USE AND PRODUCTIVITY OF EGYPT'S NILE WATER

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ABSTRACT

Many irrigated areas worldwide are facing increasing competition from agricultural, municipal, industrial, environmental and other uses of water. In water basins, changes in water use in one area often affect how water is used in another area. It is therefore vital to understand how water resources are presently used, and how changes may affect future use of water. A water accounting methodology is presented to show the use and productivity of water. The methodology was applied to Egypt's Nile River system to evaluate the present status of water use and productivity. It was shown that there has been a trend of increasing consumption of water by agriculture and an increase in the productivity of water available to agriculture. There is little water remaining to be saved, and increases in productivity must focus on gains in productivity per unit of water consumed by evapotranspiration. The example from Egypt demonstrates the use and utility of the water accounting methodology in describing water use patterns by different sectors. It is envisaged that this methodology will be further developed to be useful in a wide range of situations.

INTRODUCTION

There is a need for irrigated agriculture to perform better to meet food production and food security needs of a growing population. In many situations water available for irrigation is decreasing because industrial, urban, and environmental uses require an increased share of water resources to meet their growing demands. We must become more productive with our water resources in a manner that can be sustained, and that meets equity, environmental, and other goals of society. A common objective within irrigated agriculture is to increase the productivity of water devoted to agriculture in light of increased competition from other sectors.

Decisions about water require a clear presentation and understanding of the present uses of water. Often times the situation of water use is quite complex due

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to problems of scale, interactions between users, and use and re-use of water as it flows down a river basin. With knowledge of field level practices, it is difficult to upscale to basin-wide water use. Likewise, basin-wide information does not necessarily yield information on how water can be better used locally. With the many uses and interactions between water uses, a basin level understanding is required to better understand the effects of a change in water use. There is a need to clearly and simply present information on water use and its productivity, so the results of possible water-related actions can be understood.

To help to reveal information about water use at different levels of analysis, a water accounting methodology was developed (Molden, 1997) for evaluating water management within and among all sectors. This water accounting approach is influenced by work of Willardson (1985), Seckler (1993 and 1996), Willardson, Allen, and Frederiksen (1994), Jensen (1993), Keller and Keller (1995), Keller, Keller, and El Kady (1995), Keller, Keller, and Seckler (1996), Frederiksen (1997), and others. The purpose of this paper is to provide a detailed example of water accounting at the basin level in order to demonstrate its applicability. The example is taken from Egypt's Nile River where somewhat detailed information is available on water use and productivity. Egypt's Nile River serves as an example of increased competition for a limited supply of water. Through this and similar work, it is hoped that a common, robust methodology will be developed.

TERMINOLOGY

Many approaches, choices, and potential conflicts exist to manage basin-wide, inter-sectoral water use for better performance. Tradeoffs often considered are: municipal and industrial use versus agricultural use, water markets versus subsidies and fixed allocations, efficient on-farm practices versus reuse of water and centralized versus decentralized management. While there is much debate about the best possible strategies, it is important to be able to measure or predict the end result of combinations of actions. Water accounting provides a means for stating end results of various actions so that present performance can be understood and better strategies formulated.

Water accounting relies on a water balance approach, where balance terms are found for a *domain of interest* bounded in time and space. A domain could be an irrigation system bounded by its headworks and command area, and bounded in time for a particular growing season. Conservation of mass requires that for the domain over the time period of interest, inflows are equal to outflows plus any change of storage within the domain. A domain could be defined at the level of a certain use such as on-farm irrigation, at a service level such as an irrigation system, or at a sub-basin or basin level. The domain of interest for this study is the Nile River and its irrigated area from the High Aswan Dam to the Mediterranean Sea. A time step of 1 year is considered.

Gross inflow is the total amount of water flowing into the domain from precipitation, and surface and subsurface sources. Here the gross inflow is the flow from the High Aswan Dam plus precipitation falling into the area. It is assumed that there are no lateral sub-surface inflows.

Net inflow is the gross inflow plus any changes in storage. It is assumed that over a year's period of time there are no changes in storage in the Nile system. This ignores the effect of seawater intrusion where groundwater storage of freshwater is being decreased and replaced by saline waters originating from the sea.

Water Depletion is a use or removal of water from a water basin that renders it unavailable for further use. Water depletion is a key concept for water accounting, as it is often the productivity and the derived benefits per unit of water depleted we are interested in. It is extremely important to distinguish water depletion from water diverted to a use, because not all water diverted to a use is depleted. Water is depleted by four generic processes (Seckler 1996, Keller and Keller 1995, and Molden 1997): 1) *Evaporation:* water is vaporized from surfaces or transpired by plants; 2) *Flows to sinks:* water flows into a sea, saline groundwater, or other location where it is not readily or economically recovered for reuse; 3) *Pollution:* water quality gets degraded to an extent that it is unfit for certain uses; and 4) *Incorporation into a product* by a process such as incorporation of irrigation water into plant tissues.

Process consumption is that amount of water diverted and depleted to produce an intended good. In industry, this includes the amount of water vaporized by cooling, or converted into a product. For agriculture, it is water transpired by crops plus that amount incorporated into plant tissues.

Non-process depletion occurs when diverted water is depleted, but not by the process it was intended for. For example, part of water diverted for irrigation is consumed by transpiration (process), but also depleted by evaporation from soil and free water surfaces (non-process). Drainage outflow from coastal irrigation systems and coastal cities to the sea is considered non-process depletion. Deep percolation flows to a saline aquifer may constitute a non-process depletion if the groundwater is not readily or economically utilizable. Non-process depletion can be further classified as *beneficial or non-beneficial*. For example, a community may place beneficial value on trees that consume irrigation water. In this case, the water depletion may be considered beneficial, but depletion by these trees is not the main reason why water was diverted.

Committed water is that part of outflow that is committed to other uses. For example, downstream water rights or needs may require that a certain amount of outflow be realized from an irrigated area. Or, water may be committed to environmental uses such as minimum stream flows, or outflows to sea to maintain fisheries. In the case of Egypt, there is a need to release water to the northern lakes or the Mediterranean sea either through the Nile itself or through drains in order to flush out salts and pollution, and to maintain the environment.

Uncommitted outflow is water that is not depleted, not committed, and is thus available for a use within a basin or for export to other basins, but flows out due to lack of storage or operational measures. For example, waters flowing to a sea in excess of requirements for fisheries or environmental or other beneficial uses are uncommitted outflows. With additional storage, this uncommitted outflow can be transferred to a process use such as irrigation or urban uses.

Available water is the net inflow less the amount of water set aside for committed uses and represents the amount of water available for various uses. Available water includes process and non-process depletion, plus uncommitted water.

Non-depletive uses of water are uses where benefits are derived from an intended use without depleting water. In certain circumstances, hydropower can be considered a non-depletive user of water if water diverted for another use such as irrigation passes through a hydropower plant. Often, a major part of instream environmental objectives can be non-depletive when outflows from these uses do not enter the sea.

ACCOUNTING FOR NILE WATER USE

In this section, water accounts are given for the agricultural year 1993 to 1994. The accounts are based on water balance computations by Zhu et al. (1995). This water balance approach considered measured inflows and outflows, and assumed no change in storage and calculated evaporation and transpiration as a residual. Crop evapotranspiration was calculated after making estimates of other sources of non-crop evapotranspiration. The values for the balance are summarized in Fig. 1. The different terms are explained in some detail below for illustration purposes.

Inflows

The gross inflow into the Nile system is 56.2 km^3, which is equivalent to 55.2 km^3 of releases from the High Aswan Dam (HAD) plus 1.0 km^3 of precipitation. It is assumed that over the one year time period there are no storage changes, so gross inflow is equal to net inflow. Water released from HAD flows down the river, where most of it is diverted to agriculture. Diverted water either leaves the domain through evaporation or transpiration, or returns back into the system where it is diverted for use again. The value of 65.3 km^3 in Fig. 1 represents the reported diversions, and is greater than the dam releases. It should be noted that actual diversions are much greater than this due to considerable reuse of return flows at scales smaller than main canals. At the tail end, most water that is not depleted by an evaporative use flows out to the Mediterranean Sea.

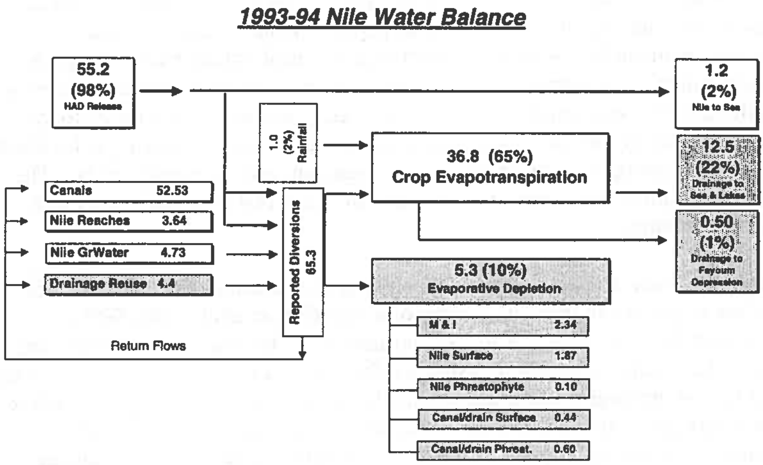

Fig. 1. Water balance components for Egypt's Nile River below the High Aswan dam for the 1993 to 1994 agricultural year. Values are in cubic kilometers (1 km^3 = 10^9 m^3).

<u>Process Uses</u>

Major process uses of Nile water are municipal, industrial, agricultural, and navigation uses. A total of 56.1 km^3 is diverted from the Nile directly to use into canals for irrigation, municipal and industrial (M&I) uses. There is considerable return flow into drains, groundwater, canals and rivers where it is available for use again before leaving the system. A recorded amount of 12.7 km^3 is reused from drains or from groundwater. There is, in additions a considerable amount of unrecorded reuse from these sources.

The total water depleted by crop evapotranspiration is estimated at 36.8 km^3, while process depletion by M&I uses[4] is estimated at 2.3 km^3. During much of January, the Nile irrigation system is closed for maintenance. During this time, some water is released in the Nile to keep levels high enough to support navigation. During this period there was outflow of 1.2 km^3 from the Nile mouth, which can be charged as a process use to navigation. Agriculture is by far the largest process user of water.

Committed Water

Some water is required to flow out of the Nile system for environmental needs, such as, to drain out salts, to carry away pollutants that would otherwise concentrate in the Nile waters, and to maintain coastal estuaries for fishing. A drastic reduction in drainage outflow would cause pollutants to concentrate, which would result in detrimental environmental effects, sicknesses and losses to the fisheries industry. Based on environmental concerns, some would argue for more discharge flowing to the northern lakes and sea than what presently exists. The minimum outflow requirement is an important value that deserves much more research attention.

With our present knowledge it is difficult to give an estimate for the volume of outflow required, but there are indicative values (Emam et al. 1996, SRP et al. 1996, and Zhu et al. 1996). A major consideration is the salinity of the outgoing water. The Drainage Research Institute (1993) reports that in 1992, 3.1 km of the 12.3 km^3 of drainage outflow had salinity levels of less than 1500 ppm, which is reasonably good quality water for irrigation. The remaining 9.2 km^3 is of marginal and poor quality water in terms of salinity. At present, water carries a heavy load of pollution that needs to be washed out. With these considerations, a first estimate of minimum outflow on the order of 8 km^3 can be made.

Non-Process Depletion

The majority of the outflow is through the drainage system. Some of this water can be considered the environmental commitment discussed above. The remainder of the water is considered a non-process, non-beneficial drainage outflow. In 1994/95, the amount of drainage outflow to the Mediterranean Sea, the northern lakes, and the Fayoum Depression was 13.0 km^3. Subtracting 8 km^3 of committed outflow from both the outflows yields 5.0 km^3 of non-process depleted water leaving the domain. This amount represents an estimate of the

[4] The depleted fraction for M&I uses was assumed to be 30% for the Nile Valley and 20% for the Nile Delta. That is, in the Nile Valley, 30% of the water diverted for M&I use is depleted through evaporative consumption, or through disposal outside of the domain.

amount of water that can be saved and converted to a process or other beneficial use.

Other types of non-process depletion are evaporation from fallow land, evaporation from free water surfaces, and evaporative use by phreatophytes and other non-agricultural vegetation. Certainly, some of this depletion is beneficial as it leads to the desirable green belt along the Nile. There may be other subsurface outflow into sinks, such as flow from the Nile Delta to the Qatara depression (Bastiaanssen et al. 1990) but here the value is assumed to be negligible. It was estimated that there was 3 km^3 of non-process, evaporative depletion during the time period of interest.

WATER ACCOUNTING

The water accounting components are summarized in Table 1, and visualized in Fig. 2. Process depletion includes ET, M&I uses and navigation. Non-process depletion includes evaporation from free surfaces, fallow land, phreatophytes, and drainage to the sea in excess of environmental requirements. Available water is the calculated volume after subtracting that water committed for environmental uses from the gross inflow. There are no uncommitted utilizable outflows remaining; thus all the water available is depleted.

Accounting Indicators

Accounting indicators characterize the use of water in the Nile. They are based on ratios of various depleted amounts to gross, net, total depleted, and available water. Following Willardson et al. (1994), they are presented as fractions as opposed to efficiency terms to avoid placing erroneous value judgments on the terms (i.e. bigger is not always better). The indicators are defined below, and Table 2 summarizes the accounting indicators.

Depleted Fraction (DF) is that part of the inflow that is depleted by both process and non-process uses. Depleted fraction can be defined in terms of net, gross, and available water. Table 2 summarizes accounting indicators. In this case, it is assumed that there is no change in storage, therefore net inflow = gross inflow, and

$$DF_{net} = DF_{gross} = \frac{Depleted}{Gross\ Inflow} = \frac{48.2}{56.2} = 0.86 \qquad (1)$$

Subtracting committed water from net inflow leads to the available water, and the depleted fraction of available water is:

$$DF_{available\ water} = \frac{Depleted}{Available\ Water} = \frac{48.2}{48.2} = 1.00 \qquad (2)$$

Table 1. Water accounting components of Egypt's Nile River.

		Total	Component
Inflow		km^3	km^3
Gross Inflow		56.2	
	Surface diversions from High Aswan Dam		55.2
	Precipitation		1.0
	Subsurface sources from outside subbasin		0.0
	Surface drainage sources from outside subbasin		0.0
Storage change		0.0	
	Surface		0.0
	Subsurface		0.0
Net Inflow		56.2	
Outflow			
Total Outflow		14.2	
	Surface outflow from rivers		1.2
	Surface outflow from drains		12.5
	Subsurface outflow		0.0
	Flow to Fayoum depression		0.5
Committed Water		8.0	
	Environment maintenance (assumed)		8.0
Available Water			
	Total (gross inflow less committed water)	48.2	
Depletive use			
Process depletion		40.3	
	Evapotranspiration		36.8
	M&I Uses		2.3
	Navigation		1.2
Non-process depletion		8.0	
	Outflows in excess of environmental requirements		5.0
	Other evaporation (phreatophytes, free water surface)		2.9
TOTAL DEPLETION		48.2	

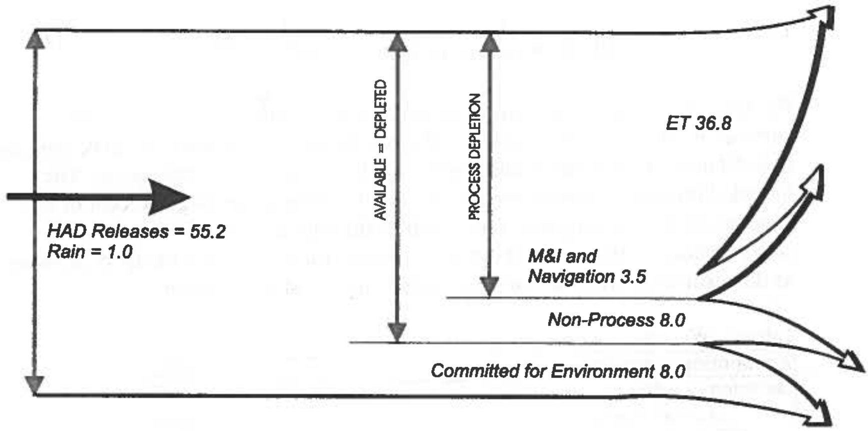

Fig. 2. Water accounting for Egypt's Nile River.

This shows that all available water is being depleted. There are no uncommitted outflows to the sea which can be further exploited, there is only savings from drainage outflows (a non-process depletion). What percent of depleted water goes to intended processes?

Process Fraction (PF) relates process depletion to inflow, total depletion, or available water and is useful to identifying opportunities for water savings. Process fraction is analogous to the effective efficiency concept forwarded by Keller and Keller (1995) and is particularly useful in identifying water savings opportunities when a basin in fully or near fully committed.

$$PF_{depleted} = \frac{Process\ Depletion}{Total\ Depletion} = \frac{ETc + Navigation + M\ \&\ I}{TotalDepletion}$$
$$= \frac{36.8 + 1.2 + 2.3}{48.2} = 0.84 \tag{3}$$

This shows that 84% is of total depletion is depleted by intended process uses, and 16% of the depleted water goes to non-process depletion. Converting the non-beneficial part of the 16% to process use represents a means to increase productivity of water.

It is possible to define a process fraction for irrigated agriculture alone. First, the amount of water available for irrigation is set at the gross inflow less committed water less M&I and navigation depletion (56.2-8-2.3-1.2=44.7).

$$PF_{available} = \frac{Process\ Depletion}{Available\ Water\ for\ Irrigation} = \frac{36.8}{44.7} = 0.82 \quad (4)$$

By doing this, evaporative depletion through phreatophytes and free water surfaces is all charged to irrigation. It could be argued that some could be charged to M&I uses as the water is conveyed through the same river and canals. The intended process of crop evapotranspiration depletes a very large percent of the water available for irrigation, and it will be difficult to increase this process consumption. In the future, the water available for irrigation is likely to decrease as domestic and industrial uses with take from this share of water.

Table 2. Water accounting indicators.

Accounting Indicators		Value
Depleted Fraction		
	of Gross Inflow	0.86
	of Available Water	1.00
Process Fraction - All Uses		
	of Gross Inflow	0.72
	of Available Water	0.84
Process Fraction for Irrigated Agriculture		
	Available for Agriculture in km^3	44.7
	Irrigated Agricultural Process Fraction	0.82

Agricultural Productivity of Nile Water

Productivity of Water (PW) in agriculture can either be related to the physical mass of production or the economic value of produce per unit volume of water. Productivity of water is similar to a water use efficiency (Viets 1962, Howell et al. 1990) term which relates mass of production to evapotranspiration or transpiration. Here productivity of water is used in a basin-wide sense and can be defined as production in terms of net inflow, depleted water, and process depletion.

Productivity of agriculture can be measured in several manners, for example mass of production, gross value of production, net value of production, or calories derived from the produce. With the multiple food and non-food crops existing in Egypt's Nile sub-basin it is intuitive to use a monetary value for production, and here both gross and net value of production are considered. An ideal expression of basin water productivity should consider the sum of net benefits obtained from agriculture, fisheries, navigation, environment, industrial, municipal and other uses. Valuing the productivity of all the uses can be quite difficult, especially in environmental and municipal sectors, and falls out of the scope of this paper.

Here the concentration will be on productivity of the irrigated agricultural sector.

In 1993/94, the total gross value of production of the irrigated agricultural sector was estimated at 24.8 billion Egyptian pounds, equivalent to 7.5 billion US$ at 1993 prices (exchange rate of 3.3 Egyptian Pounds (LE) per US$). The productivity of water defined as the gross value of production per gross inflow is:

$$PW_{gross\ inflow} = \frac{Gross\ Value\ of\ Production}{Gross\ Inflow} = \frac{7.5BUS\$}{56.2km3} = 0.13\frac{US\$}{m^3} \qquad (5)$$

A base measurement for productivity of water is to consider the value of production related to crop evapotranspiration, the process depletion for agriculture. An important means of gaining more productivity out of the water resource is to get more output per unit of evapotranspiration. Growing higher value crops or less water consumptive crops with equal value, or improving agronomic and water management practices may lead to a higher water productivity of water. The productivity of process water for agriculture is:

$$PW_{process} = \frac{Gross\ Value\ of\ Production}{Process\ Depletion\ (ET)} = \frac{7.5BUS\$}{36.8km^3} = 0.20\frac{US\$}{m^3} \qquad (6)$$

The value of productivity of water consumed by evapotranspiration compares quite favorably with other irrigated (Molden et al. 1998).

Table 3. Water Productivity Indicators.

Gross Value of Production 1993 in billions of 1993 US$	7.5
Gross Value of Production per Unit of	US$/m^3
Gross Inflow	0.13
Water Available for Agriculture	0.16
Crop Evapotranspiration	0.20

TRENDS IN WATER USE AND PRODUCTIVITY

Supplies and utilization can be understood by tracking certain key variables as presented in the water balance by Zhu et al (1995). Figure 3 focuses on the major inflow to the domain -- releases from the High Aswan Dam (HAD), and the most significant outflows from the domain -- through crop evapotranspiration, drainage outflow to the sea, and outflows from the Nile surface system to the sea.

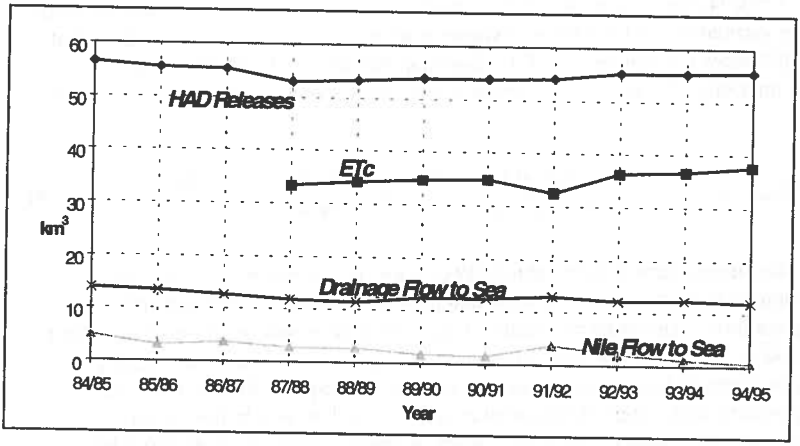

Fig. 3. Water Supply and Use of the Nile River below the High Aswan Dam.

A clear trend of Nile outflow to the sea in recent years is apparent as shown in Fig. 3. From 1974 to 1980 the average annual Nile River flow to the sea was 6.2 km^3, from 1981 to 1990 it was 3.9 km^3, while from 1991 to 1996 it was reduced to 1.7 km^3. For the 1995/96 irrigation season, the Nile River outflow to the sea was reduced to 0.26 km^3. In order to save water for use in agriculture and other sectors, managers have been devising ways to close the route of water to the sea. Future potential from obtaining more savings of this Nile River water is quite small.

Data for drainage outflow to the northern lakes and sea is available from 1984 to present and is maintained by the Drainage Research Institute (DRI 1992) in their annual yearbooks. Changes in drainage outflow to the sea have been much less dramatic than for the Nile outflow as shown in Fig. 3. Notable is the change that took place between 1987 and 1989, the period of drought when Lake Nasser reached its minimum level. Starting from 1988/89, drainage outflow was reduced from 14 km^3 to about 12 km^3, and has stayed at around this level until the present. Unlike the situation with Nile outflow, reduction in drainage outflow to the sea has been difficult to achieve. One possible major factor for the lack of reduction in drainage outflow in spite of conservation efforts is that rice irrigation in the northern delta area contributes heavily to drainage outflow, and the rice area has been increasing recently.

Crop evapotranspiration has shown a steady increase. As shown on Fig. 3, reductions in Nile discharge to the sea and drainage outflow to the sea have been balanced by an increase in crop evapotranspiration. Given the ongoing expansion of agricultural area, plus the increase in yields on existing land, this trend is expected to remain on course for the next few years, until it becomes very difficult to replace drainage water flowing to the sea with crop evapotranspiration.

Over time, the production value of Egyptian agriculture has shown an upward trend as shown in Fig. 4. The increase in gross value of crop production has been due to several factors including increased productivity, the growing of higher valued crops, and the expansion of irrigated land.

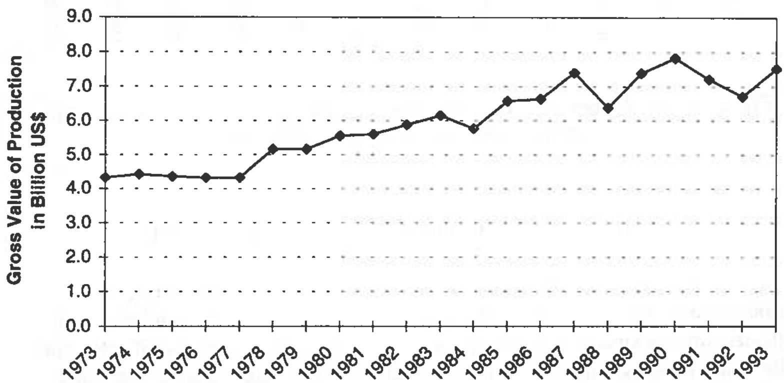

Fig. 4. Value of Production over time (Data Sources: Ministry of Agriculture and Land Reclamation, 1973 to 1992 and Agricultural Economics Research Institute, 1993. Currency is adjusted to 1993 prices as per the World Bank Tables, 1994).

Agricultural productivity per cubic meter of gross inflow provides a means of tracking performance of Egyptian irrigated agriculture (Fig. 5). From the 1970s to the 1990s, this value has nearly doubled[5]. This trend is expected to increase in the near future with expansion of irrigated land, economic liberalization, the shift to higher valued crops, and increasing productivity. It is possible however that the trend could reverse, if old lands are taken out of production through salinization or lack of water, in order to serve new facilities. Data on gross value of production per unit of ET is available for the period of the water balance analysis. During this time, the value varies around US$0.20

[5] The gross value of output reported here includes crops produced by non-Nile water, which is small in comparison to that produced by Nile water.

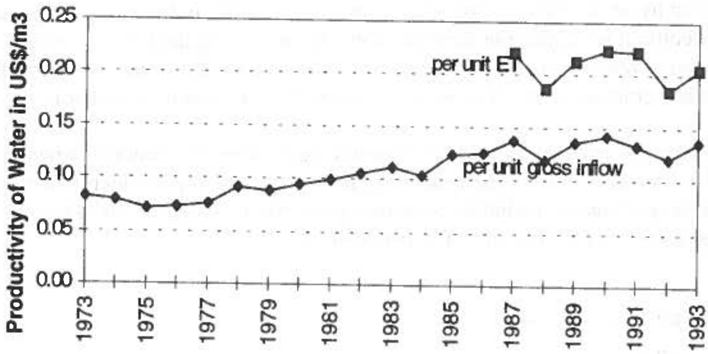

Fig. 5. Trend of gross value of production per cubic meter of water for agricultural crops. Values are in constant 1993 US$.

IMPROVING THE PRODUCTIVITY OF WATER

A picture of water use and productivity emerges from the above analysis. Agriculture dominates as the major user, with depletive use by municipal and industrial uses a small but growing factor. A very high percentage of inflowing Nile water is being depleted (depleted fraction = 0.85), and most of the water depleted is being put to productive use (process fraction = 0.82). The productivity of water in agriculture is quite good, with the productivity of gross inflow estimated at US$0.13 per cubic meter and increasing and the productivity per unit ET at US$0.20. However, opportunities for water savings are becoming more difficult in spite of increasing demand in agriculture, environmental, urban, and industrial sectors.

One opportunity to increase productivity of Nile water is to capture more of the drainage outflow and convert it into a productive use. However, initial estimates based on downstream environmental outflow requirements show only 4 to 5 km^3 can be captured with conservation efforts (El Kady and Molden 1995, WRSR reports 1 and 2, 1996). Only well-conceived projects to increase efficiency on a local level may achieve slight increases in the depleted fraction when these reduce drainage discharge to the sea. Other efforts are required including storage and further reuse of water.

Outflow into the northern lakes and the sea is a significant, but not well understood factor in determining how much water still remains to be captured and placed in productive use. Much of the existing outflow is required to flush salts and other pollutants out of the system, and to maintain an economically viable fisheries industry. There is very limited opportunity to save water for use in agriculture without adversely affecting the environment.

The Nile river below the High Aswan Dam is an example of a "closing" (Seckler 1996) water basin, where there is little opportunity for water resource development or water savings. To obtain additional water for a depletive use, water reallocation within and between sectors becomes more common. It is likely that water will be reallocated from agriculture to municipal, industrial, and environmental uses. The response to this "closing basin" situation has been in many ways remarkable. Water savings have been achieved, in particular through increased reuse. Water productivity has shown a gradual rise per unit of inflow and remains relatively high per unit of evapotranspiration.

The challenge is to sustain the water productivity increase to match the needs of a rising population in light of increased competition from between sectors. Even within the agricultural sector, there is a desire both to expand irrigated agriculture to new lands, and to increase productivity of existing lands. The most important means of increasing water productivity will be to find means to increase the returns per unit of crop evapotranspiration. This is possible through switching to higher value crops or using crops or agronomic practices that produce more but consume less. Identifying technologies, management, strategies and policies to obtain this will be an important area of strategic research for Egypt.

CONCLUSIONS

A water accounting procedure was defined and applied to Egypt's Nile River system. The procedure allows evaluation of the present status of water use and productivity, trends over time, and gives an indication of where gains can be made. While the procedure sufficiently described the Nile system, it has yet to be demonstrated in situations with more rainfall and with more variability in climate.

Worldwide, many water basins are facing perceived water shortages due to increasing demands on water from all sectors. It is vital that key information be presented in a way that can benefit policy makers. Choices, tradeoffs, and evaluation of use must be described as clearly as possible. This is the role that water accounting plays. This example represents an application of water accounting that we feel is applicable to many other situations. Over time, this methodology will be refined to be useful in many situations found in the world.

ACKNOWLEDGMENTS

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