

ASSESSING THE IMPLEMENTATION OF INTEGRATED WATER MANAGEMENT APPROACH IN CLOSED BASINS

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ABSTRACT

The National Water Resources Plan of Egypt launched in 2005 estimates that the New Lands would reach 45% of the agricultural land by 2017. The Plan envisions an increase of Egypt's agricultural land, over the period of 2000 to 2017, from 8.5 million acres to 11.2 million acres which is about 7.24% of Egypt area. The existing Oases of Egypt's Western Desert, considered part of the New Lands, form a small portion of the agricultural area. These lands are developed either by private reclamation entities or the Ministry of Water Resources and Irrigation through a variety of cooperative efforts including land and water grants to settlers, commercial farms, and providing services to the oases. The Government of Egypt has followed an efficient and sustainable path rooted based on the integrated water management approach in allocating substantive investments towards the development of the oases as anchors of the Western Desert New Land.

This study outlines a case study on the assessment of development and management aspects of water resources and land in closed basins. The case study focuses on the implementation of integrated water management approach in Siwa Oasis. This historic Oasis has been chosen as a model of water and land management in closed basin of Egypt's New Lands. In Siwa, integrated land and water management parallel with an enabling policy that fosters social and environmental sustainability have been practiced since the late nineties. This study has concluded positive consequences of applying integrated water management in various aspects of life in Siwa Oasis. Positive indicators show an increase in crop productivity, +40%; +25% growth of organized inhabitant settlement measured by family income and livelihood standards; and improving environmental quality by more than 50%.

INTRODUCTION

Egypt, being located in a belt of extreme aridity, is among countries that are very vulnerable with regard to water resources. The country depends mainly on the River Nile for its water supply (55.5 billion m³ per year). Yearly average rainfall is approximately three millimeters that mostly with an obvious bias towards the north, Figure (1). The total effective rainfall used for drinking water and agriculture is about 1.3 billion cubic meters per year (Abdel-Gawad, et al., 2002). However, under these limited water resources conditions, population that exceeds 72 million capita, is increasing at a rate that might jump over 3% (Campos, 2006). The availability of other fresh water resources is very small (at present only about 3% of the demand) and possibilities to develop other resources within the country are limited. Being the most downstream country in the Nile basin, Egypt is very vulnerable for developments upstream and a basin-wide approach is

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needed to safeguard Egypt's supply (Nile Basin Initiative 1989).

There are many-water related challenges facing Egypt. As the population continues to grow steadily and development efforts are intensifying in order to produce food and raise standards of living, it is expected that water demand will continue to increase. Traditional irrigation practices lead to loss of irrigation water that is not just wasteful; it can ruin the land through salinization, water-logging, and pollution and it means precious foreign exchange must be spent to import food. Another factor contributing to intensifying Egypt's water challenges is that environmental pollution is causing serious water quality deterioration, thus affecting public health and impairing the safe use of significant water.

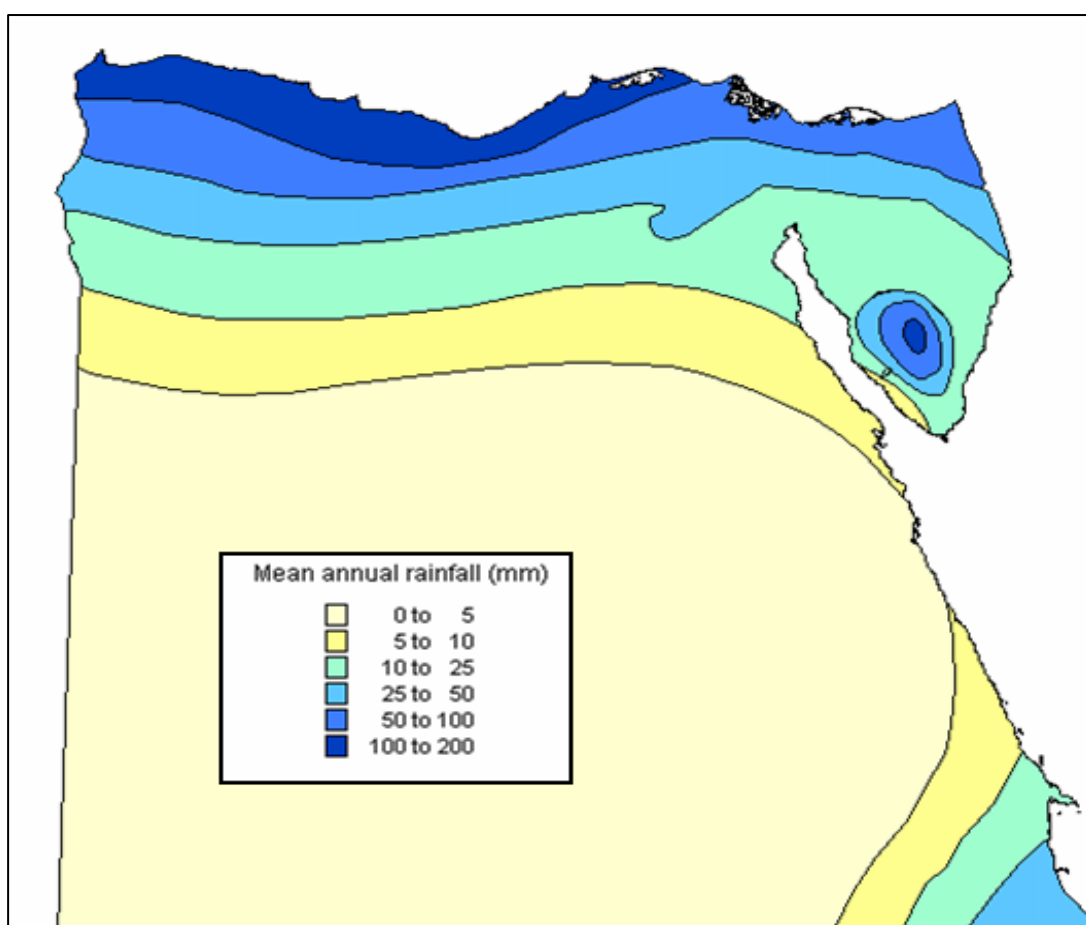


Figure 1. Rainfall distribution in Egypt

NATIONAL WATER RESOURCES PLAN OF EGYPT

In view of the serious water resources challenges that face Egypt, it is clear that the development of a long-term plan to improve irrigation practices for food production in Egypt represents a life-and-death urgency. A National Water Resources Plan (NWRP) was finalized and launched in 2005 by the Ministry of Water Resources and Irrigation (MWRI). The MWRI has taken the lead in developing the plan, but through involvement of the main stakeholders, the developed plan is

considered a real national plan (Bron, J., 2001 and Water Boards Project, 2002).

The objective of water resources development in Egypt is derived from the national development goals and policies (1998، وفاطمة عبدالرحمن، بيومي عطية). In general terms the national development goals related to water resources are,

- to increase the economic growth of the country and to increase employment;
- to increase the inhabited space of Egypt outside the Nile Valley and the Delta, by:
 - a) developing new cities
 - b) developing the Eastern Delta and Sinai (i.e., the El-Salam Canal)
 - c) developing the Western Desert and New Valley areas in Southern Egypt (i.e., Siwa Oasis, Toshka Project, and East Owenat)
- to protect public health by means of provision of safe drinking water and adequate sanitation facilities
- to protect the Nile and other fresh water resources from pollution.

The Plan describes how Egypt will safeguard its water resources in the future; both with respect to quality and quantity, and how it will best use these resources from socio-economic and environmental perspectives (Ministry of Water Resources and Irrigation, 2005). The plan is based on an Integrated Water Resources Management (IWRM) approach, taking into account the objectives of all water users, covering the period till the year 2017. MWRI developed policies and guidelines for water management in Egypt. These policies and guidelines are dynamic in nature to allow for changing conditions and the new NWRP provides an update of earlier policies and plans. It provides binding objectives, guidelines, and institutes for agencies working in Egypt's water sector.

The NWRP recognizes that facing water-related challenges is a collaborative effort of all stakeholders. The stakeholders involved in implementation of the Plan include those who are actual water users such as the agricultural, industrial and drinking water and sanitation sectors and stakeholders who are concerned about water resources because of their mandates such as health and environmental protection sectors. Stakeholders' involvement is essential for better application of the policy activities (Advisory Panel Project, 2001). The participatory approach includes regular inter-sectoral consultations, stakeholder representation on certain water management bodies and coordination mechanisms. All stakeholders concerned have major responsibilities in the implementation of Egypt's water policy. The NWRP is accompanied by implementation policies for all involved ministries and national organizations. The Plan assigns the expansion of Egypt's agricultural land to the Ministry of Agriculture and Land Reclamation (MALR) and Ministry of Water Resources and Irrigation (MWRI). The successful completion of this task will expand the agricultural lands by 3.4 million feddans¹ (acres) by same target year 2017 (Abu Hidb and Fu'ad., 1992). Currently the agricultural lands of Egypt are about 8.0 million feddans (acres); however, about 40% of Egypt's food requirements is imported. The intention of NWRP is to guide both public and private actions in the future for ensuring optimum development and management of water that benefits both individuals and the society at large.

¹ A Feddan is a common area measuring unit in Egypt, equals to $\sim 4200 \text{ m}^2 = 1.038 \text{ acre} = 0.42 \text{ hectare}$

The Plan that was born to address Egypt's growing population and economic development activities which have increased the pressure on the limited water resources and its infrastructures requires investments to better utilize and develop the available water resources and priority measures to safeguard those resources. At the same time institutional changes will be needed to decentralize and integrate the various activities. Developments in the legal and regulatory environment have to support these changes. Understanding these requirements and the importance of water resources for the socio-economic development of the country, the Government of Egypt (GOE) is committed to all necessary means and measures to manage and develop the water resources of the country in a comprehensive and equitable manner.

National Water Resources Plan of Egypt and International Commitments

From household and local scheme to regional and global water fora, water for development and water for food themes generated debate in 2003 and 2006 among the rich and poor, corporate and public sectors, and industrialized and developing countries (Abu-Zeid, 2003). Water was not only topical but also defined the sustainable development agenda during the years. It will remain a major issue in the decades to come, because water is life - for people and the environment. At the beginning of this century, world leaders declared their intention to work for a world in which people would be free from want and fear.

In this regard, Egypt, similar to other countries worldwide, has posted an impressive record with regard to the Millennium Development Goals (MDGs) targets. Currently, potable water supply coverage for urban and rural populations is very close to 100 percent and 95 percent, respectively. Per capita consumption has increased from 130 liters per day to 275 liters per day between 1981 and 2000. Sewerage and sanitation coverage also increased eightfold between 1982 and 2000, reaching about 70% and 25% in urban and rural areas (including Egyptian Oases), respectively. Wastewater treatment coverage increased from 6 percent to 30 percent. The Government is working hard toward eradication of poverty and improving living standards for all inhabitants in urban, rural, desert, and oases areas (Ministry of Planning of Egypt, 2005 and United Nation, 2002).

THE CASE STUDY

The Development Policy

The study area, Siwa Oasis, is part of the New Lands. Egypt's total arable and inhabitable area is only about 4% of its total area. The majority of its population of about 72 million inhabitants still concentrates in the narrow Nile Valley and the Delta, the so-called Old Lands. The Western Desert Region includes a number of oases; in particular, Siwa, Bahariya, and Farafra which are about 25% of Egypt's total area. The high population density puts a heavy burden on Egypt's infrastructure and services, and causes massive migration to urban centers, especially Cairo and Alexandria, with consequent urban overcrowding. This explains why Egypt has "turned to its deserts" for expansion, despite the heavy costs involved and the impact on its limited water resources. The NWRP envisages that by 2017 the agricultural area will have grown from 7.8 to 11.2 million feddans. Of the current 7.8 million feddans, 6.2 million feddans consists of Old

Lands, and 1.6 million feddans of Old/New Lands and New Lands. This would mean that with the envisaged expansion of 3.4 million feddans (acres), Egypt's cropped land would consist for 45% of Old/New and New Lands by 2017 (NWRP, 2005).

Development in most of the desert lands only started in the late 1980s, except in the oases, which are much older. Typically these lands were developed by single purpose state owned reclamation agencies, the General Authority for Reconstruction Projects and Agricultural Development (GARPAD) and MWRI, which make land and water available to a mix of settlers, sell land to commercial farms and operate the services in the area.

The new desert reclamation policy aims primarily at developing sustainable communities in newly reclaimed areas. A major divergence from the prior policies is the private sector's dominant role in the new mega projects. While the government contribution in the early stages of these projects is significant, the long-term value added activities of the private sector approaches 75-80%. The government investment is limited to the construction of major infrastructures networks including roads, communications, and central power stations. In this respect the government has set up an investor-friendly regulatory environment for projects located in remote regions (Investment Law No. 8, 1997). Various vehicles for attracting foreign investors into the water resources sectors and the new frontiers of Egypt New Lands have been instituted by the government (American Chamber, 2005). Design, Build and Operate (DBO) projects are successful outcome of these new policies, e.g., the Irrigation Improvement Project in West Delta, a Public-Private Partnership (Project Appraisal Document, 2006); and the Toshka Project, part of New Land.

Description of the Study Area

The Western Desert Region includes a number of these oases; in particular, Siwa, Bahariya, and Farafra are about 25,000 hectares in total. The study area in this paper is Siwa Oasis, which situated in the middle of the western desert of Egypt, 26° 40' to 27° 40' latitude, 27° 30' to 28° 40' longitude. It is almost 20 m below msl. It is bounded from the north, east and south by escarpment of the surrounding desert plateaus, +270 m to +300 m MSL, with residual hills as high as +350, Figure 2. SIWA population was about 25,000 in year 2005 and the population variability rate is very low. It includes many antiquities sites since ancient Egyptians times. Siwa inhabitants have their special traditions and ways of life that have been preserved for centuries. The area is famous for its dates and olives production, and is one of the most beautiful landscapes in Egypt. Famous olives' oil continues to be made in the area by crushing the olives from the 70,000 olive trees with stones. The area is also famous for its 1,000 natural springs. The water is sweet, and is believed to have remedial benefits. Intra-governorates migration and resettling of inhabitants who gained good money after working abroad for some years continued toward SIWA. It has attracted a number of private companies and private reclamation entities and investors over the last two decades. As a result, various large and privately owned companies and Olives and Dates production business started randomly without consultation with the associated governmental agencies or local authorities.

Hydrogeology, Climate and Major Land Features

Rainfall is completely absent throughout the year in Siwa Oasis. The heaviest shower recorded during the last two decades did not exceed 3.5 mm. The only available water resources in the Oasis are the fossil groundwater from the Nubian Sandstone Aquifer. The area has a nice climate, chilly in winter, hot in the summer and moderate in the spring and autumn. Average temperature ranges from 25 to 37°C and reaching 45°C (absolute maximum) from time to time in summer. In winter, the temperature ranges from 17 to 25°C, and drops to zero, especially late at night during January and February. Generally, temperature cools rapidly after sunset during both summer and winter. Other climate parameters vary as follows,

- Relative humidity ranges from 24 to 35%, and not exceeding 60% in winter.
- Evaporation ranges from 12 to 26 mm/day during summer and from 5 to 12 mm/day during winter.
- Wind speed ranges from 1.5 to 5 m/sec and characterized by heavy dust, especially during April till June as well as during September and October.

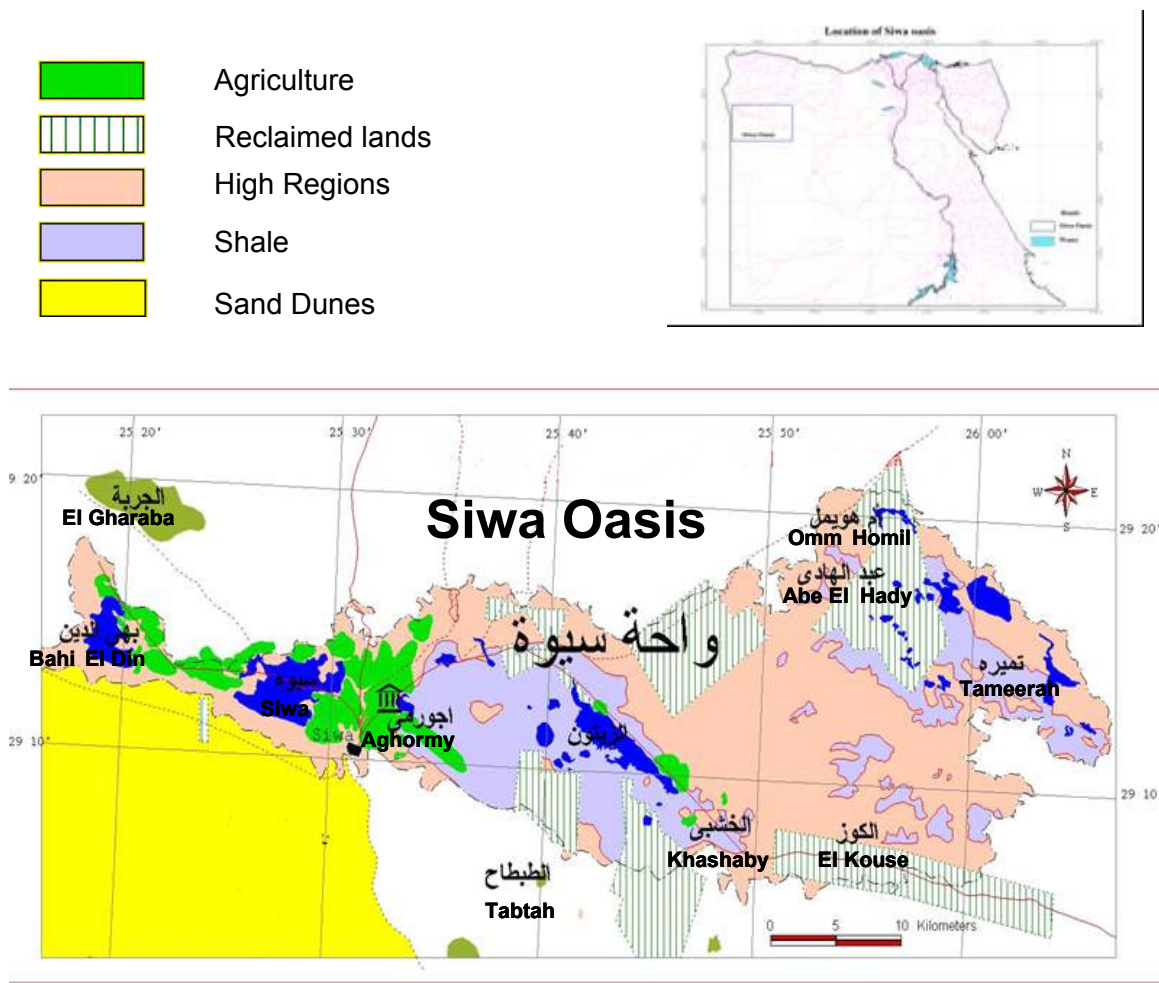


Figure 2: Siwa oasis layout showing its four main ponds

Although in terms of quantity the contribution of deep (fossil) groundwater to the total water supply in Egypt is very moderate, groundwater is the sole source of water for people living in the desert areas. There is increasing interest in further developing these groundwater resources. Present abstractions of deep groundwater are about 0.9 BCM/year, however, the potential is about 4.0 BCM/year. Figure (3) shows surface distribution of aquifer system and groundwater development status in Egypt.

Aquifer systems are distributed over the country (Figure 3). The Nubian Sandstone aquifer system is assigned to the Paleozoic-Mesozoic. It occupies a large area in the Western Desert, and parts of the Eastern Desert and Sinai. Groundwater can be found at very shallow depths, where the water bearing formation (horizon) is exposed; or at very large depths (up to 1,500 m), where the aquifer is (semi)confined. The deepest water bearing horizons are generally encountered in the north (Siwa); while the shallowest are encountered in the southern portion (East Uweinat and Kharga). The aquifer transmissivity is generally medium to low, varying from 1,000 to 4,000 m^2/day .

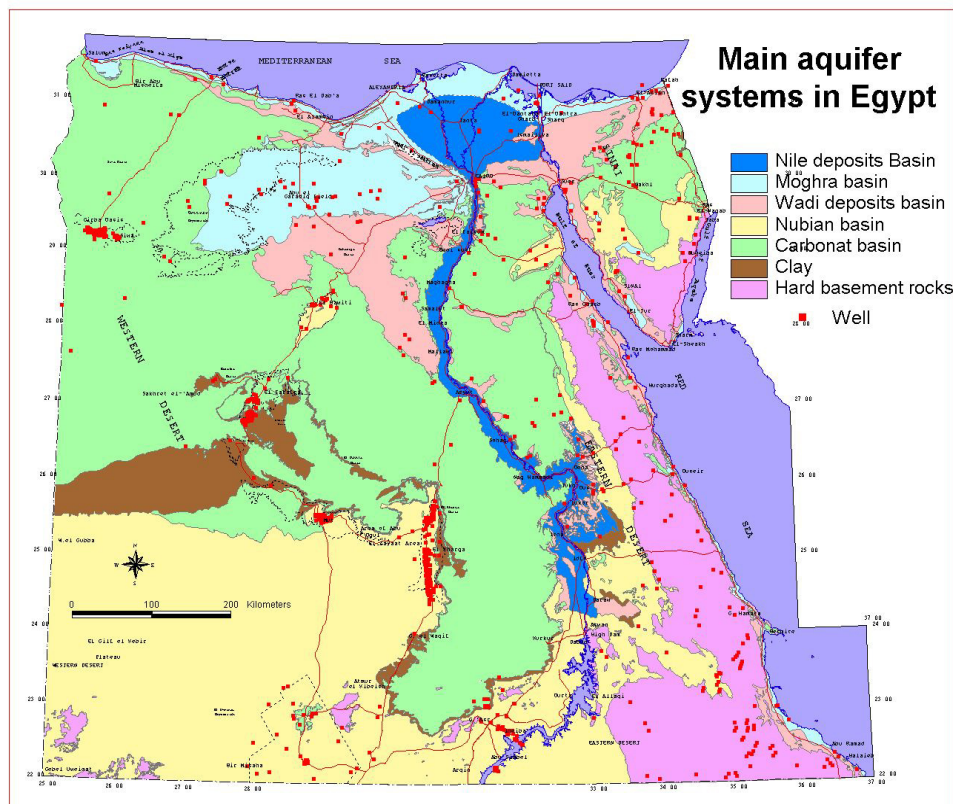


Figure 3. Surface distribution of aquifer systems and groundwater development areas in Egypt and Siwa Oasis

(Source: Groundwater Sector, Ministry of Water Resources and Irrigation, Egypt, 2006)

The Nubian sandstone aquifer system is a regional system. It extends into Libya, Sudan and Chad. The aquifer contains a huge amount of non-renewable groundwater dating back to the

rainy period (25,000 to 40,000 years). Groundwater quality is generally good (<500 ppm) in the major part, except near the coastal regions and Sinai. Groundwater recharge is limited (estimated at 500 million m³/year) across the boundaries with Chad and Sudan.

The dominated soil type is sandy silt with heavier clay soils in some locations. The eastern edge of the Great Sand Sea encroaches on the western margin of the greater Siwa depression.

Challenges of Water Resources Development in the Study Area

The majority of the population in the oases is low-income, average per capita annual income is below 400 U.S dollars. Those employed by the government and mostly the new inhabitants are immigrants from Nile Valley and Delta. Similarly, employees of private reclamation entities and investors are temporarily workers and immigrants. Thus, the new inhabitants formed rather heterogeneous ethnic and linguistic groups who exploited water resources in the Oasis without any planning which often lead to disputes and conflicts among the users. In addition, within Siwa Oasis, agriculture totally depends on the groundwater abstracted through deep wells from Nubian Sandstone aquifer, which is a finite resource.

The Oasis lacked a sanitary system up to the nineties. Health services are particularly poor in the area. Most of the rural clinics are operational with shortage of basic medical equipment. Schools, although evenly distributed in the secondary administration districts, are still very limited compared to other New Lands.

Unlike the Old Lands of the Nile Delta and Valley, the oases lands are characterized by a complicated geo-morphology and topography, which require specific land and water management approaches that were not recognized at the time of reclamation. Other constraints were mostly due to the remote location of the oases that is mostly caused by lack of communication, services, and transportation infrastructures and the required framework for development and management.

Agricultural practices in Siwa before late nineties was a typical case of mismanagement that was manifested by

- Increased population and inhabitants' activities;
- Developing of new lands and digging of new wells;
- Growth of agricultural lands by reclamation of low lands because of initial availability of water;
- Increasing number of wells in lower areas;
- Dry of wells in higher areas that lead to the use of pumping;
- Increase of drainage flows that exceed the sustainable potential of local groundwater;
- Rising groundwater table causing increase of soil salinity;
- Rising lake water level and increase in lake area and salinity;
- Water logging.

THE MITIGATION PLAN

MWRI has developed policies and tested practices for integrated development such as water and agricultural sectoral reform, decentralization, user participation and private sector mobilization. As a consequence of good land management, the adoption of the new policies in the oases is favorable. This encouraged the MWRI to pursue the broader aspects of development by mobilization of private capital to stakeholders including cooperatives, holding companies and publically owned companies

The MWRI started a rigorous integrated water resource management plan for sustainable development in late Nineties to mitigate the degraded situation in Siwa Oasis. It protects the areas from soil degradation and groundwater from over-pumping. Among the objectives of the plan are the following,

- Rehabilitate / initiate water supply infrastructure.
- Strengthen capacity of local communities to manage water and introduce participatory water management.
- Conduct awareness programs aiming at rationalizing water use and reducing losses.
- Urging inhabitants to enroll in water user associations on different levels such as; mesqas (farm irrigation ditches), tertiary canals, branch canals, etc.
- Develop marketing capacity and market oriented products.
- Increase agricultural production (per unit of supplied / consumed water) through improved / appropriate desert agriculture.
- Increase water-use efficiency and encourage transfer of development towards non-conventional ones (less water and lower water quality, including reuse) to ensure sustainability of communities.
- Diversify economic activities, making use of the comparative advantage of the Oasis.

Replacement of inefficient wells and enhancement of the irrigation and drainage networks in the study area have slowed down the wasteful pumping of groundwater which ended at drainage swamps. Though only a small portion of the irrigated agriculture is served by groundwater wells, these sources are of vital importance in those particular areas. The MWRI developed a system for user management for groundwater systems in the Oasis. In the absence of water management institutions by the MWRI in these areas, it would be necessary to establish a “District Water Board” in the Oasis thus reorganizing importance of local authorities’ institutions.

Parallel efforts taken by the Government to encourage large capital investments to stimulate economic growth included, introduction of value-added activities, agro-business, in the Dates and Olives manufacturing sector; development of specialty farms for export crops; expanding tourism programs serving antiquates sites in Siwa Oasis; and facilitating the commercial use of groundwater, e.g., bottled water packing plants. This implementation projects are still on-going by the MWRI aiming at restoring agricultural productivity, good livelihood standards, and clean environment in SWIA Oasis.

Native inhabitants, private reclamation entities and investors, and local authorities shared cooperation and progress with the Government for mitigating the problem. The survey done within this study found that before the implementation projects only 280 of a total of 1260 production wells had been controlled to save the unused groundwater. New wells, 142, had to be constructed to cover water shortage in some areas of the Oasis. These were built by local communities including beneficiaries, private reclamation entities, and investors). Currently, all groundwater companies in Siwa share a unified well constructed practice and follow a sustainable operation plan.

The Government of Egypt lead by MWRI has been carrying out large implementation projects in Siwa Oasis that included,

- Constructing controlled high capacity productive wells to replace the old randomly constructed wells, with cooperation of local communities.
- Constructing lined and elevated mesqas to replace natural narrow mesqas with high seepage.
- Rehabilitating old field drainage network.
- Constructing new open drainage canals.
- Cleaning weeds and maintaining cross-section areas of all waterways.
- Regulating water levels throughout the year at the four main swamps in Siwa.
- Providing agricultural and irrigation advisory services.
- Supporting local authorities to improve their institutional setup in water sector.
- Promoting and facilitating industries export (especially agro-industrial products such as olives and dates products), hand craft dresses and tools, and potable water industry.
- Encouraging establishment of Water Users Associations (WUAs) in Siwa.
- Attracting tourism toward the antiquity sites and health fitness sites in Siwa.

The success of the mitigation is evident through the rational use of the precious groundwater resources and improved environmental quality. These wouldn't have been possible without the integrated approach of management that provides the badly needed technical know-how to the natives who are willing participants in the plan. This has lead to new areas ready for expansion at the different parts of the Oasis which are inhabited with the native habitants. Overall, water was provided for the expansion of cultivating in 30 thousand additional feddans (acres) in the Oasis.

METHODOLOGY

Integrating Water Resources Management is an inclusive and sustainable approach that accounts for the multiple-use of water resources within an environment of laws and regulations based on societal values that govern the socioeconomic settings and driven by market forces. The multiple-use of water resources covers relevant areas such as hydropower, water supply and sanitation, irrigation and drainage, and commercial and industrial needs. An integrated water resources perspective ensures that a sustainable environmental quality considering social, economic, and technical dimensions are achieved and accounted in the management and development of water resources.

The analysis conducted through this study was limited to the problems faced by native communities in Siwa and may have resulted from reverse immigration toward the Oasis. Some survey results and indicators used in previous survey (2004، محمد عبد المنعم شحاته وآخرون) were used as guidelines for this assessment.

Study Objectives

The objectives of this study were focused on assessing implementation outcome of integrated land and water management approach in “Closed Basins” with focus on Siwa Oasis and identifying institutional deficiencies in order to develop appropriate policy changes. Three measures for the assessment were used; these are standards of living measured by sustainable livelihood of communities in Siwa Oasis, economic development, and environmental quality (El-Said, 1999).

Data Analysis

The elements introduced in the analysis and assessment matrix are those with positive correlation in the problem-impact relationship under consideration. A list of these elements relevant to the assessment measures chosen in the study is given in Table (1).

In order to quantify changes in various components under consideration for assessment the system components were viewed as hardware, i.e., irrigation and drainage infrastructure; and software, i.e., socio-economy, health, behaviors, legislation, and environmental aspects. Then a comprehensive analysis is based on statistical analysis of results under the three considered measures was conducted to investigate the change in a given measure before and after management efforts, i.e., before and after the nineties. A series of interviews with local communities, government institution in Siwa, and various stakeholders was carried out for verification of analysis results.

External Feedback for Verification of Results

In addition to the field investigation work, and the subsequent analysis and assessment, a target group consists of representatives of various categories in the Oasis (with about 25 entities) of land and water users were interviewed. The aim of selecting all the categories is to insure real assessment of improvements. Based on the prevailing conditions, the following categories were identified

- The very few natives and locals who were very much involved in tourism, in small industries of local products and in small-scale agriculture (mainly date palm orchards).
- Poor landless farmers who have settled and are facing problems.
- Medium to large investors (transfer of technology).
- Local authorities, private reclamation individuals, agro-industries workers and new inhabitants.

Results of assessment were also reviewed and discussed with the stakeholder community in Siwa for feedback. Their feedback was an important factor for the final assessment and identifying suitable development schemes and recommendations for other closed basins in Egypt.

Table 1. Assessment of Implementation of Integrated Water Management Approach in Siwa

Category	Element	Main Problems	Impacts
Water Allocation	Economy	<ul style="list-style-type: none"> ▪ Poor selection of developmental activities 	<ul style="list-style-type: none"> ▪ Poor or negative return from water
Water Management	Groundwater Management	<ul style="list-style-type: none"> ▪ Poor design of wells ▪ Poor control of flowing wells ▪ Wasting of water 	<ul style="list-style-type: none"> ▪ Degradation of natural springs ▪ Loss of fresh water ▪ Increasing cost of water ▪ High water withdrawal technologies ▪ Drainage problems
	Water Distribution	<ul style="list-style-type: none"> ▪ Inappropriate distribution systems (ag and domestic) 	<ul style="list-style-type: none"> ▪ High distribution losses ▪ Drainage problems
	Drainage	<ul style="list-style-type: none"> ▪ High rates of drainage surplus ▪ Pollution from sewage 	<ul style="list-style-type: none"> ▪ Increasing cost of drainage infrastructure ▪ Less recycling opportunities ▪ Low water-use efficiencies ▪ Health problems
Agricultural development	Cropping pattern	<ul style="list-style-type: none"> ▪ High consuming crops ▪ Poor utilization of comparable advantages 	<ul style="list-style-type: none"> ▪ Low economic return from water used in irrigation
	Irrigation practices	<ul style="list-style-type: none"> ▪ Water wastage and low water-use efficiencies ▪ High irrigation cost 	<ul style="list-style-type: none"> ▪ Low added value from water
Environment	Ecology	<ul style="list-style-type: none"> ▪ Loss of natural springs and habitat ▪ Soil salinity ▪ Introduction of polluted water bodies 	<ul style="list-style-type: none"> ▪ Ecological degradation ▪ Health problems
	Socio-economy	<ul style="list-style-type: none"> ▪ Interference with cultural in heritage ▪ Loss of land ▪ Low income 	<ul style="list-style-type: none"> ▪ Less attraction ▪ Backward immigration ▪ Change of jobs
Institutions	Inter-institutional cooperation	<ul style="list-style-type: none"> ▪ Increasing conflicts 	<ul style="list-style-type: none"> ▪ Adverse impacts on developments

RESULTS AND FINDINGS DISCUSSION

The results of the data analysis are presented in a comparative format showing pre- and post-implementation of the integrated management approach is presented in a concise graphical format. The historic value of each selected indicator measured or estimated in the first reconnaissance survey done by the MWRI in late sixties was considered as datum (baseline) of comparison. Those historic values of the selected indicators were considered baseline for comparison, as indicated in Figure 4.

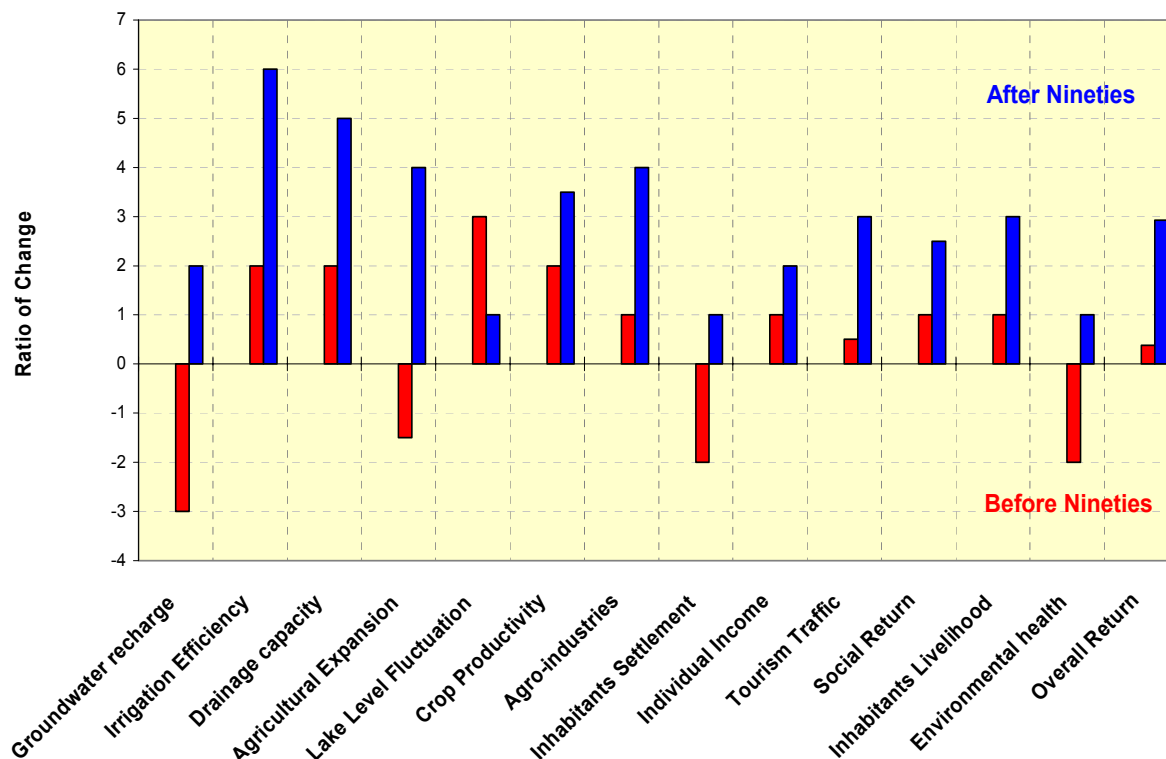


Figure 4. Outcome of the Assessment Study (Selected Indicators)

(Note: The historic values of the selected indicators were considered baseline for comparison)

Results indicated that the improvements in irrigation infrastructure undertaken by MWRI in cooperation with the stakeholders have increased irrigation efficiency in Siwa Oasis. It also confirmed an increased productivity of agriculture productivity in most of the Oasis lands. The promising finding was that the appropriate methods of irrigation could slow the pace of well-drilling and allow groundwater to recharge. It was also found that irrigation practices were strongly shaped by farmer involvement in choosing and operating irrigation systems. Consequently, a further study designed to let farmers in the newly formed WUA's to influence irrigation policies and water supplies more directly and to help extension agents distributing technical information promoting efficiency.

Disputes and conflicts over groundwater have been reduced, and the livelihood improvement of WUA farmers is 50% higher than those of non-members. Women representation inside WUA's

is on a rise after implementing the awareness programs. Still, WUA's reinforce traditional power structures; richer farmers benefit most. Despite the mixed results, this much is clear: irrigation efficiency could only be improved with the collaboration of farmers and with practical insight into their daily experience on the land, patterns, erosion vulnerabilities, and potential new irrigation approaches to support the increasingly sedentary inhabitants and their herds.

The study outcome affirms the importance of socioeconomic considerations in shaping successful sustainable water-management. This outcome has serious implications on the development of societal awareness towards the value of participation in the decision-making-process that would lead to more open and democratic policies.

System evaluation and monitoring of practices for the study area of Siwa (MWRI, 2005) have provided useful lessons regarding the success of the implementation projects including,

- A proper management system to conserve and properly utilise precious water resources;
- Implementation of the District Water Board concept in the Oasis which allows pilot development in an institutionally relatively simple situation as compared to the Old (New) Lands of the Delta; and
- The experiences gained in the Oasis would feed the development of the concept in the much more complex situations in Old Lands both Old and New.

Further analysis of the study results has identified institutional and management practices deficiencies. This task was among the study objectives as a base to identify appropriate intervention actions to overcome the defined deficiencies. Table (2) summarizes analysis of results as it relates to problems, intervention identified, and mitigations.

Table 2. Summary of deficiencies and possible interventions

Issue / Problem	Possible Intervention	Mitigations
Institution entities	<ul style="list-style-type: none"> ▪ Vision development through a regional water resources plan of New Lands, especially on institutional aspects ▪ IWRM with full participation of beneficiaries 	<ul style="list-style-type: none"> ▪ Commitment ▪ Policy framework ▪ Formation of water user organizations
Poor planning of land and water use with low economic return from water	<ul style="list-style-type: none"> ▪ Select cash crops ▪ Appropriate irrigation systems ▪ Establish O&M procedures and practices 	<ul style="list-style-type: none"> ▪ Study market mechanisms ▪ Well-managed irrigation systems ▪ Stakeholder participation
Poor design of wells and distribution systems, leading to wasting water and low efficiency of water use	<ul style="list-style-type: none"> ▪ Local IWRM plan ▪ Control of flowing wells ▪ Suitable location of wells ▪ Improved distribution systems ▪ Awareness 	<ul style="list-style-type: none"> ▪ Understanding of culture and practices ▪ Proper survey and understanding of conditions
Wasting water, low water use efficiency	<ul style="list-style-type: none"> ▪ Separation of effluent ▪ Limit use of agro-chemicals ▪ Safe reuse of effluents 	<ul style="list-style-type: none"> ▪ Collection and disposal systems ▪ Awareness raising

CONCLUSIVE REMARKS

In recent years the GOE lead by MALR and MWRI has developed policies and tested practices crucial for development; agricultural reform; decentralization; user participation and private sector mobilization. While the policy environment is favorable for change, the application of new policies and practices outside the Old Lands are far from completion.

Structured Development that integrates societal values into water resources management plans of closed basins with the aim of improving the interaction of irrigation and drainage systems has not, yet met the expected outcome. Such efforts in Egypt were not introduced to the Western Desert Oases until the early nineties.

The environment of the New Lands of Egypt Western Desert Oases (closed basins) is very fragile. The only viable source of water is non-renewable groundwater. New settlers arrived to the oases for land reclamation and development. A significant cultural difference existed between the new settlers and the indigenous population, who developed sustainable small-scale agricultural systems over the last two millennia. The MWRI recognized that a higher level of integrated water resources management in other closed basin, e.g., Farafra, Baharia, Dakhla, and Kharga is required to assure sustainable development.

RECOMMENDATIONS AND THE ROAD AHEAD

Lessons learned during the course of this study have provided an insight into the fulfillment of integrating water resources development projects. The following recommendations are suggested for future integrated management in similar closed basins;

- Partnerships through strengthening water user organizations and empowering an appropriate institutional entity for the development of new lands and through institutionalizing private sector participation in decision-making and in financing of water management;
- Strengthening decentralized local institutional authorities, involving public and private entities, and encouraging and supporting participation of local governments in water management and water related services;
- Increased efficiency of water use and added value from water use through the development of an action plan for improved water management and related multi-objective plans including agriculture and agro-industry, implemented by the respective organizations; and
- Policy development and coordination through vision and methodology development, coordinated regional and local planning and strengthening institutionalized coordination and policy coherence mechanisms.

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