determining the water use patterns to be satisfied by the release from Lake Nasser. In this regard, national water policies are annually planned to satisfy the following water consumptions (Ahmed, 1995):

- Agricultural, industrial and domestic consumptions.
- Maintaining river levels for diversion, stability and navigational purposes.
- Hydroelectric power generation.

In the Egyptian aquatic system, domestic water requirements are prioritised over those of other sectors. However, while agricultural water demands currently account for the largest amount of water usage in Egypt (approximately 56 Km³), domestic and industrial activities use about 3 and 6 Km³ of water respectively (ECP, 1999). The agricultural sector uses most of the country's water resources for the cultivation of an actual area of 3 million hectares. On the other hand, water requirements for refilling headponds upstream of the main barrages, to cover the levels of canal offtakes while maintaining the structure stability, are normally fulfilled by the daily operation of the irrigation system. Moreover, no additional discharges are currently required to satisfy navigational needs in the main river due to the recent abolition of the winter closure period, during which water was released from AHD for navigational purposes only. Finally, water requirements for hydropower generation are fully met by day-to-day releases into the irrigation system since additional releases for power generation were prohibited to counteract against drought conditions.

Optimum allocation of water supplies

Promoting water availability in Egypt through the aforementioned measures necessitates investigating the optimum allocation of extra supplies of water. In this context, the best alternative use of a new supply of water is envisaged through one of the following procedures (Ahmed, 1998):

- Increasing irrigation quantities on existing cropping patterns, which implies diverting more water to the current patterns in order to obtain maximum yields.

- Changing cropping patterns to more water consuming crops, e.g. expanding the cultivation of rice and sugar cane, or increasing the cropping intensity from the existing level of 200 percent (two crops per year) to a higher level of, for example, 300 percent.
- Reclaiming desert lands and maintaining the current profile of cropping patterns in the traditionally cultivated alluvial lands while supplying the appropriate amounts of water that produce optimum yields.

The best course of action is economically prioritised according to the attributed opportunity costs of water, which represent the marginal benefits from water in its best alternative use. In this regard, increased irrigation quantities are unlikely to generate benefits because farmers already over-irrigate due to the presence of heavy clay soils that require extensive irrigation for leaching purposes. On the other hand, the marginal benefits resulting from cropping pattern changes, which become possible with increased water supply, are reckoned to yield short-run opportunity costs of water. Long-term opportunity costs are the maximum of marginal benefits from cropping pattern changes and land reclamation projects. However, since cropping patterns can generally be changed from year to year, land reclamation is favoured for its ability to yield coherent opportunity costs of water on the long run. Moreover, due to the growing population pressure in Egypt (about two percent of population growth per annum), land reclamation has additional advantages over cropping pattern changes. These include relieving overcrowding in the Nile Valley and Delta, increasing the overall level of investment, mitigating urban encroachment on the more productive land in the Nile vicinity, creating job opportunities, etc. Finally, in the light of current rates of food exports in Egypt, which include 50, 30 and 80 percent of national consumption of grain, sugar and oil respectively, land reclamation is expected to bridge the gap that exists between population growth and food production.

Summary and conclusions

The current paper investigates the appropriateness of land reclamation with respect to water conservation measures. In this context, conventional water resources currently available in Egypt are highlighted. Water conservation measures are emphasised in a framework aiming to pro-

mote water availability countrywide, both on internal and external levels. It is estimated that water saving practices internally undertaken would yield up to 22.6 Km³ of water savings, while the country's water surplus resulting from Upper Nile conservation schemes is projected at nine Km³. The review of local water demand patterns shows that present water requirements are generally met by the actual abstraction from the River Nile and the current rates of internal water savings. However, the population growth threat imposes a challenge that necessitates increasing water availability to satisfy further consumptions. From economic and strategic perspectives, it is concluded that land reclamation can be considered the optimum alternative for allocating extra water resulting from further conservation programs inside and outside the country.

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¹ All rates are on a per annum basis.

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