MANAGING WATER IN A SUSTAINABLE MANNER

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ABSTRACT

Water is critical for human survival, economic development, and the environment. Water plays a vital role in the economy, through its use in agriculture and industry, as well as supplying energy through hydropower. Under pricing of water and lake of cost recovery, Neglect of public health, water quality, and the environment. Inadequate service delivery to the poor. The irrigated lands are losing productivity, as a result of progressive deterioration of soil caused by waterlogging and salinity. This "twin menace" of waterlogging and salinity can be largely attributed to lack of drainage and poor water management. Salinity, resource degradation, and wider damage are greater problems which damaged ecosystem. WUAs is a group of farmers who collectively manage and distribute their combined available water supply. A shift to management of water resources by the water users is being promoted as a means to improve conveyance systems, cost recovery, and the efficiency of water use. In various places WUAs have existed side by side with publicly run irrigation systems for many years. Evidence suggests that higher yields, better conveyance structures, improved maintenance, greater efficiency, and a more reliable supply are associated with WUAs.

The relationship between the average investment cost per feddan and the served area per WUAs in governorates has been estimated for J-section and P.V.C. mesqas as a quadratic function. The results indicate that the statistical estimates of the coefficients are significant and that the statistical relationship between the investment cost per feddan and cultivated area is significant. The study estimates of environmental damage costs as percentages of Gross Domestic Product (GDP) in 2004 /2005. The damage cost of environmental degradation in Egypt in 2004 /2005 at LE 28.436 billion per year (5.4% of GDP). And suggested how to overcome the weaknesses in water resources management.

INTRODUCTION

Sustainable development entails making full use of human resources by improving all needs. It is especially important, that to sustain development, basic needs should reach those living in extreme poverty. Human development also interacts strongly with other dimensions of sustainable development. As water becomes an increasingly scarce resource, countries are rethinking the best way to manage this vital resource. The approach centers less on generating new supplies and more on the demand side-economic behavior, policies to overcome market and water that is more efficient use.

Water is critical for human survival, economic development, and the environment. Indeed, few other resources affect so many areas of the economy or of human and environmental health. Water plays a vital role in the economy, through its use in agriculture and industry, as well as supplying energy through hydropower. A third of the world's harvested crops are produced by irrigated agriculture. Much of the natural environment–from coastal ecosystems to wetlands–depends on water. Degrading the quality or supply of water can have disastrous effects on the environment and on biodiversity. Clearly, the availability of good quality water is central to economic progress and to maintaining a natural environment that can help to sustain such progress, yet in most countries, water resources are not being managed in an efficient and sustainable manner – a situation that cannot continue.

To begin with, the population is growing rapidly, this implies a greater demand for food and hence for irrigation. At the same time, the demand for water by households and industry, further stimulated by economic growth, is rising. These factors imply escalating competition for irrigated agriculture, which already takes a hefty share of available water. Second, the supply of good-quality water is being contaminated through pollution originating from domestic wastes, industry, agricultural chemicals, and misguided land use- effectively decreasing the amount of water available. Third, the engineering and environmental costs of developing new water sources are much higher than those of sources already tapped. For many cities, the cost of water provided by "the next project" can be tow to four times the cost of current supplies, even before environmental costs are factored in.

As the increasing scarcity of water threatens to worsen the quality of life, impair the potential for economic development, and endanger vital ecosystems. The investments in these have often encountered implementation, operational, and social problems, most of which stem from the weaknesses in current water resources management.

Why have governments typically assumed responsibility for the overall management of water? Water's special characteristics make it difficult to use unregulated markets to deliver water efficiently or to allocate it equitably. The large capital requirements tend to create monopolies, warranting regulation to prevent overpricing. Public investments in water infrastructure are often necessary given the large size and long time horizon of projects, underdeveloped capital markets in many lower-income countries and the potential for political interference reduce incentives for private investments. Yet there are many weaknesses in the ways governments manage water, alike:

1. Fragmented management of water resources.
2. Overextended government agencies.
3. Under pricing of water and lake of cost recovery.

4. Neglect of public health, water quality, and the environment.
5. Inadequate service delivery to the poor.

PROBLEMS OF IRRIGATION

The irrigated lands are losing productivity, as a result of progressive deterioration of soil caused by water logging and salinity. This "twin menace" of water logging and salinity can be largely attributed to lack of drainage and poor water management. Salinity, resource degradation, and wider damage are greater problems which damaged ecosystem. According to study conducted by the World Bank, water logging, and salinity have reduced yields of major crops by 8.33 feddens in Egypt.

Because of emerging, the costs of supplying water-the key input in production of major cereals- may become greater than the value of the crops and services it provides. This is the basis of the emerging "water problems crisis." To forestall such problems, we must first put into place a plan for water management that views human intervention in the hydrological cycle not as an isolated act, but rather in terms of the action's system wide consequences. The water sector must be seen as part of the whole economy and as a part of the national and regional environment

Waterlogging and Salinization of Land

Waterlogging and salinization are two problems related to the productivity of land that often occur together. Salinization occurs when the salt content of the soil increases, affecting the productivity of the land and limiting the crop choice of a grower. This is particularly a problem in lands that are arid or semi-arid. In arid regions, there is little rainfall to dissolve the salts in the soil. When water is applied without proper drainage, the evaporation in arid climates can quickly lead to high levels of salt in the soil, reducing the yield potential of the land. Another type of problem that can occur on irrigated lands is known as "waterlogging." This can happen if there is a layer of rock that forms a barrier, through which the water cannot escape. Over time, the water can accumulate and reach the root zone of the plants, making agricultural production impossible. Waterlogging eventually leads to the salinization of the soil, as water evaporates and the salt content of the soil increases.

Decreased Levels of Sediment and Nutrients in Water

One benefit of river systems is the movement of sediment and nutrients. Sediment that is moved downstream by the river can replace eroding soil, and provide beneficial nutrients to downstream cropland. The construction of a dam in a river system can trap sediment and nutrients behind the dam, degrading the quality of the downstream river system on the Nile River in Egypt. Traditionally, the Nile River would flood each year, irrigating the banks of the river, and replacing eroding soil with new sediment. The new sediment not only kept the land from eroding, it also added nutrients to the soil. Since the construction of the Aswan Dam in southern Egypt, most of the sediment in the river is caught behind the dam and is not released downstream. There have been a few problems because of this. The lack of sufficient sediment is causing erosion in the coastline of the Nile Delta by 5-8 meters per year, and the removal of a natural source of nutrients has required farmers to increase their use fertilizers.

Contamination of Water Supplies

Water supply contamination from agriculture can occur from several sources, including animal waste, or fertilizer and pesticide runoff. Using water that has been contaminated with animal waste for domestic uses can cause diseases such as diarrhea, hepatitis, or typhoid fever. More than one-third of the world's population lacks access to basic sanitation, and most of these people live in developing countries. As agricultural runoff is a nonpoint source of water pollution, its regulation poses difficulties. In comparison to point source pollutants, the control of nonpoint source pollutants is more difficult, as individual emission levels cannot be directly measured, limiting the choice of policy instruments. Nonpoint source pollution control must be achieved through an indirect measure, necessitating a second-best outcome in efficiency.

One possible policy may be to subsidize irrigation technologies, which results in reduced agricultural drainage flows. Subsidization of the modern technology will lead to higher adoption rates and lower amounts of agricultural drainage.

Social Concerns (Waterborne diseases)

In many places, large dams and irrigation projects have been blamed for public heath problems, including increased incidences of diseases such as malaria, diarrhea, cholera, typhoid, schistosomiasis, and river blindness. However, there is evidence that many of these cases have been the result of poor planning, and not a necessary effect of dam construction. Often, increased vector breeding occurs in fields and not in the dams and incorporating public health concerns into the planning of a new water project can reduce the impact of the project. For example, a new reservoir can be an attractive breeding ground for mosquitoes, which can lead to the spread of malaria. Using sprays for pest control can decrease this risk in areas where this risk has been ignored. In addition, there have been areas where the incidence of malaria and other waterborne diseases actually decreases after the development of irrigation projects. Further evidence that the effect of irrigation on public health is ambiguous has been show by the work of public health researchers, who have found a range of outcomes when studying the impact of irrigation development on disease incidence.

WATER POLLUTION

The protection of water resources is one of the most critical environmental issues in Egypt. Egypt is facing an increasing demand for water due to the rapidly growing population, as well as the growth in urbanization, agriculture and industry.

- **Pollution from domestic sources**
  Despite rapid population growth in Egypt, the percentage of the population with access to municipal water supplies has also increased due to major investment in the water sector. Around96 % of households in urban areas and almost 94% in rural areas have access to piped water. As for access to sanitation, the urban governorates have the highest sanitation coverage (around 98%), while in rural governorates access to sanitation is 91%. Currently, the population that is without sewage connection relies mainly on onsite disposal using pits, or on direct discharge of raw sewage into drains and canals. These practices significantly contribute to surface and underground water pollution, as well as unhygienic living conditions.

- **Pollution from industrial sources**
  These pollutants are generated primarily from heavy engineering, electroplating and chemical industries, such as pesticides manufacturers, and petroleum refineries. Certain types of significantly polluting industries have a specific geographical distribution, such as the cement, the iron and steel, and the coke and chemical industries in Cairo; textile, food, oil and soap industries in Alexandria and the Delta region; and sugar in Upper Egypt. During the last few years, significant attention has been given to the protection of the Nile from pollution. The focus is on industrial establishments, since industrial wastewater is the major contributor to Nile pollution.

- **Pollution from agricultural activities**
  The pollutants from unsound agricultural practices comprise leached salts, nutrients such as nitrogen and phosphorous, and a wide variety of pesticides. In the Delta, salinity of drainage water increases because of intensive agriculture. This salinity can have a negative impact on the quality of fresh irrigation water, and hence on soil properties. Since the beginning of the 1990s, the use of fertilizers and pesticides in agriculture has been declining due to the adoption of technologically advanced cultivation practices, together with the availability of better quality seeds.

SUSTAINABILITY IN IRRIGATION AGRICULTURE

The traditional focus of sustainability inquiries has been the natural resource base supporting the particular sectoral area of interest. A more useful framework of analysis is explicit about what is to be sustained, and the time period of interest. It also includes in its purview the controlling policies and institution and in the specification and analysis. With respect to irrigated agriculture, three broad topical areas are suggested as a first level dichotomy of sustainability issues. First,, the sustainability of past rates of growth in production and productivity. This brings us beyond a focus on a particular irrigation system or system type and ties sustainability firmly to the economy as a whole. It also allows long-term rates of change in production for existing irrigation schemes.

The second area is that of self-sustainability. This is a topic focused explicitly on policies and institutions and contains two nested levels of generality. The first level relates to the sustainability of the functioning of irrigation systems themselves. It is suggested that the matrix of institution and incentives that control irrigation systems is, in many cases, the limiting factor in performance and that concern for sustainability should approach this constraint directly, as well as through new operational rules and technology. The second level of generality is that of the whole of the change process. The longer range "solution" to the problem of sustainability is the development of a set of institution which work together to provide the capacity to deal with change-assessing and evaluating evolving situations and problems and developing solutions to them.

The third area of concern is the interaction of irrigation with the physical resource base. This set of issues comprises those most traditionally associated with problems of sustainability in irrigation- waterlogging, salinization, and reservoir siltation. And while this clearly represents a list of most pressing problems, it is likely that to develop and implement solutions to them, the net must be cast more broadly to include the institutional and policy framework as well. Purely technical solutions are often enormously expensive and have associated with them the same kinds of operational problems that help to generate the environmental problems in the first place.

Irrigation projects are a good test for whether or not development strategies are organization-intensive and purposively construct social sustainability. The government has been supported irrigation by financing and building the physical infrastructure large irrigation systems. Without such an infrastructure, irrigation is impossible. But if the institutional structures are not created as well, sustainable irrigation cannot occur. In practice, irrigation programs have often dealt with institution building by proliferating governmental bureaucracies to manage the irrigation systems. Infinitely less attention has been paid to the creation of stable, culturally appropriate, and institutionally enduring patterns of social organization at the grassroots level. Indeed while top-heavy irrigation administrations have multiplied and flourished, the creation of networks of water users associations, or support for existing ones, has been underrated, and, in some cases, ignored. Since neglecting or bypassing existing grassroots organization amounts to disinvestment in institutions and in the social capital for development, many of these projects have been undermined, and physical irrigation structures have deteriorated (or even collapsed) much earlier than they would have otherwise.

IRRIGATION AND THE ENVIRONMENTAL CHALLENGE

Environmental costs were hardly considered in the design of irrigation systems. Irrigation schemes were viewed as highly effective means of transforming traditional agricultural systems into commercially oriented and scientifically based productive enterprises, indeed, water development projects seemed to be a fairly straightforward process. With few exceptions, urban uses, and hydroelectric power production was not regarded as seriously detrimental to the environment. It was not until the early 1970s that the trade-offs between relieving today is poverty and hunger through massive manipulation of the water cycle and its natural systems and the attendant environmental and ecological costs of doing so came under scrutiny. Public and private environmental organizations began demanding action and lobbied to enact laws to protect the environment.

As failures of large-scale irrigation schemes to protect and enhance the environment came to light, there was growing skepticism that irrigation and drainage projects could be justified solely on the basis that they provided significantly increased opportunities for food production, trade, water management, flood control, electricity, and sustaining water supplies to growing populations in both urban and rural communities. Those benefits could be offset by damage to the environment and the social disorientation caused by resettlement of affected peoples.

Helping to buttress this growing anti-irrigation bias, weak policies or lack of a clear direction in water management policy have encouraged misallocation of water resources, including the use of greater amounts of water than the actual requirements for crops. Widely varying water pricing policies and inadequate systems and methods for cost recovery of irrigation have aggravated the environmental consequences of water projects, especially in areas where problems of water scarcity are dominant such as Egypt. In many cases, lack of incentives for proper use of water, compounded by technological problems, have adversely affected system performance, resulting in poor maintenance.

Although it is difficult to quantify all the social, environmental, and ecological costs related to human interventions in freshwater systems, it cannot be denied that imprudently developed, badly designed, and poorly managed irrigation schemes have had substantial negative effects on the environment. Irrigation projects do modify the environment by reshaping the land surface and changing its hydrological regime-sometimes with harmful side effects. The construction of dams and irrigation channel networks, while providing water for irrigation and power, affects soil moisture, changes the depth of groundwater, and alters water quality. Often some of these effects show up in even the best-managed irrigation schemes in ways that scientists are just now beginning to understand.

IRRIGATION SUPPLY STABILIZATION

The construction of a water storage and conveyance system decreases the risk associated with stochastic rainfall. Farmers are better able to plan their cropping patterns with a reliable water supply. The planting of certain crops, such as tree crops, requires the assurance of a sufficient water supply and may not be an economically rational choice for farmers before water development. Irrigation also allows farmers to apply water at the times that are most beneficial for the crop, instead of being subject to the variation in rainfall. The following example illustrates this point. Due to weather shocks, the water supply is stochastic.

During dry years that occur α percent of the time, the available water supply is WL, while during wet years, which occur (1- α) percent of the time, water supply is WH. Since the choice of crop and irrigation technology must be made before the weather is observed, farmers must make these choices under uncertainty. If farmers are only assured of receiving a water supply of WL ex-ante, then they might be unwilling to invest in high-value crops such as fruit and nut trees, or vine crops; as these crops require a minimum level of water each year. If an irrigation system and reservoir is developed, then farmers can rely on receiving a water supply of W in every year, where L H $W = \alpha W + (1 - \alpha) W$. The removal of uncertainty from the water supply allows the farmers to improve their welfare through their decisions on both crop choice and irrigation technology.

THE BENEFITS AND COSTS OF IRRIGATION

Increased supplies of irrigation water have been instrumental in feeding the populations of developing countries in the last 50 years. Irrigation water has increased food security and improved living standards in many parts of the world. It was common to hear concerns of food shortages and mass starvation, and while malnutrition is still a concern in many countries, the reason is not an insufficient global food supply.

In fact, in the early 1990s, nearly80% of malnourished children lived in countries that produced food surpluses, evidence that the cause of malnutrition is a lack of sufficient income by households to purchase food, not a lack of supply.

There are a number of reasons for this increase in food production, including high yield varieties of seed and increased use of fertilizers. However, the role of water development in providing irrigation water to cropland has also been significant. Benefits include the expansion of food supply, stabilization of water supply, flood protection, and the improved welfare of some native populations.

COSTS OF IRRIGATION

Despite the benefits discussed in the preceding section, there have also been many negative impacts of water projects. There have been financial, environmental, and social costs of developing water systems.

Environmental problems include habitat destruction and a decrease in water quality while social costs include the displacement of native populations, and increased occurrences of waterborne diseases that affect those populations.

- **Capital Costs**
  The costs of constructing a dam and conveyance system for irrigation are often many millions of dollars. In deciding whether a project is worth undertaking, it is important to weigh the anticipated benefits against the expected costs. Historically, the capital costs of constructing water projects have been consistently underestimated. A recent study of 81 large dams by the World Commission on Dams found that the average cost overrun was 56%, with the distribution. In addition, ex-ante predictions of the benefits of water projects have often been overly optimistic. This combination of factors has resulted in observations that the internal rate of return to most water projects is well below the expected rate of return, although most of the return rates are still positive. In addition, the rates of return have been declining over time. There are a few reasons for increase in the cost of irrigation development. The best sites for water projects have already been developed, and those that remain are increasingly expensive. Also, improved knowledge about the environmental impacts of dam construction has led to requirement of detailed environmental impact reports before the approval of many projects.

- **Environmental Costs (Habitat destruction)**
  The construction of a large dam causes changes in a river ecosystem. There are changes in stream flow, water temperature, and water quality. These changes affect the flora and fauna living in a river basin area. Fish species that live in warmer waters might not survive the cold waters below a dam site, or species that thrive in flowing waters may not survive in the still water of a reservoir.

- **Blocking migration of native species**
  Many river systems are used by species of migratory fish, such as salmon. In the course of their lifetime, salmon species are born upstream, swim down a river, and eventually return upstream to mate and reproduce. The construction of large dams can block the routes used by these fish, and affect their reproductive behavior. This affects both the sustainability of the fish species and those whose livelihood depends on the fishery.

- **Dynamic Costs of Water Resources**
  The development of irrigation projects had allowed crop production on otherwise arid lands. This has had many benefits, including expanding output and increasing

land values. However, there are environmental problems that have occurred over time as the amount of land being irrigated has expanded. These costs include increased salinity levels in fresh water sources, and waterlogging and salinization of soil.

COST RECOVERY

The cost recovery demonstrates the different methods of calculation but do imply specific recommendations as to the level of watercharges. Only direct watercharges to be paid by farmer are taken into account and indirect recoveries, such as incremental sales taxes, are neglected. These calculations should demonstrate to participants what the effect would be on the financial situation of farmers if government would try to recover not only the operation and maintenance costs, but also the investment costs of the project. So, the cost recovery is a financial concept and not economic costs are to be recovered. Different ways to calculate cost recovery are being demonstrated.

These calculations are normally based on incremental watercharges. However, if watercharges without the project do not cover more than the cost of operation and maintenance and do not cover part of the previous investment cost, and if – as in irrigation rehabilitation projects- the watercharges proposed for the project cover also the operation and maintenance cost of the old installations, then the cost recovery calculations are to be based on the total watercharges and not on the incremental.

Two different ways of comparing costs (to be recovered) and watercharges can be distinguished which are based on: Annual Equivalents (AE) and Net Present Values (NPV).

Any discussions of cost recovery must consider the great diversity of countries as well as irrigation systems. This means that culture, history, stage of economic development, natural resource base, and the prevailing political climate must be carefully studied and understood. This implies detailed analyses, flexibility and great ingenuity in developing any cost recovery policy which indicates who pays for what when and how much for irrigation services and facilities.

- **Types of Cost Recovery**

The types of cost recovery practiced in many countries are:

1. Indirect recovery of operation and maintenance costs.
2. Attempted to recover all operation and maintenance costs.
3. Attempted to recover some costs (varied from 15% to 70% needed).
4. Annual charge for extracting water directly from system.
5. Explicit policies not to assess farmers any costs of Improvements.

RENT RECOVERY

The project rent (or incremental economic rent) is also a financial concept and establishes whish which part of a farmer's incremental benefits can be attributed to the government investments in the irrigation project alone. Therefore, the value of the farmer's incremental labor input, management effort, capital input and an allowance for the willingness to bear risks, are to be deducted from the net benefits to arrive at the incremental economic rent called project rent. The watercharges proposed by government are then put in relation to this project rent to indicate how much of this rent government is recovering through watercharges.

The calculation of the project rent is related to the farmer's situation and compares the farmer's income and watercharges on an annual and not a discounted basis. While the calculation on a discounted basis would be accurate, it would complicate the calculation considerably. When the analysis is pursued further, three necessary ingredients of a sound cost recovery policy can be identified they are considered as they apply specifically to cost recovery as part of the financial analysis.

- **Economic Efficiency**
  This aspect of cost recovery reflects the traditional concern of pricing policy with the efficient use of resources to maximize a project's net benefit to the economy. An efficient price for a product in this sense is generally taken to be the marginal cost of producing the last unit sold. The marginal cost rule may need to be modified to allow for various complications. These include the substantial cost that may be incurred in charging for the service, as in metering water, the instability that may result from adjusting prices frequently to reflect changes in costs.

- **Income Distribution**
  A cost recovery policy based solely on efficiency pricing is not necessarily appropriate when another national objective is to improve income distribution. The prices or other charges levied should then take into account differences in income level and in the ability of beneficiaries to pay.

- **Revenue Generation**
  Design of a cost recovery policy must also recognize most governments ore short of fiscal resources for development. Revenue collected from users though efficiency prices may be less than is necessary to recover the full investment and operating costs of a project.

WATER SUPPLY

The conventional water resources in Egypt are limited to the River Nile, ground water in the deserts and Sinai, rainfall and flash floods, and desalinization of seawater. Each resource has its limitations on use. These limitations relate to quantity, quality, space, time and/or use cost. The Nile River is the main and almost exclusive source of fresh water in Egypt, supplying approximately95% of the country's water needs. According to the 1959 Nile Agreement, Egypt's stable share is fixed at 55.5 billion cubic meters annually.

As for rainfall, it is limited and cannot be considered a dependable source of water, since rainfall on the Mediterranean coastal strip decreases eastwards from 200 mm/year at Alexandria to 75 mm/year at Port Said, and declines inland to about 25 mm/year near Cairo. Desalinization of seawater has been given a low priority as a source of water in Egypt, due to its high cost.

However, it is occasionally used in remote areas. Water resources in Egypt are becoming scarce. Surface water resources originating from the Nile are now fully exploited, while groundwater sources are being brought into full production. Egypt is facing increasing water needs. Supply and demand on water match each other for years 1995/1996. However, it is predicted that by the year 2017, the water demand will reach 97.79 billion M^3/year, while the water supply will reach 95.24 billion M^3/year, thus indicating the occurrence of a deficit in the water supply amounting to 2.55 billion M^3/year. In 1997, a project was initiated in Toshka and the New Valley Region for establishing the Sheikh Zayed Canal. The objective of the project is to build a new Delta" in the South Valley and to create a comprehensive urban community to accommodate about 6 million people. The canal is to be the artery that will pump about 5 billion M3 of the Nile water per year to cultivate approximately 540,000 feddans in Toshka and the New Valley Region.

Table (1): Balance between Water Supply and Demand
(Unit: billion M^3/year) in Egypt

Items	Category 1995/1996	(%)	Forecasted for 2017	(%)
Water Supply				
Nile River	55.50	72.97	57.50	58.53
Groundwater in the Nile Valley and Delta	4.80	6.31	7.50	7.63
Recycling of agricultural wastewater	12.92	16.99	16.92	17.22
Recycling of domestic wastewater	1.14	1.50	13.62	13.86
Recycling of industrial wastewater	0.70	0.92	1.70	1.73
Rains and floods	1.00	1.31	1.00	1.03
Loss due to evaporation in the water network	(3.00)		(3.00)	
Total of Supply	76.06	100	98.24	100
Water Usage				
Agriculture	60.73	83.12	75.53	77.24
Industry	7.53	10.31	15.44	15.79
Domestic	4.54	6.22	6.82	6.97
Navigation	0.26	0.35	0.00	-
Total of Usage	73.06	100	97.79	100
Supply of Usage	0.00	-	-2.55	-

Source: Ministry of Water Resources and Irrigation, 2005

Table (2): Renewable freshwater resources and total Withdrawal per sector in Egypt

Renewable Resources Per Capita	year	1960	M^3	2251
		1990		1112
		2025		645
Total Withdrawal	BCM		56.7	
	% of total		97	
	% Total		93	
Per Sector % of Total	Agriculture		88	
	Domestic		7	
	Industry		5	
	BCM agric.		28.51	
	BCM agric. actual		54	
	Water use efficiency		53	
Total Annual Internal Renewable Water Resource	BCM		1.80	
Total Renewable	BCM		58.00	
Total Avail / Year	BCM		16.00	
Annual River Flows From	Other countries		56.5	
	To other countries		-	
Net Annual Renewable Resources	BCM		58.3	

Source: AQUASTAT FAO's information system on Water and Agriculture, 2001.

WATER USER ASSOCIATIONS (WUAS)

A WUA is a group of farmers who collectively manage and distribute their combined available water supply. A shift to management of water resources by the water users is being promoted as a means to improve conveyance systems, cost recovery, and the efficiency of water use. In various places WUAs have existed side by side with publicly run irrigation systems for many years. Evidence suggests that higher yields, better conveyance structures, improved maintenance, greater efficiency, and a more reliable supply are associated with WUAs. One important question for economists concerns the effectiveness of different management strategies for a common resource; the irrigation system. In Egypt, there are mainly two types of WUAs: J.section and PVC pipes mesqas. There are more than 7500 have started as an initial potential for establishment of WUAs in 1998.

The objectives of the study are to shed lights on economic assessment of WUAs as an improved irrigation system, to study the implications of WUAs on total revenue items, variable cost structure, investment costs, estimate gross margins, and estimate the relationship between the investment costs and the command area of WUAs by type of mesqa.

INVESTMENT COSTS STRUCTURE OF WUAS

The investment costs of WUAs depend on the type of mesqa, command area of mesqa in feddan, length of mesqa and year of establishment. Table (3) indicates the average of investment costs per WUA and per feddan (000L.E). The investment costs of WUAs vary from one governorate to anther. Investment costs consist of costs of construction and lining of canals, construction of gates of mesqas, filling up and pavement of old mesqas, and association pumps. The grand mean for all governorates of investment costs for J-Section is about LE75200, LE 80100 for P.V.C. and LE 78000 for two types.

Table (3): Average of Investment Costs for WUA and Per Feddan (000L.E)

Governorate	J-Section		P.V.C.		Grand Mean	
	WUA	feddan	WUA	feddan	WUA	feddan
Sharkia	92.5	1.9	122.7	2.0	109.0	1.9
Beheira	65.4	1.8	71.2	1.7	68.3	1.7
Gharbia	78.1	1.4	89.4	1.8	82.7	1.6
Kafr El-shiekh	171.0	2.0	58.4	1.0	113.6	1.5
Fayoum	-	-	35.5	1.7	35.5	1.7
Beni-Suife	57.9	1.6	75.3	1.7	65.0	1.6
Menia	57.8	1.7	68.2	1.5	63.0	1.6
Grand Mean	75.2	1.6	80.1	1.7	78.0	1.7

Source: Compiled and computed from database sheets, 2004/2005.

VARIABLE COSTS STRUCTURE OF WUAS

Variable costs for J-Section or P.V.C. consist of costs of fuel, oil, labor concerning guards for irrigation pumps and equipment, irrigation operators and maintenance costs. Total variable costs for the association depend on the actually irrigated area within the command area of WUAs and the working hours of irrigation equipment. Average of variable costs of J-Section is about LE 6100 and LE 71.7 per feddan. Average of variable of costs of P.V.C. is about LE 1250 and LE 59.2 per feddan. Table (4) indicates the average of variable of costs.

Table (4): Average of Variable of Costs for WUA and Per Feddan (L.E)

Items	J-Section		P.V.C.		Grand Mean	
	WUA	feddan	WUA	feddan	WUA	feddan
Fuel	2287	26.9	469	22.3	1358	25.6
Oil	506	5.9	104	4.7	309	5.8
Maintenance	1190	14.0	245	11.7	720	13.6
Instauration	1018	12.0	209	9.9	615	11.6
Mechanical	579	6.8	118	5.6	342	6.4
Guarding	520	6.1	105	5.0	315	5.9
T. of costs	6100	71.7	1250	59.2	3659	68.9
Return	8684	102.2	1434	68.3	5111	96.4
Net revenue	2584	30.5	184	9.1	1452	27.5
Average of area	85 feddan	-	21feddan	-	53feddan	-

Source: Compiled and computed from database sheets, 2004 /2005.

RELATION BETWEEN AVERAGE INVESTMENT COSTS AND THE COMMAND AREA

The relationship between the average investment cost per feddan and the served area per WUAs in governorates has been estimated for J-section and P.V.C. mesqas as a quadratic function in Tables 5 and 6.

- Y= average investment cost per feddan
- X= average cultivated area
- Figures between brackets indicate T- rations of estimated coefficients.

The results indicate that the statistical estimates of the coefficients are significant and that the statistical relationship between the investment cost per feddan and cultivated area is significant.

Table (5): Relationship between Average Investment Costs and Command Area of J-Section Mesqas

Governorates	Equation	R^2	F
Sharkia	$Y = 3910.3 - 103.9X + 1.13X^2$ (21.5) (16.4) (10.01)	0.85	89.7
Beheira	$Y = 3498.3 - 47.24X + 0.214X^2$ (6.94) (2.21) (1.99)	0.81	33.9
Gharbia	$Y = 2617.5 - 34.6X + 0.415X^2$ (5.27) (2.74) (2.53)	0.74	49.7
Kafr El-shiekh	$Y = 4822.6 - 40.71X + 0.389X^2$ (4.15) (2.68) (3.71)	0.72	66.8
Beni-Suife	$Y = 1901.4 - 11.16X + 0.17X^2$ (8.07) (3.20) (4.23)	0.75	34.0
Menia	$Y = 4852.3 - 215.4X + 0.217X^2$ (11.25) (9.023) (7.46)	0.88	41.4
All Governorates	$Y = 2845.8 - 29.9X + 0.118X^2$ (27.45) (8.12) (6.27)	0.82	63.0

Source: Compiled and computed from database sheets, 2004 /2005.

Table (6): Relationship between Average Investment Costs and Command Area of P.V.C. Mesqas

Governorates	Equation	R^2	F
Sharkia	$Y = 2364.3 - 105.4X + 0.76X^2$ (6.04) (3.13) (2.79)	0.66	34.9
Beheira	$Y = 5112.3 - 132.7X + 1.95X^2$ (6.64) (3.42) (2.79)	0.72	10.1
Gharbia	$Y = 2617.5 - 34.6X + 0.415X^2$ (19.04) (4.11) (2.12)	0.77	34.2
Kafr El-shiekh	$Y = 3218.5 - 92.7X + 1.08X^2$ (23.4) (12.4) (10.8)	0.69	89.2
Fayoum	$Y = 2711.1 - 49.13X + 0.408X^2$ (8.59) (2.99) (3.07)	0.89	35.1
Beni-Suife	$Y = 2495.8 - 31.4X + 0.41X^2$ (6.22) (3.17) (2.19)	0.74	65.4
Menia	$Y = 6841.8 - 218.3X + 2.09X^2$ (7.14) (8.49) (7.14)	0.67	48.2
All Governorates	$Y = 2094.6 - 26.48X + 0.134X^2$ (29.62) (4.14) (3.17)	0.76	95.3

Source: Compiled and computed from database sheets, 2004 /2005.

COST ASSESSMENT OF ENVIRONMENTAL DEGRADATION

Damage cost is presented for each of the following environmental categories: water, air, soil, waste, coastal zones and cultural heritage and the global environment. For each of these categories cost estimates are presented for: health / quality of life and natural resources. It should be noted that these estimates are orders of magnitude and therefore only an indication of actual costs. The estimates of the cost of environmental degradation do not include all environmental area because of lack of data and difficulties in quantifying impacts. This is particularly, but not limited to incomplete or absent assessment of solid waste (industrial, hospital, waste), water resources pollution, and coastal zone degradation.

Calculations of each of the estimates of environmental damage costs as percentages of Gross Domestic Product (GDP) in 2004 /2005 are presented in Table 7. The damage cost of environmental degradation in Egypt in 2004 /2005 at LE 28.436 billion per year (5.4% of GDP).

Table (7): Mean Estimates of Annual Cost of Environmental Degradation

Sources	Million LE per year	Present of GDP
Air	11059	2.1
Soil	6319	1.2
Water	5266	1.0
Coastal zones, cultural heritage	1580	0.3
Municipal waste	1053	0.2
Sub- Total	25277	4.8
Global environment	3159	0.6
Total	28436	5.4

Source: Compiled and computed from Egyptian Environmental Affairs Agency (EEAA), 2006.

NEW APPROACHES

How to overcome the weaknesses in water resources management has been the subject of much international discussion. At the June 1992 United Nations Conference on Environment and Development in Rio de Janeiro, member countries endorsed policies that stress integrated water resources management " based on the perception of water as an integral part of the ecosystem, a natural resource and social and economic good". They also stressed "the implementation of allocation decision through demand management, pricing mechanisms, and regulatory measures".

These policies reflect the current worldwide consensus on moving away from past approaches that tended to center on developing new sources of water- a "supply" focus. The new emphasis is on economic behavior, policies to overcome market and government failures, and technologies for increasing the efficiency of water us a "demand" focus. The approach underlies new policy for managing water resources. Among the measures countries are increasingly adopting:

- Appling a comprehensive analytical framework, incorporating cross-sectoral and environmental consideration.
- Placing greater emphasis on incentives for efficiency and financial accountability.
- Establishing strong laws and regulations.
- Decentralizing water service delivery.
- Prescribing and encouraging the participation of stakeholders.
- Protecting, enhancing, and restoring water quality and water dependent ecosystems.
- Assigning greater priority to the provision of adequate services for the poor.
- Supporting research, development, and adoption of low-cost technologies to conserve water and enhance its quality.

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