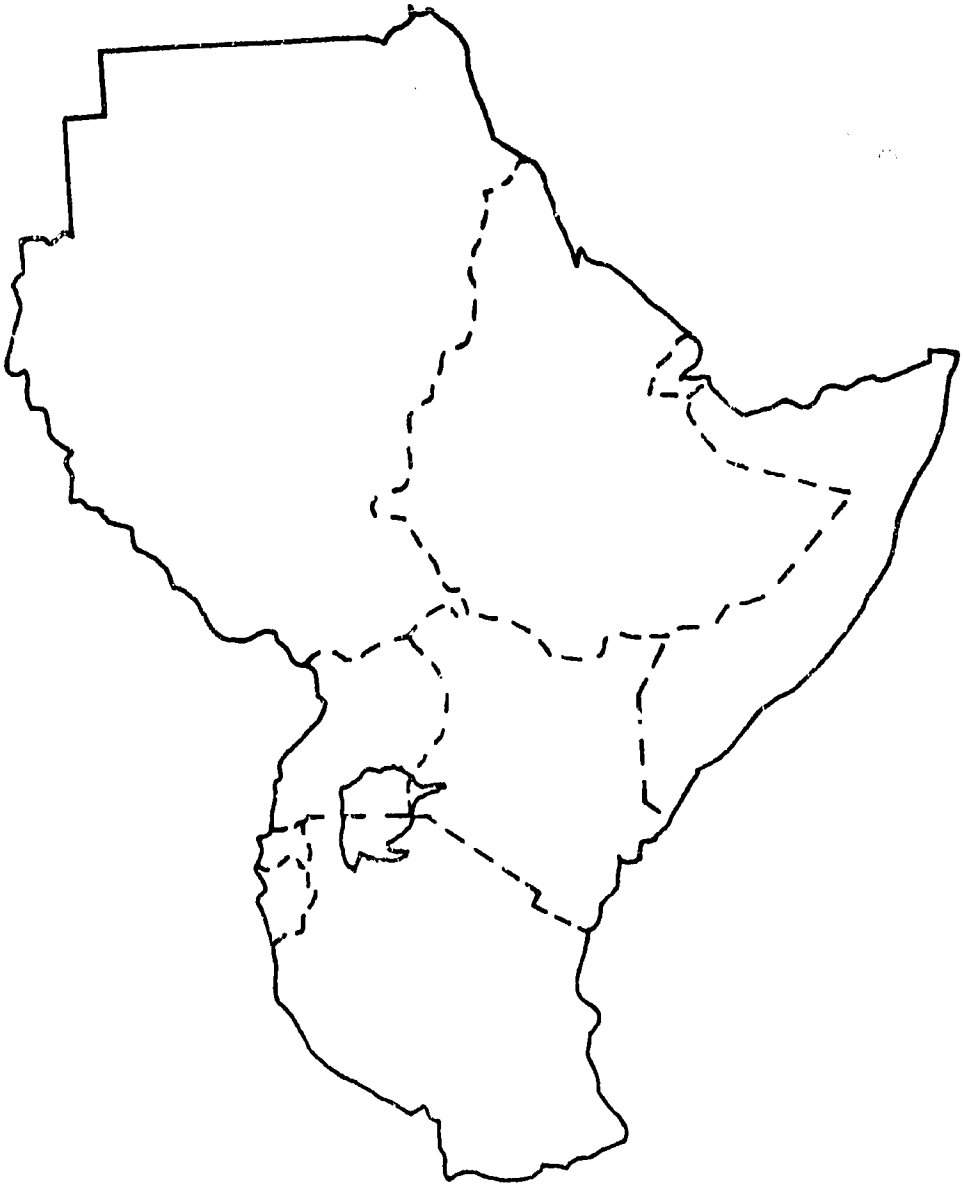
RP10

Eastern Africa Regional Studies

RIVER BASIN DEVELOPMENT



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RIVER BASIN DEVELOPMENT IN EASTERN AFRICA

A preliminary appraisal

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1. INTRODUCTION

River Basin development schemes or the damming of part of a river with associated large scale projects have come to be one of the most visible strategies for accelerating development in the Third World. The twin concerns for increasing agricultural productivity through techniques that are not totally dependent on the vagaries of the weather; and for finding local alternatives to fossil energy make these strategies ever more popular in spite of the vast resources in land, money and manpower that have to be invested.

A great deal of literature has developed questioning the contribution of such strategies to economic and social growth because of negative side effects such as salinization of fertile lands, deterioration of the environment, increased vulnerability to ill-health and diseases and inequitable distribution of benefits (Ackerman, White and Worthington, 1973; Farvar and Milton, 1972; Feacham, McGarry and Mara, 1977; Lagler, 1969; Obeng, 1977; Stanley and Alpers, 1975; to name just a few). These questions are not likely to deter governments in the Third World from embarking on such ventures. National and international pressures are much too strong. Nor is the concept intrinsically wrong; the hydraulic civilizations of the past are proof of what can be achieved. However, these civilizations are also proof of what can happen if the balance between technology, society and nature is not maintained.

2. PATTERN OF RIVER BASIN DEVELOPMENT IN EASTERN AFRICA

The use of river basins for development purposes has a long history in Africa as indicated in Table 1. Eastern Africa here includes Ethiopia, Somalia, Kenya, Tanzania, Uganda and Sudan.[1]

[1]Ethopia is included in this analysis as its use of river water has an impact on Somalia and Sudan.

TABLE 1

SUMMARY OF MAJOR RIVER BASIN DEVELOPMENT SCHEMES IN EASTERN AFRICA

Country	River	Irrigation Scheme	Irrigation Area	Hydroelectricity Scheme	Hydroelectricity Mw	Other
Sudan	Nile	Gezira	1,114,000 feddans	Roseires Dam	90	Transportation
	"	Managil	946,000 feddans	Sennar	15	
	"	Rahad	250,000 feddans	Khashm el Girba	13	
	"	New Halfa	400,000 feddans			
Kenya	Tana	Mwea	6,000 hectares	Kamburu	94	
	"	Hola	860 hectares	Ataru	216	
	Perkerra	Perkerra	200 hectares	Masinga	100	
	Nyando	Ahero	1,470 hectares	Kindaruma	n.a.	
	Nzoia	Bunyala	360 hectares			
	Lake Victoria	West Kano	883 hectares			
Somalia	Juba	Juba I	11,000 hectares			
	Shabelle	(several)	details n.a.			
Ethopia	Awash	Awash Valley Basin	24,300 hectares	Awash I, II, III Koka Power Sta.	440	
Tanzania	Pangani	details not available		Kidatu	100	
	Rufiji			Hale	21	
				Pangani Falls	17	
				Nyumba ya Munga	8	
				Moshi	20	
				Ruvu	7.5	
Uganda				Owen Falls	154	

SOURCES: See text under each country.

2.1 Sudan

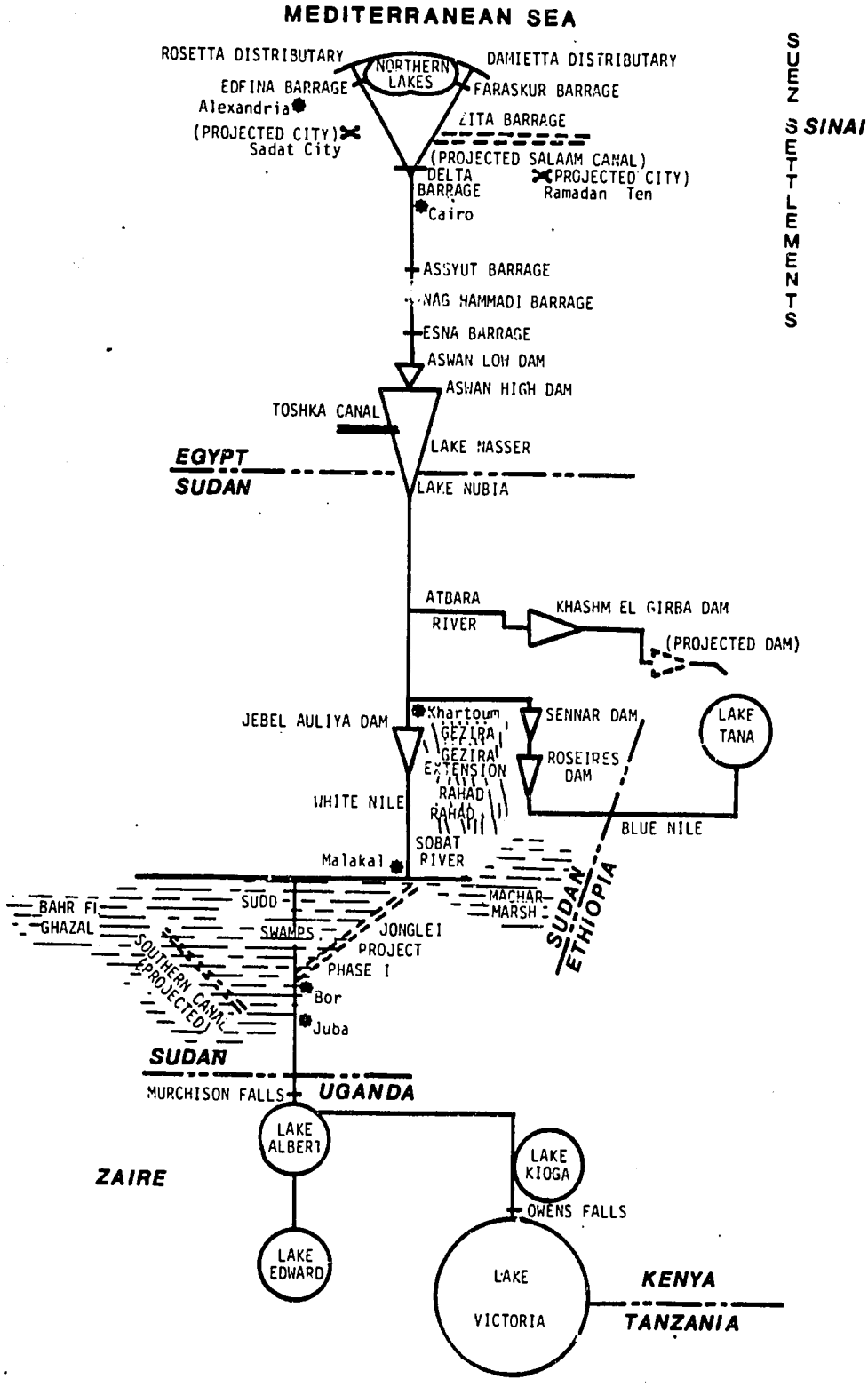
As early as 1925 Sudan began harnessing the waters of the Nile River for irrigation purposes by building the Sennar Dam on the Blue Nile to store water for irrigating the 300,000 feddan Gezira Cotton Scheme south of the junction of the two Niles. Since then the area under irrigation has increased steadily particularly with the addition of the Managil South West Extension between 1958 and 1963. The Scheme now covers 2.1 million feddans (see Figure 1.)

The regulation of the Nile waters for irrigation has required close co-operation with Egypt. Formal agreements have increased Sudan's share of the Nile waters from 4 billion cubic meters in 1929 to 18.5 billion cubic meters necessitating storage dams to be built at Jebel Aulia (1937), Khashm el Girba on the Atbara River (1964) and the Roseires Dam on the Blue Nile (1966). These dams have made it possible for Sudan to extend its irrigated agricultural land. At present Sudan uses 16.62 km ^{3}/y of its quota of 20.35 km ^{3}/y to irrigate some 4.2 million feddans. The quota will be totally used and even exceeded by 1985 and plans are underway to increase the waters available for irrigation.

In addition to irrigation Sudan also uses the Nile River for hydroelectric power and navigation. At present the three dams, Sennar, Roseires and Khashm el Girba together have an installed capacity of 118 MW. The existence of cataracts, rapids and gorges along the main Nile and low flows during the dry season as well as vegetational obstructions along the Bahr el Jebel and White Nile prevent the full utilization of the Nile for navigation. Nevertheless a network of 3,000 km is currently available and the present transport capacity is estimated at 200,000 tons per year. Future plans are likely to be concentrated on the Blue Nile which links Khartoum with the most productive region of the Sudan.

FIGURE 1

SCHEMATIC OF THE NILE RIVER WORKS



SOURCE: Haynes and Whittington, 1981.

2.2 Kenya

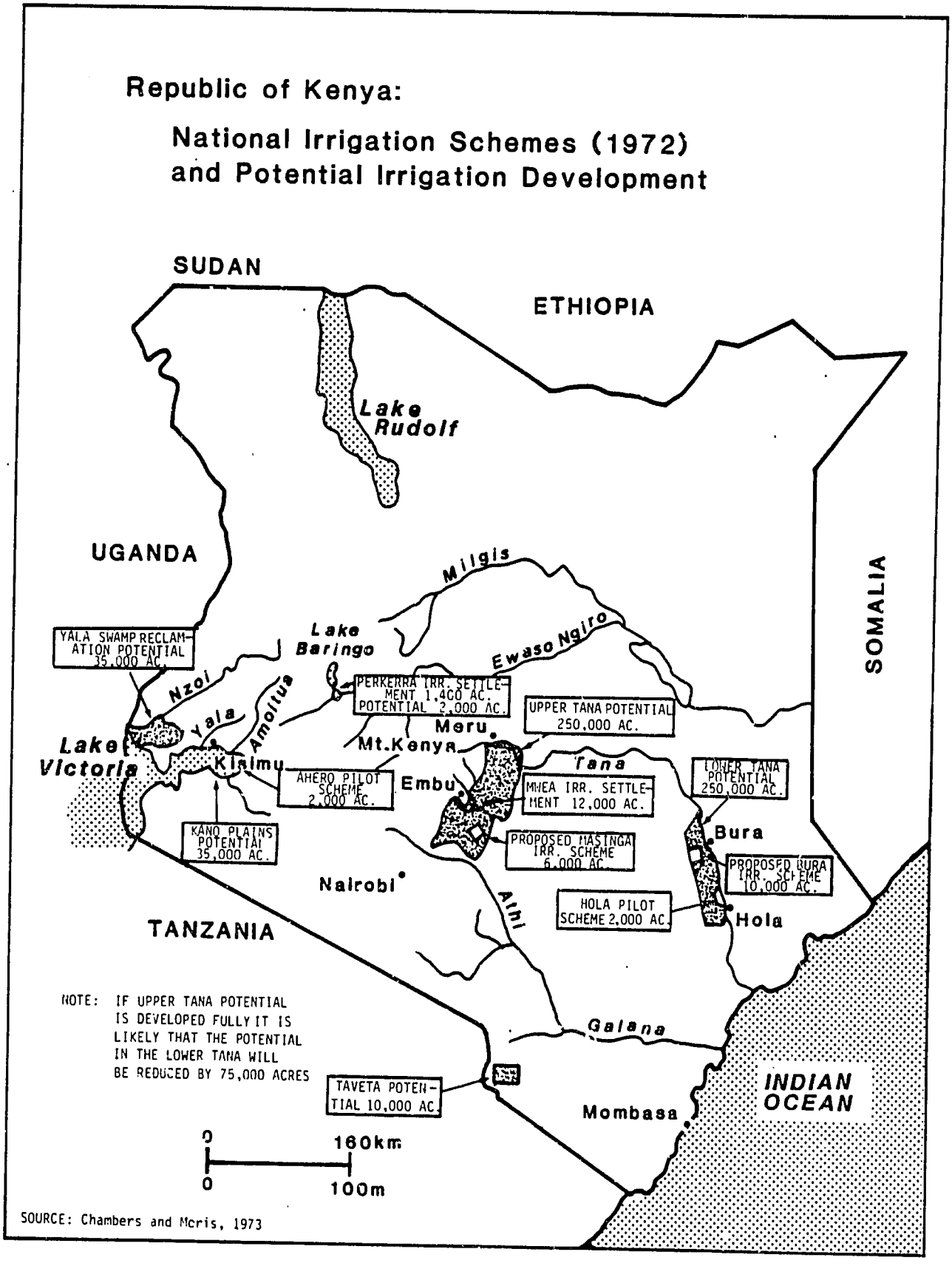
In Kenya, too, the government has considered irrigation development as a component of the overall agricultural development strategy. Irrigation schemes were initiated about 30 years ago but unlike the Sudan, Kenya actively encourages small scale irrigation which now constitutes 50% of the total irrigated land. About 20 such projects are scattered in the Umba, Ramisi, Sabaki and Tana River basins. Even the large scale schemes are modest by comparison with Sudan.

The river basin with the greatest agricultural and hydroelectric potential is the Tana River Basin covering about 20 percent of the country and about 1/3 of the total fresh surface water. The largest and earliest irrigation scheme on the Tana is the Mwea Rice Irrigation Scheme initiated in 1954. From an initial 500 acres (200 ha) the scheme has expanded to 6,000 hectares by 1978 and now produces about 40,000 tons of rice. Relatively smaller schemes exist on the Tana and other rivers and future expansion is being planned for (see Figure 2). The Tana River has also had major investments for hydropower development. Most of this development is centered on the Seven Forks Hydroelectric Scheme which involves four dams: Kindaruma (1968); Kamburu (1974); Gtaru (1978); and Masinga (1980/81).

2.3 Tanzania

The potential of river basins in Tanzania is only partially developed although small hydroelectric and irrigation schemes have been established on the Pangani since the 1930's. The Pangani River was significant for irrigation and hydroelectric power projects until the 1960's. Since then the Rufiji River and its tributaries, the Ruaha and the Kilombero have taken precedence for development projects. Tanzania's hydroelectric power potential is

FIGURE 2


Republic of Kenya:
National Irrigation Schemes (1972)
and Potential Irrigation Development
SUDAN
ETHIOPIA
Lake Rudolf
UGANDA
SOMALIA
Milgis
Lake Baringo
Ewaso Ngiro
YALA SWAMP RECLAMATION POTENTIAL 35,000 AC.
Nzoi
Yala
Amolitu
PERKERRA IRR. SETTLEMENT 1,400 AC. POTENTIAL 2,000 AC.
UPPER TANA POTENTIAL 250,000 AC.
Meru
Mt.Kenya
Lake Victoria
Kisumu
Tana
AHERO PILOT SCHEME 2,000 AC.
Embu
MWEA IRR. SETTLEMENT 12,000 AC.
LOWER TANA POTENTIAL 250,000 AC.
KANO PLAINS POTENTIAL 35,000 AC.
PROPOSED MASINGA IRR. SCHEME 6,000 AC.
Bura
PROPOSED BURA IRR. SCHEME 10,000 AC.
Nairobi
Athi
HOLA PILOT SCHEME 2,000 AC.
Hola
TANZANIA
NOTE: IF UPPER TANA POTENTIAL IS DEVELOPED FULLY IT IS LIKELY THAT THE POTENTIAL IN THE LOWER TANA WILL BE REDUCED BY 75,000 ACRES
Galana
TAVETA POTENTIAL 10,000 AC.
Mombasa
INDIAN OCEAN
0
160km
0
100m
SOURCE: Chambers and Morris, 1973

estimated to be 1400 MW but so far only 262.5 MW have been exploited (Odingo, 1980). The largest hydropower scheme is Kidatu on the Ruaha with a current capacity of 100 MW.

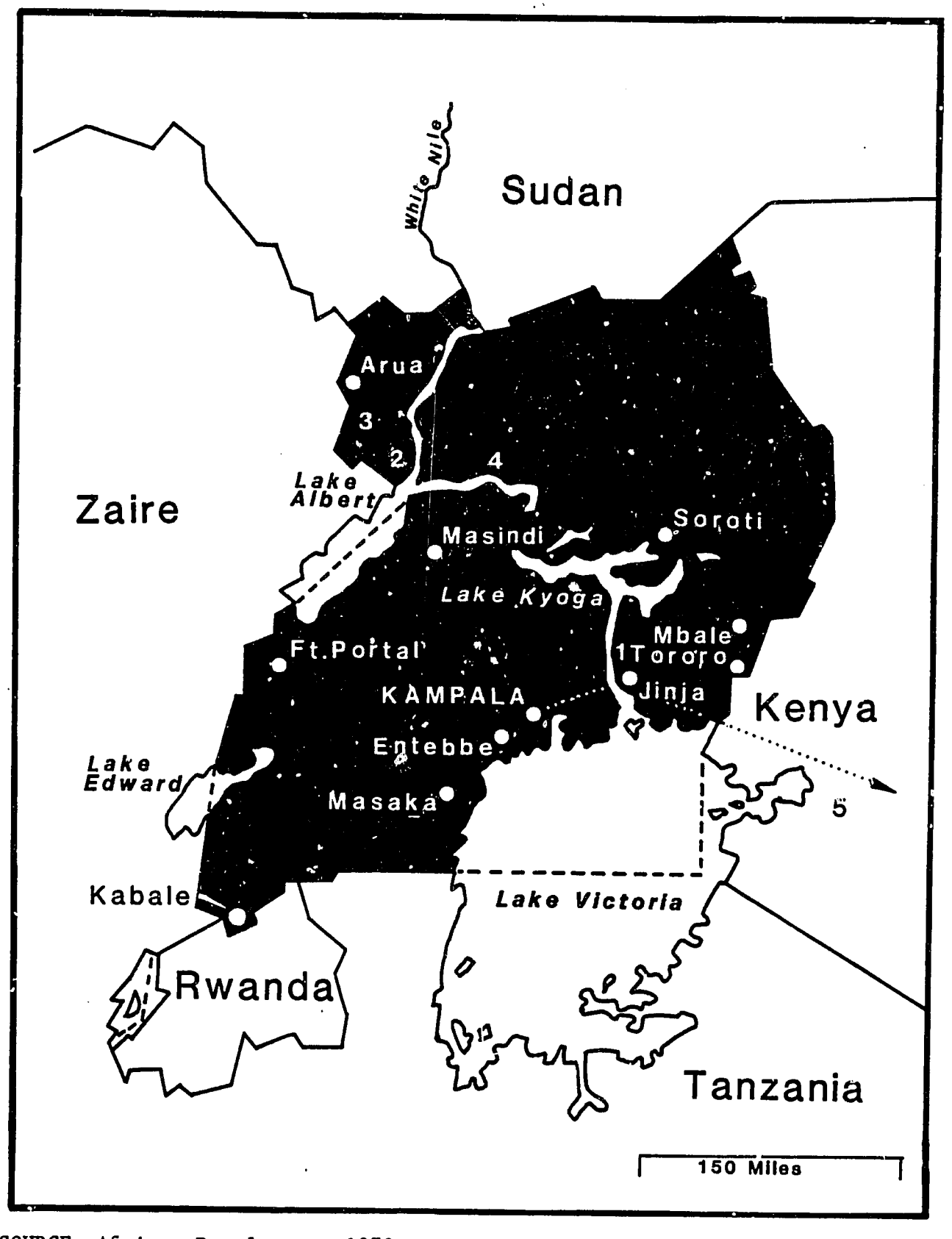
Small irrigation projects like the sugar production scheme at Arusha Chini or the Mbarali Rice Scheme have part of the agricultural strategy to increase production but on the whole the irrigation sector is very small. The recent frequency of droughts and shortfalls in rainfall have led the government to seriously contemplate irrigation to reduce dependency on rain-fed agriculture. Several studies have been undertaken to investigate the feasibility of irrigation in the Rufiji River Basin. In 1972 an organization known as the Rufiji Basin Development Authority was set up to plan for and coordinate, an integrated development of the river basin--electricity, agriculture, fishery, tourism and the necessary infrastructure. Work has already begun on the transport links to the project site of a proposed multi-purpose dam.

2.4 Uganda

The prospects for river basin development in Uganda are less certain. The only river of significance in the country is the Nile as it leaves Lake Victoria and flows north through lakes Kyoga and Albert to Sudan (see Figure 3). The Owen Falls Hydroelectric scheme which is built across the River Nile only a few miles from Lake Victoria generates 99% of Uganda's electric power. One third of this is exported to Kenya. The power plant which was initiated in 1954 has exceeded its peak capacity and the government has contemplated various schemes to increase its hydropower.

FIGURE 3

UGANDA-MAJOR PROPOSED IRRIGATION SITES



SOURCE: African Development 1972.

2.5 Ethiopia

River Basin Development in Ethiopia is concentrated mainly in the Awash Valley under the coordination of the Awash Valley Authority which was set up in 1954. The original plan envisaged an integrated development of agriculture, livestock, agro-industries and hydropower. At present the total area under irrigation in the Awash Valley is 24,300 hectares (Winid, 1981). It is the policy of the government to increase the area under irrigation. Surveys carried out in recent years have identified about 50 potential irrigation projects with a gross irrigable area of over 704,000 hectares (Beijer Institute, 1981). The Awash River Valley is also utilized for hydroelectric power. The Koka Power Station and Awash I, II and III produce 440 MW. Total hydropower is estimated at 53 billion kwh mostly in the Blue Nile of which only 2.3 percent is currently being exploited.

2.6 Somalia

In Somalia only 650,000 ha of a potential 8.2 million ha are currently being cropped. Of these, 100,000 ha are under flood irrigation and 34,000 ha are under controlled irrigation. The irrigated land is fed by waters of the two major rivers, Shabelle and Juba. About 80,000 hectares of irrigated land are used to grow bananas, sugar cane, citrus fruits, maize and some rice. Of this area one-third constitutes controlled irrigation and two-thirds flood irrigation (United States Agency for International Development, 1980).

One of the biggest schemes in the country is the sugar production project in the middle Juba region. It involves irrigating over 11,000 ha of sugar cane to produce around 100,000 tonnes of sugar largely for domestic market. The project, which is financed by Abu Dhabi and Arab aid agencies, has been estimated to cost £ 88 million sterling in the initial stages. (New African, 1977). For other projects see Table 2.

TABLE 2

ON-GOING AND PROSPECTIVE NEW IRRIGATION PROJECTS

IN SOMALIA, AUGUST 1976

	Stage of Work	Completion Date	"Subjective" Completion Dates	Additional[1] Area	Improved Area
Afgoi-Mordinle	I	1977	1978	3,108	
Jowhar Offstream Storage	I	1977	1979	-	Land Downstream
Balad (cotton)	I	1978	1979	10,000	
Turda (cotton)	F	1979	1980	2,400	
Fanole I	I	1979/80	1981	8,133	
Juba Sugar (Phase I)	T	1980	1981	6,145	
Settlement areas (to end of Phase II)	I	1984	-	-	10,000
Sakow Barrage	F		1979	-	Land Downstream
Kalanji	I		1979	800	
Northwest Agricultural Development	F		1981		25,000
Improvement of existing commercial land	I		1986		18,000
Improvement of existing traditional land	I		1982		500,000
Avai	I		1983	500	-
Bardere Dam	F		1984		Land Downstream
Golwein	I		1985	1,500	
Genale-Bolo Marerta	PF		1985	16,540	11,330
Juba Bardere Youte	PF		1987	10,000	
Fanole II	PF		-	10,000	
Juba Sugar (Phase II)	F		-	5,223	

I - Implementation
T - Tender
F - Feasibility
PF - Pre-feasibility

1/ About 30,000 hectares by 1980 according to completion status. Of this the greater part will already be under some form of traditional production, often by flood irrigation. Thus, traditional production could fall by the equivalent of 25,000 tons of maize.

SOURCE: International Labour Office, 1977.

3. EFFECTS OF THESE PROJECTS

3.1 Production

River Basin Development has facilitated the expansion of large scale agriculture in Eastern Africa, particularly in Sudan, Kenya, Ethiopia and Somalia. In the Sudan it enabled the development of over 4 million feddans of irrigated land over the past 50 years (World Bank, 1979). Cotton produced under irrigation is the major export crop accounting for over 56% of all the exports. The lowest tenant on the scheme earns about 240 Sudanese pounds per annum; by contrast, the average farmer outside the scheme, earns about 82 Sudanese pounds (World Bank, 1979).

In Kenya, too, the largest irrigation scheme in the country, at Mwea, is generally regarded as a success story from an economic point of view. Cash incomes in Mwea ranged from 116 to 140 Kenyan pounds per annum between 1963 and 1966 whereas the average cash income of farmers in the home districts from which the tenants had been drawn ranged in 1963 from 35 to 79 Kenyan pounds per annum. The Mwea incomes were even better than the targets of 60 to 100 Kenyan pounds per annum set for the low density settlers on the Kenya settlement schemes of the former White Highlands (Chambers and Moris, 1973). In Ethiopia, a preliminary economic analysis of irrigation schemes in the Awash Valley showed a favorable overall benefit: cost ratio of 1.95:1 and individual schemes showed ratios of 5.5:1 (Winid, 1981).

Irrigation schemes can also be a source of employment for those not able to maintain a livelihood through subsistence agriculture. The Rahad Project in the Sudan, for instance, was expected to cater for 14,000 tenant families and provide employment for 90,000 non-family workers. On the whole, Sudan has

a mobile labor force of 1 million (World Bank, 1979), many involved in laboring on irrigation projects. In Somalia, the ILO estimated increased rural employment as a result of the expansion of irrigation (see Table 3).

TABLE 3

EMPLOYMENT OPPORTUNITIES IN IRRIGATION SCHEMES IN SOMALIA

		Estimate I		Estimate II		Estimate III	
Hectares in Shabelle and Juba (000)	Category	Assumed extra jobs per ha	No. of Jobs (000)	Assumed extra jobs per ha	No. of Jobs (000)	Assumed extra jobs per ha	No. of Jobs (000)
11	Intensifying existing controlled irrigation	0.5	5.5	0.25	2.75	0.125	1.38
17	Improved existing water command	1.0	17.0	0.5	8.50	0.25	4.25
80	Switching from flood to controlled irrigation	1.5	120.0	1.0	80.00	0.5	40.00
45	Irrigated area not previously used	2.0	90.0	1.5	67.50	1.0	45.00
			232.5		158.75		90.63

SOURCE: International Labour Office, 1977.

Yet questions have been raised about the real extent of the success of these schemes. Most large-scale irrigation schemes have been isolated pockets of development and have not resulted in revolutionizing the national agricultural sector. The schemes in fact have resulted in a polarization between the capital intensive, highly mechanized modern agricultural sector and the traditional sector with its low technology and low yields. The latter has

been relied upon to provide for its own reproduction without appropriate inputs as well as to supply the modern sector with cheap labor. This neglect is particularly detrimental to the economic growth of countries in which industrialization is insignificant and the agricultural sector is both the main employer and the main contributor to the country's GDP and GNP.

The costs have also been heavy. In the Sudan it is estimated that investments in irrigated farming cost ten times as much as in mechanized farming and 25 times as much investment in traditional farming. Investment costs per worker in irrigated agriculture are seven times as large as in mechanized agriculture and forty times as large as in the traditional agriculture (Lees and Brooks, 1977). The grand irrigation schemes like the Gezira tend to steal the limelight and obscure the advance made in more modest, privately financed schemes that add up to an impressive total. In Sudan, about 2 million acres have been brought under mechanised farming in rainfed areas (Sylvester, 1973).

Nor have the projects always been successful in improving agricultural efficiency or socio-economic conditions. Increased output has been obtained through areal expansion rather than higher yields and in some cases production costs were uneconomical. Again in the Sudan, the production costs of sugar were 11 cents per pound while the international purchase price was 8 cents a pound in 1978 (World Bank, 1979). (At this rate large scale irrigation schemes would be subsidizing the sugar consumption countries of the developed world at enormous costs to themselves.)

Other studies have shown that large scale irrigation projects have brought only marginal returns to producers because of the international economic system (Barnett, 1977; Sorbo, 1977). The best testimony to this is the fact that after 50 years of heavy investment in large scale irrigation, Sudan

is still one of the least developed countries. In the Mwea Irrigation Scheme, in Kenya, economic benefits have not been so uniformly beneficial as implied by better cash incomes (see above). Many of the tenants did not have enough land for food and "some families had to go hungry even when net incomes were high" (Hanger and Moris, 1973). Thus while large scale irrigation schemes may have brought some short term localized benefits, the long term overall benefits have been dubious mainly because the schemes were not integrated into the overall strategy for development through linkages with other sectors.

3.2 Hydroelectricity

The need for electricity as a "cheap" indigenous alternative to petroleum imports has been the major aim or major secondary aim of river basin development. In many countries the achievements have been remarkable. In Kenya hydroelectricity provides 50% of the total electricity needs of the country and 10.3 percent of the total production (Odingo, 1980). In the Sudan, the three dams, Sennar, Roseires and Khashm el Girba together generate about 400 MWH which in 1956 was 58% of the installed capacity and 82% of the energy needs of the country (World Bank, 1979). In Uganda, the Owen Falls Hydroelectric scheme not only provided the country with 99% of its electric power but also enabled the country to export one-third of the output to Kenya (African Development, June 1972). With the construction of Stage I of the Kafue Hydroelectric scheme and its share of the Kariba Hydroelectric power, Zambia became self-sufficient in hydroelectricity (Williams and Howard, 1977).

There is no doubt that many of these schemes have helped the industrial development of their countries, as for instance, the textile and other industries around Jinja, Uganda, using the power from the Owen Falls Project and the Zambian copper mines using power from the Kariba Dam. In Tanzania, the

opening of the Nyumba ya Mungu hydroelectric station enabled the establishment of sisal and cashew processing industries in Tanga (Kaduma, 1977). The initial costs of these schemes has been high but annual savings in oil imports are also impressive. The opening of the Hale Power Station in Tanzania in 1964 reduced the country's requirements of diesel for thermal power by 75% at an estimated savings of £ 270,000 in foreign exchange (Datoo, 1965). Hydroelectricity has thus come to be accepted as a viable alternative to fuel oil.

Where the generation of power has been combined with irrigation in river basin development schemes, hydropower has also provided the fuel needs of irrigation thus showing a viable integrated approach to development. On the other hand, some of the multi-projects have always given precedence to hydroelectricity and some conflicts have arisen. In Tanzania, for instance, the Hale Ordinance of 1961 to regulate the flow of water for the power station resulted in eliminating irrigation in the Pangani Basin above Hale although the irrigation of this upper valley was part of the development scheme (Kaduma, 1977). In the Sudan, too, there is likely to be a conflict between water for electricity generation and irrigation as the country uses up its quota of the Nile waters. Part of the conflict arises from the fact that the two sectors, energy and agriculture, are managed separately. The integrated river basin approach is a fairly new concept in river basin development.

3.3 Ecological Repercussions

The river basin development schemes in Eastern Africa like many similar projects elsewhere in Africa have had serious ecological repercussions. The transformation of the physical environment and ensuing new patterns of land use, as well as new densities of human and livestock populations, result in

serious negative impacts which are seldom sufficiently considered, understood or catered for during the planning stage.

Physical Consequences

One of the most serious repercussions has been increased soil erosion and siltation of the dams and irrigation projects. In 1977 the National Irrigation Board of Kenya spent over Ksh 3 million for dredging irrigation canals on the project (Ongweny, 1980). Soil erosion and siltation is threatening the hydroelectric potential of the dams on the Tana River. At the current rate of siltation, it is estimated that the dams on the Tana River have a life span of 30 to 35 years. In the Kindaramu Dam, for instance, total sedimentation load was about 12.6 million m^3 between July 1968 and July 1977. The main cause for the accelerated soil erosion is overgrazing and destruction of vegetation for agriculture and charcoal burning (Ongweny, 1980). Similar figures are obtainable for the Sudan. Siltation of the existing reservoirs is estimated at 50 m^3 per year or 90 million tons/year. Already the Sennar and Khashm el Girba have a residual life span of 30 years (World Bank, 1979). Siltation also lessens fertile soil for fields and fisheries. The detrimental effect of nutrient losses to the off-shore fisheries in Egypt because of irrigation is well documented (Farvar and Milton, 1972).

Other problems of a basically physical nature that are encountered in eastern Africa are uncontrolled flooding and salinity. Where flood control measures are not efficient, uncontrolled flooding disrupts agriculture and settlements as well as programs designed to eliminate weeds and pests. Flooding also leads to waterlogging and salinization. The specific data for these aspects is not available but information from other irrigation schemes in the world would indicate that the eastern African countries will have to face the

problem sooner or later (Saha and Barrow, 1981; United States Council on Environmental Quality 1980).

Biological Consequences

River Basin development schemes also affect the biological life of the environment of these schemes. Large-scale irrigation projects tend to use heavy dosages of chemicals in the form of fertilizers, pesticides, herbicides and molluscicides which are drained back into the river system after irrigation. It has been estimated that this return run-off can amount to 40 percent of the total surface water used for irrigation.

In the Sudan fertilizer rates have increased from 6.5 kg hectare in 1954 to 15 kg hectare in 1974. The use of pesticides including DDT has also increased. Total pesticide use in Kenya has increased in monetary terms from 313,000 pounds in 1967 to 1,026,000 in 1973 and 4,455,000. This represents a fourteen fold increase within a period of less than 10 years. A significant amount of these quantities is used on the irrigation schemes. In the Gezira, in 1976, it was estimated that at the then rate of spraying, not less than 2,500 tons of active insecticides are being deposited annually in the Gezira, nearly two-thirds of which are DDT (Pollard, 1981).

The heavy use of such chemicals has two results: the nutrients lead to eutrofication of the reservoirs which manifests itself in the form of excessive growth of algae and aquatic weeds. The profusion of weeds and especially the spread of the water hyacinth and their effect on the economic and health aspects of the irrigation schemes are well documented. In Eastern Africa weed infestation of canals is quite common providing excellent habitat for disease carrying vectors such as snails and mosquitoes.

Residues of pesticides and other chemicals affect life downstream directly through the chemical content of the water and indirectly through fish and other aquatic life that may be consumed by the people in the area. Pesticides, especially the use of DDT also directly affect the settlers and workers exposed to the spraying and atmospheric residuals.

Interest has also centered on the effect of large scale irrigation schemes on the fish potential of the rivers. This is perhaps best exemplified by the Kariba Dam. Although the Kariba was built specifically for generating electricity, it was assumed that the fishing potential of the area would increase considerably with the damming of the river. Post impoundment studies showed that the fish populations increased dramatically during the first four years of the filling of the dam. However, as the dam waters stabilized, fish levels have declined and commercial fishing is not yet a viable commercial activity (Balon, 1978). Decreasing fish levels were also found at Nyumba ya Mungu Dam on the Pangani River in Tanzania. According to a survey carried out in 1974 there were three main reasons for the decline: over-fishing; encroachment of dense swamps into and spreading out of the inflow deltas and the overall drop in the lake level in 1972 (Kaduma, 1977). The continuous flooding of the Kafue Flats will affect the fish potential of the area. Currently the perennial ponds and the river have large populations of fish which breed and feed extensively on the floodplains during inundation. They are readily harvested as the floods recede and when the river is low. Average yield between 1954 and 1964 was 5079.2 metric tons (Ackerman, White, and Worthington, 1973). Continuous flooding will eliminate the perennial ponds and variations in the height of the river waters.

3.4 Health Implications

Perhaps no other aspect of large-scale irrigation schemes has received as much attention during the last 20 years as the health conditions of the settlers and workers on these schemes. Interested parties have ranged from international organizations to individuals and medical personnel to economists and sociologists. The disease that has been most associated with irrigation schemes is schistosomiasis. Examples from Eastern African river basin development schemes confirm this association.

Prior to the establishment of the Gezira in 1925, for instance, there was no schistosomiasis in that region. Three years later snail hosts of the disease became prevalent in the canals--Egyptian laborers infected with S. haematobium and White Nile farmers infected with S. mansoni were attracted to the scheme. The deadly combination of snails and infected subjects led to the establishment of the disease. Recent surveys indicate infection rates of 60 percent to 70 percent among adults and up to 90 percent among children (Amin, 1978).

Similar evidence comes from other countries. In Ethiopia S. mansoni was quite prevalent in the Awash Valley. Even the provision of piped water did not preclude the transmission of the disease because the nature of the work necessitated the laborers to stand or work in canals infected with schistomiasis carrying snails (Bruijning, 1969).

The 3,600 ha sugar estate of Arusha Chini, Tanzania, depend on water from the Weru Weru river to irrigate land. The open canal irrigation system created a favorable habitat for the snail host of S. mansoni. In 1962 infection rates were 80% for newly employed workers (Fenwick, 1972). In Kenya the disease was not known in the Mwea Irrigation scheme area until 1959. In 1966 the incidence was 12.5 percent; in 1974 the rate had risen to 24.4 percent. The

percentage of the people infected has continued to rise (Chambers and Moris, 1973). Other irrigation schemes have even higher incidences of the disease. In Hola over 70% of the population are infected by the disease (Wanga, 1980).

The disease not only causes great human suffering and increases vulnerability to other diseases, but it also affects the productivity of the workers and hence the economic performance of the schemes. In the Sudan economic loss as a result of absenteeism due to ill health was estimated at 30 million Sudanese pounds. To this must be added the cost of 1 million pounds every year for mollusciciding and 1/2 million for treatment (Amin, 1977). In the mid-1960's in Arusha Chini, Tanzania, the costs in absenteeism and treatment amounted to 6,000 pounds while 3,500 pounds were spent on chemical control of the vector snails in the canals (Foster, 1967).

Malaria is another disease that is associated with irrigation schemes. Surtees (1970) identified four major ecological changes caused by irrigation practices which affect mosquito populations: simplification of habitat; changes in water flow and water table levels, increased areas of surface water and increased human population densities. At the Athero ricefield these changes enhanced the mosquito populations, and the house entry for all species of mosquitoes was four times greater than in the non-irrigated areas near the scheme (Hill, Chandler and Highton, 1977). In the Mwea Irrigation Scheme rates of infection were as high as 75% (Wanga, 1980). In the Gezira, although malaria was endemic, the long dry spell of 8 months gave the population a chance to recover. With the implementation of the scheme malaria transmission became a perennial problem (Pollard, 1981). Control measures using DDT are ineffective because this method has led to the evolution of resistant strains. Higher human population densities in the irrigation schemes also facilitate

higher vulnerability to infections both of malaria and other communicable diseases.

3.5 Resettlement

Most of the river basin development schemes have involved direct resettlement of people or have attracted considerable numbers of immigrants. The Mwea Irrigation Scheme was set up specifically to resettle the detainees and landless Kikuyu laborers from the overcrowded Kikuyu reserves (Chambers and Moris, 1973). The construction of the Kariba Dam necessitated the resettlement of 51,000 Gwenbe Tonga. In other schemes the prospect of economic opportunities has led to considerable migration and consequent high population densities in the schemes. In Kenya for instance, the irrigation schemes had a population density of 800 persons per square kilometer and was comparable to densities in major urban areas (Wanga, 1980).

Since most of the schemes in Eastern Africa were set up for economic reasons, social aspects are given secondary considerations. In many cases, although feasibility studies for irrigation and hydroelectric power are carried out over several years, comparatively little attention is paid to the human settlement and livelihood patterns of the affected area. Some attempt is made to provide services like housing, health and schools but these are usually inadequate. In the Sudan, pit latrines were constructed only after heavy incidences of schistosomiasis. In Mwea, there was no piped water supply on the scheme even as late as 1972, almost 20 years after the initiation of the scheme. The people on the scheme were compelled to use polluted water from the furrows and canals. Life can also be particularly difficult for certain groups like the women or the casual workers. This aspect is again best illustrated with Mwea where a comprehensive survey of the special problems

faced by the women on the scheme was carried out. Some of the problems were lack of an adequate plot to grow food, a special task of the women; lack of firewood within a reasonable walking distance and a disruption of the concept of the extended family which gave both psychological and physical support to the women in maintaining the household. Some of these problems arise out of a genuine difficulty in obtaining a balance between economic returns and social welfare. Others arise out of the fact that a "development from above" approach is adopted in river basin development schemes. The concern of the local people are not incorporated in the planning phase through a sustained effort to understand these problems. Although a total dependency on the state to provide all the services is not desirable, economic returns from the schemes have not yet proved to be high enough for the tenants to organize their own self-improvement.

4. PROPOSED DEVELOPMENT

All the countries of Eastern Africa have plans for future developments with key purposes again being agriculture/livestock and the production of hydropower although integrated development is the avowed aim.

In the Sudan water for irrigation and hydropower is viewed as expansion of the available resources as well as better management of the existing ones. The proposed expansion consists of four main projects on the Upper Nile:

1) Jonglei Phase I which entails a 280 km canal enabling the Nile to by-pass the swamps of Bahr el Jeble and Bahr el Zeraf. This is due to be completed in 1983 at the staggering cost of Sudanese pounds 185 million and will enable Sudan to increase its irrigated lands by 1.2 million feddans.

2) The second project involves draining the Mashar marshes.

3) Jonglei II involves the widening of the Jonglei I canal and regulation of the outflow of the White Nile from the three lakes: Victoria, Albert and Kyoga.

4) The last project, known as the Bahr el Ghazal conservation project entails construction of a series of reservoirs on the tributaries.

Only Jonglei I is within Sudanese jurisdiction; the other projects require cooperation with Ethopia and Uganda and are therefore clouded with uncertainties. If they are completed as envisaged, Sudan's share of the Nile waters will increase as shown in Table 4 below and will enable the country to increase its irrigated land by some three million feddans.

TABLE 4

PLANNED INCREASE OF SUDAN'S SHARE OF THE NILE WATERS

	Addition	Cumulative	Projects
1977	--	20.35 km^3/y	
1983	.98$^3/y$	22.33 km^3/y	Jonglei I
1990	1.78	24.11 km^3/y	Mashar marshes
2000	1.00	25.11 km^3/y	Jonglei II
after 2000	3.12	28.23 km^3/y	Bahr el Ghazal

SOURCE: World Bank, 1979.

The main effects of the Jonglei Canal will be: first to increase the flood capacity of the Nile north of the Sudd. When complete the Jonglei Canal will divert one-quarter of the White Nile's flow which would otherwise have evaporation losses of about 4,750 cubic meters. The canal will also dry up a considerable part of the Sudd, and if the low stage water is equally distributed between the river and the canal, it will provide a considerable source of water from the canal in areas well away from the river (Wright, 1978).

It is not all clear what the ecological or even irrigation repercussions will be. The partial drying of the swamps would be of general benefit but complete drainage might be disastrous. Also, in low or normal years, the extra water might be beneficial to those living close to the river but in years of high flood, the combined effect of the White and Blue Nile would swell the discharge in the Main Nile to the north affecting housing, fields and irrigation works.

The benefits of the Jonglei Canal are put at 45m pounds a year in terms of new land brought under irrigation. Work in the project has already begun but has been delayed because of shortages in fuel and finances. The deadline for the completion of the canal is now 1985.

In Tanzania, the Rufiji River has a great potential for multi-purpose developments. It covers an area of 175,000 square kilometers in the southern and central parts of mainland Tanzania. One of the major developments planned for the Rufiji River Basin is the multi-million dollar Stiegler's Gorge Hydro-electric Scheme. It involves the construction of a 130m main high dam at Stiegler's Gorge and a number of saddle dams. The power plant is expected to have an installed capacity of 850 MW and firm capacity of 620MW. The dam is also expected to control the annual flood regime and promote irrigation (Tanzania, 1979). The project is estimated to cost Tz. Sh. 2,234,533,000 and will spill over into the Fourth Five Year Plan. Preparatory work includes an access road to the site, environmental studies, training to manage the various activities of the project and transmission lines from Kidatu to supply power for the construction of the dam. The project is expected to affect about 70,000 people now depending on the flood regime of the river for their livelihood. In addition, it will also have ecological repercussions particularly on the marine fisheries of the area and possibly on the spread of schistosomiasis.

Another project that is currently being proposed is the development of the Kagera River Basin. The Kagera Basin covers 6,000 sq. km each in Rwanda and Tanzania. The project includes the construction of a dam at Rusumo Falls and will be jointly executed by Burundi, Rwanda and Tanzania. The dam will be 1325 m high and will produce up to 80 MW. Rwanda and Burundi will be compensated for the loss of 2,510 ha and 1200 ha respectively as well as for moving 2,200 Rwandan and 540 Burundian families (African Business, Jan. 1982).

The prospects for river basin development in Uganda are less certain. The power plant which was initiated in 1954 has exceeded its projected peak capacity and the government has contemplated various schemes to increase its hydropower. One of these involved building a second hydroelectric power plant on the Murchison Falls in northeast Uganda. The controversial scheme which envisaged a capacity of 600 MW had to be abandoned for ecological reasons. Another proposal for a dam to be built at Aru was found to be unfeasible because the flow of the Nile at that point was too unreliable. A joint Ugandan-Zairean team is surveying the possibility of a hydroelectric site on Lake Albert (African Development, June, 1972) (See Figure 3).

In Ethiopia the government has decided to increase the area under irrigation and reduce the dependence on unpredictable rainfall. Surveys carried out in recent years have identified about 50 potential irrigation projects with a gross irrigable area of over 704,000 hectares distributed as follows:

Awash Valley	103,000 ha
Baro-Gilo-Akobo	5,000 ha
Blue Nile Basin	381,000 ha
Northern Rivers	103,000 ha
Ono Valley	10,000 ha
Rift Valley Lakes	42,000 ha
Wabe Shebelle Valley	50,000 ha

Of the identified projects, the government has selected about eight that are going to be treated as priority areas. These include:

Angelele Bolhamo	14,000 ha
Manswa-Agordat	40,000 ha
East & West Megech	13,000 ha
Lower Ono	10,000 ha
Lower Awash	63,000 ha
Alwero	10,000 ha
Dabus	15,000 ha
Chen Bahir	12,500 ha

The country has an ambitious program to resettle 1.3 million agriculturalists and about 93,000 pastoralists displaced by wars and drought. The resettlement program will be closely linked with the irrigation expansion (United Nations Conference on the Least Developed Nations, 1981).

In Somalia, the key element of the river basin development strategy is the Juba Valley. One of the schemes planned for is the Baardheese Dam. The dam would regulate the flow of the river for irrigation, harness hydropower for electricity and prevent uncontrolled flooding. The Baardheese dam would help irrigate 200,000 ha. It would have a capacity of 4,000 m^3 and would generate 260 Gwh. Agricultural emphasis would be on the production of cereals for food self-sufficiency, fruits and vegetables. Financing is expected to come from the EEC which in 1979 had set aside $30 million for the Juba Valley Scheme (African Business, 1979). For other schemes see Table 2.

Somalia is also involved in large resettlement schemes based on irrigated agriculture. The future expansion of such schemes will depend on the success of the three large schemes.

Specific data for Kenya was not available at the time of writing this paper. However the expansion of irrigation and hydroelectricity are major strategies of development planning. These developments are summarized in Table 5 as far as information is available.

TABLE 5

SUMMARY OF PROPOSED DEVELOPMENT SCHEMES

Country	River	Scheme (Agricultural)	Hydro-electric Schemes
Sudan	Nile	Jonglei I Marshar Marshes Jonglei II Bahr-el Ahazal	Rosieres dam expansion 250 MW Sennar dam 75-100 MW Jebel Aulia dam 25 Settit dam 20
Tanzania (with Rwanda, Burundi)	Rufiji Kagera	Rufiji Basin Irrigation Scheme Kagera River Basin Develop.	Stiegler's Gorge 850 MW Rusumo Falls Dam 80 MW
Uganda	Nile	n.a.	n.a.
Ethopia		n.a.	n.a.
Kenya		n.a.	n.a.
Somalia	Juba	Juba Valley Dev. Scheme	Baardhese Dam 260 GWH

4. CONCLUSION

Most of the Eastern African nations have regarded the major rivers in their countries as a significant resource for development. River basin development both for the expansion of agriculture through irrigation and for the generation of hydroelectricity has been and continues to be, part of national economic development strategies. So far the benefits have been mixed. Agricultural production overall has increased but the contribution to development has been questionable. The repercussions of increased incidence of disease, particularly schistosomiasis and malaria as well as environmental degradation and pollution, have generally detracted from the overall economic benefits and potential for future development. Nevertheless, the potential for development is real. The advantages of having a system of agriculture that is not dependent on the vagaries of nature or that is capable of turning semi-desert areas into farmlands and pastures are also real. The rising costs of importing energy make hydroelectric power generated within the country very attractive. However, the initial costs of setting up these highly capital intensive schemes are so heavy that there is a real danger that some sectors of the economy may suffer because of the unbalanced investment in a few obviously visible development schemes. This poses a real dilemma particularly if long term benefits do not materialize.

The problem, of course, is not merely a national one. Dependence on external sources for capital and technology to initiate and maintain the schemes also poses a dilemma. The answer may well be in small irrigation schemes that can use local resources and local expertise, are less costly, and can be incorporated into development schemes without sectoral dislocations. River basin development involving highly capital intensive schemes should therefore be considered only as an option for economic development.

Another aspect that needs consideration is the approach to these schemes. So far they have been enclaves in areas of low technology and low inputs. In order to make these schemes economical, ways to spread the benefits of the costly investment within the country must be found. This will mean developing other sectors of the national economy: industry, local technical and managerial skills and the traditional agricultural sector, so that the river basin development schemes can be integrated into these sectors.

So far the orientation of the schemes has been towards external markets or a type of import substitution. Both these strategies have proved incapable of revolutionising development in the third world countries. A new strategy is therefore required--should the highly capitalised river basin development schemes therefore have to be postponed until the country is better able to utilise their full potential? Should the countries, rather than postponing, not consider alternative forms of river basin development? After all, irrigation using the flood waters of the rivers is not a discovery of the highly developed countries. Every country in Eastern Africa has had some form of local irrigation schemes that could be improved upon at minimal costs. The essence is controlled, not necessarily expensive, irrigation.

The need for hydroelectricity could similarly consider all the options for generating relatively inexpensive hydroelectricity. Small is not always beautiful but it may be the only rational choice in the transitional stages, particularly when foreign aid is becoming restricted and the countries' own resources are strained.

In all cases, the river basin development schemes can be said to bring about "development" only if they raise the people's total well-being status. Future development schemes therefore need to pay more attention to the health, ecological and social aspects that appear to have been neglected in past schemes.

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