Potable Water for All: The Egyptian Experience with Rural Water Supply

by ***Gilbert F. White and Anne U. White***
Institute of Behavioral Science
University of Colorado
Boulder, Colorado 80309, U.S.A.

ABSTRACT

Egypt during 1952-1960 achieved a more rapid and proportionately larger improvement in potable water supply for its rural population than any other developing country. The way in which this was done laid the groundwork for later difficulties in maintenance and extension of services. Similar problems arose in the Fayoum project in 1953-1964. A program for basic village services initiated in 1979 applied some of the lessons learned in the earlier program, but raised new environmental issues. The early change in water service was not followed by striking reductions in prevalence of childhood disease.

INTRODUCTION

The International Drinking Water Supply and Sanitation Decade is seeing the promotion of efforts designed to make massive improvements in potable water supply, and to some degree in sanitation, over a short period of time. In the interest of effective action, it is important to ask what lessons that can be learned from any such attempts in the past may have relevance today. Egypt is a prime case.

Egypt provides the experience of a national "crash" program, as well as several bilaterial efforts, where the proportion of the rural population reported as provided with potable water supplies increased from somewhere near 15 percent in 1952 to about 72 percent in 1960. It was reported as high as 87 percent a few years later [1, p. 52], an outstanding figure among developing countries of comparable income per capita [2]. Egypt today is a middle income country, according to World Bank classifications, which in many ways resembles its low income brethren more than those countries in the middle bracket to which it is assigned (Table 1). Its large proportion of the population living in cities, its extensive reported proportion of the population with access to safe drinking water supplies (74%), abundant caloric intake and, with the benefit of subsidies, better than average per capita income make it resemble the middle group. But its low life expectancy at birth, low adult literacy rate, and especially its high, albeit rapidly falling, infant mortality rate (110 per thousand in 1981) bring it much closer to the low income group of countries.

Demographic and public health studies indicate very little significant relationship between urbanization, with its benefits of increased literacy, purer water and electrification, and infant mortality [3]. Nor has it been demonstrated that rural development shows any clear association with that measure of health. Infant mortality in Egypt seems remarkably resistant to change in the face of the many "modernizing" influences at work [4], although there apparently has been a major decline in infant deaths during the past three years as a result of oral rehydration and other new programs. Given the rapid early improvements and the current situation, it is of interest to examine how the improvements in water supplies came about, and to speculate on their relationship to the health of the population.

THE 1952-1960 PROGRAM

Mohamed Naguib, Gamal Abdel Nasser and 13 other army officers assumed power in Egypt on July 23, 1952, marking the culmination of a revolutionary process which had been simmering since 1948. The military regime promised the people many reforms, and at first enjoyed support from both the Egyptian people and Western powers. Perhaps the most far-reaching act of reform came in the Agrarian Reform Act of September 9, 1952, which limited land ownership to 200 feddans, and distributed 430,000 feddans of excess landholdings to 120,000 landless peasants. The extension of water supplies to the villages was started in the same year, another move that strengthened the regime's ties to the villagers.

The improvement in rural water supply was a vis-

0250-8060/86/$3.30 *Water International, 11* (1986) 54-63

Table 1: Selected Macroeconomic, Demographic and Social Indicators for Egypt and All Low- and Middle-Income Countries, 1960 and 1980

	Egypt		All Low Income Countries	All Middle Income Countries
	1960	1980	1980	1980
GNP per capita 1979-81 dollars	260[c]	480 (1979)[a] 650 (1981)[b]	270 (1981)[b]	1500 (1981)
Population (millions)	26.1[g]	43.3 (mid '81)[b]	2210.5 (mid '81)[b]	1128.4 (mid '81)[b]
Population growth rate				
1960-1970	2.2[c]		2.1[c]	2.5[c]
1970-1980		2.1[c]	2.1[c]	2.4[c]
Percentage urban population	38[b]	44[b]	21[b]	45[b]
Life expectancy at birth, years	46[b]	57[b]	58 (1981)[b]	60 (1981)[b]
Adult literacy percent	26[b]	44[b]	52[b]	65[b]
Percentage population with access to safe water	69[f]	74[e]	25 (1975)[d]	52 (1975)
Per capita caloric supply	—	2972[b]	2218[b]	2579[b]
Infant mortality (per 1000 live births)	128[b]	110 (1981)[b]	99[b]	81 (1981)[b]

a) *World Development Report*, World Bank, 1981, Table1.
b) *World Development Report*, World Bank, 1983, Tables 1, 22, 23, 25.
c) *World Tables*, World Bank, 1980.
d) *World Development Report*, World Bank, 1975, Table 17.
e) *The International Drinking Water Supply and Sanitation Decade Directory, World Water Magazine*/World Health Organization. Thomas Telford, Ltd., 1981.
f) Estimated from *The Five Year Plan*, Vol. 5, Arab Republic of Egypt, 1977, p. 57.
g) *Statistical Yearbook: 1952-1981*, Arab Republic of Egypt, 1982.

ible benefit from a government to a growing population that enables Egypt, even in 1980, to stand out as a major anomaly in this respect among countries of the developing world. It still claims a much higher proportion of its people served with potable water than do other countries of similar per capita income [2].

The Egyptian program is distinguished in two aspects: (1) the rapid rate at which new water supply and distribution facilities were provided, and (2) an implementation strategy that did not approach the villagers to determine their preferences or request their assistance. In a period of about eight years the program reached more than 3500 villages, about 88 percent of the total. It can be taken as an example of Feachem's thesis [5] that with a strong, experienced, ministry and a favorable economic and political climate, environmental improvements can be extended without community participation.

Investment of funds in water supply dramatically increased. Twenty-six million Egyptian pounds (L.E.) were expended between 1952 and 1960, with L.E. 15 million of this contracted in four years (1955-1959) to establish the facilities for the supply of drinking water to the countryside, thus extending the water network to most of the Delta villages [1, p. 54] (see Figure 1). These improvements reached about 9.5 million people, and represented an expenditure of about L.E. 2.7 per capita for the total population in villages [6].

It still claims a much higher proportion of its people served with potable water than do other countries of similar per capita income

In pharonic times there had been ingenious efforts in Egypt to improve the quality of water by filtering it through sand [7], but the origin of what might be called modern potable water supplies in Egypt came with the formation of a French water company in Cairo in 1865 using sedimentation basins, slow sand filters, and gravity distribution lines to provide potable water to the city [8]. The Alexandria Water

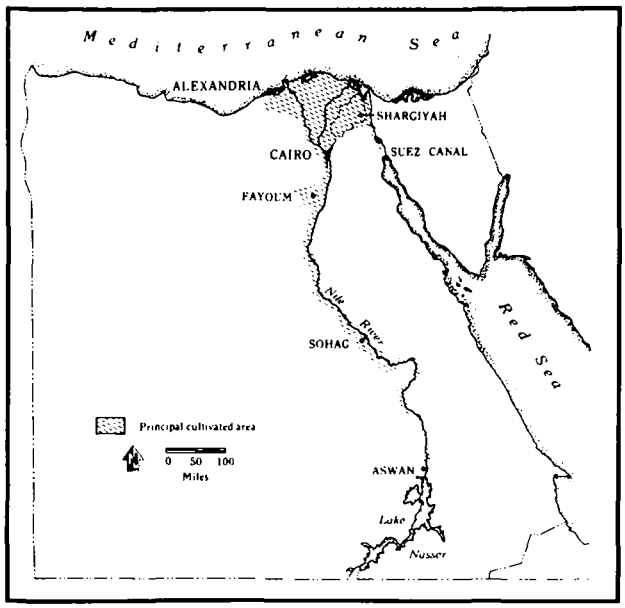

Figure 1. Map of Egypt.

Company, a British limited liability firm, was given a concession in Alexandria in 1879. It operated under British administration until 1954 when it was made into an Egyptian joint stock company, and finally nationalized in 1961 [9]. While the upper income people of the cities enjoyed this water service, the people of the villages continued to draw water from the river Nile, or from canals or wells, as they had from ancient times.

The second major program of social reform following land reform in Egypt was undertaken in 1952, under the guidance of national councils on economics and on public services recruited from a wide range of citizens. It concentrated on a cluster of elementary improvements in the life of the common people in Egypt, including provision of water supply, schools, and community health and social welfare activities.

In 1952 there were approximately 4000 villages — where all the rural population except nomadic peoples live — ranging in population from 2,000 to 10,000, and 140 cities in Egypt, with a total population approaching 26 million, growing at a rate of 2.5 percent annually. Of the cities, 24 were capitals of provinces, and 116 were county seats. In 1947, 66 percent of the population was classified as "rural," decreasing to 54-56 percent in 1976 [10]. By the early 1950s, every city had its own water plant of some character constructed by the Ministry of Municipalities. The exceptions to the central program were Cairo and Alexandria which, as has been noted, were served by private enterprises.

Prior to 1952 the government had tried to serve a few villages with water. These were places that were selected largely because of political connections such as the interest and concern of a powerful member of the parliament [11]. Probably about 150 villages and not more than 200, many in the vicinity of Cairo and Alexandria, had been reached in this fashion. Typically, artesian wells were linked with high storage tanks to serve a distribution system. In 1936-38, Fayoum Province had been the target for the first complete effort by the General Authority for Drinking Water to provide a treatment plant for Nile water outside of the cities. By 1941 that system was serving a total of 1.7 million people in Fayoum, or about 15 percent of the rural population of that time [1, p. 52].

In 1952 the new program took shape under a new Minister of Municipal and Rural Affairs (MMRA) and was organized into two major geographical sectors. The southern sector, in which groundwater was everywhere present and nowhere salty, was in the area roughly south of the meridian 30.5°. Its program consisted almost wholly of the drilling of wells. The northern sector consisted of six regions, including Fayoum, in which the government provided a system of plants following a uniform design for the diversion, treatment, pumping and storage of water in reticulation systems. We draw much of our information from Ahmed Khalad Allam [11] who served as an engineer in the program. He and others have estimated that 80 percent of the villages were reached by the supplies over the next eight years. The L.E. 15 million [1, p. 52] construction program during 1953-59 involved a staff of engineers who operated out of the Cairo office of the MMRA. They went into the field, walked along the paths, visited

The southern sector . . . program consisted almost wholly of the drilling of wells

the villages, and laid out the design of mains from the central treatment plants to the farthermost villages. The engineers of the Ministry, while in the field, made field surveys for the necessary network of pipes from the main distribution lines to the villages. In a few instances (approximately 10 percent), they found the village too distant to serve, and designed no improvements. At the village site the water main commonly was laid out to follow the route of the ring road that typically encircled the village. In most instances, pipe lines did not traverse a village because of difficulties that would result from right of way, and from pipe leakage and subsequent crumbling of the houses that were constructed almost exclusively of mud brick.

Along the ring of pipe, hydrants were placed at approximately 300 meter intervals. The spacing depended upon the spatial layout of the village, the

density of the population, and the local conditions. The rule was to locate the hydrants so that women could "go without hardship" to the watering place. Each hydrant consisted of a fire tap and of four other taps, two on each side of a block with a stone on each side on which the women could place their buckets (see Fig. 2). Where a small hamlet was encountered, the hydrant would be limited to two taps.

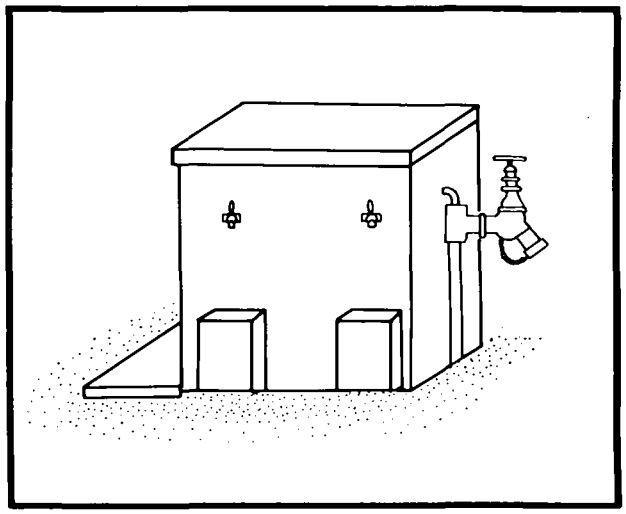

Figure 2. Design for a typical standpipe.

The designers assumed a daily consumption of about 40 to 50 liters per capita. They typically took into account the size and type of the village, estimated its likely growth over a 40 year period, and laid out a system of pipes, T-joints, valves, and hydrants that counted on the use of standard size and character of equipment. Design procedures were simplified.

When public hydrants had first been installed in the 1930's in a few villages, some women had refused to use the public supply because, consistent with their general suspicion of any government enterprise, they believed that the government was introducing some imaginary birth control chemicals into the water supply. They apparently were subsequently persuaded that this was not the case, and, by 1952, generally accepted the new supplies with enthusiasm.

The representatives of the Ministry did not consult with local administration except to tell the local leaders what they were doing, and they thus did not either solicit opinions as to the suitable layout and location of the water system, or ask for contributions of funds or labor in constructing and operating the supply.

Once the supply had been designed and the design had been approved by the superintendent of the program in Cairo, a contract was let, and a constructing company or a consortium of companies in the northern area undertook the construction subject to supervision by the Ministry representatives.

Representatives of the Ministry did not consult with local administration except to tell the local leaders what they were doing

When the program was first begun there were no private tap connections, but by 1958 arrangements were made for private individuals to pay for individual connections at their own cost for installation and meters. No charge was made for the water at the hydrants, hospitals, health centers, schools, or other public enterprises. People having private connections were either metered or were charged on a monthly basis proportionate to the number of persons in the residence or the number of rooms in the dwelling [6, p. 26].

Once the construction was completed and accepted by the Ministry, all of the operation and maintenance was assumed by the provinces, but inspection was the responsibility of the MMRA. It should be remembered that, until 1960, the village and city administrations in each province were entirely appointed by the central government, although village councils and city councils often had a substantial number of their members elected. Provinces came to be termed "governates" in 1960.

The contractors in the north and south were independent firms formed into groups under so-called "collective tender". In 1961 the big firms were nationalized, and the amount of independence and energy that had been displayed in the earlier program disappeared, according to Allam. There was little or no financial incentive to the contractors for extension of service.

As part of the revolutionary reforms, a program of so-called "combined units" for groups of four to five villages, including health, school, laundry, playground, social service, and agricultural facilities, was undertaken for 864 places in Egypt. They were intended to be centers for health education and other social services to benefit the local communities. Of these, 330 had been built by 1960. No more were undertaken from that year forward, when so-called "local administration" was initiated. Some of the communal facilities provided then were still in use in 1982, some were not. In the village of Kafr el Khadr, for example, the community buildings, when we visited them, were used for an externally supported health project and a milk products scheme, but the community laundry basins had found no acceptance, and stood almost unused.

It should be recognized that Egypt — in the 1950's and now — is peculiarly suited to a highly concen-

trated program of rural water supply improvement. Virtually all of the population lives in villages or cities, and these cities and villages are concentrated in about 3 percent of the total area of the country — the irrigated areas of the Delta and the valley of the Nile (Figure 1). The average acreage of cultivated land per person is about 0.35, and there is only a very small proportion of land in agricultural areas that is not cropped. Thus, the designers of the 1952-1960 program were able to operate within a relatively small, densely populated, contiguous area. Moreover, they were able to draw rather readily upon either surface water in the northern part of the Delta or upon available ground water at shallow depths in the valley upstream.

Egypt is peculiarly suited to a highly concentrated program of rural water supply improvement

AFTER 1960

In the years after 1960, the water supply and the health education situation deteriorated considerably. The population continued to grow at a rate of 2.2 percent a year after 1965, resulting in a tremendous rise in demand for water both in the rural villages and in the swelling metropolitan areas of Cairo and Alexandria. In the early 1960's Nasser's interest evidently turned away from public services and towards military hardware. The Second Five Year Plan (1965-70) proposed an expenditure of L.E. 18.3 million for water supply, but only L.E. 9 million was allocated. Little more was invested during the period 1970-76 [1, p. 53].

By 1977, when we had occasion to visit selected communities, most facilities were heavily overloaded, operating beyond capacity and without reserve, and with almost no money for maintenance or repairs. The centralization of responsibility in the governates and the lack of local workshops and repair crews had led to deteriorating levels of service. Frequent shutdowns occurred. Pressure was insufficient to serve the upper floors of many buildings. The rising demand had led to increased production at the expense of quality and cost control. The distribution systems were bursting from old age and insufficient repair. New satellite villages were being formed with no public water service at all. In 1977 it was estimated that 120 villages and 11,000 farms, estates and residential areas were lacking in improved water supplies [1, p. 44]. People in those areas were obliged to use the surface water of the canals or, in some cases, shallow wells with handpumps. In a number of village, workers returning from overseas were using part of their savings to build new houses and to install pumps.

A similar situation arose with the village health services that had received an energetic push in the 1950's. The Ministry of Health was deeply involved in the water supply effort at first, but lost that responsibility in the 1960's. A marked slowdown in the provision of all such services began in the 1970's and slowed even more with the decentralization program begun in 1975. In health services, this showed up in deterioration in training and in the quality of the field staff. Whatever other reasons were involved, there was undeniably a lessening of per capita resources as the population increased.

Sanitation was in even worse shape than water supply. Throughout the Delta and along the valley the groundwater table began rising at various rates after the completion of the High Aswan Dam in 1967, as a result of extensions of the irrigation season. In those circumstances the drainage of waste water became increasingly difficult, creating new health threats. Many of the shallow wells in use in Upper Egypt are now believed to be contaminated from human wastes.

By 1977 . . . most facilities were heavily overloaded

By 1979, the population of Egypt had risen to 41 million people, and projections were made, assuming continued high birth rates, of 60-75 million by the year 2000. The largest cities were increasing at a faster rate, with 7 million people estimated to be in Cairo, and 16 million projected by the year 2000 [12].

By the late 1970's, nearly 30 years after the great push for rural water supplies, the best estimates were that 87 percent of the urban population and 64 percent of the rural population had access to treated water from public supplies (Table 2), making a total of 74 percent with such access for the whole population. This was still much better than many countries of comparable per capita income. For the majority of the rural residents, the service was by standpipe, in most cases those that had been installed in the 1950's. Those with private pumps were counted as having no treated source.

These estimates are probably too high. As the Master Plan points out, except for the larger cities, where there had been recent consultants' reports, there is a conspicuous lack of "hard" data regarding domestic water supply and consumption in Egypt,

Table 2: 1976 Population by Type of Water Supply ($x10^3$)

Type of Access	Urban		Rural		All	
	No.	%	No.	%	No.	%
Treated water						
tap in dwelling	9,719	60	777	4	10,496	28
tap in building	1,368	8	365	2	1,733	5
tap outside	2,986	19	12,041	58	15,027	41
No treated source	2,025	13	7,378	36	9,402	26
TOTAL	16,098	100	20,561	100	36,658	100

Source: Arab Republic of Egypt, 1981. *Water Master Plan. Municipal & Industrial Sectors.* Ministry of Irrigation, UNDP, IBRD, Table 2.2 (information from CAPMAS preliminary 1976 census).

since "the data which do exist are inconsistent and reflect, at best, an incomplete and rough picture of present network capacity and demand, especially in the rural areas" [13]. Another estimate puts the proportion of the rural population served in 1980 at 56 percent [14], illustrating the difficulty in arriving at any precise figure.

In Cairo and Alexandria, the rapid growth of population and the deterioration of supply, treatment and distribution facilities had resulted in intermittent services, and growing concern over possible health hazards resulting from broken sewers, extension of water supply to unsewered areas, and discharge of sewage into drainage canals, the Nile and coastal waters. This concern prompted some action, and in 1979 four studies were completed by consultants (Binnie & Partners et al., John Taylor and Sons et al., Camp, Dresser & McKee International et al., and Anderson Nichols & Co.) Based on this information, the national Water Master Plan which was developed [13] included plans for water for the municipal and industrial sectors. These studies were assisted by the United Nations Development Programme, the International Bank for Reconstruction and Development and various bi-lateral arrangements, principally with the United States and Great Britain. Much of the attention to domestic supply was focused on the large cities, but some, particularly in terms of U.S. assistance, was directed at the water supply for rural areas.

There have been two periods of intense involvement of the U.S. with Egypt during the last 35 years, and the intertwining of political and economic affairs in the Nile Valley has affected all aspects of the life of the people. When Abdel Nasser gained power in 1952, the U.S. government welcomed him, intent on enlisting his support and that of the Arab world in an alliance directed against the Soviet Union (the Baghdad Pact). The second period came with the gradual rejection of Soviet support by the Egyptians after Sadat came into power in 1971, and the acceptance of military support from the United States. Again, development aid became the price of popular support.

These policies affected the country in many ways, and among them, the drinking water supply provisions. There has been a considerable shift in policy with regard to the desirable degree of centralization of government control over such projects, as a description of two U.S. funded projects, one begun in 1952 and the other in 1980, will illustrate.

THE FAYOUM PROJECT

At about the same time that Nasser's government was extending water to the villages a forerunner of USAID, the Technical Cooperation Administration, set up the Egyptian American Rural Improvement Service (EARIS) project, supported under what was designated in President Harry S. Truman's inaugural speech as the Point Four foreign assistance program. This land reclamation project reclaimed 37,000 acres of lake bottom and desert land in three sites: Abis, near Alexandria, and Qoota and Kom Oshaim in the Fayoum in the period 1952-1963.

As part of the Fayoum project, 13 complete villages and more than 60 hamlets were constructed to house 7,600 households. The identical block houses each had an inside tap located near the latrine; the water came from existing water treatment plants. The latrines were a pour-flush type, usually connected from the households to drainage canals or to trenches, or, in the case of public buildings, to septic tanks.

As with the larger scheme of water supply provided by the Egyptian government, the water and excreta disposal systems in these villages declined sharply in service after their installation. A USAID evaluation report [15] found that all the water systems were inadequate, ranging from moderate problems in some Delta villages to a total lack of safe drinking water seasonally in parts of Fayoum. The problems included low pressure, intermittent service, and suspect water quality. The latrines, dependent on water service, were frequently unusable.

The houses were all built before the settlers entered the area, and therefore they had no voice in what kind of facilities were provided. The evaluation report notes that the project failed to provide for recurrent maintenance costs. The total cost of EARIS, from 1953-1964 when it was terminated, was $42.5 million.

Disposal systems in these villages declined sharply in service after their installation

One of the enduring results of the earlier provision of water supplies, both in the rural areas generally [16] and in the EARIS project areas [15], is that given the opportunity to choose between piped supplies, even if less convenient, and the open waters of canals and drains, villagers reportedly will choose the piped and presumably safer supply for their drinking water. The concept of "safe water" appears to be strong, even though the desired effects on health have not come about. How much the presence of sanitarians or health workers in the villages influenced this attitude is difficult to determine and does not seem to have been explored.

BASIC VILLAGE SERVICES

The U.S. took a second turn in influencing Egyptian internal affairs after the termination of agreements between Egypt and the U.S.S.R. Large amounts of money were channelled into Egypt through the U.S. Agency for International Development [17] Commodity Import Program and Food for Peace (Public Law 480) for imported food, machinery and supplies. These provided balance of payment support amounting to a total of $4.9 billion for the years 1974-1983. The 1983 program obligated $1.0 billion (USAID, n.d.). As a major contribution to the rural areas, the Basic Village Services Program (BVS) was initiated in 1979, as a Public Law 480 Title III ("Food For Development") agreement, for $75 million over a five year period, supplemented by a $70 million USAID grant in 1980. As of late February, 1984, with "decentralization" as the major thrust of the program, the total amount of disbursements by BVS was $234 million [18].

The BVS program was administered through the Organization for Reconstruction and Development of the Egyptian Village (ORDEV). It's purpose was to reinforce and strengthen local government at the village, district and governate levels in supporting rural development. It was also designed to improve the capacity of local units to plan, organize, finance, implement and maintain locally chosen infrastructure projects [19].

First initiated in 1980 on a trial basis in three governates — Fayoum, Sohaq, and Sharqiyah — the program was intended to "support and accelerate the process of administrative decentralization" [20] by providing funds whose use could be decided upon at the markaz (district/county) and village level. In 1981 it was extended to 6 additional governates, and by 1983 it had reached 20 rural governates, covering almost the entire country [18].

By mid-1984, funds under the BVS program had been made available through the governates for infrastructure improvements in 1,400 villages [21]. The program gave village councils the option to select needed projects for one or more of the following purposes:

Road construction
Ferry installation
Slaughterhouse construction
Drainage and sewers
Water supply
Solid waste removal
Food storage facilities

Water supply was selected for support by 64 percent of the 886 village subprojects in 1981-82, and by 50 percent of the 1183 subprojects in 1982-83, with roads the second in popularity. By September, 1985, total expenditures for water amounted to more than $85 million [22]. It was evident that water supply was regarded by the local groups as the most pressing of the needs recognized by USAID. Only an estimated 12 percent of the projects were for sanitary drainage [23]. The quality of record keeping varied among the governates, and BVS found it difficult to obtain reliable statistics [18].

In executing the program, USAID acted on some of the lessons that could be drawn from the earlier bursts of water supply investment. By delegating the basic choice of projects to the village councils, it avoided the excessive centralization of decision that characterized the 1952 initiative. This aim was furthered by training offered to members of village councils in procedural and legal aspects of government. By decentralizing the responsibility for operation and maintenance, it sought to build local capacity to keep the works operating in good order. It financed workshops on construction intended to be used by governate employees in repairing the new improvements. As of 1984 an estimated 21,000 village council members and governate technical personnel had received training in village planning and management, accounting and financial management, water pump maintenance, road construction and BVS goals and procedures [18]. They were supported by a series of manuals intended to give guidance in design and maintenance of equipment. These measures were carried out by Chemonics, a U.S. contractor, which administered the program.

It sought to build local capacity to keep the works operating in good order

The council could select projects for new wells, pumps, water pipes, treatment plants, sewer pipes, or waste treatment facilities so long as they satisfied U.S. specifications and fell within the fund alloca-

tion. It was not free to connect onto city systems or to join with nearby villages in a regional plan. Technical assistance in the form of training, manuals, guidelines, and consulting services favored techniques that had been well tested in the United States and would be likely to meet the performance standards of public agencies there.

As a result of this posture on the part of the funding agency's contractor, the adopted designs avoided many of the innovations and excluded certain options practiced in some other developing countries. The new water supply systems tended to be designed to provide 60-100 liters per capita daily, thereby anticipating the installation of multiple taps and of water closets (a household with only one interior tap is unlikely to use more than 50 liters per capita daily). Although Chemonics spoke of discouraging individual household connections and multiple taps, these were already in place in many villages, and the design manuals explicity provided for the larger consumption.

This prospect was especially significant in Delta villages where groundwater tables are high and no longer fluctuate seasonally, and where aquifers are subject to increasing pollution from pesticides, herbicides and fertilizers. If water consumption is enlarged sufficiently in this situation, sewage flows into septic systems may result in low, wet areas turning into permanent pools of sewage, seeping into the floors of houses and causing weakened foundations.

As the BVS came to a close in 1985, a second phase, Local Development II, was being introduced with an expected expenditure over a four year period of $228.2 million, of which nearly one-third was to be paid by the Government of Egypt. Democratization through "decentralization" was again the major theme with two new features included: 1) a recognition that operation and maintenance systems were seriously deficient, and 2) that the installation of new water supply systems without provisions for wastewater and excreta disposal had brought acute health and high groundwater problems to Delta villages [22]. Pilot projects for low cost appropriate technology solutions to these household and community problems were being considered [24], but had not yet been adopted. It was not clear in 1985 what effect such a change in policy would have. It appears that either an extensive collection and evacuation system or sewers and treatment facilities would be required soon or later at per capita costs three to seven times the per capita water supply costs, well beyond the capacity of the present USAID program. USAID at first neither suggested low water use designs such as would be provided by double-vault latrines and single taps, nor warned villages that a heavy investment in water supply would in time call for a much larger investment in sewers and waste disposal.

The primary focus of the program on strengthening local government in support of development raises questions about the needs as identified by some external technicians. To what extent should they suggest, or the central government allow, water supply extension that will exacerbate drainage problems? Should they urge the local governments to initiate a drainage program unless it is perceived locally as a pressing problem? It could be argued that they are presenting an incomplete technical picture unless they stress the problems of drainage arising from water supply improvements. The serious health aspects of the worsening sanitation situation in Egypt have been pointed out for some time [25, 26], but there appears to have been little coordination at the local level regarding responsibility for health impacts of the various programs. The USAID administrators have hesitated to push hard on health issues at the expense of local autonomy.

Another sensitive area in which USAID does not seem to have intruded much at the local level is that of the pricing of water supplies, although it may have exerted considerable pressure for reform at the national level. Water has been free at standpipes since Nasser's time, and the rates for private service are very low. A survey of the governates of Beheira and Kafr el Sheikh in 1979 found that three-fourths of all the respondents in rural areas and over half of those in urban areas drew their water from a standpipe source, all without charge. The consumers who did have private connections paid an average of 41 p.t. (about $0.74 U.S.) per month for an average usage of 15.5 m^3 per month [27]. Until very recently there were no wastewater tariffs in the public sector in Egypt, but the cost of private sewage disposal from vaults pumped by a contractor reached 12 L.E. per month in an unsewered section of Cairo [28].

Water supplies are heavily subsidized, but this must be seen in the context of the subsidies present in the whole economy of Egypt. It is estimated that in 1979, subsidies for food and energy cost the Egyptian economy approximately $4 billion U.S. Removal of these subsidies would require an increase in income of about 20 percent to purchase the same level of goods and services [29]. The United States has provided much of this money in an effort to assure domestic stability within the country. Water is a part of the general policy of housing subsidy. Water tariffs applicable in Cairo, Alexandria and the Suez Canal cities were substantially below the average maintenance cost of the systems per cubic meter of water produced, with no provision for improvements and debt service [30].

As of 1985, efforts were underway to change this situation. Ironically, the policies of a social revolution in Nasser's time later contributed to the provision of cheap water to the wealthier parts of society,

and inadequate service to the poor. Although strenuous efforts were made under USAID through ORDEV administration to improve training for operation and maintenance, unless the rate structures are changed and people agree to pay for services as some do for schooling or medical advice, or some other provision is made to supply funds, it is hard to see how the upkeep effort can be sustained.

OBSERVATIONS

A few observations on strategies and tactics for water-supply improvements emerge from this review of the sequence of programs in Egypt. We do not suggest that the lessons learned there are generally applicable. We do believe that they identify sobering problems that deserve consideration wherever large-scale efforts are undertaken to change the supply situation in low- and middle-income countries.

The Egyptian experience shows that it is possible for a strong central government committed to a program of social reform and in a country where rural population is clustered in villages to achieve rapid, massive expansion of water services within five to six years. Sanitary facilities were much more expensive to construct, were not provided under the early Egyptian government program, and continue to be deferred or neglected.

Once constructed and their operation and maintenance turned over to local governments, the water storage, treatment and sewage facilities were not kept up in good running order in many areas. Even where the facilities were operated in reasonably good fashion, extension of distribution lines to peripheral areas was slow or lacking. Storage and pump capacity were not expanded to meet the demands of growing populations. Provision of individual house connections was at the discretion of local authorities and at only the partial cost of home owners who were not required to contribute to the full cost of the supply, so that high-income consumers tended to benefit at the expense of low-income consumers. Hand pumps were installed at the owner's expense, and there have been no standards established to ensure that they are not contaminated.

They identify sobering problems that deserve consideration

A major characteristic of all the water projects undertaken in Egypt between 1952 and 1985 was the lack of capacity and funding for operation and maintenance. This is not unique to Egypt; in many developing countries the same situation exists. Pricing policy and the separation of revenue streams for investment and for maintenance seem major factors, but it would be helpful to understand with some precision why in a country where there is much investment in machinery it is so often not maintained, and where in particular the water supply and sanitation facilities are so neglected.

In the early Egyptian cases, the failure to involve the local community in the design, construction and operation of the new systems encouraged later neglect and irresponsibility in their operation and maintenance. There was little or no local initiative in modifying the systems to cope with new demands. This situation was reinforced by the policy of making no direct or indirect charges to the standpipe users, of pricing water from individual taps at less than proportionate costs, and of not returning revenues directly to the local government for its administration. Funds for local improvements were given lower priority than military expenses.

When the policy was changed to support local decisions as to priority and design for new improvements these difficulties were remedied in part but there remained the question of what would be appropriate measures in view of waste disposal needs created by enlarged use and, in some places, by changing groundwater conditions. The 1952-1960 program did not address these issues. Later, local autonomy came into conflict with external professional judgment.

The extension of water services was not accompanied by a conspicuous change at the national level in the prevalence of diarrheal disease. Neither was it followed by marked changes in life expectancy and infant death rates.

It is not easy to explain the continuing high rate of infant mortality in the face of improved supplies. The problems of analysis are well known [3]. In the Egyptian experience it seems clear that piped supplies in some areas are closely associated with declines in schistosomiasis prevalence by providing convenient alternatives to infected sources [31]. The lack of change in diarrheal disease prevalence might be ascribed in part to the weakness of community preventative education and therapeutic health care. The latter has been strengthened in recent years by a national program to promote oral rehydration, and this is beginning to show in the morbidity and mortality statistics. We suspect that a more basic cause is to be found in the prevailing Egyptian household patterns of defecation habits and excreta disposal, water use, and food handling.

Until the past few years no effort was made by the organizers of the national programs to find out how villagers use water in their homes, how they value water, and what they would be willing and able to do to

improve water supply and waste disposal within the constraints of local organizations. Without knowledge on those matters it was not surprising that the results in many instances fell short of expectations. We look to the detailed field studies initiated in 1984 as possibly offering answers to the question [32].

Considering the three recent decades of Egyptian domestic water and sanitation experience, at least six major factors clearly contributed to the success and failure of the giant programs. These were the quality of local participation, pricing policy, the allocation of revenues, the constraints of design aims, the quality of community health services and their user education programs, and the patterns of household behavior.

ACKNOWLEDGMENTS

We are indebted to Professor Ahmed Khaled Allam, Professor of City and Regional Planning, Azhar University, Cairo, for much valuable information on the 1952-1960 program. We also thank James Beverley and the following members of the USAID staff for data on its programs: Olivier Carduner, Sylvia Mitchell and Douglas Tinsley. Chairman Ahmed Rachid of ORDEV and his colleagues Magid el Shaabiny and Omar el Azhary provided useful information. The following have given us helpful criticism of an earlier version of this manuscript: David Donaldson, Ahmed Gaber, Samiha El Katsha, and F. De Wolfe Miller.

REFERENCES

1 Arab Republic of Egypt. *The Five Year Plan, 1978-1982*. Vol. 5, "The General Strategy of Housing, Utilities and Construction." Cairo: Ministry of Planning, 1977.

2 White, Anne U. & White, Gilbert F. "Economic Growth, Health, and Physical Well-being, 1970-1980." In *Water and Sanitation: Economic and Sociological Perspectives*, edited by Peter Bourne. New York: Academic Press, 1984.

3 International Bank for Reconstruction and Development. "Measurement of the Health Benefits of Investments in Water Supply." Report of an Expert Panel (Unpublished) P.U. Report No. PUN 20. Washington, DC: IBRD, 1976.

4 Field, John Osgood and Georges Ropes. *Infant Mortality, The Birth Rate, and Development in Egypt*. Health Care Delivery Systems Project: Monograph #1. Cambridge, Massachusetts: Prepared by Technology Adaptation Program, Massachusetts Institute of Technology. Sponsored by USAID, 1980.

5 Feachem, R. G. "Community Participation in Appropriate Water Supply and Sanitation Technologies: The Mythology for the Decade." *Proceedings of the Royal Society*, B209: 15-29. London: The Royal Society, 1980.

6 ARE. "Policy of Generalizing Potable Water for Drinking and Domestic Purposes." Paper delivered at the Brussels Water Conference, May, 1958. Cairo: Ministry of Municipal and Rural Affairs, 1958.

7 Baker, Moses Nelson. *The Quest for Pure Water: The History of Water Purification from the Earliest Records to the Twentieth Century*. New York: American Water Works Association, 1948.

8 Eid, Hussein Talat. "Future Plans to Fulfill Demand for Drinking Water to Greater Cairo till the Year 2000, With Special Concentration on Next Five Years 1981-1985." Paper presented at the National Consultation (Workshop) on Development of Drinking Water and Sanitation Programmes, Alexandria, February 18-20, 1981.

9 Shohayeb, Ahmed A. "Agency Paper Outlining the Alexandria Water General Authority Plans in the Field of Drinking Water for the Coming Decade 1981/1990." Paper presented at the National Consultation (Workshop) on Development of Drinking Water and Sanitation Programmes, Alexandria, February 18-20, 1981.

10 Cairo University, Faculty of Engineering. *Appropriate Water Supply and Sanitation Technologies for Small Egyptian Communities*. Interim Report #2, "Situational Analysis." FRCU Grant No. 82024. Cairo: Cairo University, p. 6, 1983.

11 Allam, Ahmed Khalad. Interview by the authors on September 26 and 29, 1977, Cairo, supplemented by conversations in 1985. Allam served as an engineer responsible for planning and contracting for provision of village water supply under the Ministry of Municipal and Rural Affairs. His official titles during 1953-1960 were Junior Engineer, Senior Engineer, Assistant Director and, finally, Director of Works. He then became head of the municipality of Aswan, 1977.

12 USAID. *Cairo Metropolitan Area Land Use Infrastructure Development Study*. OTR-1-1853. Prepared for USAID by Dames and Moore, Inc. Cairo: USAID, 1981.

13 ARE. *Water Master Plan: Water and Wastewater Studies: Municipal and Industrial Sectors*. Cairo: Ministry of Irrigation, UNDP, IBRD, 1981.

14 World Water Magazine/World Health Organization. *The International Drinking Water Supply and Sanitation Directory*. London: Thomas Telford, Ltd., 1981.

15 USAID. *Egypt: The Egyptian American Rural Improvement Service, A Point-Four Project, 1952-63*. AID Project Impact Evaluation Report No. 43. Washington, DC: USAID, 1983.

16 Miller, F. DeWolfe. "Analysis of Environmental Data from Rural Egyptian Villages." Washington, DC: University of Michigan School of Public Health/USAID, 1981.

17 USAID. *Ten Years of Progress. USAID in Egypt*. Washington, DC: USAID, n.d.

18 USAID. "Basic Village Services. Fourth Mid-project Evaluation." Office of Local Administration and Development. Cairo: USAID, 1984.

19 Rachid, A. R. H. "Local Development Overview." Cairo: Organization for the Reconstruction and Development of the Egyptian Village (ORDEV), n.d.

20 Gardner, George R., et al. *Egypt: The Basic Village Services Program*. Annual Evaluation. Cairo: USAID, 1982.

21 USAID. "Assistance to Local Governments: Experience and Issues." AID Program Evaluation Paper No. 17. Washington, DC: U.S. Department of State, 1983.

22 USAID. *Local Development II: An Egyptian-American Cooperative Program*. Program Paper. Cairo: USAID, 1985.

23 USAID. "Country Development Strategy Statement, FY 1986." Annex G. Washington, DC: USAID, 1984.

24 Chemonics. *Preliminary Designs for Pilot Wastewater/Drainage Projects in Six Delta Villages*. Prepared for USAID, Basic Village Services Program. Cairo: Chemonics, 1985.

25 Weir, John M., *et al.* "An evaluation of health and sanitation in Egyptian Villages." *Journal of the Egyptian Public Health Association*, 25, no. 3, 55-114, 1952.

26 USAID. *Rural Sanitation in the Arab Republic of Egypt*. Prepared for USAID by MetaMetrics, Inc. Washington, DC: USAID, 1981.

27 Coopers and Lybrand Associates, Ltd. "Egypt Provincial Water Supply Project Report on a Survey of Consumers' Attitudes Towards Potable Water Supplies." Prepared for the International Bank for Reconstruction and Development, 1979.

28 ARE. General Organizations for Sewerage and Sanitary Drainage. *Rehabilitation and Expansion of the Cairo Wastewater Systems*. Interim Development Plan Report, No. 1, Vol. 2, Appendices, prepared by AMBRIC, American British Consultants, in association with ATCO, SANES and TENCON, p. 43, 1980.

29 Blue, Richard N., David W. Dunlop, Michael Goldman and Lloyd S. Harbert. *PLO 480 Title I: The Egyptian Case*. AID Project Impact Evaluation No. 45. Washington, DC: USAID, 1983.

30 Amato, Peter. "Water and Wastewater Tariff Rates." U.S. Agency for International Development: Mission to Egypt. Economic Policy Discussion Paper #2. Cairo: USAID, 1983.

31 Miller, F. DeWolfe, Mohamad Hussein, Khalil H. Mancy and Morton S. Hilbert. *Shistosomiasis in Rural Egypt: A Report of U.S.-Egyptian River Nile and Lake Nasser Research Project*. Athens, GA: Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, 1978.

32 El Katsha, Samiha. "Progress Report on Women, Water and Sanitation." Cairo: Submitted to the Ford Foundation, 1985.

Aspects of Egyptian Hydrogeology

by ***Robert Bowen***
Geologisches Institut der Universität Köln
*(Cologne, Federal Republic of Germany)**

**Present address:*
Geologisch-Paläontologisches Institut
4400 Münster, Corrensstrasse 24, F.R. Germany

ABSTRACT

The hydrometeorology of Egypt is examined and the groundwater situation analyzed with reference to the use of environmental isotopes and the information they can provide as to pluvial and post-pluvial inputs to the Nubian aquifer system. Recharge to and discharge from this vast reservoir of partly fossil water indicate its dynamic state. The water table has declined appreciably in historic times. Lack of data makes extreme caution advisable in drawing general conclusions.

INTRODUCTION

Egypt bestrides two continents and is bounded by the Red Sea to the east, the Mediterranean to the north and the Great Sand Sea of the Sahara to the west and parts of the south. The country is divisible into the Sinai Peninsula, the Eastern Desert, the Nile Valley and the Western or Libyan Desert. The Sinai and the Eastern Desert are characterized by high relief and are wetter than the western part of Egypt. Parts of both comprise crystalline rocks of the Arabian shield extending across the Suez graben.

Most of the 47 million Egyptians live on the 4% of the land irrigated by the Nile and its enormous delta. Historically, this was called the "long river between the deserts" and it has no tributaries in Egypt. Many dams have been constructed to regulate its flow, the largest of which is the Aswan High Dam completed in 1971 and impounding Lake Nasser which has a storage capacity of 48 billion cubic meters and has added 728,500 hectares of irrigated land to the total available for cultivation. The Nile River system developed in the middle or late Miocene in an area of structural weakness in response to sea level changes in the Mediterranean.

Most . . . Egyptians live on the . . . land irrigated by the Nile and its enormous delta

This sea was isolated from the world oceanic system then and became dessicated, see e.g. C.G. Adams et. al. [1], Egypt simultaneously undergoing intense erosion. Subsequent transgressions and regressions are evidenced, these showing that much deeper and larger rivers than the existing one formerly existed.

West of the Nile lies the Western (Libyan) Desert which is much flatter than the Eastern Desert and includes several Quaternary depressions and oases such as Qattara, Farafra, Siwa, Kharga and Dakhla. Eolian processes were important in excavating these. This desert contains important minerals such as iron ore at Bahariya, petroleum at El Alamein and phosphates at Abu Tartur. Below it, there is a vast artesian groundwater reserve considered sufficient to permit a major development project, that of the New Valley. Geological surveying began early. A map on papyrus dating from the 19th Dynasty King Seti 1 illustrates the El Fawakhir gold mine, the British much later founding the Egyptian Geological Survey in 1896. More details are given by G.N. Rassam [2].

In general, in Egypt, crystalline basement outcrops margin epicontinental, sedimentary basins, diminishing in extent northwards. They constitute huge massifs such as the Gebel Uweinat and the mountains of the Eastern Desert. Rifting along the Red Sea occurred during Oligocene or early Miocene times and separated basement outcrops from similar exposures in Saudi Arabia and Yemen, Sinai, etc. The epicontinental sedimentary series began with early Paleozoic

Below it, there is a vast artesian groundwater reserve

0250-8060/86/$3.30 *Water International, 11* (1986) 64-70