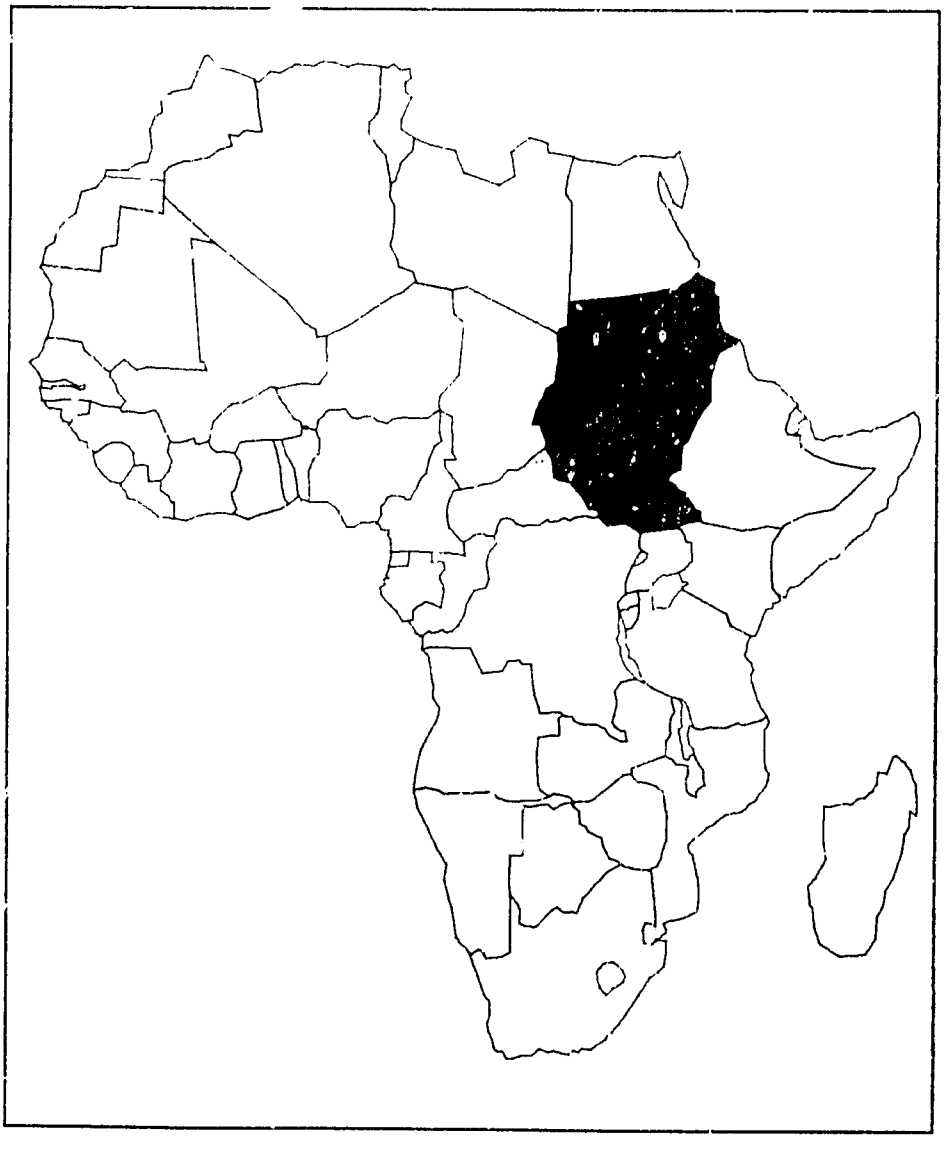
SUDAN

Floods, Displacement, and Concern Over Vulnerability

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 (USAID). 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**
- **Mauritauia**
- **Mozambique**
- **Niger**
- **Sudan**

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

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. In addition, the FEWS system obtains information directly from FEWS Field Representatives currently assigned to six USAID Missions.

FEWS analyzes the information it collects, crosschecks and analyzes the data, and systematically disseminates its findings through the following publications:

- **FEWS Country Reports** - produced monthly during the growing season, and bimonthly during the rest of the year, and
- **FEWS Bulletins** - produced every ten days during the growing season.

In addition, FEWS serves the USAID staff by:

- preparing **FEWS Alert Memoranda** for distribution to top USAID decision-makers when dictated by fast-breaking events;
- preparing **Special Reports, maps, briefings, analyses, etc.** upon request; and
- responding to **special inquiries.**

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FEWS Country Reports, Bulletins, Alert Memoranda, and other special studies are prepared for USAID's Africa Bureau by **Price, Williams & Associates, Inc.**

The work of the FEWS Field Representatives is 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.

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September 1988

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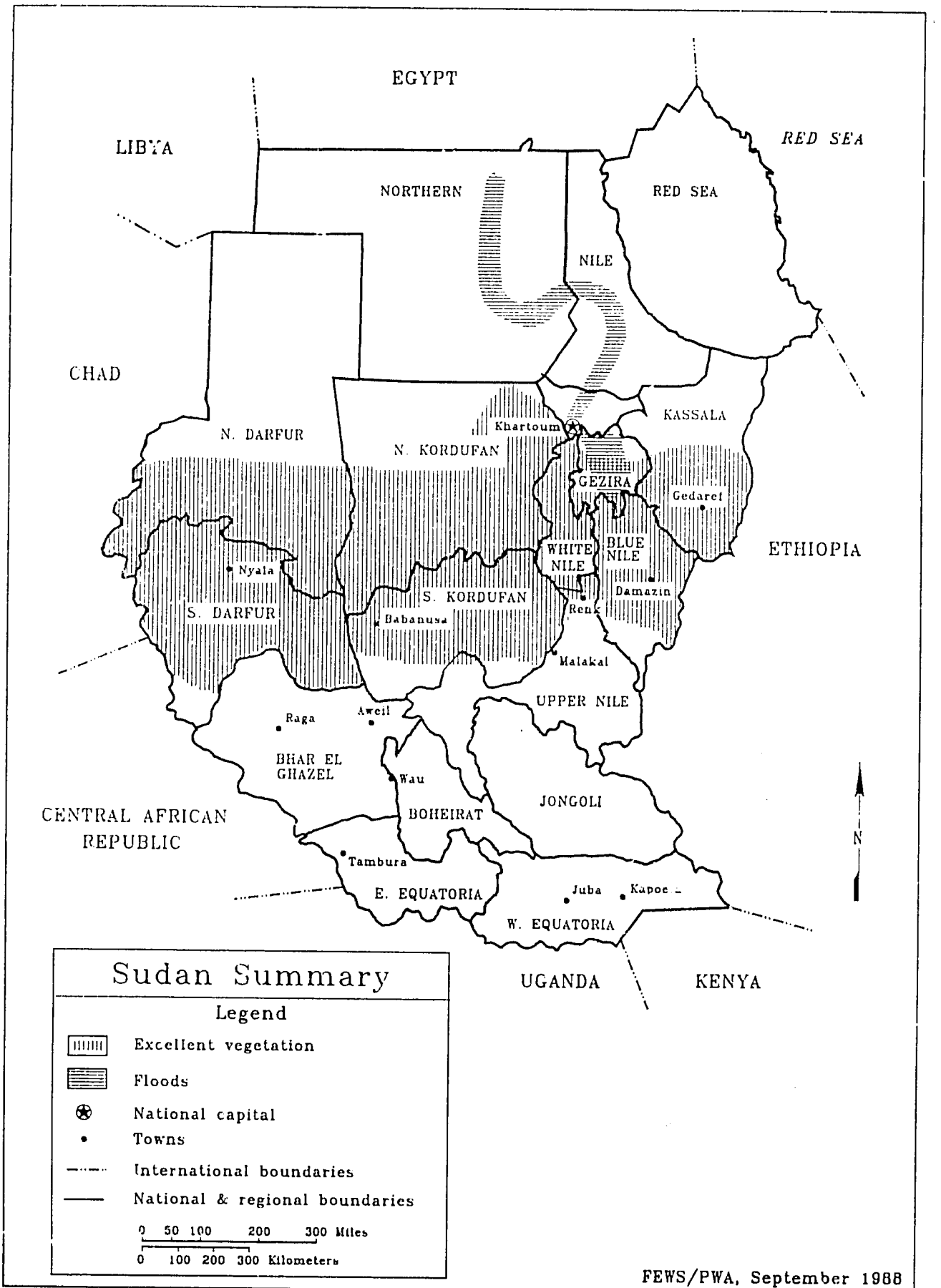
Map 1


EGYPT
LIBYA
RED SEA
NORTHERN
RED SEA
NILE
CHAD
KASSALA
Khartoum
N. DARFUR
N. KORDUFAN
GEZIRA
Gedaref
WHITE NILE
BLUE NILE
ETHIOPIA
Nyala
S. KORDUFAN
Damazin
S. DARFUR
Renk
Babanusa
Malakal
UPPER NILE
Raga
Aweil
BHAR EL GHAZEL
Wau
JONGOLI
CENTRAL AFRICAN REPUBLIC
BOHEIRAT
N
Tambura
E. EQUATORIA
Juba
Kapoe
W. EQUATORIA
UGANDA
KENYA
Sudan Summary
Legend
Excellent vegetation
Floods
National capital
Towns
International boundaries
National & regional boundaries
0 50 100 200 300 Miles
0 100 200 300 Kilometers
FEWS/PWA, September 1988

Floods, Displacement, and Concern Over Vulnerability

Summary

Excessive rainfall and overflowing rivers caused severe flooding in Sudan, especially in the eastern irrigated areas of Northern, Nile, and Gezira provinces. Seventy percent of towns in Gezira were reported devastated by flooding. In Northern Province, 450 square kilometers have been inundated by the Nile River, due to the exceptional discharge of its tributary the Atbara. Up to 100,000 people there could become at risk of malnutrition and disease. While damage to the infrastructure for irrigation could be extensive, flooding should improve the net fertility of soils in these areas.

Many displaced Southerners, especially those enroute to South Kordufan, are in poor health. Many deaths are reported among those trekking out of the south, especially Bahr El Ghazal Province, enroute to Meriam and Babanusa. In Aweil, on the rail line to Babanusa, 4,000 deaths have been attributed to starvation. The rail line is in poor condition and it seems unlikely that a relief train will be able to depart from Babanusa. Flooding and rains both limit relief efforts and present an added risk to those attempting to flee conflict in the South. Current movements of people could reflect increasing insecurity in the countryside and bode ill for livestock production and the current crop in the Region. *These movements could also presage greater displacement when travel becomes easier during the dry season*. If relief supplies do not reach Aweil soon via rail, donors will support an airlift of emergency supplies.

Sudan is highly vulnerable to a nutritional emergency in 1989 if this year's harvest is poor. The USAID Mission, especially, has expressed its concern because public and private stocks are low and will be depleted by harvest. Grain prices are at record high levels. A good harvest would require an expansion of acreage devoted to grain, good yields, and less than catastrophic levels of locust destruction. Farmers have reportedly responded to the record grain prices by planting "every nook and cranny," at least in western Sudan. It seems likely that acreage devoted to grain (primarily sorghum and millet) will be high. Scattered rainfall stations report receiving generally better rainfall than last year (which itself was good through mid-September), although less than the long term average. Exceptions are rainfall stations in Gedaref and Damazin, the areas of greatest sorghum production (from mechanized agriculture). Rainfall reports, received too late to reconcile for this publication, suggest substantially different scenarios in those two critical grain areas (Gedaref and Damazin). The lower figures would put national sorghum supplies at risk in 1989; the higher figures would support great optimism. Satellite imagery suggests vegetation is at or above the historical maximum for this time period in every rural council in Sudan. In crop production, the timing of rainfall is as important as the cumulative total, and these satellite images suggest that the timing has been good. Rainfall, as judged only from satellite imagery, also appears excellent everywhere. Increased acreage combined

with possible good yields could produce a record harvest in 1988. Poor yields, however, especially in major producing regions, could lead to extremely poor harvests. A negative indicator is the potential for extreme locust destruction this year. Locusts could be especially damaging in western Sudan. Nonetheless, lush native vegetation and the extreme northerly position of the Intertropical Convergence Zone (ITCZ, see inside of back cover) could help to limit damage to important crops and agricultural areas. While local damage could be severe, it might not be critical at the national level.

Rainfall, Vegetation and Agricultural Potential

Sudan is clearly highly vulnerable to a nutritional emergency in 1989 unless 1988 agricultural production is good. The most important contributor to this vulnerability is the abysmal state of public and private grain stocks. These should be depleted by harvest time.

A good harvest will protect Sudan from a nutritional emergency in 1989. Such a harvest depends on increased acreage devoted to grains (compared to 1987), good yields, and Desert Locust activity that does not exceed that of recent years.

The acreage devoted to food grains should have increased dramatically from last year. Record high grain prices appear to have motivated farmers to plant as much area as possible, especially in western Sudan. Record grain prices fueled 1985's record acreage and the same could occur in 1988.

Good yields depend on rainfall in the right quantities and at the right times. Just prior to publication, too late to reconcile, FEWS received two sets of rainfall data (see Table 1). Reporting rainfall stations show that this year's rainfall is above that of 1987 in many places and above the long-term average in some. The long-term average (probably 1950-1980) is higher than recent experience, since rainfall has generally declined from 1950 to the present. Thus, below-average rainfall could still be sufficient.

TABLE 1: Cumulative Rainfall (mm) for 1988, 1987, and the Average (1951-1980) up to 13 August (Source A) or 10 August (Source B)

Rain Gauge	1988 Source A	1988 Source B	1987 (Source A)	Average (Source A)	Normal (Source B)
Gedaref	229	320	309	364	329
Kassala	177	176	109	178	175
Damazin	255	343	375	446	423
Sennar	285	282	181	298	273
Kosti	175	145	200	233	210
Wad Medani	201	137	120	216	203
El Obeid	136	136	76	209	199
Kadugli	340	409	362	378	422
El Fasher	82	110	57	161	147
Nyala	267	250	111	262	259

The differing rainfall measurements in Damazin and Gedaref are of great concern. Both of these areas have extensive mechanized grain agriculture that, combined, can account for up to 50% of national sorghum production. A dismal harvest there in 1988 would be a catastrophe for Sudan. One set of rainfall data (Source A) suggests very low cumulative totals and the danger of reduced yields.

The other set of rainfall data (Source B), supported by assessments of rainfall from weather satellite images, suggests better rainfall than reported from Source A. Satellite assessments of meteorology show excellent rains everywhere in Sudan (see Map 2). Analysis of satellite images of vegetation (Normalized Difference Vegetation Index or NDVI, see inside of back cover) also supports Source B and suggests vegetation is at or above the historical (1982-1987) maximum in almost every rural council in Sudan.

If accurate, this finding (supported by remote sensing) would provide grounds for some optimism about yield potential in these areas. An analysis of satellite imagery of vegetation (NDVI, see Map 2) shows that the vegetation levels in both Damazin and Gedaref Rural Councils were higher than the historic maximum over the same period addressed by these rainfall reports and have continued higher. These trends suggest that these maximum levels will continue until harvest, barring a catastrophic end to the rainy season. If present conditions continue, the increased acreage and yield potential could lead to production levels above those of 1986, and possibly as high as those of 1985 -- a record year. Satellite images show vegetation levels (NDVI) well above the historical maximum (see Map 2) throughout the southern part of northern Sudan. An analysis of NDVI trends so far this year shows every rural council to be at or above the historical maximum. Figure 1 shows the trends so far in 1988 (August 30) for six rural councils (containing six of the rainfall stations shown in Table 1) along with the historical annual trends of maximum, average and minimum NDVI for those same rural councils.

There is some fear in Sudan that, even if agricultural potential is otherwise good, "locust infestations may destroy a high proportion of the harvest." Historically, locust plagues appear to have contributed to nutritional emergencies only when drought, warfare, or other factors have limited agricultural potential. While locust infestations can be expected to destroy crops, leading to at least a local requirement for food aid, there would usually be no reason to suspect widespread or significant loss throughout Sudan. This year's locust infestation is unique in several ways. It could be that swarms will move south (instead of east, west, and north) to threaten crops.

In any case, lush native vegetation should act to disperse locusts and divert them from crops. A high ITCZ could also lead to their northward movement into the desert. Locusts now coming to adulthood in western Sudan could swarm if limited vegetation and prevailing winds prompt them to congregate. They will begin moving toward winter breeding grounds along the Red Sea coast, where they must be contained.

Regional Weather and Vegetation

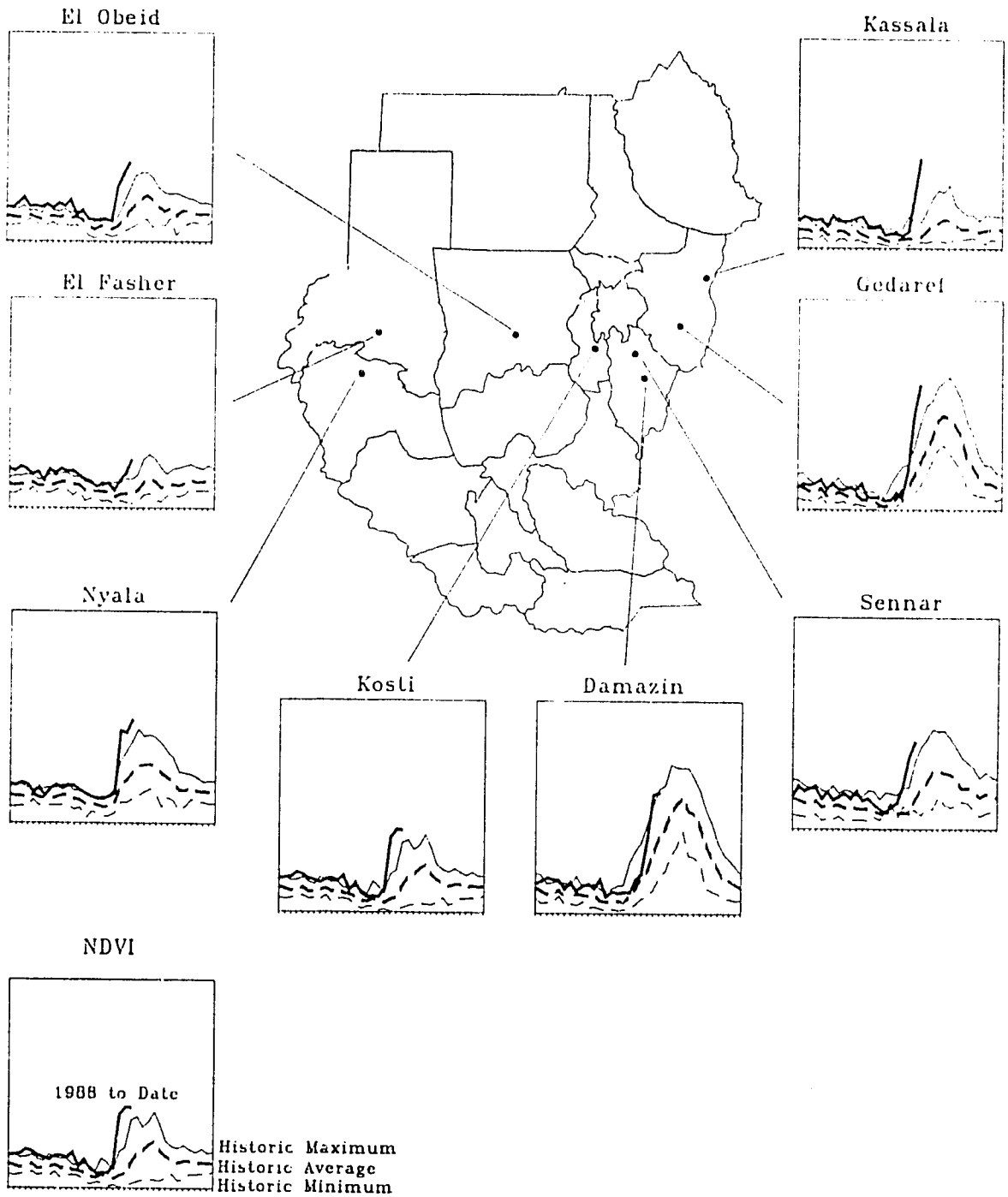
The Intertropical Convergence Zone (ITCZ, see inside of back cover) has been farther north and has remained north longer than at any other time during the last ten years. The average ITCZ was hovering at about 21° N during the last ten days of August. Normally, the ITCZ is at 19° N during this period. As a consequence of the ITCZ holding such a northerly position, the rains have created good pastures farther north than in recent years (see Map 3). The unusual position of the ITCZ is evident in the mid-August report of 64 millimeters (mm) of rain at Moudjeria (central Mauritania) -- an area which last year had only 6mm of rain and the year before had none.

For FEWS-monitored countries, cumulative rainfall during the first ten days of August showed a generally favorable pattern (see Map 4). Heavy rainfall in the western Sahel continued through the end of August (see Map 5). With these heavy rains, northwestern Senegal approached 100% of normal

Map 2

Normalized Difference Vegetation Index (NDVI)

Current trends through August 30, 1988, compared to the historic maximums, averages, and minimums for selected sites

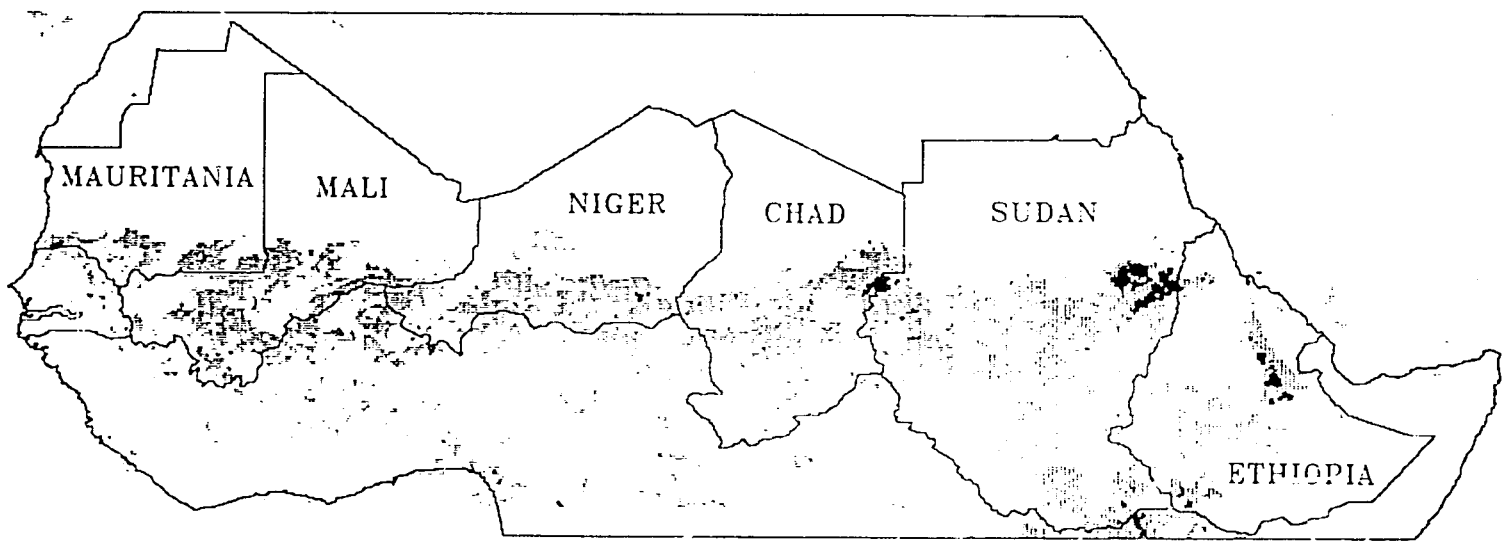


FEWS/PWA, September 1988

Map 3

Much Stronger Vegetation than Historical Maximum

August 11-20, 1988 vs 1982-87 Maximum for Same Decade



Stronger than historical maximum

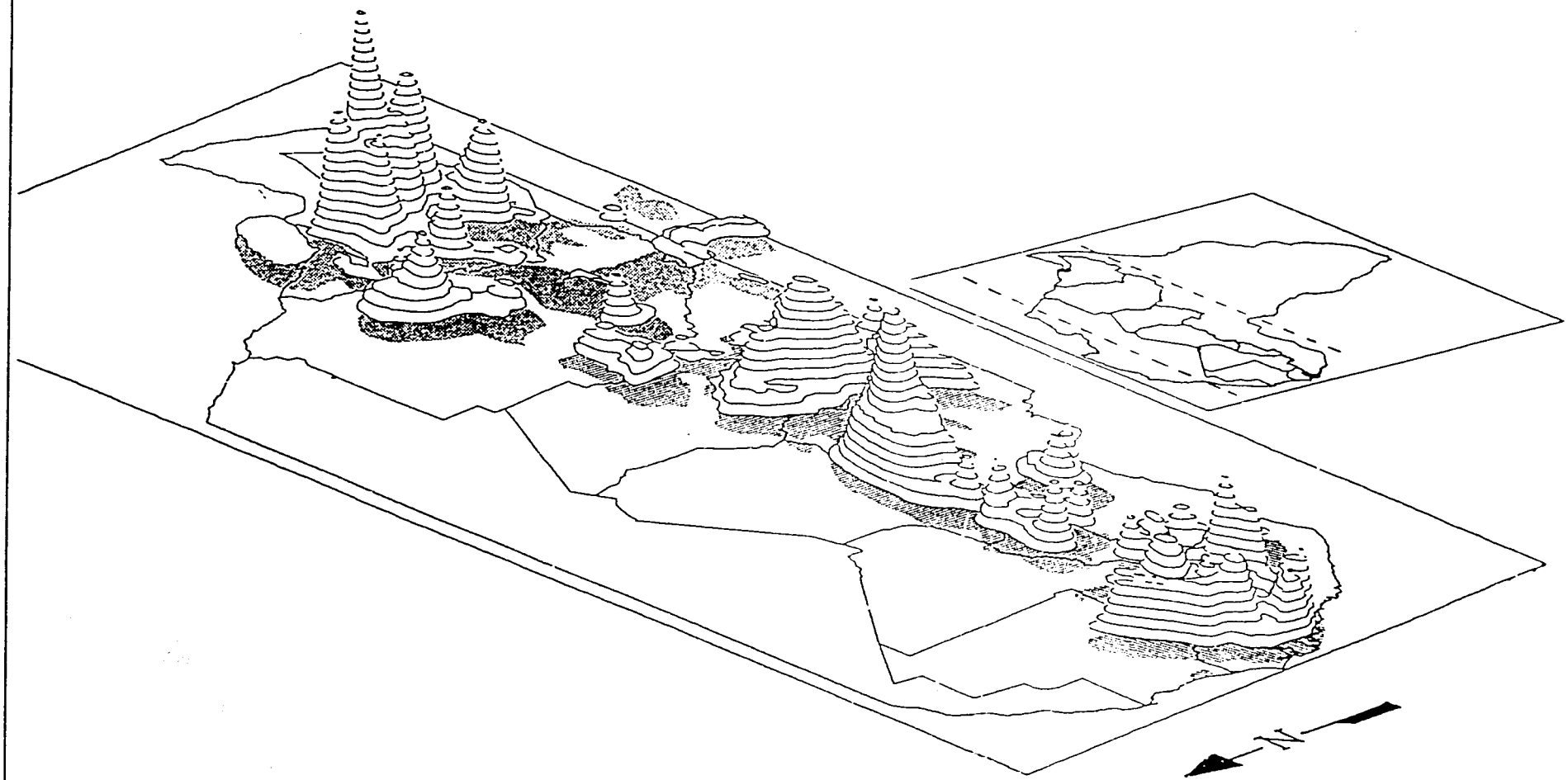
Much stronger than historical maximum

N

Source: NOAA/NASA GAC Imagery
FEWS/PWA, August 1988

Early August Rainfall

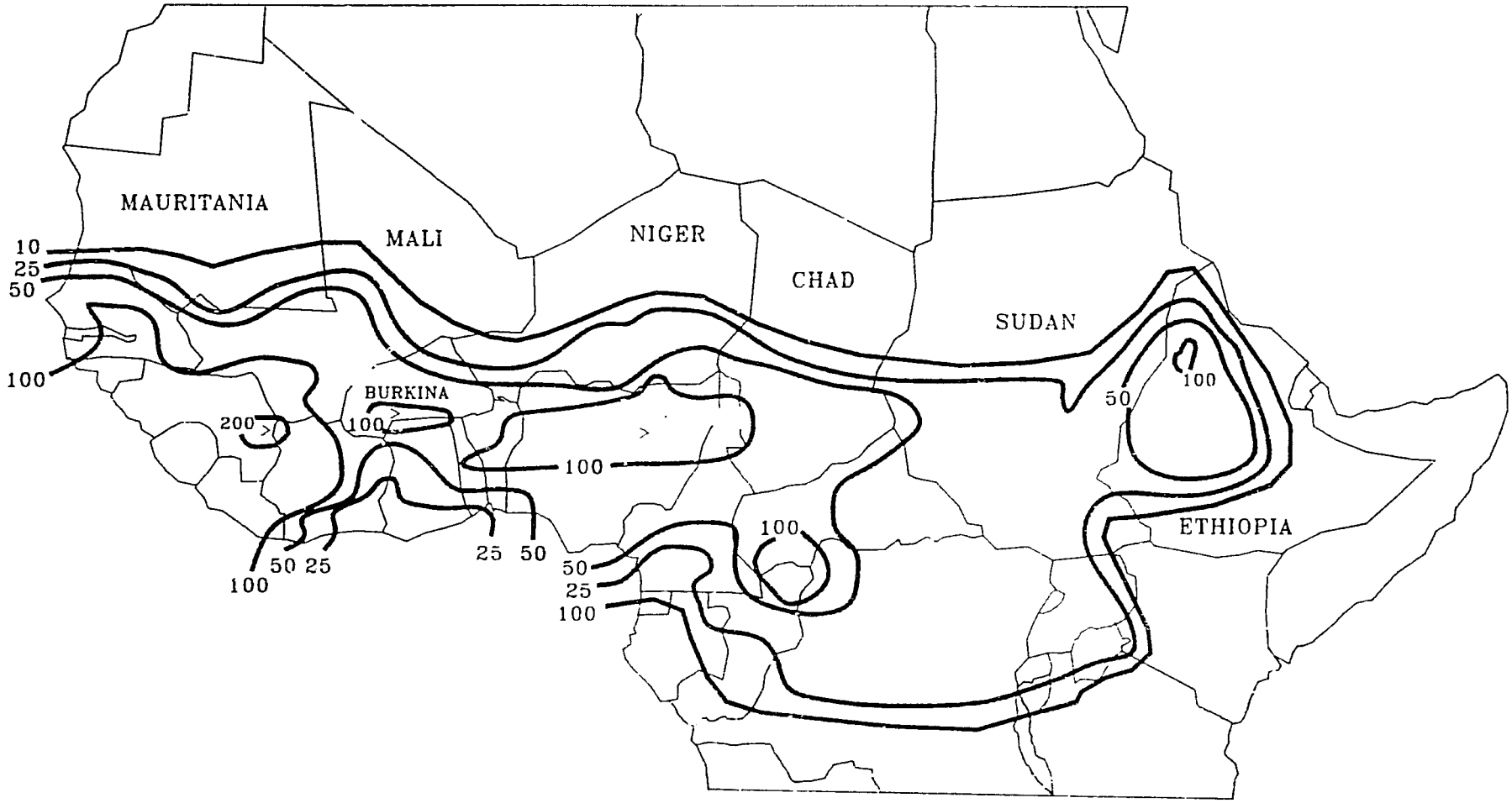
Contour Interval Equals 5mm



FEWS/PWA, August 1988

Rainfall

August 24-30, 1988



Source: JAWF assessments
FEWS/PWA, August 1988

cumulative rainfall after experiencing a significant rain deficit through mid August. Two areas in the Sahel had also received less than 75% of normal rainfall at mid August: a crescent shaped area around Senegal's Cap Vert, including the towns of Kaolack and Diourbel, and an area in southern Gourma Province (south of Fada N'Gourma Town) in Burkina. The abundant to torrential rains during the final ten days of August has brought these areas close to 100% of cumulative rainfall for the season. AGRHYMET, the regional agricultural weather facility, indicates that soil moisture levels in much of the Sahel outside of Mauritania and northern Senegal are now sufficient for short-season crops to survive until harvest, even if the rains were to stop in early September.

The persistent and abundant rains have brought flooding and loss of life and have destroyed homes and crops in Burkina, Niger, and Chad. Reports indicate that, among western Sahelian countries, Chad has been the hardest hit by floods. Heavy and regular rains also continued through the end of August in eastern Sudan (moving toward Khartoum), aggravating the floods there. Flooding is reported in the Gezira and in other irrigated areas of Sudan. Rains have continued in Ethiopia as well, with much of the Nile watershed in that country receiving up to 100 mm of rain.

The Senegal River has been rising at Bakel, indicating a good flow of water from the Falémé and other Senegal River tributaries. The Niger River and its tributaries are also at average to above-average levels to date. The Niger is particularly high in Niamey as a result of record-breaking flows from right-bank tributaries. Both the White Nile and Blue Nile rivers are higher than is normal at this time of year.

By mid August, satellite imagery showed substantial green-up extending as far north as 18° N in Mauritania, 17.4° N in eastern Chad, and 17.2° N in eastern Sudan. Some green-up is also apparent in Mali's Adrar and in the Air Mountains of Niger.

Satellite imagery for mid August confirms the impression that cumulative rainfall this year is considerably greater than during the past several years (see Map 3). Vegetation levels across the Sahel and in Sudan are much higher than the maximum levels for mid August during the last seven years. At the least, these elevated values would imply a great improvement in pasturage over previous years. In agricultural areas, the high NDVI values probably herald similarly high grain yields. Late July and August rains have raised NDVI levels above the historical maximum along the escarpment in Tigray and Wello regions of Ethiopia. Other areas of Ethiopia, particularly the Hararghe and Bale highlands, still display below-average vegetation levels. Late August imagery suggests these predominantly positive trends are continuing.

Regional Desert Locust Summary

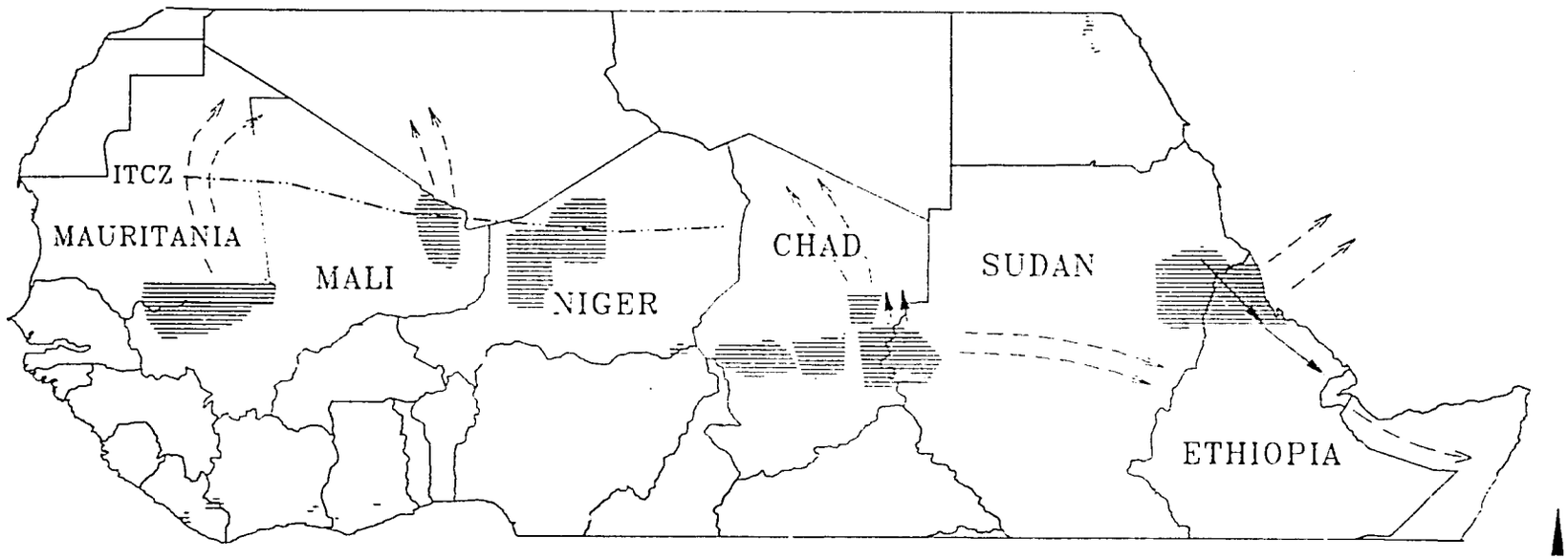
Large desert areas in all the Sahelian countries have been showing above-average vegetative conditions this summer, reinforcing the likelihood that Desert Locusts will find favorable conditions in most of their traditional winter breeding areas. An overall late start in the summer breeding cycle has limited the number of generations to two in most areas, instead of the three feared earlier. As a consequence of the rapid northward movement of the ITCZ and associated rains, the locusts have been pulled to the north, keeping them away from the most important grain-producing areas of the Sahel and limiting the amount of crop damage. Desert Locusts are now in greater numbers farther north (and in more remote areas) than has been usual over the past several years. This makes the job of crop protection services more difficult as locusts must be controlled over larger and less accessible areas. The most serious Desert Locust outbreaks (shown on Map 6) remain:

- in east-central Chad and bordering areas of Sudan, and
- south and west of Niger's Air Mountains.

Map 6

Desert Locusts

To August 30



Desert Locust sightings

Current movement of swarms and hopper bands

Possible future movement

SOURCE: Mission Cables; AID/OFDA/DLTF; NOAA/NASA AVHRR GAC Imagery; NOAA FEWS/PWA, August 1988

Rains over Chad's initial infestation areas have been heavy enough to drive the locusts northward. The position of the ITCZ over eastern Chad and western Sudan will determine the direction in which the locusts will fly. If the ITCZ remains to the north, the accompanying winds will push the locusts to the north and west, into the desert and away from croplands. If the eastern end of the ITCZ swings south, the Desert Locusts will be funneled into generally advantageous winter breeding grounds in Ethiopia and Somalia. So far, Chad's Desert Locusts are known to be moving north from the country's eastern Sahel. The infestations in northern Niger are important both because of their size and because of their inaccessible location, making control of the area difficult.

Less serious, but still important, outbreak areas include:

- the border area between western Mali and southern Mauritania,
- the Adrar des Iforas in Mali,
- a long band across southern Niger,
- west-central Chad, and
- the border area between Kassala Province in Sudan and Eritrea Region in Ethiopia (these areas might become very important later in the season).

The southern Niger outbreak zone and the Mali-Mauritania area contain some recent vegetative growth and recently emerged larvae, but these areas are not considered as great a threat as the outbreak areas in Chad and western Sudan. In southern Niger, the swarms are broken and scattered, making imminent gregarious behavior unlikely; in Mali and Mauritania, the individual infestations are small (making control a bit easier than in other parts of the Sahel).

Recent rainfall in summer Desert Locust breeding areas on the Red Sea Coast has significantly improved breeding conditions. In the fall, Desert Locusts could pose a serious threat to both Sudanese and Ethiopian agriculture.

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.