The Central Region: Problems and Perspectives

Yahia Abdel Mageed
and
Mahmoud Abu-Zeid

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INTRODUCTION

The Arab region is one of the most dry and water scarce zones in the world. Its average water availability is 1,700 m^3 per capita, which may be compared to the world average of 13,000 m^3 per capita. Although it spans a wide diversity of climate extending from the equatorial humid tropics in its southern tip, through Mediterranean weather to the temperate zone in the north, 40% of the land area is desert.

The water scarcity condition which characterizes most of the region continues to pose a serious constraint on development and the environment. Since the dawn of history the region witnessed spectacular ancient fluvial civilizations in Egypt in the Nile delta, and in Mesopotamia on the banks of the Euphrates and the Tigris. Clive Ponting in *A Green History of the World* describes the rise and fall of the Sumerian empire in the latter basin, the first civilization to develop script. Huge canals siphoned off considerable amounts of water to irrigate vast expanses of land. Continuous forest clearing for the expansion of irrigated agriculture induced soil erosion, local climatic changes, reduction of rainfall and desertification. In addition, the irrigated lands suffered from impeded drainage and rising water tables, eventually leading to the collapse of environmental stability. If one visits the Mesopotamian desert now it is hard to imagine that these very soils supported the Sumerian civilization 4,500 years ago.

Since the beginning of this century, the Arab region, due to its strategic location at a crossroads of the world, became a stage of complex political and huge economic interventions, particularly after the construction of the Suez Canal and the discovery of huge fossil fuel reserves. Water was an important tool and played a pivotal role in these interventions. Today, the water sector poses a constraint to development and carries potential risks for the future, not only from the difficulty of satisfying rising and increasingly adversarial demands for water, but potentially threatening the integrity of the environment and the water resource base.

In recent history, the Arab region has witnessed major projects to harness its water resources to meet the increasing needs of the populations for food, and for industrial and domestic water supplies. These projects include a number of impoundments in the major basins of the region, spectacular among them the high Aswan Dam, the Great River project in Libya which extracts fossil ground water reserves and transfers them to the coastal areas, and the Jonglie Canal project in Sudan, aimed at the long distance transfer of water from the Sudd region to the water scarce zone in the north of Sudan and in Egypt, which has not been completed due to circumstances in Southern Sudan.

The region's population growth ranks among the highest in the world. Present population, estimated at about 200 million, is expected to reach 300 million by the year 2010 and 750 million by the middle of the 21st century. The region is now witnessing huge demographic changes. Urban and industrial centers along the river banks and the coastal areas are growing at enormous rates. It is estimated that almost two-thirds of today's population lives in urban and industrial conglomerates, exerting a lot of pressure and straining water supplies and sanitation facilities. Irrigated and rain-fed agriculture have expanded into marginal lands, and due to the absence of adequate infrastructure and the increasing population pressure, pastoral systems have broken down in many areas in the region. All these developments are leading to serious environmental consequences disturbing the resources base and the

sustainability of production. The food gap in the Arab region increased from $2.5 billion in the mid-1970s to $13 billion in the mid-80s and food imports to the region stand now at $23 billion (AOAD, 1986).

Following the 1973 confrontation in the Middle East and the sharp rise in the price of petroleum products, food self-sufficiency and food security became the catchword for most of the region. The central region, particularly Sudan, came to be seen as a focal area where untapped land and water resources offered vast opportunities for the investment of Arab funds to realize goals of food security and self-sufficiency for the Arab world..

THE CENTRAL REGION

The Arab central region includes Egypt, Sudan, Somalia and Djibouti. Unlike the other regions, the Central Region is composed of two distinct sub-regions separated by the Ethiopian plateau which is the main source of water to both of them through the Blue Nile, Atbara and Sobat of the Nile system and the Wadi Shebelli and Juba systems. In geographic, climatic and hydrologic features the Somali/Djibouti sub-region relates more to the southern part of the Arab Peninsula than to the Sudan/Egypt sub-region. For the Somali/Djibouti sub-region, population interactions across the Gulf of Aden are dominant, while the Ethiopian highlands act as a barrier against such interactions with the Sudan/Egypt sub-region. The water supplies of both sub-regions, apart from direct rains, are transboundary resources shared with other riparians.

Central Region Land and Water Resources

The central region constitute 30% of the land area of the Arab region and has a population of 85 million people, 38% of the total population of the Arab region (see Table 1).

Table 1
Land Resources

Land. Ave.		Agric. Land	Forest	Pasture
Arab Region	1401.4	198.2	130.3	1401.4
Egypt	100.2	4.5	--	100.2
Sudan	250.5	59.0	91.0	250.5
Somalia	63.5	9.0	8.8	63.5
Djibouti	2.3	0.01	--	2.3
Central Region	416.8	72.51	99.8	416.8
% of Arab Region (rounded)	30.0	36.0	77.0	30.0

Table 2 gives a summary of the water resources of the Central Region in relation to the Arab Region total. It is, however, cautioned that these global figures be taken as indicators rather than as quantities of water reliably available for use. Agriculture accounts for 80% of the use of this water, and agricultural use, whether rainfed or irrigation, cannot be based on average annual yield, but only on at best an 80% reliable year, which is very much less than the average. The quantities of water above are not always available in the places and times when they are to be used.

Table 2
Water Resource in BCM

	Rainfall	Surface Water	Ground Storage	Renewable Recharge Water
Arab Region	2211	295.60	7730	42
Egypt	15	*60.50	6000	4.5
Sudan	1094	*23.00	39	1.0
Somalia	191	8.15	--	3.3
Djibouti	4	0.20	--	--
Central Region	1304	91.85	6039	8.8

Source: Khouri *et al.*, 1986, modified.

The asterisked figures above are the surface water that reaches Aswan; they include the 10 billion cubic meters (bcm) that are lost by evaporation in the High Aswan Lake. When that subtraction is allocated equally between the two countries, 55.5 and 18.5 bcm are available for use by Egypt and Sudan, respectively, according to the 1959 Nile Waters Agreement. It is planned, however, to increase the yield of the Nile by about 25% through conservation projects in the Egypt/Sudan sub-region to meet future demands.

In many studies and documents it is estimated that the average water resource of the Arab Region is 338 bcm, of which 296 bcm are surface water and 42 bcm are renewable groundwater. The present water use is estimated at 172 bcm, of which 140 bcm are from surface water. The use in the year 2030 will be 435 bcm with a gap of about 100 bcm. If we take an 80% reliable year, the gap will be much bigger than this figure. However, this does not apply to the Nile as the over-year storage in the High Aswan Lake guarantees the average yield of the Nile of 84 bcm at Aswan.

While the Central Region remains the richest in terms of land and water resources within the Arab Region, it is the poorest in terms of GNP/capita ranging between $600 in Egypt to $120 in Somalia, compared to an average of $1720 in the Middle East and North Africa (World Bank, *World Development Indicators*, 1992).

SUDAN/EGYPT SUB-REGION

Egypt and Sudan are the principal downstream riparians in the Nile basin, which is the main source of surface water supply to both of them. The Sudan is the meeting place of all the Niles originating in the Ethiopian highlands and the Equatorial Lakes beyond the borders of the Sudan and Egypt. The river is unified as the main Nile to cross Egypt to the Mediterranean Sea. Over the years, despite natural barriers such as the six cataracts in the north and the Sudd region in the south, the waters of the basin have brought about significant political, cultural and economic relationships between Sudan and Egypt on one hand, and the higher riparians on the other hand. Development and water use patterns and trends in the basin have to a great extent been influenced by the hydrological characteristics of the river, and by political and economic events and circumstances that prevailed at the basin at different times in history.

The Basin's Natural Characteristics

The basin has a total area of 2.9 million km^2 and an average annual discharge of 90 bcm at Aswan over the last hundred years; its monthly and annual discharges vary considerably. The annual discharge that reached Aswan in normal years (1912-1955) amounted to 84 bcm, based on the following contributions:

Blue Nile	59%
Sobat	14%
Atbara	13%
Bahr El-Jebel	14%

The contribution of the Ethiopian plateau amounts to 85% of the flow of the Nile at Aswan. Out of the annual flow of other waters totalling 46.6 bcm entering Sudan (equatorial lakes:34.6 bcm, Bahr El-Ghazal system flow: 12 bcm), only 15 bcm reach the White Nile. A total of about 34-40 bcm form the vast swamps of the Sudd region of Bahr El-Jebel and Bahr El-Ghazal which are largely lost by evaporation and evapotranspiration.

The annual discharge at Aswan in the present century varied from 104 bcm (1946) to 42 bcm (1913). This sharp variation is mainly due to variations in the river systems originating on the Ethiopian plateau. The seasonal variations of the Blue Nile for the period 1912-1982 range from 6200 m^3/sec during flood to 125 m^3/sec in the dry season.

The White Nile system's seasonal variations range from 525 m^3/sec to 121 m^3/sec and this is mainly due to routing effects at the equatorial lakes and the Sudd region. Out of the total annual flow at Aswan almost 65% is contributed during the flood time, August to October.

Annual rainfall in this sub-region ranges from 1500 mm in the southern tip to nil in the north, except for the narrow coastal area in the northern tip of Egypt and the Red Sea coastal area which receives some winter rainfall. The duration of the rainy season ranges from 7 months in the southern Sudan to 3 months in the central Sudan. Direct rainfall is an important source for forests, pasture and rainfed crop production in the Sudan.

These natural characteristics have had over the years a marked influence on the patterns of water management and development, which have aimed to meet the increasing and diversified needs of the population. Egypt, being the most downstream state and having no other sources of water supply, suffered the most from the annual and seasonal fluctuations of the river. Basin irrigation was the earliest form of irrigated agriculture practiced by diverting flood waters to the low-lying fertile soils of the delta by a system of canals and dikes. This practice was later transferred to north of the Sudan. Egypt has always been threatened by the devastating floods of high water years, and by low flood years that result in shrinkage of the irrigated basins and a consequent shortage of food. These were the problems that tempted the Egyptians to penetrate into the upper reaches of the basin in search of flood control and storage sites to meet their increasing needs for water. Over the years, annual storage reservoirs were built to store water from the tail of the flood to augment the low dry season flows. Multi-year storage came into being with construction of the Aswan High Dam to guarantee the average annual flow of the river. Since the beginning of the century plans were in hand for conservation works in the Sudd region of the Sudan to reduce the losses there and thereby increase the yield of the river.

Development and Hydropolitics

Following the fall of the Turkish rule, the basin became a stage for European interventions and domination which continued up to the middle of this century, and was divided into influence zones. Most of the basin – Egypt, Sudan and the East African countries – fell under the influence of Great Britain. At the turn of the century, Great Britain concluded three agreements which applied only to upper riparians of the basin. They prohibited any construction without British consent on the tributaries of the Nile above the Sudan and affecting the flow of that river. These included the 1891 agreement with Italy, the 1902 agreement with Ethiopia and the 1906 agreement with the Congo Free State (Teclaf, *The River Basin in History and Law*, date). Sir William Willcocks, the famous Nile architect, declared in 1903 that with the aid of concrete, steam and electric power, of huge dredges and dynamiting equipment, more could be constructed in two decades of the modern era than during an entire dynasty of rulers in antiquity employing corvée labor and armies of prisoners. Already in 1890 he had planned the Aswan dam on the Nile for irrigation and navigation, one of the first multi-purpose projects in the world. The Aswan Dam, completed in 1902, marked the beginning of expansion of modern irrigation in Egypt. It is an annual storage dam arresting part of the flood in order to increase river yield during the dry season. The main goal of the British policy was to expand cotton production for the textile industry in Britain.

Following the reconquest of the Sudan in 1899, further plans were made for expansion in irrigation mainly for cotton production both in Sudan (the Gezira) and Egypt. These plans included heightening of the Aswan Dam, providing storage facilities for Egypt in the Sudan at Jebel Awlia in the White Nile, and Sennar Dam on the Blue Nile for irrigation of the Gezira projects. These plans were interrupted by World War I, but immediately after the war were put into motion. This set of projects necessitated new arrangements for apportioning the Nile waters between Sudan and Egypt, and for examining basin-wide plans that emerged for over-year storage in the equatorial lakes, for flood control proposals concerning Lake Tana and Sudan, and for provision of timely water for Egyptian needs. The 1929 Nile Water Agreement was concluded between *xxxxx and Great Britain on behalf of Sudan and the East African countries and the government of Egypt.

The working arrangements based on the agreement provided Egypt with full rights over the whole natural flow of the river during the dry season from January to July with very limited withdrawal by the Sudan during this period. The agreement also stipulated that the East African countries would not construct any works in the Equatorial Nile without consulting Egypt and the Sudan. The British government used its good offices to facilitate the establishment of over-year storage in the equatorial lakes linked with the conservation projects in the Sudd region to increase the Nile yield. It gave the Egyptians facilities in the Sudan and in the East African countries to gauge the river and oversee its control.

This agreement has limited the development of irrigation in the Sudan to the Gezira project, with cotton as the main crop over an area of 1 million acres and a cropping intensity of 50%. During the Korean War and with the sharp increase in cotton prices, further irrigation areas were developed totalling 500,000 acres in the Blue and White Niles, drawing only flood waters from July to the end of December. This situation created a potential conflict between Sudan and Egypt in the apportioning of Nile water. In the period of the independence of the Sudan, this question became over-politicized, particularly because there were strong political movements in Sudan for unity with Egypt and for an independent Sudan in coalition with Britain. The Nile water question became an important issue in creating rivalries between the two countries, particularly after the 1952 revolution in Egypt.

This was a deliberate British policy. The 1929 agreement did not stand in the way of Sudan's irrigation expansion. It is known that the irrigation development potential of the Sudan is in the vicinity of the Blue Nile and Atbara River, and no appreciable development can be made without provision of storage dams to store part of the flood waters to use during the dry seasons. Therefore, it was not the 1929 agreement that restricted such development, but a deliberate delaying policy. By the time the two countries resolved the Nile question in 1959, the Sudan had established rights to only 4 bcm, compared to Egypt's 48 bcm, while 32 bcm of the flood water found its way to the sea.

After the 1952 revolution, the concept of over-year storage in Aswan emerged, seeking to control the full flow of the river and to gain 32 bcm of water otherwise lost in the sea (net benefit of 22 bcm, since 10 bcm is lost to evaporation from Aswan Lake). This project, despite many unjustified criticisms, has resolved the conflict accumulated by the 1929 agreement between the two countries by lifting the restriction of abstraction during the dry season and guaranteeing an average flow of the river of 84 bcm. The 1959 Nile water agreement between the two countries divided the net benefit of 22 bcm, 14.5 bcm to

Sudan and 7.5 to Egypt, making their shares 18.5 and 55.5 bcm, respectively. The agreement formed the first joint commission between the two countries ever to be established in the basin, laying down the foundation for basin-wide cooperation. It also recognized the riparian rights of the other basin states.

1959, during the cold war era, was in a period extremely politicized by issues having nothing to do with water, but water issues were used to deepen the rivalries between the basin countries as dictated by the world politics of that time. The 1959 Nile waters agreement resolved the most critical conflict in the basin between the two downstream countries, Sudan and Egypt. Since its conclusion 34 years ago, no harm has been inflicted on the upstream countries of the basin. Present withdrawals in the upper riparians are not felt downstream. There are plans, however, in the future for irrigation of 130.000 hectares in Uganda, 57.000 in Kenya and 200.000 in Tanzania in the catchment of White Nile system (UNDP Fact Finding Mission Report, 1989). In Ethiopia, according to a 1984 FAO study, the potential for irrigation identified in the Blue Nile basin includes 100,000 hectares of perennial irrigation and 165,000 hectares of small-scale seasonal irrigation. The irrigation water requirements in these humid zones are very much less than those in the arid and semi-arid zones in Egypt and the Sudan. Therefore, this should not form an obstacle to basin-wide cooperation.

Discussing the problems of water in this sub-region in the context of water in the Arab region should not obscure the merits of considering the water in this sub-region in its basin-wide context, although the geography of the southern part of the basin leads away from the Arab world. The basin is a hydrologic unit and an economic unit. It has vast potential for socioeconomic development and for increasing the well-being of the basin societies, particularly in the agricultural sector which is the primary sector for economic growth in all the basin states. The overall Nile basin has a potential to contribute towards the Arab region's food requirements and to offer other agriculture raw materials. The Nile basin has vast untapped water and water energy potential in its upper and lower reaches awaiting investment to mobilize the agricultural resources for food self-sufficiency within the basin, and to create food surpluses to meet market opportunities readily available in the Arab region.

Egypt and Sudan have almost utilized their shares allocated by the 1959 Nile waters agreement between them. Egypt's present water use and availability in bcm is as follows:

Water Use		Availability	
Irrigation	49.7	Nile	55.5
Municipal	3.9	Groundwater	2.6
Industrial	4.6	Agriculture Drainage	4.7
Navigation and Regulation	1.8	Deep Fossil Waters	0.5
TOTAL	59.2	TOTAL	63.5

Source: Abu-Zeid, *Egypt's Water Resources Management and Policies*, 1992.

By the year 2000, Egypt's water requirements will be about 69.4 bcm. In the Sudan the total committed use from the Nile waters up to 1990 is 16.17 bcm from its share in the Nile waters amounting to 20.5 bcm (18.5 bcm at Aswan). Most of the projects that were planned during the late '70s and '80s, including heightening of the Roseries Dam on the Blue Nile, the Setit projects, and associated expansion in irrigated areas including Rahad II and Setit irrigation project (totalling 1.0 million asic, were postponed due to economic difficulties.

According to these plans in Sudan and similar plans in Egypt, both countries went ahead to implement the Jonglie Canal project in the mid-1970's, the first conservation project in the Sudd region, which aimed to increase the river yield by 4.0 bcm at Aswan. However, construction of the project was suspended in 1983 due to disturbances and political conflict in the southern Sudan, with almost two-thirds of the canal completed.

The Sudd region in the Sudan is the largest fresh water swamp in the world, where almost 50% of the waters originating in the equatorial lakes are lost in the Bahr El-Jebal swamps. Almost all the rainfall in Baha El-Ghazal, amounting to about 15 bcm, is lost in the Bahr El-Ghazal swamps and never reaches the Nile. Over 12 bcm are lost in the Machar marshes from the Sobat system and from the eastern torrents originating in the Ethiopian highlands. Since the beginning of the century, there have been plans for an Equatorial Nile Project such as the Jonglie Canal providing conservation works to reduce losses of the water which is needed to meet the increasing needs in the arid and semi-arid north. Egypt and Sudan have plans to ultimately increase the Nile yield by 18 bcm to be divided equally between them, according to the 1959 agreement.

However, these conservation projects have complex political and environmental implications within the Sudan and for the upper riparians. Within the Sudan, the development in the southern Sudan very much depends on sound environmental management of these swamps. The water conservation projects within the swamps to increase the Nile yield will ultimately create an environment conducive to development in the south. As for storage works required in the equatorial lakes on the territory of upper riparians, the merits of such projects for them need to be justified within a system of very strong Nile basin cooperation. Despite all these complexities, the Sudd region's waters remain a promising source to meet the increasing needs in the basin and particularly in Egypt and Sudan.

Development and the Environmental Challenges

Since the conclusion of the 1959 Nile waters agreement, Egypt and Sudan have embarked on major programs to control the river and to expand irrigated agriculture and hydropower generation.

In Egypt, with the completion of the High Aswan Dam, the land reclamation program which started in 1953 gained momentum. This was coupled with a deliberate policy of industrialization utilizing the 2100 MW of hydropower that became available from the high dam. The land reclamation program included expansion of irrigation by about 2.50 million acres in areas outside the old congested valley lands. These extensions are planned all over the country, in the east Delta and Sinai, middle Delta, middle Egypt, upper Egypt and the New Valley. Water needs for these new areas will be met by waters from the High Dam, by the reuse of drainage waters, and in limited amounts from groundwater in the New

Valley and the coastal areas. These sources are in addition to waters that will become available from the conservation projects in the Sudd regions in southern Sudan.

Since the completion of the high dam in the mid-60s, this program has met with many constraints and difficulties. They were caused mainly by the war with Israel and the economic crisis associated with it, which has effects remaining to our present times. The total area reclaimed to date is about 986,000 acres, mainly in the western Delta. The same period witnessed the growth of enormous urban and industrial conglomerates in the old lands and associated demographic changes. Agriculture's share of the GDP fell from 34.3% in 1955 to 20% in 1990, while its share of employment fell from 56% of the population to 10% over the same period (Abu-Zeid, 1992). Land loss to top soil skimming and urbanization averaged 30,000 acres per year. There is still a big gap between the areas reclaimed and those cultivated, due to constraints on settling farmers, and a major portion of the lands have not yet reached target production. Egypt's old lands, due to intensive cropping, are suffering from water logging and salination, and marked decline of productivity.

It could be concluded that the High Aswan has certainly provided flood protection for Egypt and a safe water supply in the summer, making a double harvest possible throughout the country. It has also provided inter-annual storage to boost lean years. However, hopes for irrigation of additional land have been only partly fulfilled (Meybeck, Deborah and Helmer, 1989).

Depriving the old valley lands of the silt which now accumulates in the lake has necessitated a marked shift towards artificial fertilization. Increasing cropping intensities have been practiced in the old lands after the construction of the high dam, and since water continues to be a free commodity in Egypt, farmers tend to overwater their fields. These factors have led to more water logging as drainage programs have progressed too slowly. However, the long-term problem will be salt. Salination is increasing rapidly and yield and consequently revenues are decreasing as a result of soil degradation.

The major challenge facing Egypt now is the absolute need to better develop and manage very limited natural resources of water, land and energy to meet the needs of the population which is increasing at 2.5% per year. The population of Egypt was 36 million in 1960, 56 million in 1990 and is expected to be 70 million by the year 2000. Egypt has to import two-thirds of its wheat and vegetable oil. The nutrition food gap in Egypt is estimated at 40%.

The availability of good quality water in Egypt is also strained by the increasing discharges of untreated industrial, domestic and agricultural wastes into the fresh and marine water systems. Lake Manzala is a good example of this. One study estimates that the sixty six agricultural drains into the lake that are monitored carry an annual discharge of 3.2 bcm which includes raw sewage from 5000 rural centers and semi-treated or untreated wastewater from Cairo and other urban centers (World Bank, 1990). Use of different types of fertilizers increased sharply between 1960 and the present: nitrogen from 192,000 to 791,000 tons, phosphates from 48 tons to 190, and potash from 2,000 tons in 1960 to 7,600 tons in 1986.

In the face of these challenges, the Egyptian government has undertaken a number of programs and adopted certain policy frameworks. These included the Irrigation Management System (IMS), the

Structural Replacement Program, sponsored by USAID, as well as the Canal Maintenance Program, financed by the World Bank. These programs mainly aim to improve the efficiency of irrigation and drainage networks.

The most important policies adopted include:

- the water policy
- the Irrigation Development Policy: The National Irrigation Improvement Programme (NIRP)
- the reuse of drainage water policy
- the groundwater use policy in the Delta and desert areas
- the canal maintenance and prevention policy
- the aquatic weed control policy

(Source: Abu-Zeid, 1992)

For protection of water quality, Decree #xxx was issued in 1982, but it continues to face many difficulties in bringing about treatment of the sewage and industrial wastes which are the main pollutants of the Nile system in Egypt. This problem is a major growing constraint on the availability of water of good quality, and is raising a health threat.

Since the early 70s, a number of institutional reforms and policy frameworks for managing the water resources in Egypt were established. An important institutional development is the creation of the Water Resources Center (WRC), which has 11 institutes doing research on the management of water resources. Through a number of technical assistance initiatives, WRC is carrying out a number of research programs and is developing scientific and technical capabilities to face the challenges in the water sector.

In the Sudan, the management and development of water resources is more complex than in Egypt. In Egypt, the main source, the Nile, is fully controlled at Aswan. Almost all the control infrastructure is complete, and irrigated agriculture, the main user of the water, is the dominant production system.

All the Niles originating in Ethiopia, the equatorial lakes and in the Sudan, come together in the Sudan. The Bahr El-Ghazal systems with their different hydrological regimes and socioeconomic systems associated with them from the Sudd region in the desert north. Rainfall, the main source for rainfed agriculture, for the pasture system and forestry system, supports the majority of the population throughout the country. The main socioeconomic systems, including agro-forestry, sedentary agriculture systems and nomadic and pastured herding systems that prevail in the different zones are dependent primarily on the rainfall regimes. These vary in magnitude and duration from the annual 1000 mm in the south, to the desert north with no rainfall, where the only sources of water are subsurface and deep groundwater aquifers in the Nubian sandstone.

The agriculture sector in the Sudan is the primary sector for economic growth and about 80% of the population is engaged in agricultural activities, ranging from the irrigated subsector to the rainfed crop and animal production sectors. These production systems have vast land and water potential to meet Sudanese needs and beyond that, to contribute significantly toward the Arab region's food needs. But over the years, due to many complex factors, these roles could not be realized. With the persistent drought spells that struck the African continent since the mid-70s, many parts of the Sudan water-scarce zones suffered food shortage and many pockets were hit by famine in 1984.

Since the beginning of the century, coinciding with the reconquest of the Sudan in 1899, Nile waters became the focus of action for the development of the irrigation in the Sudan. The Sennar Dam which was completed in 1924 provided storage water for about 920,000 acres in the Gezira, the most modern irrigation system in Africa. As dictated by the British policy, the main crop in the Gezira was cotton on a four-course rotation with cropping intensity not exceeding 50%, a system which influenced Sudan irrigation development for many years thereafter. The production system was based on a partnership among the investing syndicate, the government and the farmers. The share of the government constituted the water rate. Up to the independence of the Sudan in 1955, irrigation development in the Sudan followed the 1929 Nile Water Agreement as explained earlier. During this period the rainfed traditional agriculture was the main source of food supply. Sorghum wheat needs at that time were limited to a small sector of the population.

With the conclusion of the 1959 Nile Waters Agreement and the construction of the Aswan High Dam, the Sudan share of Nile water increased from 4.0 bcm to 18.5 bcm at Aswan (20.5 bcm in the Sudan) and restrictions imposed by the 1929 agreement on the natural flow between January and July were lifted. Between 1959 and the present the Sudan's irrigation system expanded from 1.5 million acres to 4.5 million acres.

The cropping patterns and crop-water relationships between the government and the farmers almost followed the Gezira pattern. Storage of water to realize this expansion was provided by Roseries Dam in the Blue Nile and Khashin El Girba Dam in the Atbara River.

This horizontal expansion of irrigated land in the last two decades was backed by a vertical expansion of intensification and diversification programs to meet the increasing needs for wheat and (food) oil. Plans were done to raise the crop intensities of the Gezira project and its managed extension totalling 2.0 million acres from 50% crop intensity to 100%. All new projects were designed to 100% and even 150% intensity in the northern parts of the country to achieve food self-sufficiency. This policy has increased the need for more storage facilities in the Blue Nile and Atbara rivers. Plans were prepared to heighten the Roseries Dam and for future storage dams at upper Atbara and Setit. It became evident that to meet the water requirements it would be necessary to provide more water by increasing the Nile yield through conservation projects in the Sudd region. The mid-70s witnessed the start of the implementation of the first phase of the Jonglie Canal.

The same period witnessed the emergence of mechanized rainfed farming in the east of the Sudan, in the Gadaref area and the southern parts of the Blue Nile province.

Following the 1973 war with Israel, and the sharp rise in fuel prices, food self-sufficiency and security emerged as a preoccupation of the region. Sudan, which at the time was experiencing a period of political stability following the 1972 accord which had halted the seventeen year war in the country's south, received much attention a major potential contributor to achieving such food security. The Arab Fund for Economic and Social Development in 1975 made an important initiative in this direction, aimed at a comprehensive 10-year program to develop Sudanese agriculture to meet its own needs and to create a surplus for the Arab region market. This ultimately led to the establishment of the Arab Authority for Agricultural Investment and Development (AAAID) in the Sudan in 1978. The authority started modestly, but very soon was caught off guard by the political complexities within the region, and by economic and political instability within the Sudan itself. The program of the Authority was finally interrupted after the Gulf War. However, it is continuing its management of the projects implemented in Sudan and is doing feasibility studies according to its mandates in other countries of the region.

In 1973, the Arab League established the Arab Organization for Agricultural Development with headquarters in the Sudan. This organization has assessed the natural resources of the Arab region and developed a strategy for Arab food security and a comprehensive program to achieve its goals. Nonetheless, due to economic and political constraints, the food gap in the region continued to increase sharply.

During the 1980s, the Sudan's natural resource base witnessed major challenges. A host of economic, racial and political factors, together with the persisting drought spells that prevailed in the last two decades, have led to critical environmental problems. Population and animal pressures are increasingly straining the resource base, as over-grazing, excessive tree felling and expansion of agriculture into marginal lands are leading to soil degradation and desertification. The rainfed areas are witnessing production declines due to lack of proper water management in both the high rainfall areas and in water-scarce zones. The sustainability of the irrigation systems is threatened by lack of funds for operation and maintenance, by poor irrigation efficiencies, and by increasing intensification of cropping.

Due to the drought spells and the war in the south of the country, enormous demographic changes are taking place in Sudan. Rural-urban immigration is increasing sharply, exerting increasing pressures on domestic water supply facilities and creating health hazards.

Many efforts are being made in terms of institutional reforms and adoption of many institutional reports, but still management of water resources remains fragmented and overfocused on Nile surface water, and lacking in a comprehensive approach. All efforts will remain futile without a broader vision of water and water-related issues, and without sufficient funding and capacity-building to tackle these environmental challenges.

THE PERSPECTIVE

The problem of water in the central region is critical. This critical situation cannot be judged by the gap in quantity of water as is reflected in much literature. That is an over simplification of the

problem, which in reality is much more complex. It goes beyond just a gap in water quantity, and needs to be seen in the context of emerging environmental problems.

- Most of the major river basins in the central region are transboundary, originating outside the region. Therefore, water needs to be considered in the basin context and requires cooperation among the basin states, most of which are outside the region. In the present time, despite the many efforts in this respect, the accumulated over-politicization of basin relationships is obstructing the benefits of such cooperation and may lead to water conflicts which will endanger the maintenance and sustainability of water resources for the benefit of society.

- Water scarcity is resulting from the vulnerability of the arid and semi-arid climate in the face of population growth. There are increasing pressures on a finite water availability, and an increasing point demand for water for urban centers.

- In the last two decades, many pockets in the central region (Sudan, Somalia) have been hit by persisting drought leading to very grave environmental consequences, including dislocation of population, particularly in the pastoral systems.

- Water pollution is emerging as another threat to water resources systems (Egypt). It is threatening water availability, and affecting marine life in the coastal areas. The main sources of pollution are untreated domestic, industrial and agricultural wastes.

- Water-related soil degradation and the spread of desertification is another threat facing many parts of the region. This includes water logging, and salination resulting from poor irrigation management and poor drainage systems. Rainfed agriculture, which constitutes a major food production system, is suffering from many ills connected with soil-water management, variability of rainfall and the shocks of drought.

- Extensive tree felling and over-grazing due to poor water supply facilities are accelerating the spread of desertification and demographic changes.

- The region is exposed to global environmental problems associated with global warming and sea level rise, pollution of international waters and depletion of biodiversity. There are scientific speculations that part of the region could be flooded within the next century, displacing tens of millions of people.

ACTION NEEDED

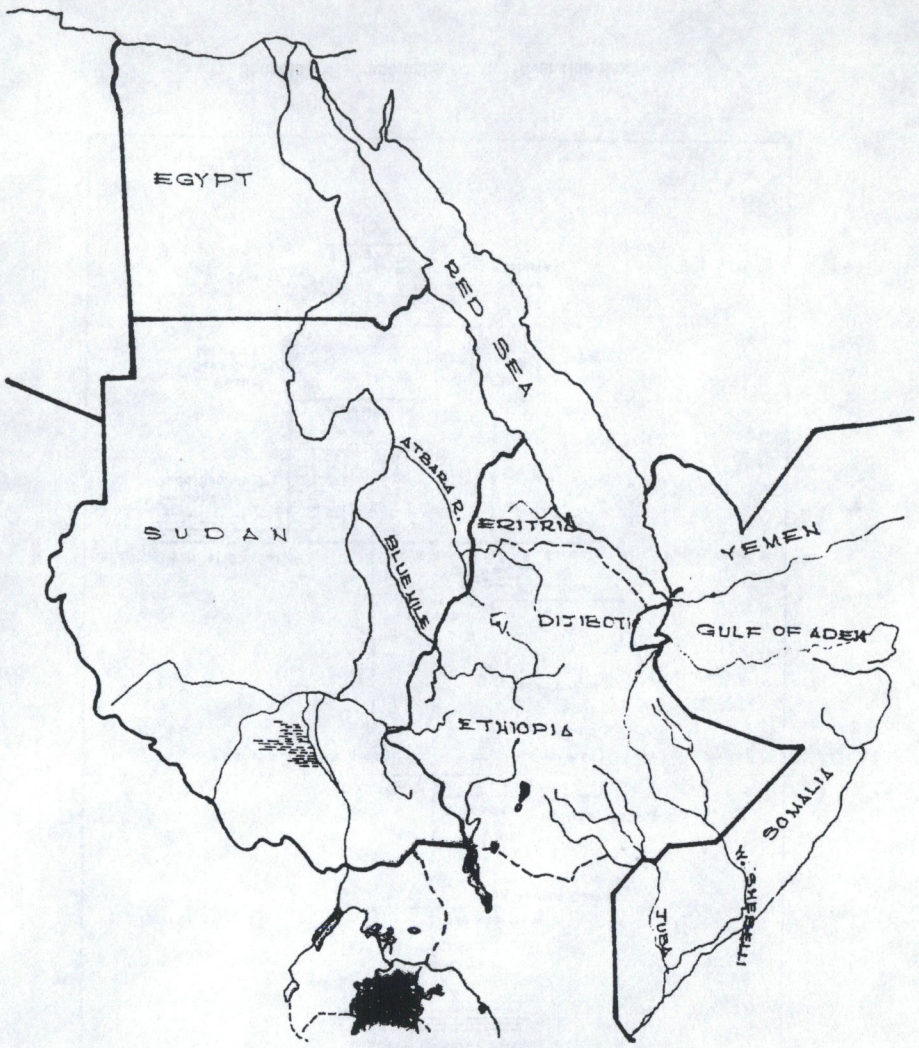
In front of these environmental challenges and threats, the countries of the region need to act at both national and regional levels to develop water policies and strategies that find a balance between short-term acute needs and the long-term perspective. Short-term strategies are necessary immediately where sustainability of life-support systems is at risk. Long-term strategies have to be developed and

implemented taking a multi-sectoral approach and integrating water-related issues with the broader national economy. The ultimate goal is a strategy for integrated and sustainable development of water resources.

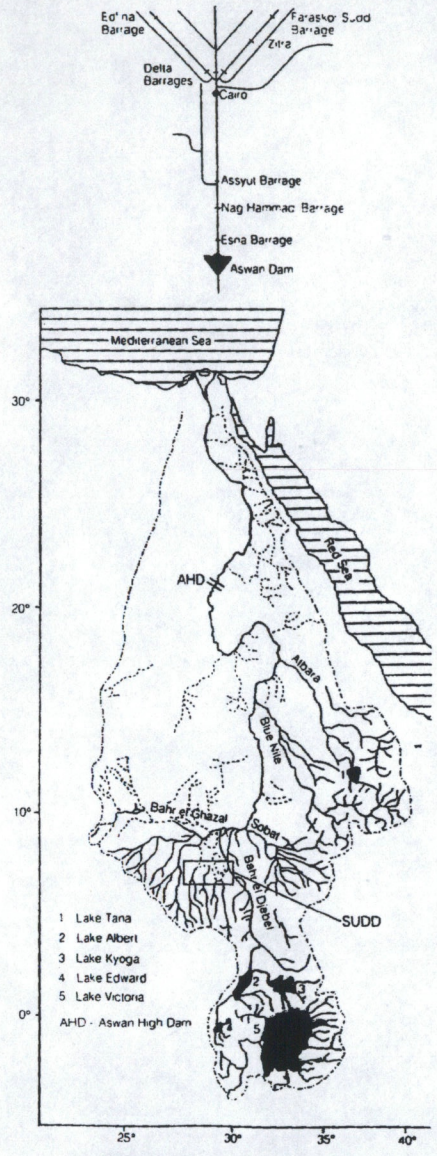
It is necessary to review and set priority rankings of water and environmental problems (of a physical and technical nature) that affect the region's development. These include the analysis of the nature of these problems and derivation of objectives for sustainable solutions.

Based on these analyses, capacity building programs can be formulated. Existing water institutions need to be restructured to move from pure professional biases to multidisciplinary functions. They should enhance their capabilities to undertake environmental assessment and management. The mobilization and involvement of the scientific community and research centers is vital for meeting these challenges.

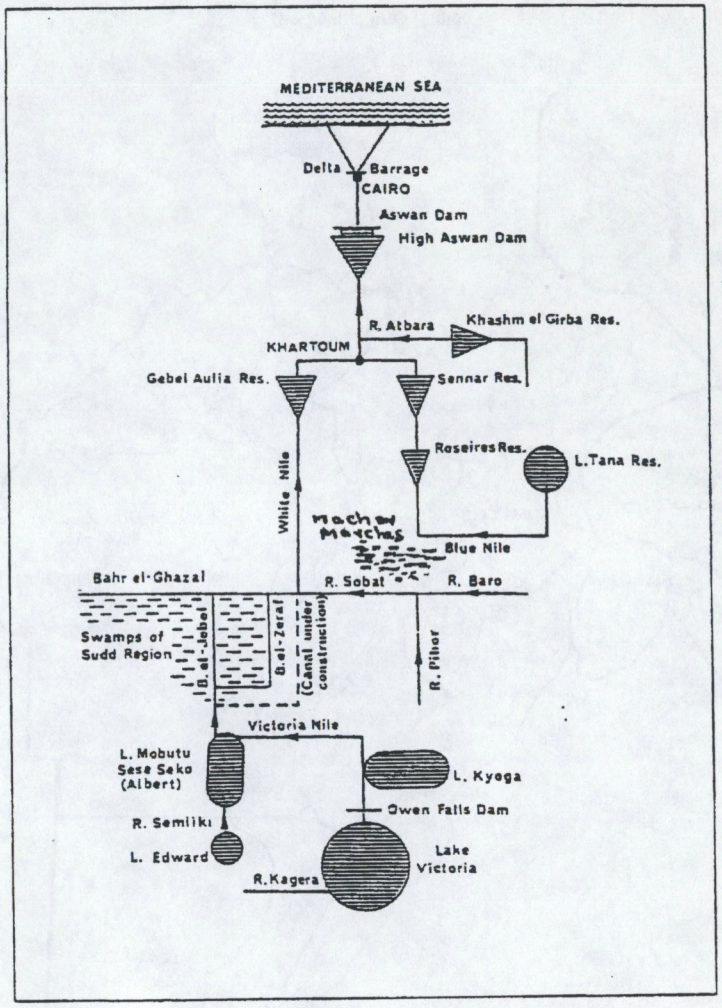
REFERENCES



The Central Arab Region



The Nile Basin



Schematic Representation of the River Nile Basin