PN-ABD-369
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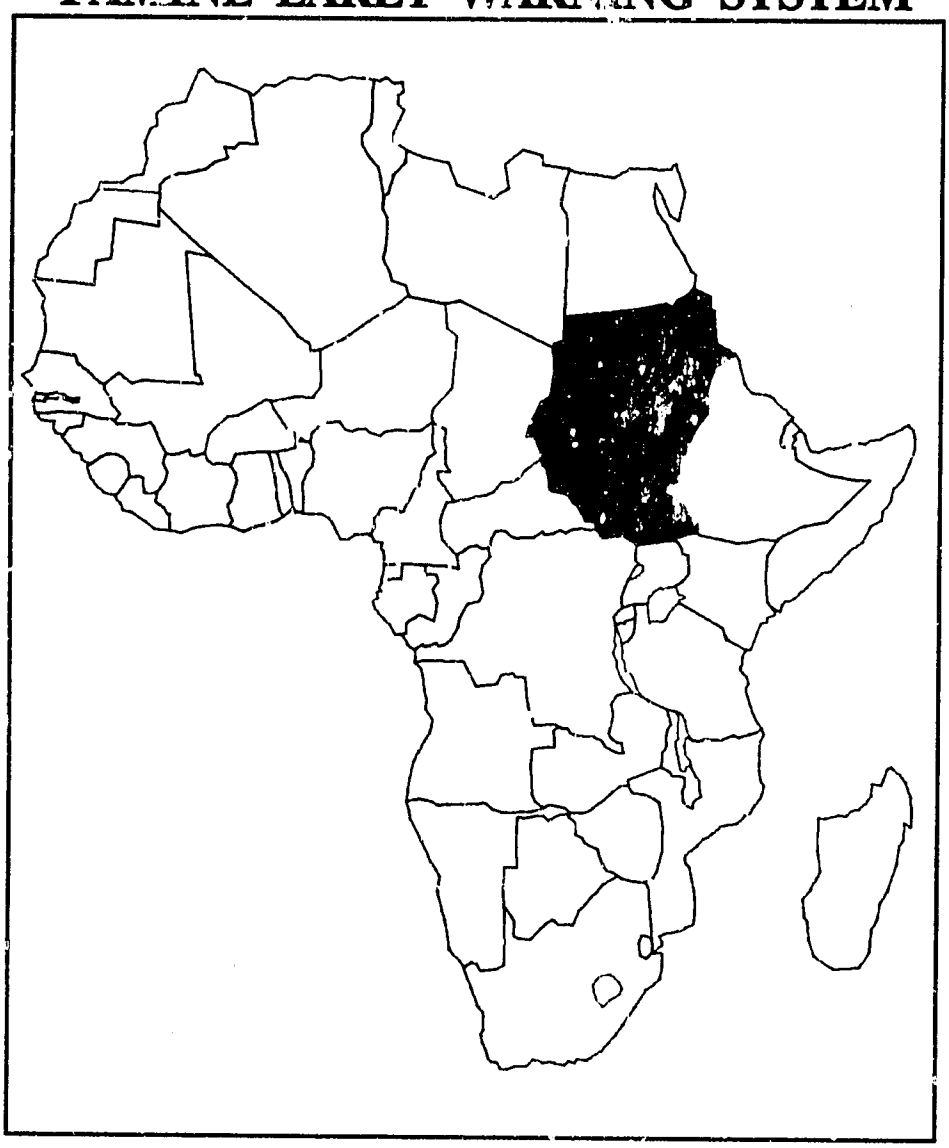
SUDAN

VULNERABILITY ASSESSMENT

FAMINE EARLY WARNING SYSTEM



Produced by the Office of Technical Resources - Africa Bureau - USAID

FAMINE EARLY WARNING SYSTEM

The Famine Early Warning System (FEWS) is an Agency-wide effort coordinated by the Africa Bureau of the U.S. Agency for International Development (AID). Its mission is to assemble, analyze and report on the complex conditions which may lead to famine in any one of the following drought-prone countries in Africa:

- **Burkina**
- **Chad**
- **Ethiopia**
- **Mali**
- **Mauritania**
- **Niger**
- **Sudan**

FEWS reflects the Africa Bureau's commitment to providing reliable and timely information to decision-makers within the Agency, and among the broader donor community, so that they can take appropriate actions to avert a famine.

The FEWS system obtains information directly from FEWS Field Representatives assigned to six USAID Missions. In addition, FEWS relies on information it obtains from a wide variety of sources including: USAID Missions, host governments, private voluntary organizations, international donor and relief agencies, and the remote sensing and academic communities.

This is the final report prepared under FEWS Phase I. The vulnerability assessment was completed for USAID's Africa Bureau by **Price, Williams & Associates, Inc.**

Under Phase I, the work of the FEWS Field Representatives was coordinated by **Tulane University's School of Public Health and Tropical Medicine.**

NOTE: This publication is a working document and should not be construed as an official pronouncement of the U. S. Agency for International Development.

SUDAN

Vulnerability Assessment

June 1989

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SUDAN

Vulnerability Assessment

Executive Summary

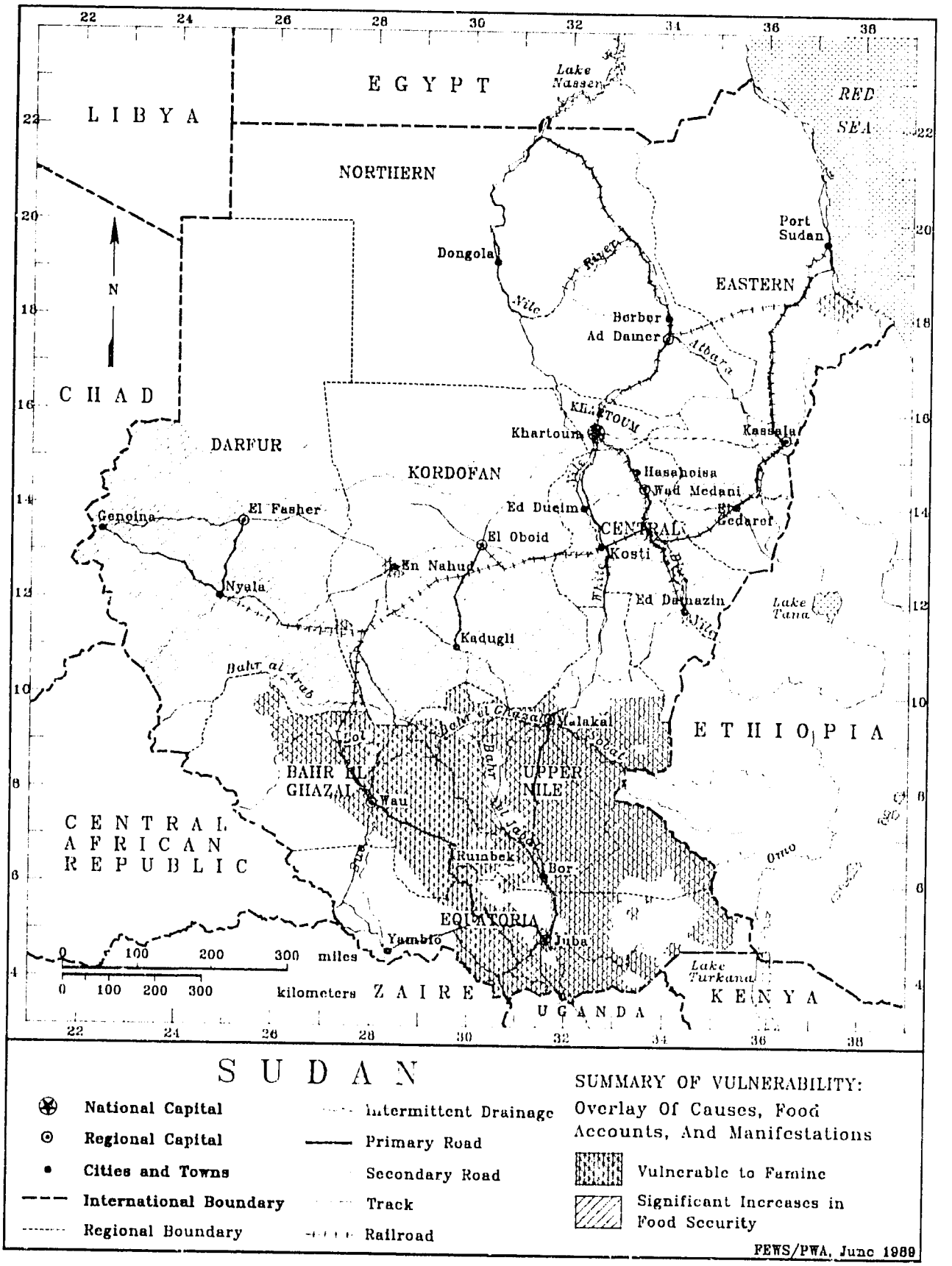
Most of Southern Sudan is highly vulnerable to famine, but the area does not appear to be in as drastic a condition as it was last year at this time. We are not hearing the reports of daily starvation, although food shipments are getting through to central towns only after enormous effort. The most worrisome area is Upper Nile Region. As of mid-June, little food aid had reached the region's major towns and the World Food Program had received reports of serious malnutrition in the area. In contrast to the South, Sudan's mechanized and rainfed agricultural areas experienced a record harvest in 1988, with up to two years' surplus grown in parts of Darfur and Kordofan regions. Government of Sudan food stocks are low. Available stocks will be used in the Agricultural Bank of Sudan's 1989 commitment to export two million metric tons of cereals.

DRY FORECAST FOR 1989 RAINFALL IN THE SAHEL

The Synoptic Climatology Branch (SCB) of the U.K. Meteorological Office forecasts a 60% chance that the Sahel will receive less than 75% of normal rainfall. The SCB therefore expects rainfall to be less than 1988 (an average year compared to the long-term mean) but more than the "very dry years of 1986 and 1987".

As part of the SCB's research into the effects of sea surface temperatures on Sahelian rainfall, it has made experimental rainfall forecasts each year since 1986. The SCB employs four forecast methods, all based upon sea surface temperature anomaly patterns in April. Three statistical methods predict that 1989 will be dry to very dry. A dynamic general circulation model method predicts more rain in the Sahel than either of the statistical methods. At this early stage of research, the SCB has more confidence in the dry forecast. The SCB warns that the forecasts are experimental and must be used with caution. The forecasts are based on the assumption that sea surface temperature anomalies will not change in an unusual way between spring and summer. This assumption broke down for the 1988 forecast, leading the SCB to continue monitoring sea surface temperatures after April this year.

Map 1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El Oboid
Kosti
Ed Damazin
En Nahud
Kadugli
Genoina
El Fasher
Nyala
Malakal
Wau
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Yambio
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SUDAN
National Capital
Regional Capital
Cities and Towns
International Boundary
Regional Boundary
Intermittent Drainage
Primary Road
Secondary Road
Track
Railroad
SUMMARY OF VULNERABILITY:
Overlay Of Causes, Food Accounts, And Manifestations
Vulnerable to Famine
Significant Increases in Food Security
FEWS/PWA, June 1989

I. Vulnerable/At-Risk Populations

Methodology: Vulnerability Assessment

The FEWS vulnerability assessment uses agro-meteorological and socio-economic indicators to define a population's probable level of vulnerability to famine. Four stages of vulnerability are identified: vulnerable, at-risk, nutritional emergency, and famine. Because available indicator data are frequently of relatively poor quality, or without extensive baselines for reference, FEWS relies upon a "convergence of evidence", a comparison of several indicators, to interpret the meaning of any single indicator. Each section that follows (Causes, Food Accounting, Manifestations) uses indicator data in different ways to locate actual and potential food stress (see Appendix 1 for details). Each surface of food stress thus created is mathematically weighted for significance to vulnerability, subjective judgements are applied, and then the surfaces of food stress are combined into a summary of vulnerability. Maps for each surface and the summary are provided within this assessment.

Most of Sudan's South is highly vulnerable to famine (see Map 1), although the situation appears to be slightly less drastic than a year ago. Last year at this time, there were reports of daily deaths as displaced people waited at central points for food shipments that rarely got through. This year, similar reports are not being heard. While there was a large exodus of people from rural areas during the month of April (approximately 330,000 people arrived at camps for displaced populations during that month), the migration seems to have slowed down since the beginning of May. This is probably due to the fact that conditions are not as severe as they were last year at this time, and to roads having become impassable with the start of the rains. The unhatched areas found amid the otherwise highly vulnerable zones northwest of Juba and at the southeastern tip of the country reflect areas of much higher than normal vegetative potential (see NDVI, inside back cover), reflecting the good rains of 1988. Nevertheless, it is certain that much of this potential was unrealized due to the warfare and social disruption found in the area. The area without hatching along the western edge of the South reflects the lower levels of fighting reported from those areas.

Much of the rest of the non-desert area of the country has seen significant increases in food security caused by one of the best rain and harvest years seen across the Sahel in the past two decades. An immense, record-breaking national harvest has been produced, largely in the rainfed and mechanized agricultural areas across the middle of the country. Small areas of increased vulnerability are seen in scattered areas. One area of intense pest damage stands out along the southern coast of Eastern Region (along the Tokar Delta), while two vulnerable areas are visible in western Kordofan Region (at En Nahud and southwest of there near El Muglad). These latter areas are sites of camps for populations displaced from the South. None of these areas is in the same degree of danger as the vulnerable areas of the South. The area of intense pest damage is not highly agricultural, so the people of the area will have other resources on which to fall back. The two areas with displaced populations are far enough from fighting that supplies designated for those towns only have the hurdle of weak infrastructure to jump. There are several other concentrations of displaced populations outside of the South, but all are either in areas of strong vegetative potential, or are close to large stores of food, which is the case for populations near Khartoum.

Flags that might indicate changing levels of vulnerability during the 1989 rainy season include:

- for the rainfed agricultural areas, the amount and pattern of rainfall. This will give a good indication of how the 1989 harvest will fare. In the many areas where there are no reporting rain stations, comparisons of NDVI levels with those of previous years will aid in assessing whether the rainy season is progressing adequately.

- an increasing number of people displaced from specific areas of the South as the rainy season progresses. This could indicate that the agricultural season in those areas will not be successful, whether because of poor weather, insufficient agricultural inputs, or interference from warfare or civil strife.

- increasing malnutrition levels in towns and displaced populations. These data would disclose the magnitude of both known and suspected food security problems.

- the outcome of any further negotiations between parties to the civil war, especially if such talks lead to cease fires that open the way for emergency food deliveries.

II. Causes of Reduced/Increased Access to Food

Methodology: Causes of Reduced or Increased Access to Food

Food is acquired through production, exchange, or transfer (gifts). Many factors, including rainfall, pests, floods, and warfare, can affect these acquisition mechanisms. This section provides a qualitative assessment of these factors and their likely impact on food access.

The available indicators of access to food show that, for the most part, food acquisition systems in the North functioned neither poorly nor especially well during 1988, systems along the central, Sahelian tier functioned much better than usual, and food acquisition systems in the South functioned poorly (see Map 2 for results of analysis and Appendix 2 for a list of the indicators used).

North of the Civil War Zone

Food acquisition systems functioned relatively normally to excellent in most places outside of the war-torn areas. Nevertheless, there were areas of significant damage to food production in the North. The area of decreased access to food along the coast in Eastern Region reflects reports of intense locust damage (more than 30 percent of crops destroyed), while other spots in that region reflect areas where the late 1988 floods damaged crops. The spot of decreased access in northwest Kordofan is a second area of heavy pest damage.

In other areas, much higher than normal NDVI, indicative of good growing conditions, drowned out reports of moderate pest damage, such as the damage reported at Sodari, northwest of El Obeid in Kordofan Region. The interpretation here is that vegetative growth and, indirectly inferred, crop yields were strong enough that the moderate pest damage did not have a significant impact on the harvest. Areas of moderate pest damage therefore do not appear on the map.

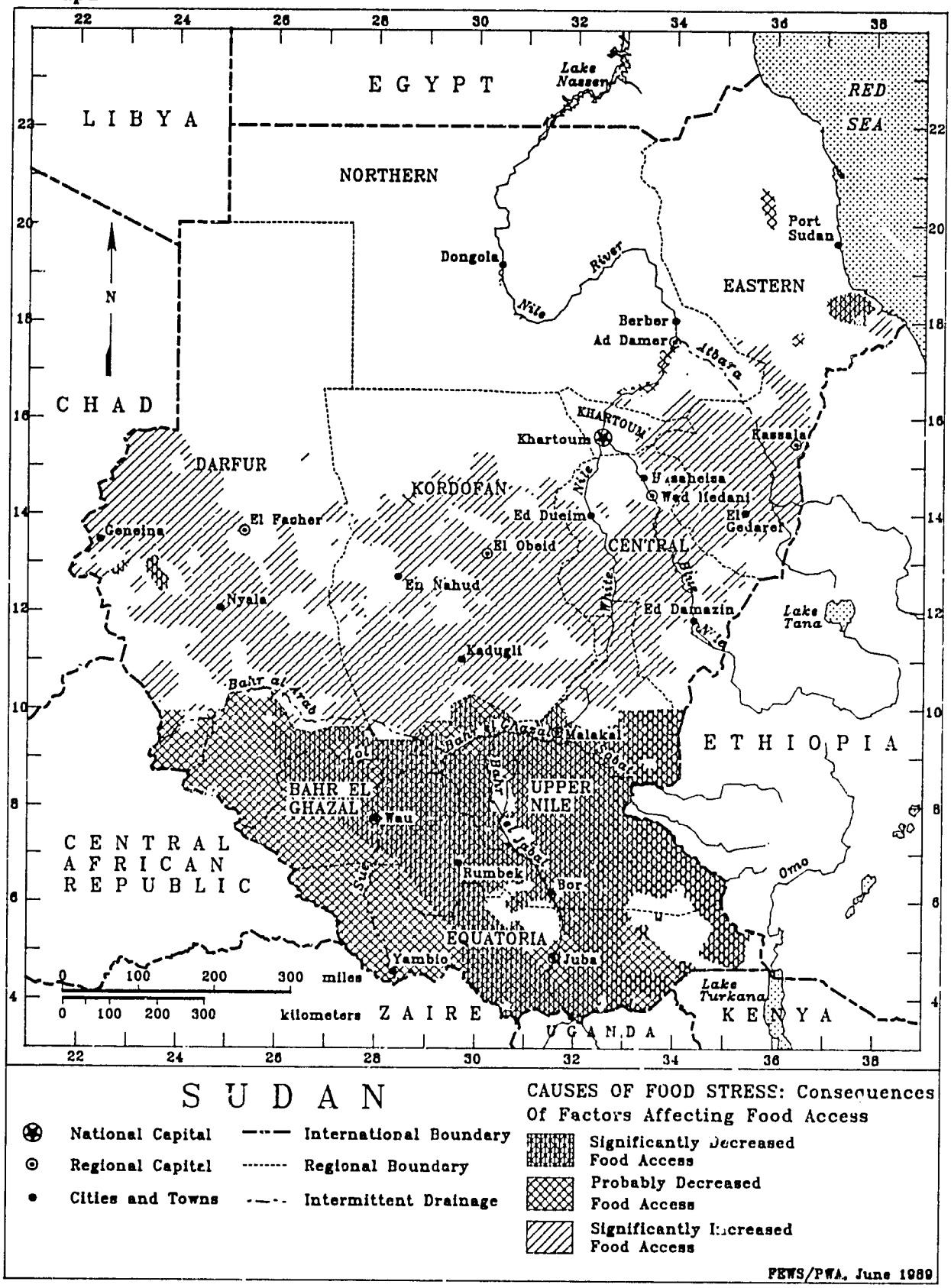
The "probably decreased food access" shown along the Nile in Northern Region is also caused by flooded crops, although the actual impact of the floods on crops is hard to quantify. Finally, the decreased access to food shown just south of Geneina in Darfur Region reflects the impact of inter-tribal conflict in that area, which is independent of the civil war in the South.

In Map 2, all of the areas of "significantly increased access" are areas where the season-long cumulation of NDVI for 1988 was significantly greater than the maximum NDVI for all years from 1982 through 1987. The interpretation here is that crop yields were much better than in any of the previous six years. If farmers increased the area planted over previous years, one would expect enormous gains in crop production. This apparently was the case, as reports from many of these areas state that there is enough production to meet food needs for two years.

Southern Sudan

It is no surprise that just about the whole of Southern Sudan has experienced inadequate food access over the past year. For several years, the area has experienced generalized warfare in which manipulation of the food supply has been a weapon alongside guns, bombs, and mines. In

Map 2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CAUSES OF FOOD STRESS: Consequences Of Factors Affecting Food Access
Significantly Decreased Food Access
Probably Decreased Food Access
Significantly Increased Food Access
FEWS/PWA, June 1989

general, the territories of western Bahr El Ghazal and western Equatoria regions have experienced somewhat less intense strife than areas to the east. This is probably due in large part to the very remote nature of these areas.

The holes in the hatching northwest of Juba and at the eastern tip of Equatoria Region (from Torit eastward) derive from the strong NDVI seen in these two areas during 1988. The relatively high NDVI in eastern Equatoria is unusual, as that area usually appears as bare rock in the vegetation imagery. The strong NDVI may have amounted to nothing if the people there were not able to farm or graze their herds. Because of the paucity of contact with rural areas of the South, we do not know whether the populations were able to carry out normal activities -- the suspicion is that they were not able to do so.

There has been a recent attempt to bring food aid at least to large cities in the South through "Operation Lifeline". This ambitious program was aimed at getting enough food aid for the rest of 1989 to distribution points before the start of the rains. As of June 14, the World Food Program (WFP) had noted that 52 percent of required food aid had been delivered to distribution points. Table 1 shows the status of Operation Lifeline deliveries to the South as of June 21. The program

Table 1: Food Aid Requirements for Displaced Populations, March to June 1989

Region	GOS Areas	SPLA Areas	Total
Equatoria			
Needs	17,353	16,500	33,853
Allocated	27,290	18,976	46,266
Available	19,100	13,700	32,800
Underway	3,170	2,250	5,420
Delivered	19,083	9,986	29,069
Arrived	N/A	N/A	N/A
Upper Nile			
Needs	12,120	17,625	29,772
Allocated	13,794	13,090	26,884
Available	7,231	15,050	22,281
Underway	360	770	1,130
Arrived	6,873	1,464	8,337
Bahr El Ghazal			
Needs	13,403	8,630	22,033
Allocate	13,183	N/A	N/A
Available	10,100	N/A	N/A
Underway	2,811	N/A	N/A
Arrived	9,398	4,116	13,514
For Displaced Population in Darfur, Kordofan, Central, and Khartoum Regions			
Needs	31,184	N/A	31,184
Allocated	27,003	N/A	27,003
Available	27,003	N/A	27,003
Underway	8,729	N/A	8,729
Delivered	21,621	N/A	21,621

Source: World Food Program

has been hampered by rains, mechanical failure, and uncertainty about safe passage, but has gotten the Government of Sudan (GOS) and the Sudanese People's Liberation Army (SPLA) to agree to a mutual cease fire to allow food shipments through. There has been an ambiguity to the cease fire, as there are third parties to the fighting who are not under the control of either the GOS or the SPLA. There have been attacks on food convoys that have been ascribed to these third parties. Nevertheless, one major difference between June 1989 and June 1988 is that we are not hearing the reports of hundreds of people dying daily from starvation.

III. Food Accounting

Methodology: Food Accounting

A quantitative account of all estimable food resources (production and aid) available for consumption until harvest is calculated using region-level data. Seed, feed, post-harvest losses, exports, and consumption-to-date are subtracted from this account. The months of food remaining are then calculated by dividing the food resources by the consumption rate (population times monthly consumption rate). Inadequate food access is assumed if stocks fall short of needs until harvest.

The food account picture for Sudan is much more positive than it was last year at this time (see Map 3). Areas of surplus are a direct result of recent local production -- in no part of Sudan did households have significant carryover stocks from the mediocre 1987 harvest. According to sources in the field, Darfur Region and Southern Kordofan Province produced enough millet and sorghum with the 1988 harvest to replenish household stocks for the next two years. The mechanized farming areas of Central Region also produced record crops, although a shortage of labor and sacks slowed the area's harvest considerably. By mid-May, however, the Mechanized Farming Corporation reported that almost all of the sorghum crop had been harvested. The positive food account in Khartoum Province is tied to expected commercial inputs -- the area does not normally grow more than a minimum of cereals.

The low per capita production in Northern and Eastern Regions is not surprising, as both regions are quite arid. North Kordofan Province had the lowest per capita production outside of Khartoum and the South (1988 production will supply about 58 percent of North Kordofan's need). At the same time, however, North Kordofan's 1988 production was more than 50 percent higher than the 1980 to 1984 average, and almost 30 percent higher than the province's 1985 production. For the South, the assumption was made, for purposes of this food accounting exercise, that there was no agricultural production in that zone during 1988. There is no reliable information upon which to confirm or refute this assumption.

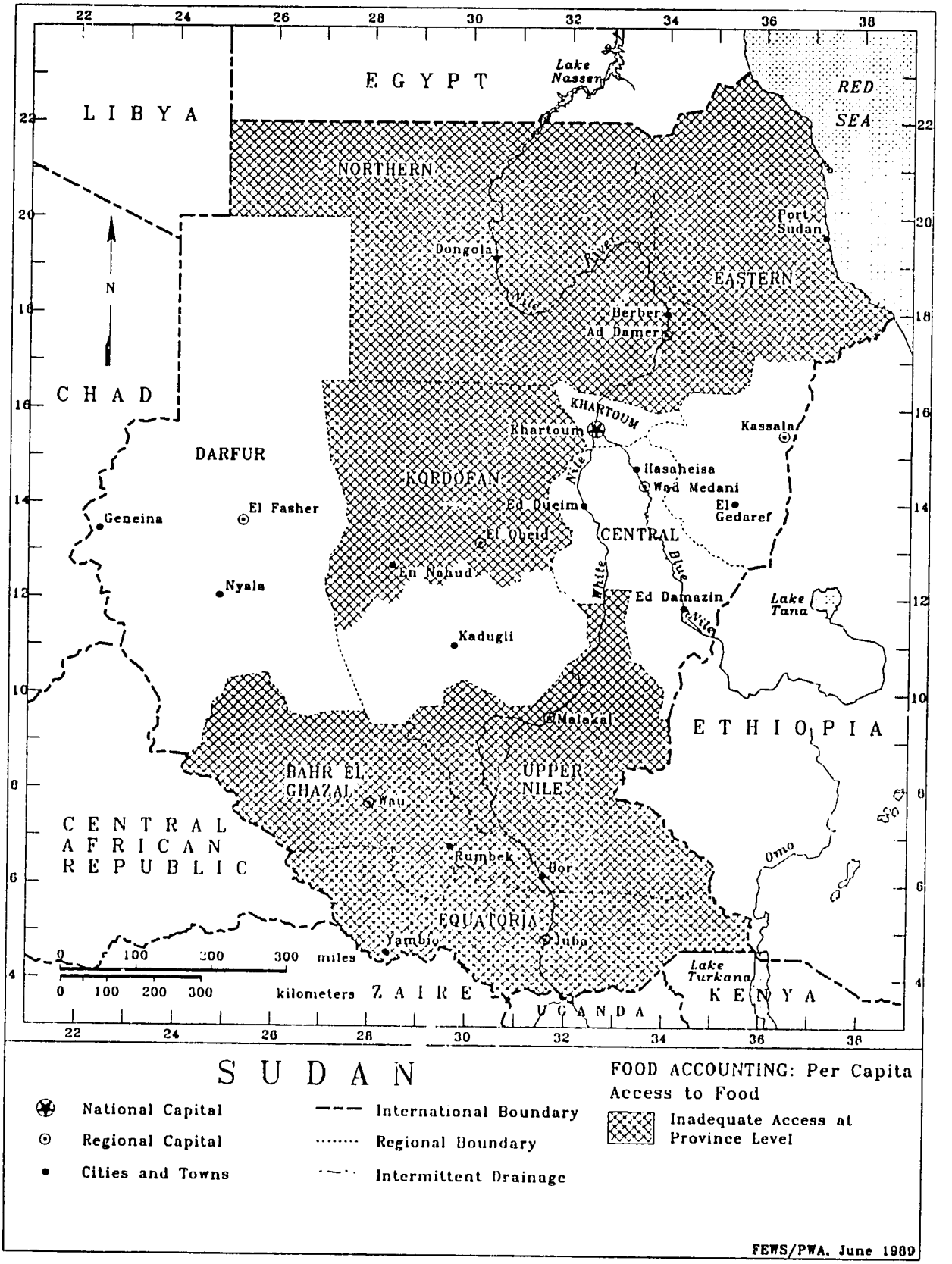
Because estimates of the contribution to the food supply of the commercial sector outside of Khartoum, herding, and remittances are not available, the food account picture is based chiefly on domestic cereal production and is therefore skewed to the negative side for pastoral and marginal agricultural production areas. Agricultural Bank of Sudan (ABS) stocks were also not included in the food accounts, as it was not clear that stores in a given location would be consumed in that area. This is especially true of stocks near Khartoum, as the ABS intends to sell 2 million metric tons (MT) of cereals abroad to raise foreign exchange.

IV. Manifestations of Reduced Access to Food

Methodology: Manifestations of Reduced or Increased Access to Food

Populations may manifest their current vulnerabilities to famine by their physical and socio-economic reactions to food access conditions. Based upon observed behaviors and conditions compared to a reference baseline, a subjective judgement is made of their degree of vulnerability.

Map 3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Intermittent Drainage
FOOD ACCOUNTING: Per Capita Access to Food
Inadequate Access at Province Level
FEWS/PWA, June 1989

The location of populations displaced from rural areas of the South is the prime mappable manifestation of reduced access to food available for Sudan this year (see Map 4 and Appendix 2). Map 4 shows where displaced southerners plus one displaced group from southeastern Darfur Region had congregated as of early May. The group from southeastern Darfur were fleeing local inter-tribal conflict. The southerners are all people who found themselves with little food or few resources with which to obtain food, and who are seeking relief at larger towns within the Southern Region or at major towns between the South and Khartoum. By early May, there were an estimated 1.4 million displaced people in Sudan (see Table 2 for the RRC accounting for the start of May). Of these, 720,000 were in camps, up from 400,000 at early April: the camp population at Wau increased from 15,000 to 100,000 people over that month; Malakal saw the creation of an 80,000 person camp; other new camps sprang up at Maridi, Renk, Mayoum, Ban-

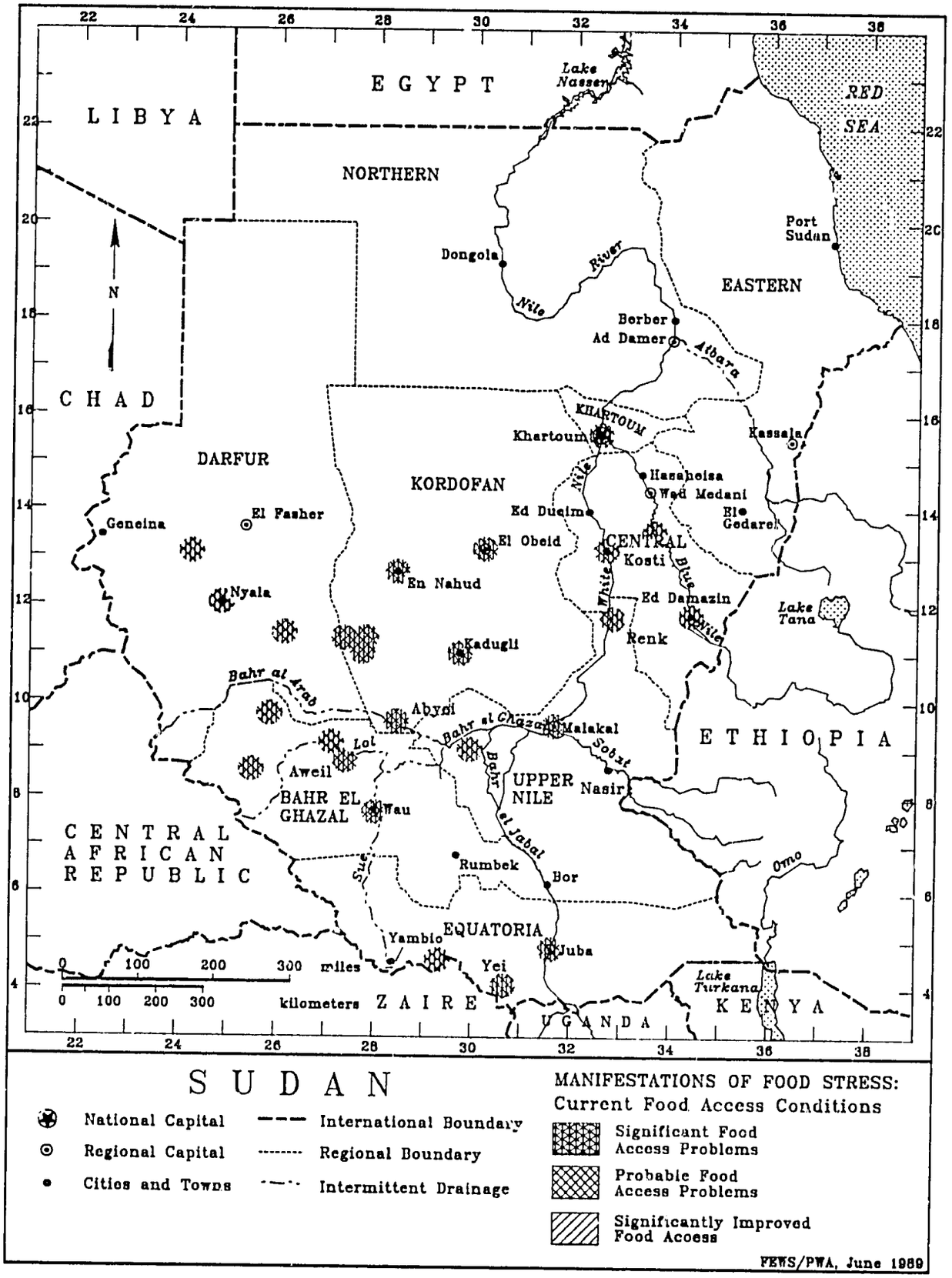
Table 2: Displaced Populations In Sudan, May 1989

Region	Area Council	Displaced, In Camp	Displaced, Not In Camp	Total
S. Darfur	Nyala	6,000	0	6,000
	Ed Daein	10,500	0	10,000
	Jabal Marra	20,000	0	20,000
	Abu Matariq[1]	0	3,000	3,000
S. Kordofan	Abyei	15,000	0	15,000
	El Meriam	14,000	0	14,000
	El Muglad	19,000	0	19,000
	Babanousa	10,000	0	10,000
	Kadugli	4,560	0	4,560
	El Tibun	0	0	0
	El Gantur	0	0	0
N. Kordofan	El Obeid	8,000	0	8,000
	El Nahud	13,000	0	13,000
Central Reg.	Kosti	37,514	30,000	67,514
	Ed Damazin	9,000	26,000	35,000
	Sennar	0	10,000	10,000
Khartoum	Khartoum	0	600,000	600,000
Equatoria	Juba	162,984	0	164,850
	Yei	50,376	0	50,376
	Maridi	9,250	0	9,250
Upper Nile	Malakal	80,000	0	80,000
	Renk	15,000	0	15,000
	Mayoum	15,000	0	15,000
	Bantio	20,000	0	20,000
Bahr El Ghazal	Wau	100,000	0	100,000
	Aweil	60,000	0	60,000
	Malwal	15,000	0	15,000
	Raga	30,000	0	30,000
Total	**Sudan**	**724,184**	**673,000**	**1,397,184**

Source: Sudan Early Warning System; USAID/Khartoum

[1]Reported by USAID/Khartoum

Map 4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Ed Dueim
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Kosti
Nyala
En Nahud
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Blue Nile
Ed Damazin
Lake Tana
Renk
Kadugli
Bahr al Arab
Abyei
Bahr el Ghazal
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MANIFESTATIONS OF FOOD STRESS:
Current Food Access Conditions
Significant Food Access Problems
Probable Food Access Problems
Significantly Improved Food Access
FEWS/PWA, June 1989

tio, Malwal, and Raga; and at Aweil, the camp population increased by 42,500 people to a total of 60,000. Such increases in the number of people leaving rural areas just at the beginning of the rainy season is not a good sign. In peace-time, this would be the period for soil preparation and planting.

Over the same period, camps at Juba, Yei, Abyei, and Babanousa shrank, although, according to the WFP, the camp at Babanousa had grown by 2,000 at the start of June. At some camps, displaced families were given seed and tools so that they could take advantage of the start of the rainy season. Camps at El Meiram, Wau, and Abyei all shrank immensely during the month of May. At Juba, however, there was some hesitancy about farming nearby areas, as mine fields were still in place.

The population of identified displaced southerners outside of camps also shrank between early April and early May (from 810,000 to 670,000). The greater part of the shrinkage was in Malakal, Renk (both in Upper Nile Region), and Wau (in Bahr El Ghazal Region). It is not clear whether those 110,000 people moved into camps or migrated further north. In both April and May, the bulk of the non-camp displaced population (about 600,000 people) has been in shanty towns surrounding Khartoum.

The only other current information regarding manifestations of reduced access to food are reports of malnutrition of a semi-specific nature (for example, "reports have been received of serious malnutrition in places such as Nasir"). Such valuable information, although scant and unverified, may assist in determining the import of other problems (in the case of Nasir, the fact that, by mid-June, planned food deliveries had not reached the area of southern Upper Nile Region in which Nasir is situated).

APPENDIX 1

Mechanics of the Vulnerability Assessment

All available indicator data of major significance to the food security of Sudan was gathered and analyzed for significance. The geographic boundaries for each were mapped as accurately as possible. Using a computer-based Geographic Information System (ArcInfo), the indicator maps were scored according to a three position scale of food stress to indicate whether they showed 1) an obvious cause of food stress, 2) no obvious food stress or significant increase in food access, or 3) a significant increase in food access (only applicable in areas without stress).

All indicators relating to "Causes" of food stress were overlaid to produce a summary surface of food stress as seen by these indicators (Map 2). A similar process was used for all indicators relating to "Manifestations" of food stress (Map 4). For the food accounting analysis, areas were mapped and scored as having adequate or inadequate access depending upon whether all food resources identified met assumed food needs (Map 3).

In a final step, the "Causes", "Manifestations", and "Food Accounting" summary maps were themselves overlaid for a grand summary of "Food Access" (Map 1). Analysts were free to use subjective criteria in applying food stress scores at each stage based upon their best judgments.

APPENDIX 2

Indicators Used in the Sudan Vulnerability Assessment

NDVI - Growing Conditions: The 1980 NDVI maximum was compared to the normal (1982-1987) yearly maximum. All areas significantly higher or lower (+/- 0.05 NDVI) than normal were identified. Areas of sparse vegetation (less than 0.1 NDVI) were excluded from this analysis. Sources: NOAA/NASA GAC NDVI.

Pest Damage: Areas in which pest damage was judged to have had a significant negative impact on food access were identified. Source: FEWS/Sudan.

Flooding: Areas in which floods were judged to have had a significant negative impact on food access were identified. Source: FEWS/Sudan.

Food Stock Reserves: These were noted for their bearing on food security but were not mapped.

Nutrition Data: These were noted for their bearing on food security but were not mapped.

Conflict/Civil Disruption: Areas in which conflict was judged to have had a significant negative impact on food access were identified. Source: FEWS/Sudan.

Food Accounting Notes: Net harvest includes sorghum, millet, and wheat, and is calculated at the region level. The food accounting includes distributions of emergency food aid since the 1988 harvest season. The calculation assumes no carryover of stocks from 1987-88 and counts imports only for Khartoum. Rate of consumption used is 146 kg per person per year. Date of harvest assumed to be November 31. Amount of cereals consumed is based on the June 1989 population times six months of consumption to give amount consumed from harvest until June 1. Sources: Government of Sudan/Ministry of Agriculture and Natural Resources/Planning and Agricultural Economics Administration/Department of Agricultural Economics (December 1988), Darfur Region Agricultural Planning Unit, Sudan Early Warning System (March 1989), and UN World Food Program (May 1989).

Key Terms

At Risk - FEWS Reports employ the term "at risk" to describe those populations or areas either currently or in the near future expected to be lacking sufficient food, or resources to acquire sufficient food, to avert a nutritional crisis (i.e., a progressive deterioration in their health or nutritional condition below the status quo), and who, as a result, require specific intervention to avoid a life-threatening situation.

Where possible, food needs estimates are included in the FEWS reports. It is important to understand, however, that no direct relation exists between numbers of persons at risk and the quantity of food assistance needed. This is because famines are the culmination of slow-onset disaster processes which can be complex in the extreme. The food needs of individual populations at risk depend upon when in the disaster process identification is made and the extent of its cumulative impact on the individuals concerned. Further, the amount of food assistance required, whether from internal or external sources, depends upon a host of considerations. Thus the food needs estimates presented periodically in FEWS reports *should not* be interpreted to mean food aid needs, e.g., as under PL480 or other donor programs.

ITCZ - The Intertropical Convergence Zone (ITCZ) is where the high pressure system originating in equatorial regions of the Atlantic (the St. Helena's High) collides with the Azores High descending from the north. The ITCZ tends to move northward during the spring and summer in response to normal global weather patterns. The position of the ITCZ normally defines the northern limits of possible precipitation in the Sahel; rainfall generally occurs 100 to 300 kilometers south of the ITCZ.

NDVI - Normalized Difference Vegetation Index (NDVI) images are created at the laboratory of the National Aeronautic and Space Administration (NASA) Global Inventory Modeling and Monitoring System (GIMMS). These images are derived from Global Area Coverage (GAC) imagery (of approximately 4 km resolution) received from the Advanced Very High Resolution Radiometer (AVHRR) sensors on board the National Oceanic and Atmospheric Administration (NOAA) Polar Orbiting series of satellites. The polar orbiter satellites remotely sense the entire Earth and its atmosphere once each day and once each night, collecting data in 5 spectral bands. Bands 1 and 2 sense reflected red and infra-red wavelengths respectively, and the remaining 3 bands sense emitted radiation in 3 different spectral bands. The NDVI images are created by calculating

$$(\text{infrared} - \text{red}) / (\text{infrared} + \text{red})$$

for each pixel from the daytime satellite passes. Since chlorophyll reflects more in the infrared band than in the red band, higher NDVI values indicate the presence of more chlorophyll and, by inference, more live vegetation. A composite of daily NDVI images is created for each 10-day period, using the highest NDVI value for each pixel during that period. This technique minimizes the effects of clouds and other forms of atmospheric interference that tend to reduce NDVI values. NDVI is often referred to as a measure of "greenness" or "vegetative vigor." The NDVI images are used to monitor the response of vegetation to weather conditions.