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Girma Kebede

LOSING GROUND: LAND IMPOVERISHMENT IN SUDAN

SUDAN IS endowed with large expanses of arable land, estimated at 80 million hectares—the largest in Africa. It has abundant supplies of water. Its livestock asset (estimated at 63 million heads) is the second largest in Africa, surpassed only by neighboring Ethiopia. The country's economy, hence, is almost entirely based on the agricultural sector. In 1993-1994, agriculture generated nearly 40 percent of the gross domestic product. The industrial sector, which is mostly agricultural-based, accounted for about 17.5 percent of the gross national product. The agricultural sector is also the source of virtually all of the country's export earnings. About four-fifths of the labor force of the country earns its living from farming and animal husbandry. The country, however, is increasingly impoverishing its agricultural resources through the promotion of environmentally destructive modes of production.

In this chapter I argue that the Sudanese state has failed properly and fairly to utilize the country's agricultural resources, and has transformed the country into a land of poverty and degraded environment. The state greatly undermined the security of the rural population by vastly reducing their access to land, water supplies, grassland and wood resources in favor of ecologically unsound large-scale agricultural schemes. These modern large-scale schemes today control over one-half of the land under cultivation and consume nearly all the production enhancing inputs. On the other hand, the traditional small-scale agricultural sector, which provides a livelihood for the overwhelming majority of the rural population, controls no more than two-fifths of the total land area under crops, much of it ecologically beleaguered because of overuse.

The Physical Environment: What Nature Has Provided

Sudan is Africa's largest country, covering 8 percent of the entire continent. With over 2.5 million square kilometers, it is roughly the size of Europe or a third of the continental United States. Only eight countries in the world are larger than Sudan. The landscape of this huge country is mostly flat and relatively low, much of it not exceeding 200 meters above sea level. In fact,

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much of the country is the basin of the White and the Blue Niles and their tributaries. High altitude areas are found near the country's borders, the only exception being the Nuba mountains located west of the White Nile. Jebel Marra in the western part bordering Chad rises to 3,100 meters, and over 1,760 kilometers (1,100 miles) away in the northeast are the rugged Red Sea hills—a continuous range of hills and mountains running parallel to the coast—with elevation ranging between 700 and 2,500 meters. Toward the East, near the border with Ethiopia, topography shifts rapidly with the escarpment of the western Ethiopian plateau rising steeply to over 3,000 meters. Along the southern borders are some of the most densely forested high grounds in Sudan—Imatong and Acholi mountains, the Aloma plateau, and the Didinga and Dongotana hills. The Imatong, at 3,187 meters, is the highest altitude in Sudan.

The most important physical feature of the country is the Nile River which bisects it from South to North. More than a third of the length of the river is within Sudan and all its tributaries run most of their length within it as well. Hence, Sudan is called the land of the Nile even though it is far less dependent on the river than Egypt because the southern third of the country is endowed with sufficient rainfall.

A huge shallow basin covers much of the southern part of the country. In this basin meander indolently the Upper White Nile (Bahr el Jebel) and its numerous tributaries that flow down from the watershed that lie between the Nile and Zaire basins. There is an enormous swamp—locally known as el-Sudd—in the center of this basin, one of the most expansive in the world. Downstream from the Sudd region the White Nile flows across the flat plains of Sudan until it reaches Khartoum where the Blue Nile, its main tributary, joins it.

Agro-ecological and Vegetation zones

Sudan extends latitudinally over 1,900 kilometers (1,200 miles) and in this vast territory a series of agro-ecological and vegetation zones, each running west to east, can be recognized. The desert zone prevails in the northern third of the country. The western part of this zone consists of the southeasterly extension of the Libyan desert and the Nubian desert east of the Nile River, extending to the Red Sea hills. The zone extends southward as far as Shendi, approximately 16 degrees north latitude. The landscape consists primarily of sand dunes in the west and sand and gravel in the east. The annual average rainfall is generally less than 200 millimeters and in many areas less than half of that amount. For instance, in Khartoum—which is located at 15 degrees latitude outside but very close to the southern edge of this climatic zone—rainfall ranges between 100 and 200 millimeters during most years. The

infrequent precipitation that occurs in this zone, more especially in summer, comes from the occasional inflow of maritime tropical air masses originating from the South and mid-Atlantic Ocean.

A vegetation cover is almost non-existent in much of this desert climatic zone, especially in the western portion where precipitation is rarer. Desert shrubs and short grasses are the dominant vegetation. Thus, much of this flat and barren landscape, with average day temperatures of 43 degrees Centigrade (110 degrees Fahrenheit), is virtually uninhabited. Only in a few scattered oases and along the narrow strip comprising the banks of the Nile River is permanent habitation possible. Along the Nile's banks, between Khartoum and the border with Egypt, there are small farming communities who cultivate subsistence crops, pumping water from the river and using other traditional methods of irrigation. Very little cultivation exists away from these banks, except along *wadis* (seasonal rivers) where some isolated tribes cultivate crops for a brief time. Also, a small number of transhumant Arab nomadic pastoralists keep a few camels and herds of hardy desert sheep and goats wherever desert feed and water are available. On the banks are also found a succession of towns such as Shendi, Ed Damer, Atbara, Berber, Dongola and several small villages.

The semiarid-arid zone lies approximately between 14 and 16 degrees north latitude in the central region of the country but extends into the northeast covering much of Kassala Province. At least one-fifth of the country's total area lies in this zone. Latitudinal variations exist within this climatic zone with moisture availability. The northern half of this zone—adjoining the desert climatic zone—is characterized by light rainfall, dry, warm winters, and very hot summers. The amount and frequency of precipitation vary from year to year. Average annual rainfall rarely exceeds 400 millimeters, and it is unreliable in occurrence—annual fluctuations of nearly 100 percent from the mean are not uncommon. The high rates of evaporation reduce the usefulness of even this amount. Almost all the rain falls between June and September. The remaining time of the year is virtually rainless, with the winter period being extremely dry. *Haboob* (hot and dry wind) ravages this zone every year before the rainy season arrives. During a *Haboob* temperatures often rise brusquely and a fine dust blankets everything. At times when a thick fine dust fills the atmosphere, day turns into night. The southern half of the semiarid zone and the elevated grounds just behind the Red Sea coast (which receive winter rains in January from the Red Sea), however, are slightly more humid, with precipitation averaging between 400 and 550 millimeters annually. In general, much of the semiarid climatic zone can be characterized as a zone of long months of extreme heat broken by a short period of occasional rain, followed by cooler weather. In terms of natural vegetation, this is basically an acacia-steppe grassland. Flowering plants also appear during brief rain storms. The short grasses are good for

cattle and small-stock grazing, while the trees are short and make good fodder for camels. Nomadic pastoralists move north and south following the rains. The Red Sea hills receive fairly adequate precipitation to support sparse nomadic activities.

There is no permanent agriculture except on higher grounds in the western region, along and between the White and Blue Niles, along the Atbara River, and in the Baraka and Gash Deltas in the northeast. The Atbara River supplies the Kashm el Girba irrigation scheme. The government established the scheme to resettle the Nubian people who were forced to abandon their original homes at Wadi Halfa when the construction of the Aswam High Dam in Egypt flooded their land. Varieties of crops are grown on 330,000 feddans of irrigated land. The Atbara is, however, very much a seasonal river. It surges only for four months when summer rains fall in the northwest plateau of Ethiopia. For the rest of the year it turns into a series of puddles. The Gash Delta is flooded to a varying degree each year during its three months flow. It provides dry season grazing areas for the Beja (who raise cattle and camel, the latter for sale in Egypt) and arable land for the semi-sedentary Hadendowa cultivators. The Baraka flows from Eritrea towards the Red Sea coast and terminates south of Suakin. It provides silt rich delta soil for crop cultivation for a brief period of the year. In the western sandy upland areas, including the volcanic Jebel Mara region, sedentary farming and mobile livestock raising exist in a symbiotic relationship. Pastoralists in this region keep a mix of herds of cattle, sheep, goats and camels as an adaptive strategy.

Much of the semi-arid zone has lost its natural vegetation. Acacia species (such as *A. seyal*, *A. mellifera*, *A. nubica*) and grasses (such as *Sorghum purpreo-serceum*, *S. aethiopicum*, *Cymbopogon nervatus* and *Hyperbentia pseudocymbaria*) used to dominate this zone. Large scale land clearance for mechanized cultivation has greatly diminished the population of these and several other species. Still others have been eradicated as weeds.

To the south of the semi-arid climatic zone is the savanna zone. It covers nearly one-half of the country's landscape. The rainy season corresponds with the high-sun period starting in May and ending in September. Within this zone, there are wide variations with the amount of rainfall and duration of the dry season. The rainfall increases appreciably from north to south and the reliability increases likewise. The annual average rainfall ranges between 500 and 700 millimeters in the Sahel savanna, the northern region adjoining the semi-arid zone. Here there is a pronounced dry season lasting from 7 to 9 months. Rain is unpredictable as variations between 25 percent and 50 percent are likely. In the Sudan savanna—in the intermediate zone—the average annual rainfall ranges between 700 and 1,000 millimeters. The dry season is 5 to 7 months long. Rainfall varies with altitude as well. For instance, because of their

high altitude, Jebel Marra in the far West and Nuba mountains in the South-Central receive more rain than the surrounding plains. Farther south the savanna woodland region experiences greater annual rainfall and a longer wet season than any other part of the country. Here the average annual rainfall ranges between 1,000 and 1,600 millimeters, with marked concentration in the period from March to September. The highest amounts of rain fall on the Imatong mountains bordering Uganda and on the Iron Plateau on the Nile-Zaire watershed bordering Zaire.

The type and density of vegetation in the savanna climatic zone as a whole vary with the amount of precipitation available. Where rainfall is low, tree growth becomes bridled and grasses predominate. The vegetation in the Sahel savanna consists of thorny shrubs, low annual grasses, scattered drought-resistant baobab trees, and acacia albida. In the intermediate savanna, tall perennial grasses, denser acacia trees, and deciduous wood varieties are the typical vegetation; but today it is largely deforested. However, the hill regions of Nuba mountains and Jebel Marra have much more vegetation or woodland than the surrounding lower areas that receive less rain. Dense, large deciduous trees, several acacia species, and tall grasses characterize the high-precipitation savanna region. There are areas of rainforest with many species of trees, bushes and ferns in higher elevations such as the Dongotona and Didinga mountains, Imatong, and the Ancholi.

The agricultural capacity and the vast livestock wealth of Sudan are concentrated in the savanna zone. The areas of production extend from the southern regions of Darfur and Kordofan through the vast and rich alluvial plains along the banks of the White Nile north of Malakal and the Blue Nile north of Roseires to Kassala Province in the east. These areas dominate the country's economic life. With rich alluvial soil and ample irrigation available all year round, they are considered the "breadbasket" of Sudan. In the center of the Blue Nile Province, between the two Niles, is the Gezira, a two million hectare (5 million acres) clay plain. It is the site of extensive irrigation schemes, particularly for cotton, wheat, and dura (millet) production. In the eastern region, on the clay plains surrounding Gedaref, cereals and sesame are produced for export on a vast acreage of irrigated and rainfed mechanized farms. The clay soils of this flat and uninterrupted region are the most productive in the country. In Darfur and Kordofan, west of the White Nile, most inhabitants are sedentary farmers dependent upon small-scale, rainfed cultivation of staple crops and the collection of gum arabic; but nearly a third of the population are nomads raising camel in the North and cattle in the South. The growing season is about five to six months long and is suitable for many rainfed crops. The South Kordofan clay plains, especially, are suitable for such crops like dura, sesame, cotton, and groundnuts. As a result, there exists a growing mechanized farming in this

region at the expense of the Baggara herdsmen. The Baggara are major cattle keepers whose mobility covers a vast area in this region. In the dry season they move to the fringes of the high rainfall savanna area along the Bahr el Arab and Bahr el Ghazal rivers into Upper Nile. When the rains arrive, they move north to central Kordofan and the Kosti area of the south-west Blue Nile Province to avoid biting flies. On the Darfur plateau, seasonal water from Jebel Marra gives good grazing. The Fur people raise cattle and cultivate crops on terraced fields.

The Transformation of Sudan's Agricultural Sector

For centuries pre-colonial traditional societies in Sudan had communal forms of ownership of the means of production: land, pastures, water, and other sources vital to sustain life. Community chiefs exercised responsibilities to apportion land and other resources to all members, settled disputes over the use of resources, and regulated land uses and resource utilization. These community chiefs, however, sought advice and consent from their "subjects" to carry out their communal obligations.

Within traditional societies, peasant farmers and pastoralists pursued self-sufficient, risk-minimizing, and sustainable economies. Farmers built up soil fertility with organic matter and extensive use of legume-based rotations and maintained sound fallow practices. They also practiced land uses which mixed the production of crops, trees and shrubs, and livestock. Trees and shrubs not only provided sustained supplies of forage and fuelwood, but they also replenished soil fertility as well as reduced soil erosion. Pastoralists developed various types of sophisticated traditional methods that enabled them to maintain sustainable land use. Mobility—governed by seasonal changes—is the hallmark of their life. They always made sure that they moved to areas where biological productivity was at its maximum.

All this started to change with the introduction of a new mode of production when Sudan was brought under British rule during the last decade of the nineteenth century. The new mode of production de-emphasized communal ownership of resources in favor of private ownership, transformed land into an exchange value, and geared production to external market and to serve colonial economic interests. The colonial government imposed several taxes, including the hut tax, the individual tax, and the livestock tax. To be able to pay these taxes people had to produce cash crops or sell their livestock or work on colonial farms as wage workers.

Throughout Sudan's colonial rule, the British administration encouraged the production of cotton primarily to supply this product to the textile industries in England. Cotton was produced on the largest irrigated land in the world—the Gezira, located between the White and Blue Nile rivers. Today, the scheme continues to produce cotton as the principal export revenue earner. In

recent years, as part of a diversification program, the scheme allowed farmers to produce wheat, sorghum, and groundnuts, and the latter has increasingly become one of the principal export crops.

In the 1940s the British also promoted privately operated rainfed mechanized farming. The exigency to supply the food needs of the Allied Forces in Africa during the World War II primarily prompted this policy. Most of the land brought under this operation was arrogated from traditional peasant farmers. The expansion of large-scale rainfed agriculture continued in the 1950s and, more so, in the early years of the post-independence period. During this period, however, discouraged by the falling world cotton prices, most mechanized farmers as well as small-scale farmers found it profitable to grow food crops. Small-scale farmers became not only self-sufficient in food but also produced surplus for the market. Farmers also kept grain reserves for use in time of drought. Some farmers used part of their land for grazing to stock additional reserve in the form of livestock. Thus, the depression of cotton prices was an unexpected benefit that ultimately helped the country to become self-sufficient in food. So, when drought and famine ravaged the Sahelian countries between 1968 and 1973, Sudan went relatively untouched. (Bennett, 1987: 55). In fact, during this period Sudan was able to export substantial quantities of food crops to Saudi Arabia and elsewhere in the Gulf region.

Sudan's agricultural development, however, underwent a major transformation since the late 1960s. The state-initiated policies which encouraged and subsidized shifts toward large-scale, commercial, and often export-oriented agriculture. The state opened its doors to agribusiness firms, multilateral financial institutions, development agencies, and rich Arab governments to promote export-oriented commodity production. Food export schemes were vastly increased. The state expropriated thousands of acres of prime savanna land from the farming and pastoral communities to facilitate this shift to external markets. For instance, many traditional subsistence farmers as well as nomadic and semi-nomadic pastoralists lost their farms and grazing lands under the 1971 Unregistered Land Act that brought under the state's control and ownership the so-called unoccupied lands. Wealthy citizens (mostly large landowners, politicians, retired bureaucrats, merchants, military officers, and traditional chiefs) and foreign investors eventually leased this land to use for capital-intensive rainfed mechanized and irrigated farming. The World Bank provided funding for the clearing of more than 5 million acres of nomadic grazing land in the 1970s (Bennett, 1987: 57). The resulting shift gravely disrupted the self-sufficient, surplus-producing, and ecologically sound peasant and pastoral productions systems. It created conditions for the rapid decline of the welfare of the rural population, the recurrence of drought and famine, and widespread environmental abuse.

The Big Schemes, Ecology, and People

The factors that have contributed to environmental abuse in Sudan are largely of recent origin. For four decades, the agricultural policies of successive governments in Sudan have been to maximize the production of export crops, regardless of the environmental consequences of such an endeavor. The willingness of the Sudanese state to pursue a 'Faustian bargain', whereby short-term benefits are traded for long-term, unknown costs, can be demonstrated by the building of huge dams to advance large-scale irrigation schemes, the expansion of mechanized farming on ecologically fragile land, the displacement of hundreds of thousands of small-scale traditional farmers and pastoralists, and the increasing use of environmentally hazardous chemicals.

Large-scale Irrigation Schemes

Irrigation has been the mainstay of Sudan's agricultural development. Irrigation is made possible by the building of four major dams: two on the Blue Nile, one on the Atbara River, and one on the White Nile. The expansion of irrigated schemes in the post-independence period has been a principal form of state control over agriculture and the peasantry. All major irrigation schemes in Sudan are state-controlled and -administered public enterprises. The Ministry of Irrigation and Water Resources is responsible for delivery of irrigation water to the major canals and, jointly with the Agricultural Corporations, for the operation of minor canals. Irrigated lands produce over three-quarters of the nation's export of cotton, sorghum, and groundnuts. The country has increased the area under irrigation five-fold since 1956.

The Gezira Scheme

The Gezira, the oldest and largest irrigation scheme in Africa, began operating along the Blue Nile in 1926. The British established it to provide long-staple cotton for textile factories in England. Other crops such as wheat, sorghum, and groundnut were also introduced at different stages of the development of the scheme. Today, the scheme covers over 840,000 hectares, including the Mangil and Rahad extension. The government operates the scheme through the Sudan Gezira Board which provides administrative, technical, credit, and marketing facilities to more than 100,000 tenant farmers. Tenants are entitled to a standard tenancy of 40 feddans which they can pass to the next generation, but they are prohibited from transferring, selling or mortgaging it. Even though tenants lack legal security of tenure, eviction is rare.

Under the Gezira tenant system, the government board controls water, plows the land, sprays pesticides, provides chemical fertilizers, decides what is to be produced, and markets the harvested crops. Control over land use by the government board means that a significant proportion of tenant holding must be devoted to cotton cultivation, the principal export revenue earner. Tenant

farmers pay for all these services and inputs. They must irrigate their own piece of land, maintain the canals, and weed and harvest the crops as well (Kontos, 1990: 653-654). These tasks routinely require a substantial amount of labor input and, hence, tenants on the scheme employ a total of a quarter million or more seasonal workers every year.

By all accounts the Gezira scheme has failed to better the lives of the majority of the 100,000 or so tenant farmers and workers. From the very outset the scheme was intended to advance primarily the interest of the state, "to control and deliver cotton for export" (Aricani, 1990: 217). Until a few years ago, cotton had been Sudan's most important crop, accounting for nearly two-thirds of the total export revenue. In spite of persistent fall in world market price, the state pushed tenants to produce more of this commodity for ludicrously low return. The gap between what the state paid to tenants for their produce and the export price has always been extremely wide. The state's strict control of all farm decisions (including the size of farms and types of crops grown, the prices and quantities of inputs, prices of outputs, and timing of operations) prevented tenants from allocating more land and labor to crops (sorghum and millet, for instance) that provided good returns on the market. Tenants also suffer from ponderous and continuing indebtedness for failing to pay for services and inputs they are required to purchase from the state. Because incomes from the tenancies are so low and unpredictable, many Gezira scheme tenants have to depend on off-farm employment. A recent study showed that income from off-farm activities amounted to nearly three-fifths of the total net income of the tenants (Hassaballa and Eltigani, 1995: 27).

In spite of the application of increasing amounts of chemicals, the quality of the soil has deteriorated over time, and outputs for all the crops grown on the scheme (cotton, wheat, groundnuts, and sorghum) have consistently declined, while the area under cultivation has grown.* The declining soil fertility is attributable in large part by lack of crop rotation, absence of fallow period, improper irrigation (water-logging), poor maintenance of drainage channels, and salt build-up. Salinization, which stems from poor irrigation management, is especially becoming a problem in parts of the Gezira irrigation scheme. As the intense heat of the sun evaporates the water from the farm fields, it leaves behind the salts. Additionally, inadequate drainage has caused the water table to rise,

* Total acreage for sorghum increased from 3 million hectares in 1979 to 6.2 million in 1994. But the yield declined from 725 kg/ha to 561 kg/ha during the same period. Millet's acreage increased from 1 million ha to 2.3 million; yield declined from 394 kg/ha to 268 kg/ha. For groundnuts, the acreage increased from 0.9 million ha to 1.1 million; yield declined slightly from 792 kg/ha to 742 kg/ha. Acreage for cotton was drastically reduced from 332,000 ha in 1979 to 147,000 ha in 1984. Cotton's yield declined as well, from 490 kg/ha to 363 kg/ha during the same period.

bringing salt water into contact with crop roots, which kills them. Cropping intensity has dropped to less than 60 percent as over 100,000 hectares were taken out of production due to siltation and mismanagement of the irrigation canals, resulting in reduced availability of water. Local agricultural experts fear that unless more efficient water management system is in place, much of the land currently under cultivation will either suffer greatly reduced productivity or go totally out of production.

Ill-health and premature death are major problems in much of rural Sudan. Whereas this is largely attributable to the poverty of rural living conditions, large-scale irrigation farming schemes are increasingly responsible for the deteriorating health conditions of farmers and seasonal laborers. For instance, irrigation-related diseases such as malaria and bilharzia are widespread in the Gezira districts of El Managil, El Hasaheisa, El Mehiriba, El Mielig, and Rufaa. The Gezira as a whole has a high rate of incidence of malaria and bilharzia because of the presence of many irrigation canals that provide breeding grounds for snails which host bilharzia vectors and malaria-carrying mosquitoes. Malaria cases tripled and bilharzia cases nearly doubled within a ten-year period (Berry, 1983: 105). Other water-borne diseases such as typhoid, leptospirosis and amoebiasis are becoming more prevalent than before as well.

The use of pesticides and chemical fertilizers has also become a major health hazard for the inhabitants living in and around the Gezira Scheme. Sudan is one of the largest pesticide users in Africa. Large-scale agricultural schemes routinely use pesticides to control pest infestation and herbicides to control weeds. Sudan applies many different types of chemicals to control pest infestation six times a year (Prendergast, 1989: 52). The Gezira scheme has been using pesticide since the 1940s. The amount of pesticides applied on this and other mechanized agricultural schemes elsewhere in the country has steadily increased over the years, reaching 2,500 tons a year in the late 1990s (Adams, 1992: 119). Most of the pesticides are applied to cotton plantations, with an area ranging between 220,000 and 300,000 hectares annually (Dinham, 1993: 70). Despite this effort and the increasing cost of pesticides, crops losses to pests continue.

Pesticides and herbicides are sprayed by aircraft. Aerial spraying is frequently carried out with little or no regard for the inhabitants living close to large farm schemes, to crops these people produce, and to non-target areas such as rivers, dams, and other water sources. As a consequence, irrigation canals are contaminated, the fish population has declined, and the pest population has built up genetic resistance.

Banned or obsolete pesticides and inappropriate disposal of used pesticide containers have become health hazards to communities around major large-scale agricultural production. In 1987, a Sudanese research group iden-

tified a number of sites where old and banned pesticides stored for several years have “corroded, spilled out and been washed down with heavy seasonal rain to pollute surrounding water ponds which are used by domestic animals and in some household utilities” (El Gadi, 1991: 3-4; Dinham, 1993: 54). The research group’s extensive interview with residents of Hasahissa, located in the middle of a populated region, and the Gezira irrigation schemes, found a high incidence of headaches, nausea and dizziness, skin hypersensitivity, loss of appetite, running nose and sinusitis, and sore and stinging eyes. The study also noted the intoxication of birds, fish, cattle and wildlife during the pesticides spraying season, and incidents involving the death of many domestic animals (Dinham, 1993: 54).

Irrigation Schemes on the White Nile

Along the middle course of the White Nile between Khartoum and Kosti, there are several state-operated pump irrigation schemes, each operating 50,000 or more feddans of land. There are also many privately owned schemes with lesser farm sizes. The total area under current cultivation is well over half a million feddans of land (Sin, 1995: 17). Built in 1937, the Jebel al-Awliya Dam controls to a large extent the level of water supporting the schemes. Cotton, of course, is the main product of these schemes with sorghum, fruits, vegetables, and spices grown as secondary crops.

Prior to the construction of the dam, people used the clay plains of the river valley and the upland areas productively without abuse. During the dry season they pastured their cattle and cultivated crops on the land along the White Nile. Small-scale irrigation farming, using the traditional shaduf or *sagia*, was also practiced. During the summer season, when the valley was flooded, people moved to the upland to graze their cattle and grow rainfed crops. Throughout the river valley, crop rotation and a transhumant mode of livestock rearing prevailed in a symbiotic relationship for several generations. As Horowitz and Salem-Murdock (1987: 107) have noted: “In the market, pastoral produce (milk and milk products, live animals, meat, and hides) was exchanged for cereal grains; on the cultivated fields, crop stubble was exchanged for manure, as the harvested farms constituted an important source of dry season fodder.”

With the building of the dam, a vast amount of the riverine land was flooded and people lost access to grazing and cultivable land. The expansion of irrigated schemes further reduced the traditional grazing area, particularly the dry-season grazing land close to the river, forcing herders to graze their animals on the semi-arid range for the whole year. Thus the concentration of grazing and farming in upland areas, along with increased human and cattle population, inevitably led to permanent land degradation (Horowitz and Salem-Murdock, 1987: 97-98).

With diminishing grazing land came increased use of vegetation for cattle fodder, thus competing with the need for fuelwood. Decreased farmland also led to wholesale removal of trees to make room for cultivation. The environmental consequences of the removal of the natural vegetation are several: the lowering of the net photosynthesis rate, the reduction in the accumulation of biomasses, the reduction of food for domestic and wild animals, the disruption of the energy, nutrient, and hydrologic cycles, the reduction of nitrogen fixation and nutrient and moisture availability in the soil, an increase in soil erosion via water and wind agents, and an overall decrease in the biological productivity of the land (Whitney, 1987: 132-133).

The New Halfa Scheme

Similar ecological disruptions have taken place in the New Halfa Scheme in the East. Also known as Kashm el Girba, this irrigation scheme is a large-scale project (330,000 feddans in 1993) along the western bank of the Atbara River. The scheme was established in 1965 for the settlement of Sudanese Nubians whose Wadi Halfa lands and communities were inundated by the Aswam Dam reservoir in southern Egypt. Prior to the construction of the Kashm el Girba dam, the lower Atbara economy was predominantly agricultural, mainly dependent on irrigation from the Atbara River. The inhabitants of the area led a self-sufficient subsistence economy practicing various types of river-based cultivation: *Gerf* cultivation on the river bank (flood irrigation); *Karu* cultivation which makes use of irrigation by means of pumps and water wheels; *Magat* cultivation of the river bed when the river water recedes and develops into pools; and *Atmur* rainfed cultivation in some parts of the Atbara basin (Ati, 1992: 24). Cattle raising, fishing, and wood collection were also pursued as supplementary economic activities. Indigenous pastoralists such as the Shukriya and Hadandawi grazed their cattle on the plains and riverine pasture. They pursued a mode of production compatible with the natural resources and constraints of the semiarid nature of the region.

The impact of the dam on the downstream economy has been significant: 1) a severe drop in the amount of water flowing downstream, 2) erosion of the river channel as coarse and dissolved materials were deposited behind the dam, 3) reduced fertility of the riverine soils as the annual flow of silt decreased, 4) increased deforestation due to decreased annual river-drifted wood downstream, 5) increased overgrazing due to loss of the riverine pasture, and 6) disturbance of the feeding and breeding system of the fish population (Ati, 1992: 29-31). The ecological and human effects of the reservoir itself are the loss of upstream terrestrial ecosystems and the displacement of tens of thousands of farming and pastoral communities.

Increasing sedimentation of the Kashm el Girba reservoir and irrigation

systems has also become a major problem. This problem has been linked to land clearing for agriculture and degradation of watersheds. The reservoir was estimated to be 55 percent full of silt in 1983, after only about 20 years of operation (Lewis and Berry, 1988: 184). According to recent finding the storage capacity of the reservoir was “reduced due to silting from 1,300 million cubic meters to 718 million cubic meters by 1976 and is expected to reach 500 million cubic meters in 1997” (El-Ashry and Ram, 1987: 90). At the current rate of silt accumulation, there will be little water for irrigation by 2025 (Adams, 1992: 132). At present, because the reservoir provides much less irrigation water than in the past, much less land is being cultivated. Salinization is beginning to become a problem in some areas of the irrigation scheme.

The Expansion of Rainfed Mechanized Farming

The 1970s in Sudan saw the spread of large-scale mechanized farming into the savanna plains of the central rainland areas of the Blue Nile province, eastward to the vast flat plains of Butana in Kassala Province, and westward into southern Kordofan and Darfur provinces. In 1973, for instance, with loans obtained from the World Bank, 200,000 feddans of the most fertile land in southern Kordofan was turned into public and privately operated mechanized farming schemes (Ahmed, 1983: 55). A wealthy Saudi Prince obtained a 99-year lease on 1.1 million feddans of fertile land in Blue Nile Province to produce sorghum to feed animals in the oil-rich nations (Prendergast, 1990: 41). The total area under mechanized rainfed farming increased from slightly over one million feddans in 1968 (Suliman, 1993: 105) to over 7 million feddans in 1989 (Sin, 1995: 17). On average, mechanized farmers cultivate 3,500 feddans each, but there are some who farm between 10,000 and 35,000 feddans (UNHCR and ILO, 1984: 5). In 1987, there were 3,500 large-scale farmers who cultivated as much land as all the small-scale traditional farmers combined (Shaddad, 1987: 33). The expansion of mechanized farms depended on expensive imports of fuel, machinery, chemical fertilizers, and other goods. These inputs consumed much of the hard currency earning of the country. This in turn led to an increase in borrowing to pay for these imports.

Mechanized farming became the most profitable agribusiness for foreign and wealthy local investors with little or no interest in sustainable land management. First, investors leased land from the state at bargain prices. Second, they obtained farm equipment and imported inputs at subsidized prices. Third, they obtained loans from the state bank at low interest rates. Fourth, they were permitted to lease fresh land after they exhausted soil fertility. Fifth, they pursued monocropping, ignoring state regulations requiring fallowing and crop rotation to ensure soil fertility. Sixth, some scheme operators sold, rented or sharecropped the land they leased from the state. Seventh, they hired

seasonal labor at extremely low wages. In most instances, the machine does the ploughing and seeding. Cheap labor does the land clearance, planting, weeding, and harvesting.

The mechanized agricultural sector produced the bulk of the export commodities. However, the small-scale peasant sector slowly felt pressured to get involved in export commodity production. Increase peasant involvement in export commodity production has been brought about “by soaring rates of direct taxation, scarcity of consumption goods produced by the subsistence sector, and intensified commercial trade in the products of both mechanized agricultural schemes and nomadic communities” (Prendergast, 1990: 36).

Competition from large-scale mechanized farming sectors has forced small-scale cultivators in rainfed areas in the eastern region to look for other sources of income. Today, a large number of small-scale farmers are involved in wage labor working on large-scale farms or irrigated schemes. Many also engage in non-farming activities such as trading, hand-crafting, and wage laboring in nearby urban centers.

From an environmental and social point of view, the expansion of rainfed mechanized farming in eastern Sudan has produced disastrous results, some of which include the following.

1. Mechanized farming expanded by cutting down nearly all the natural vegetation in the area. In the past, tall grasses, flat-topped acacia trees, the drought-resistant baobab trees, bushes and shrubs were dominant vegetation in the clay soil plains of southern Kordofan, southern Darfur and eastern Sudan that have now turned into large mechanized farms. In the wetter southern parts of these regions, dense forests of tall trees were common features of the landscape not long ago. All these forests have almost disappeared in the last thirty years or so. Grasses and shrubs have also gone, and during the dry season the soil in this vast region is exposed to intense wind erosion. In 1970s alone, an average of 8,750 square kilometers of forest were removed annually to make room for mechanized cultivation (Government of Sudan, 1982: 53; Berry and Geistfeld, 1983: 69).

2. Efforts to grow the same crop on the same field each year provided neither rest for the land nor opportunities for the land to regenerate its fertility. Once the land is exhausted and yields start to decline, abandonment of the land for neighboring new areas follows, destroying once again vegetation cover, especially perennial vegetation, and, in turn, leading to a rapid loss of topsoil by erosion. Soil erosion has also taken a toll in the region, owing largely to the widespread use of

tractors. Today, the topsoil on much of the abandoned land in the eastern region has been destroyed to the point of sharply lowered productivity.

3. The expansion occurred at the expense of the traditional farmers and nomadic pastoralists; the government forcefully drove them out of their well-endowed farmlands and pastures. The transformation of this intermediate zone into modern mechanized farms pushed pastoralists to more marginal lands and blocked their traditional seasonal movements between the semiarid-arid land of the North and the savanna of the South. With less land available, farmers intensified their use of the land, neglecting the traditional land use practices such as fallowing and crop rotation—which ensured the recuperation of soil fertility—thus leading to further environmental degradation. As the productivity of the land decreased and land impoverishment increased, farmers and pastoralists were unable to generate sufficient income to meet their basic necessities. As a result, many moved to marginal and increasingly inhospitable areas or became farm laborers or migrated to urban areas to seek employment. Those pastoralists who were driven out of their traditional grazing lands are wrongly blamed for the degradation of the marginal ecological zone they are now forced to inhabit and for the encroachment of the desert, estimated at about 10 kilometers per year.

One of the most glaring incidents of wholesale clearing of vegetation, induced by the expansion of mechanized farming and state pricing policies, is the fast decline of the *Acacia senegal*, the tree that produces gum arabic, an important export crop of Sudan, which is used for pharmaceuticals, printing, and food preparation. In western Sudan, the tree is a crucial part of a crop rotation because, as a leguminous plant, it fixes nitrogen from the air into the soil as a fertilizer, gives shade, and helps prevent soil erosion. The leaves are used as cattle fodder and older trees are felled and used for firewood. Over the past several years, however, the cultivation of gum arabic trees has vastly declined due to (1) pressures on land from displaced farmers and pastoralists as rainfed mechanized cultivation expanded, (2) the decline of gum arabic returns to small farmers resulting from low government prices and farmers opting to grow other crops such as millet and sorghum as alternatives, and 3) increased fuelwood demand. The decline of the gum arabic trees accelerated during the droughts of the early 1980s as farmers made three times as much money by turning their gum arabic trees into charcoal for sale as fuel, than by harvesting the gum (Carter, 1986: 10). Economic necessities continue to force

people to engage in wholesale destruction of these environmentally useful trees, after having exploited them prudently for many centuries.

4. The continuing expansion of large-scale mechanized farming has also ruined the symbiotic relations that had existed for centuries between the farming population and the nomadic pastoralists. Both communities depended on one another for their livelihood through the exchange of each other's produce. Also, historically pastoralists moved to areas inhabited by sedentary farmers after the latter had harvested their crops. While the pastoralists benefited from access to grazing pastures, their cattle also enriched the farmers' land with their organic waste. Frequent tensions and conflicts between the two communities have now become the norm as both have to scramble for scarce and ever diminishing cultivable land and fresh grazing land. The conflict usually arises when pastoralists move their herds into farmers' cropped fields in search of pasture, often destroying maturing crops. Violent conflicts over land have become more frequent, particularly in Southern Kordofan, Upper Nile, Blue Nile, and White Nile Provinces (Prendergast, 1989: 45).

The dilemma for the pastoralists is that their livestock population steadily increased at the same time as large-scale irrigation and mechanized schemes have cut into traditional grazing areas. The domesticated animal population (dominated cattle, sheep, goats, and camels) of the country increased from about 33 million in 1970 (Ministry of Information and Culture, 1971: 131) to 57 million in 1983 to over 63 million in 1993 (Amanor, 1996: 911). The number would have been considerably higher had the drought of 1983-85 and 1990-91 not significantly depleted stocks. The relatively high rate of livestock growth can be attributed largely to improvements in veterinary services, wider provision of bore-holes for year-round grazing, and the traditional values which attach one's well-being and prestige to the possession of large herds, regardless of the quality of animals.

World Bank-supported government plans to permanently settle nomadic or semi-nomadic groups around reservoirs and water-holes may have solved the short-term water and grazing needs of their livestock, but have, unfortunately, resulted in excessive degradation of range land. Areas where water-holes induced "permanent" settlement have been over-grazed to the point where all the natural cover is destroyed, exposing the topsoil to water and wind erosion. Wind erosion is particularly severe in the semi-arid and savanna grazing lands of Sudan.

5. The loss of woodlands has also led to the almost total disappearance of wildlife in most parts of northern Sudan. Land clearance for rainfed mechanized farming and irrigation, especially, has expanded by virtually eliminating animal habitats. Additionally, large increases in human and cattle populations, removal of vegetation for fuel, and hunting have deprived most of the semi-arid and savanna zones of the country of their wildlife (Davis, 1987: 190). Many people in the savanna woodlands of the eastern region recall the existence of such primates as the zebra, giraffe and elephant only about two or three decades ago. They say none exist today.

Pushing Environmental Destruction Southward

In the last two decades or so, the government has also been engaged in pushing environmental destruction southward. For instance, the government's construction a 360-kilometer long and 54 meters wide canal between Jonglei and Malakal—bypassing the swamps of the Sudd (the largest freshwater swamp in the world) in southern Sudan, is expected to result in deleterious environmental consequences. Those in favor of the Jonglei Canal argue that the canal will enable the South to irrigate the fertile land to be reclaimed from the Sudd. The South will also benefit from improved water and land transportation (Lako, 1992: 45). Others also contend that water diversion around the Sudd will not significantly alter the existing ecosystems since much of the Nile's water will continue to flow through the Sudd. (Lewis and Berry, 1988: 337). Environmentalists, however, point out that draining the Sudd would force the inhabitants of the region to alter their way of life. The livelihood of the Dinka, Nuer, Shilluk, and many others in the Sudd region depend on cattle raising, agriculture, and fishing, and their whole existence is adaptive to the regime of the river with periodic movements back and forth across the river. The Sudd provides a good dry-season pasture from November to April. The excavation of the Jonglei canal would destroy an estimated 40-50 percent of this pasture (Burton, 1991: 515). The Sudd provides a productive breeding ground for a great many variety of fish and game, an important supplementary diet for the local inhabitants. It is also home to millions of migratory birds and thousands of large herbivores (Howell, et al., 1988: 464). The construction of the canal would mean that the people and wildlife living in the areas of the project would have much less water and a diminished habitat. There would also be serious problems of access across the canal for pastoralists. In 1983, the SPLM/A forced a halt to the construction of the canal, with about two-thirds of the project completed.

CONCLUSION

This paper has argued that environmental and natural resource degradation has been driven primarily by state policies that have pushed the expansion of agricultural exports and massive land alienation. Agricultural development projects such as irrigated and rainfed schemes have not only reduced the productivity of the land as a result of inappropriate land use practices (for example, monocropping), but also forced a vast number of peasant farmers and pastoralists to move into marginal lands and engage in ecologically destructive practices. The damage done to the land's ability to sustain life in many parts of the semi-arid and savanna regions of Sudan is extremely extensive. Some areas, which once supported tens of thousands of lives, are now barren, and the land is totally degraded and incapable of supporting flora and fauna.

Clearly, the decline in the well-being of the Sudanese people and their means of livelihood dictates that development as usual cannot continue. Successful development depends on the sustainable use of environmental resources and on minimizing, as far as possible, the negative impacts resulting from the extraction of resources. This cannot be realized without ending the impoverishment of the rural producer, which leads to the impoverishment of both the rural economy and natural environment. Ending this impoverishment requires the state's transfer of agricultural resources back into the hands of those whose survival directly depends upon their prudent management, the restoration of traditional knowledge and systems of land use that have proved environmentally appropriate, and the supporting of peasant farmers and pastoralists in their endeavor to rehabilitate their degraded environment. The obstacles to achieving such a transformation in state policies towards community-based resource management and development strategy, however, should not be underestimated. The empowerment of the rural masses and the transfer of resources back to local communities will undoubtedly be opposed by those who benefit from the prevailing strategies of development. The hope is that formidable industrial and agricultural trade unions, peasant organizations, local non-governmental organizations and grass-roots pressure groups will emerge to force those in political power to embark on a development strategy that is socially and economically just, politically empowering, and ecologically sustainable.

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