PN-AAZ-968

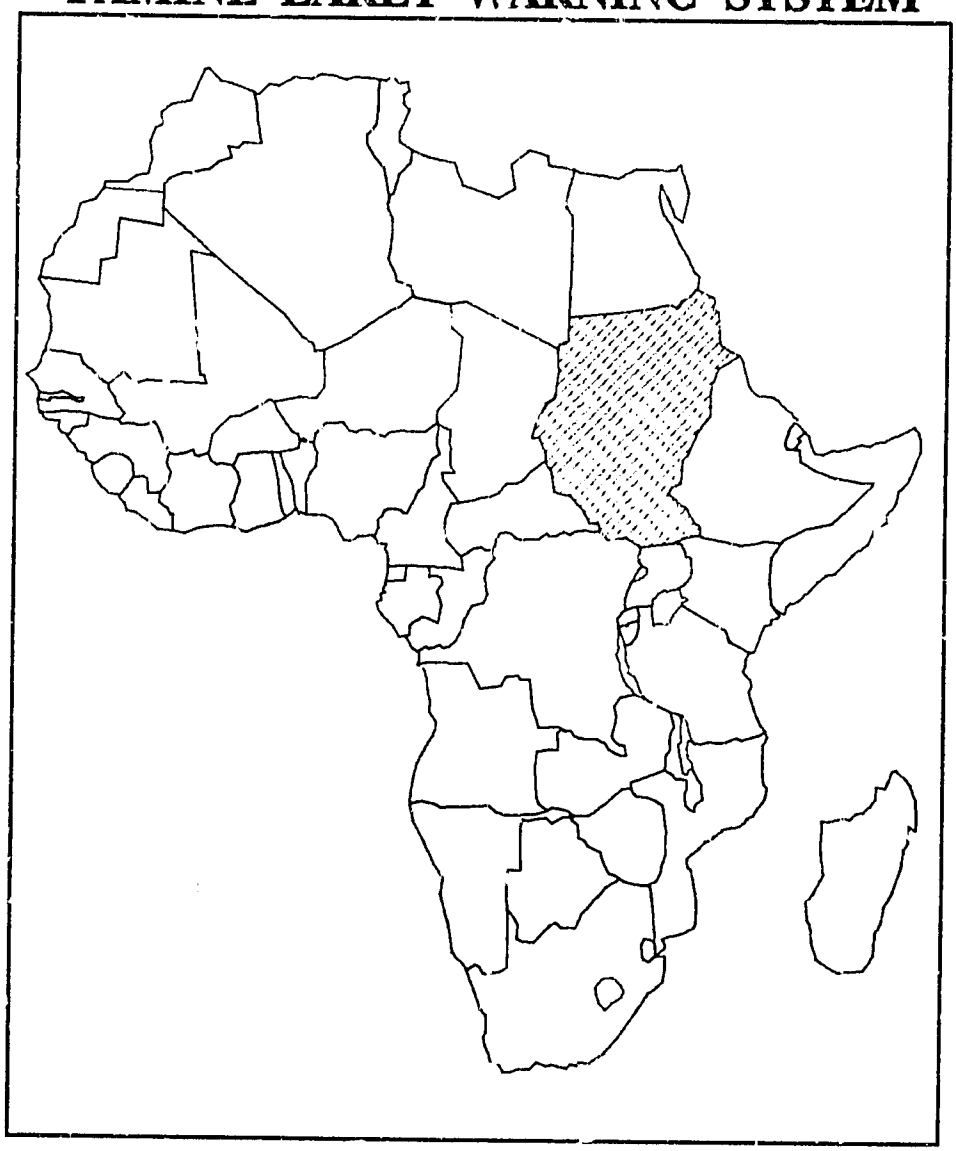
FEWS Country Report

JUNE 1988

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 U.S. Agency for International Development (USAID)'s Africa Bureau. 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**
- **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 (for more information on FEWS publications turn to the back inside cover of this report); 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**.

****

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.

SUDAN

Vulnerability Assessment

June 1988

Contents

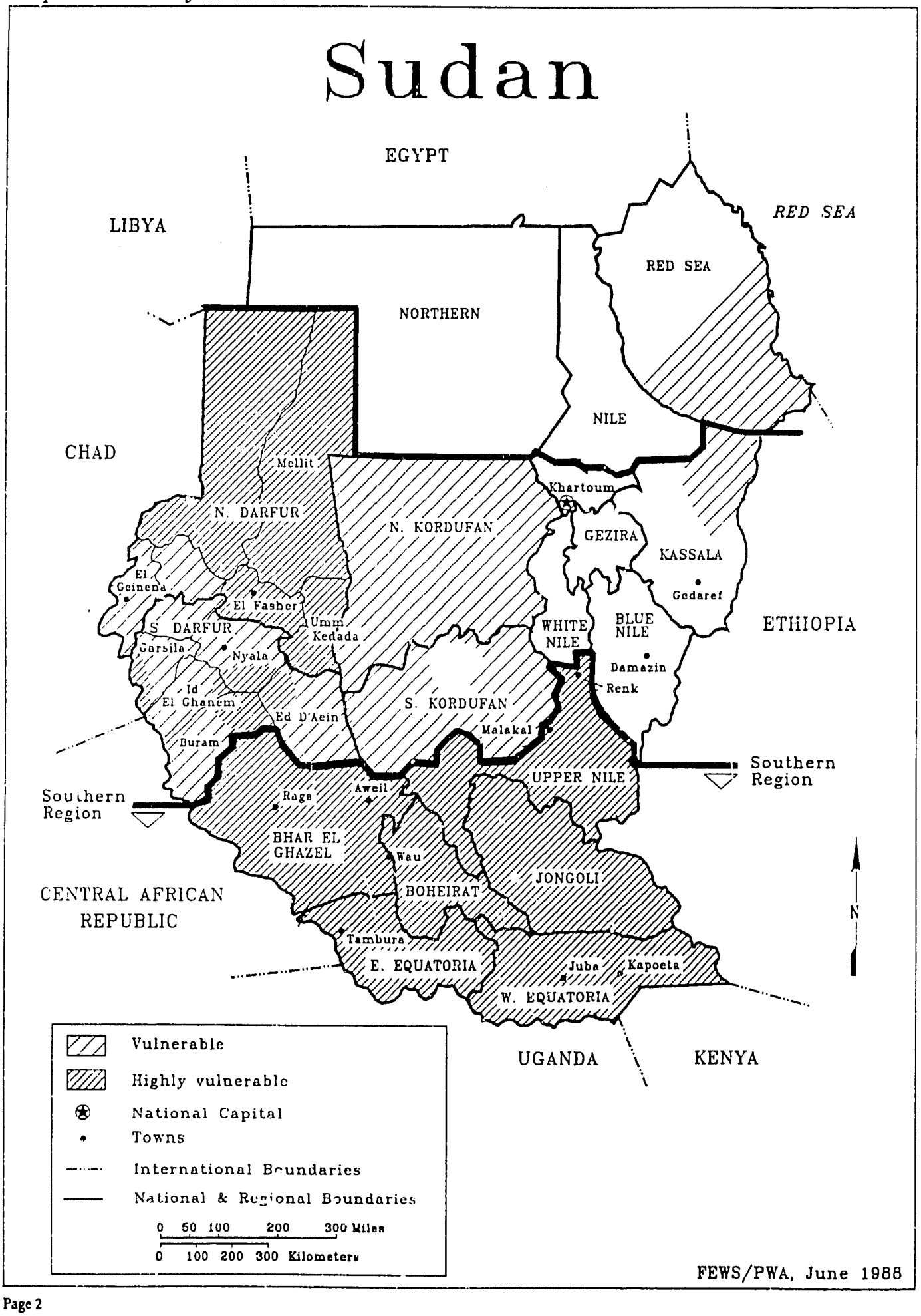
Summary 3
Current Situation 3
Pre-Season Assessment of Vulnerability 4
Measures of Vulnerability 5
Availability of Other Resources 18
Manifestations of Vulnerability 19
Relative Vulnerability to Famine 22

Appendix 25

List of Figures

Map 1 Summary Map 2
Map 2 Average Vegetative Vigor 7
Map 3 Average Growing Season NDVI 8
Map 4 Change in Rural Per Capita Production 9
Map 5 Relative NDVI Variability 10
Map 6 Variability of NDVI (African Context) 12
Map 7 Absolute NDVI Variability 13
Map 8 Range of Average NDVI 14
Map 9 Adequacy of 1987 Production 15
Map 10 1987 Rural Per Capita Production 17
Map 11 Relative Rural Nutrition 20

Map 1: Summary



FEWS/PWA, June 1988

Vulnerability Assessment

SUMMARY

The Southern Region is the area most vulnerable to famine in Sudan, primarily due to high levels of insecurity and armed conflict. Within northern Sudan, it is no surprise that Darfur Region is especially vulnerable to a nutritional emergency; it has a large population at risk and very low per capita production (food stocks). It also has relatively low agricultural potential, and is an area of relatively high childhood malnutrition levels. While grain prices are extremely high throughout northern Sudan, they are highest in Darfur Region and lowest in the eastern productive zone. Agricultural production in Darfur has been highly variable (and often inadequate) and vegetative cover shows relatively high variability from year to year. Darfur is also an area of increasing insecurity for its people. The least vulnerable region in Sudan is the Central Region, especially Gezira Province, where stocks and employment opportunities combine to insure relatively high levels of childhood nutrition.

A calculation of Sudan's projected food supply, just prior to the 1988 harvest, yields a break-even situation at best. With no carryover stocks, 1988 national production must cover all of 1989 needs. Sudan's national production is dependent on the eastern agricultural area, characterized by mechanized, non-irrigated agriculture. Historically this area shows high variation in yields, production, and NDVI (a vegetation index derived from satellite imagery) from year to year.

Agricultural Bank of Sudan (ABS) stocks will cover only 29.5% of Sudan's sorghum needs from May until harvest in November, according to the May report of the Early Warning Unit of the Sudanese Relief and Rehabilitation Commission (RRC). On June 15th the RRC reported that sorghum stocks, *both public and private,* would cover only 76% of sorghum requirements until harvest in November, a shortfall of 250,000 metric tons. Evidence of this shortfall is also seen in extremely high millet and sorghum prices throughout Sudan. The ABS estimates its stocks to be greater than the RRC believes.

There are reports that rainfall has occurred in all the agricultural areas of Sudan. Flooding has been reported in El Obeid, North Kordufan Province.

CURRENT SITUATION

Satellite imagery shows vegetative green-up advancing northward more or less as expected for this time of year in Sudan. The exception, in northern Junglei Province and extending west into the southern arm of Upper Nile Province, could be the result of exceptional fires (set to aid movement and improve pasturage). It is possible that this is, instead, an area of early poor rainfall, adding to the risk for people in the Southern Region.

At the beginning of June, there were unconfirmed accounts of up to 800 deaths in a week from starvation among displaced people in Aweil, Bahr El Ghazal Province. If these accounts are true, these deaths from starvation would emphasize the inadequacy of food aid flows to the Southern Region. Aweil lies on the rail line from the eastern provinces, between Babanusa (South Kordufan Province) and Wau (Bahr El Ghazal Province). The most recent train of relief supplies, which arrived there last March, was the first to arrive in over a year. Twenty-four wagons of 9,000 sacks of sorghum (810 metric tons), apparently allocated for food aid to Aweil over the last two years, have recently been discovered on sidings in Babanusa. It is not yet known how much is still fit for human consumption. Plans are to redistribute it among displaced people in South Kordufan Province.

Recent reports of very high childhood malnutrition in Mellit and Umm Keddeda Districts of North Darfur Province confirm USAID/Khartoum assessments of last years' agricultural production and reemphasize the need for additional food aid there. Food aid flows to Darfur Region have risen as high as 250 to 350 metric tons (MT) per day, as a result of large, recently negotiated increases in transport fees to truckers. Nonetheless, deliveries are currently low and behind schedule. Recent assessments of rainfall (from satellite imagery) suggest that plans to pre-position food in the west of Darfur cannot now be accomplished. In addition, all of Darfur has been declared a security zone and drivers of trucks carrying relief supplies are reluctant to proceed beyond El Fasher without an armed escort. Part of the second tranche of relief supplies for Darfur has been diverted to displaced people along the rail line from Babanusa to Aweil. No other supplies were available for purchase.

Locust experts in Sudan expect the imminent arrival of Desert Locust swarms from Chad into Darfur Region. These swarms may have already arrived and begun to lay eggs. Darfur is ill-equipped to cope with an extraordinary increase in crop losses to pests this year. The size of these swarms, and their actual arrival dates, will determine their potential impact on Sudanese agriculture. Their presence could have a devastating effect on local production in Darfur Region. Grain production (primarily millet) in Darfur, however, is only a small fraction of total national production. It is unlikely that national production would be significantly affected.

PRE-SEASON ASSESSMENT OF VULNERABILITY IN SUDAN

As expected, this assessment points to Darfur Region as the area most vulnerable to a food emergency, outside the Southern Region -- where civil strife dominates. Other vulnerable areas are in the Eastern Region (Kassala and Red Sea Provinces), although these are not usually given the attention accorded those in the west, and Kordufan Region. Gezira (especially) and Blue Nile Provinces showed high per capita production and sufficient stocks, and are expected to have reasonably good childhood nutrition levels.

National annual food production is highly variable and often not adequate for Sudan's population. Yields in important agricultural regions are also highly variable. Measures of the variability of vegetation in Sudan's most productive area show it to be the most variable of any area in any of the countries under FEWS scrutiny. While production in surplus years usually carries over as stocks into deficit years and beyond, the combination of both public and private stocks this year may not be adequate to carry the population until harvest. Sudan is dependent on its own agricultural production and donor food aid (much of it concessional). Normal childhood nutrition levels, while varying regionally, are nonetheless high in absolute terms -- much higher than appear normal in the other FEWS countries. These findings combine to show that Sudan as a nation has undependable and often inadequate food production, poor stocks, and limited other resources with which to obtain food.

Grain prices are extremely high throughout northern Sudan, although declining from west to east. For areas already stressed, such as Darfur Region, these prices limit people's ability to cope with local and

household food shortages. In addition, insecurity, the primary cause of famine, is endemic in the Southern Region and has made inroads into western Sudan and the Central Region.

The purpose of this assessment is to define the nature and degree of vulnerability through an understanding of food availability. This assessment will:

- indicate what food supply-related data are available for Sudan and the degree of confidence that can be placed in them;
- describe the structural vulnerabilities to famine in sub-national areas of Sudan; and,
- describe current conditions of food security in these areas and the possible impact of differing agricultural season events.

Three primary factors, the dependability and adequacy of production, food stocks, and the availability of other resources to acquire food, determine food availability, especially for rural people. These same factors, or their surrogates, can be measured and used as indicators to describe the vulnerability of people to famine. These three indicators, or their surrogates, will be defined, examined, and compared. This will permit some conclusions about the characteristics and current relative condition of the famine process in the several regions of Sudan. (Because of insecurity, little data is available to assess relative vulnerability in the Southern Region.) Revealed stress on the food supply system, i.e., the consequences of food shortages, will be mapped and compared with the patterns of vulnerability seen for each of the three indicators. Definitions and assumptions about measuring vulnerability to famine, upon which this assessment is based, are found in the Appendix.

Measures of Vulnerability

The degree to which agriculture is both dependable and adequate, from year to year, is an *a priori* measure of an area's vulnerability. Agricultural production in the non-irrigated areas of Sudan is highly variable from year to year in terms of both the amount of acreage and yields. Last year, with the exception of the Central Region and southern Kassala Province, no province produced enough to feed its population. What is more, total production was not adequate for the nation as a whole. Interestingly, satellite imagery (i.e., NDVI -- see inside of back cover) suggests that eastern Sudan, the area of greatest production, is also the area where vegetation varies the most from year to year. The only other areas of high variability are found in Darfur Region. Dependability and adequacy measure the degree to which people have been able to rely on local food production. If the other primary factors (stocks and other resources) do not normally cover production deficits, vulnerability to famine will be high when harvests are poor.

Food production in Sudan is, to a great degree, centered upon sorghum production on mechanized farms (both demarcated and undemarcated) in eastern Sudan. In traditional rainfed agriculture, millet (especially in Kordufan and Darfur Regions) and sorghum are the most important food crops. In 1986, Sudan changed the way it collects agricultural statistics. While production and yield statistics from previous years are useful, they must be used carefully because of this change in method. In any case, production is defined and located in the greatest detail for irrigated agriculture, in broader areas for mechanized agriculture, and in whole provinces for traditional agriculture. Current agricultural statistics provide a useful estimate of national production. As these statistics are disaggregated, however, their accuracy declines. Nonetheless, they do allow a fairly good view of relative agricultural production and adequacy and offer some insight into agricultural variability.

Inferences about dependability and adequacy can be drawn from satellite imagery of vegetation (Normalized Difference Vegetation Index or NDVI). These inferences help to describe both the

spatial distribution of agricultural potential and agricultural system dependability. Satellite images of NDVI provide a view of vegetative conditions within Sudan. NDVI primarily reflects native vegetation, including pasturage. Nevertheless, it allows careful and qualitative inferences to be drawn about crop conditions and potential yield and also permits historical analysis of the variability of vegetative conditions. Other factors, such as vegetative type, area under cultivation, and moisture, could affect the NDVI measure. Map 2 shows the average values of NDVI from the period July 1 to October 31 from 1982 to 1987. The areas of greatest interest are those areas corresponding to an average NDVI value of .05 to .3. These areas generally lie on or about the 300-650 millimeter isohyets. Areas to the north of this band do not usually support rainfed agriculture. Areas to the south of this can normally produce crops, all other factors being equal.

Estimates of per capita food consumption are needed to assess the adequacy of food production. This analysis uses only grains (converted to sorghum caloric equivalents) for both food consumption and production. Sorghum is the most important single food in Sudan, although other foods supply much of the "average" Sudanian diet. Millet is traditionally the preferred food in western Sudan (although sorghum is the primary relief food there). Wheat, the bulk of which is imported, is especially important in urban areas. In the Southern Region, maize, rice and sorghum are important, but animal products provide a large share of the diet. In northern Sudan, the annual per capita consumption of all grains is estimated at 146 kg. In the Southern Region, the annual per capita consumption of all grains is estimated at 92 kg. Milk, milk products, meat, beans, root crops, vegetables, and wild foods combine to supply an important part of the diet for many people in Sudan. Production statistics for these food items are either not available or not reliable. Their role in the regional food supply cannot, as yet, be measured.

Variability of Agricultural Production

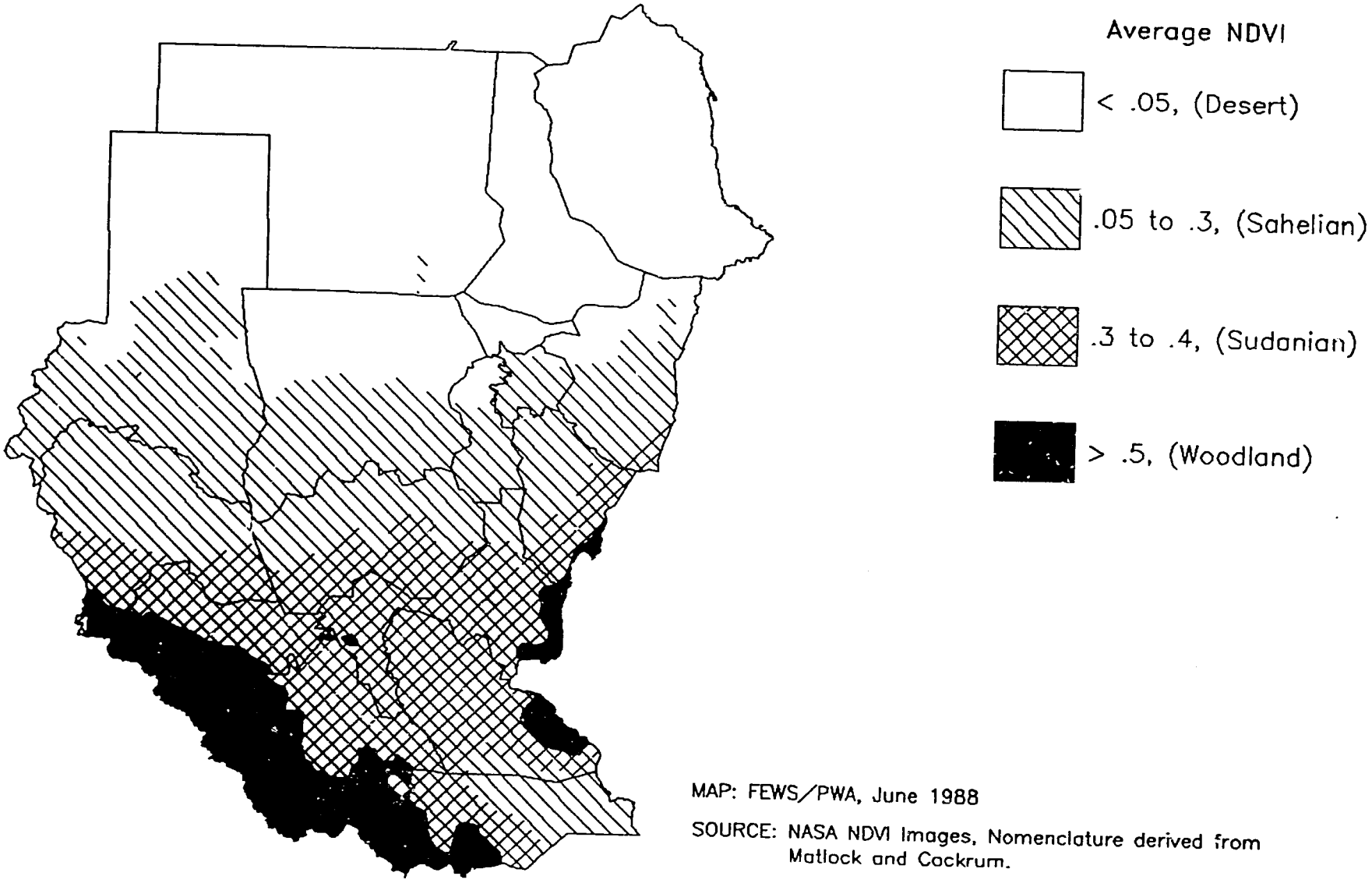
Agricultural production is highly variable throughout Sudan, as are historic yields. In fact, eastern Sudan, the area of highest production, is an area which varies greatly from year to year in production, yields, acreage and total vegetation. There is also a high level of variability in total vegetation in Darfur Region.

Agricultural production in general shows great variability from year to year, especially in transitional climatic areas like the Sahel and its extension across the Sudan from El Geneina in Darfur Region to Gedaref in Kassala Province (see Map 2 for the general location of this zone in Sudan, Map 3 for the African context). Rain forests and deserts usually receive predictable amounts of rain and, from year to year, usually present similar opportunities for agriculture. The northern limit of rainfall, however, varies from year to year. In this transitional area, a farmer's fortunes will rise or fall depending on the extent of the northward progression of the rainy season. As shown in Map 4, per capita production declined throughout Sudan between 1986 (a year of very good rainfall, yields, and production) and 1987 (a year of poorly timed rainfall, poor yields, and poor production).

The variability of NDVI can be used as a surrogate measure of yield variability. Ongoing research suggests that vegetation conditions (vigor) reflect the condition of crops in the same location. The area of highest NDVI variability (shown in Map 5) therefore indicates areas of relatively greater potential variation in crop yield. Changes in NDVI from year to year generally show a positive correspondence to changes in yields, e.g., NDVI was high (in eastern Sudan) when yields were high (1985), higher when yields were higher (1986), and low when yields were low (1984). An exception exists for 1987, when yields were low but average NDVI was high. In this particular case, the failure of rain during September 1987, a critical period for grain formation, caused very low yields despite excellent early season growth. Inferences drawn from NDVI variability do not apply to irrigated areas.

Average Vegetative Vigor, July 1 to October 31

Average NDVI value July 1 to October 31, 1982–1987.

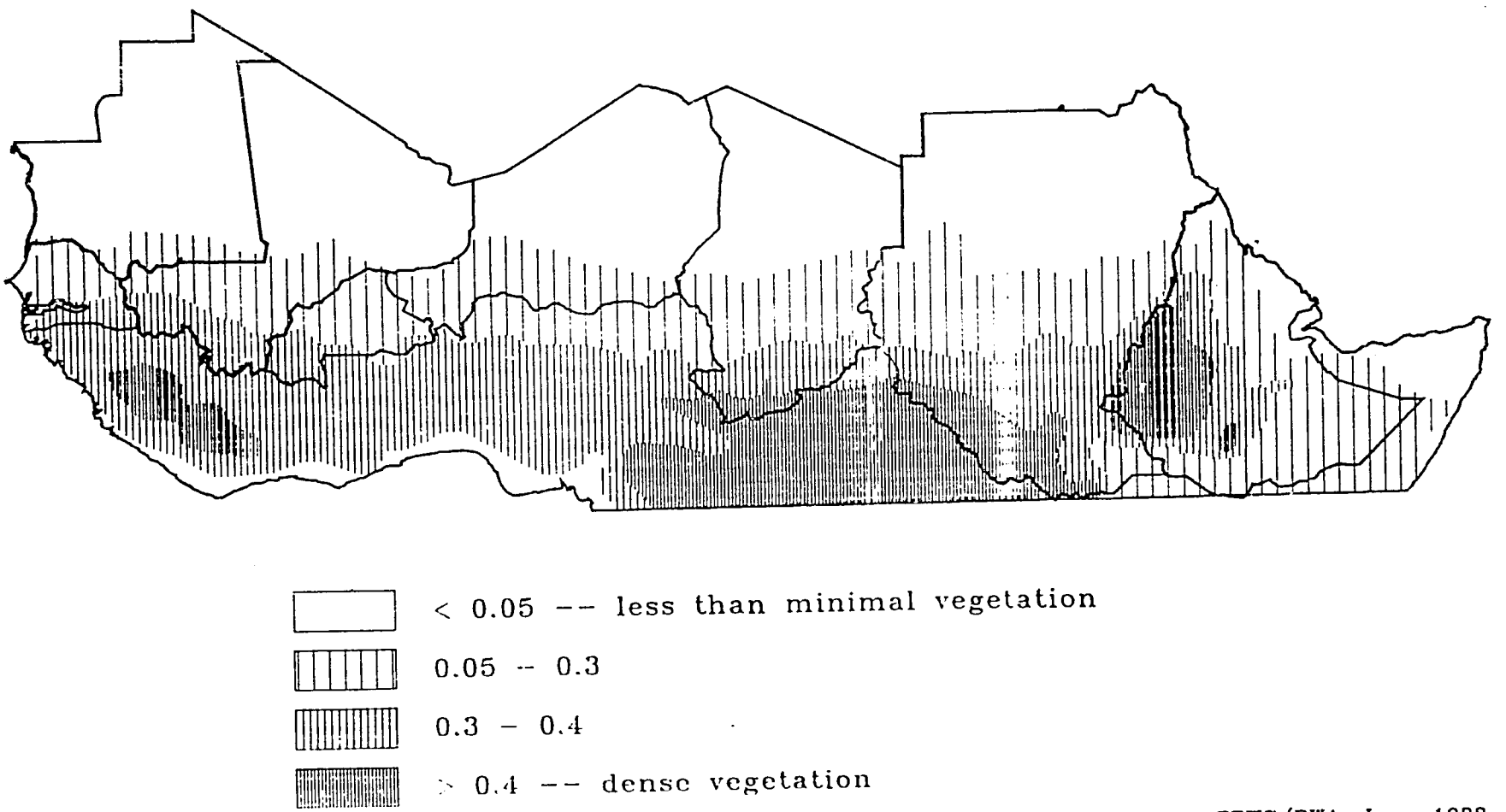


MAP: FEWS/PWA, June 1988

SOURCE: NASA NDVI Images, Nomenclature derived from Matlock and Cockrum.

Average Growing Season NDVI

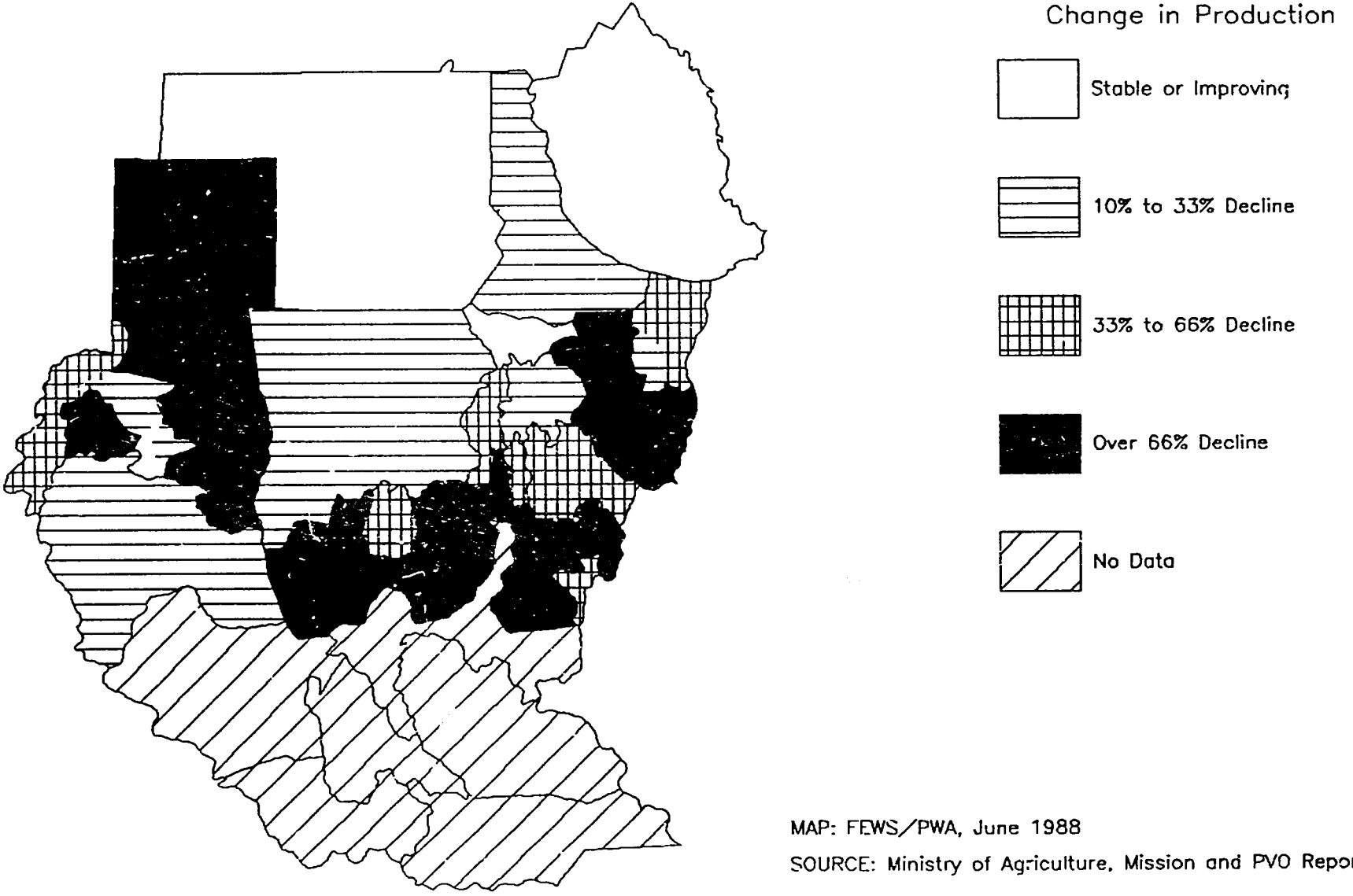
Based on Indices for 1982-1987



FEWS/PWA, June 1988

Change in Rural Per Capita Production, 1986 to 1987

The percentage change in rural per capita production of grains, estimated from the best available data.

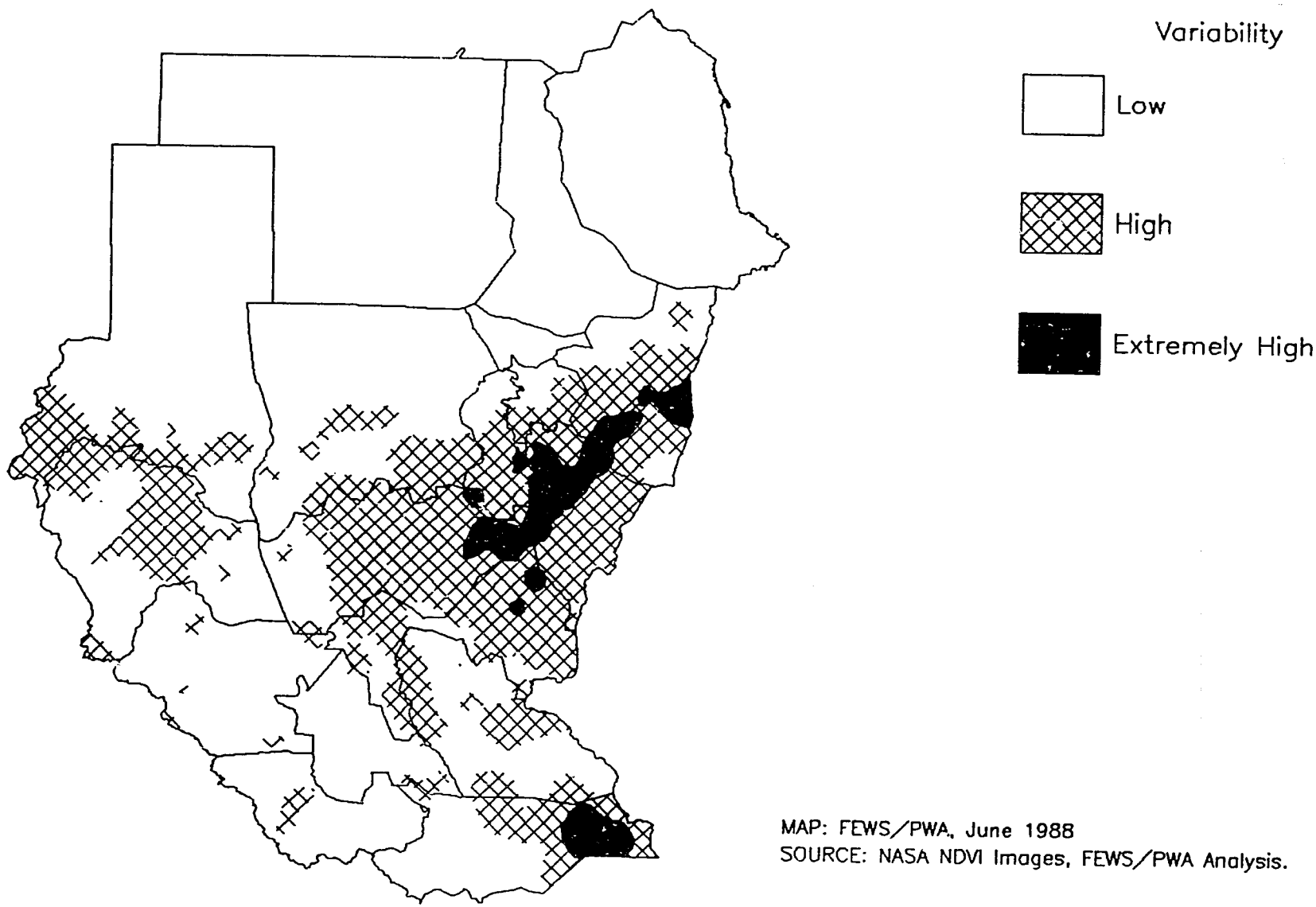


MAP: FEWS/PWA, June 1988

SOURCE: Ministry of Agriculture, Mission and PVO Reports.

Relative NDVI Variability, July 1 to October 31

The normalized variability of vegetative vigor from year to year (1982–1987)



MAP: FEWS/PWA, June 1988
SOURCE: NASA NDVI Images, FEWS/PWA Analysis.

In the absence of trustworthy, detailed, historical agricultural statistics that extend at least as far as the seven years of available NDVI data, the relative variability of NDVI over the growing season probably represents the historic dependability of agricultural systems and thus the *a priori* probability of yield. Map 5 shows the range of 1982-1987 NDVI values (the maximum annual NDVI minus the minimum annual NDVI) during the period July 1 to October 31, divided by the average 1982-1987 NDVI value for the same period. Map 6 shows the regional context for this measure, suggesting that production in eastern Sudan is especially variable. Clearly, areas of high average NDVI are less at risk than areas of low average NDVI that experience the same absolute range. (See Map 7 for the absolute range of NDVI variation and Map 8 for its regional context.) The black areas in Map 7 have experienced great swings in vegetation from year to year.

Yields are also highly variable. Sorghum yields from mechanized agriculture during 1984-87 showed very high variability in the Damazin and Gedaref agricultural areas (which together can account for 55-65% of non-irrigated sorghum production). High yield variability also exists in irrigated agricultural areas in Gezira and White Nile Provinces, which are also in the east. In these eastern provinces, traditional rainfed agriculture has shown low yield variability in Blue Nile, but high variability in White Nile and Gezira.

In northern Sudan, the areas usually thought to be vulnerable and at risk are in the west and in Red Sea Province. Production in these areas is generally inadequate (with certain defined exceptions). Neither of these areas experiences as high a variation in NDVI as do the highly productive areas in eastern Sudan. In those highly productive areas of eastern Sudan, agriculture is concentrated in a relatively narrow band that shows a steep transition between areas of high vegetation and little or no vegetation. As a result, this area has very good yields in some years, and very poor yields in others. A high level of agricultural investment there helps to ameliorate (what may be) the inherent variability of the region.

Adequacy of Agricultural Production

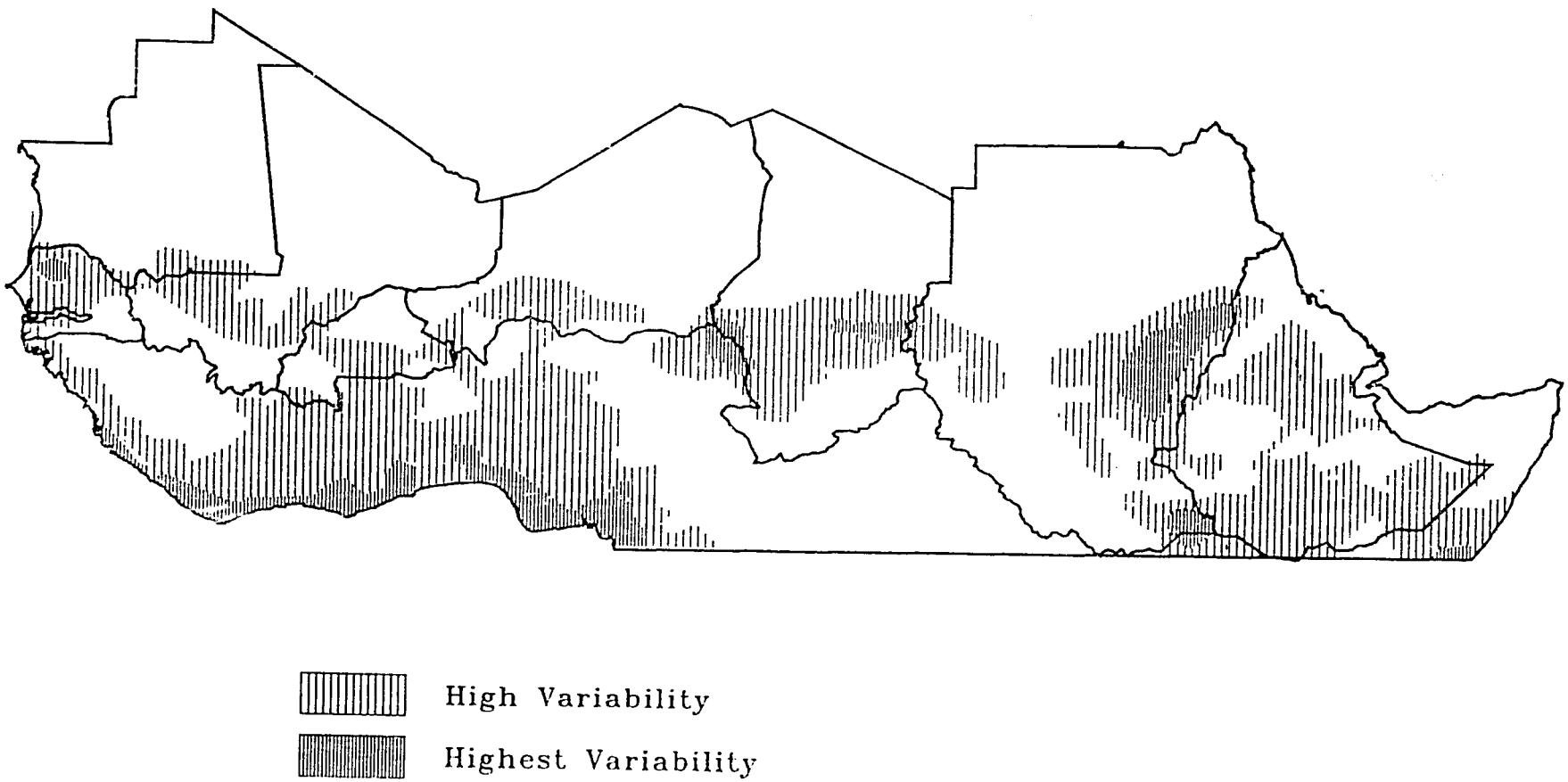
In 1987 Sudan did not produce enough food to feed its population. Regionally, adequate production occurred only in the Central Region and in Kassala Province. This occurred primarily on large mechanized farms. It is thought that household production, even in this area, was not adequate.

Defining minimal food needs, and thereby the adequacy of production, is not a straightforward process. Two consumption measures are in use for Sudan. They are based on historic production and importation studies and estimates of the importance of grain in the Sudanese diet. People in northern Sudan are estimated to require 146 kg of cereals (in sorghum equivalents) per year. People in the Southern Region are estimated to require 92 kg of grain per year. Taking into account seed, animal feed, post harvest losses, and milling losses, gross production must reach 195 kg/person in the north and 123 kg/person in the south to maintain nutritionally adequate diets. In the absence of detailed surveys of consumption, these best estimates must serve to calculate where food shortages may exist, and what assistance may be required.

Map 9 shows where these levels of 1988 consumption were not met by production in 1987. Approximately two-thirds of northern Sudan's 258 rural councils (sub-districts) did not produce enough (based on official statistics) for their populations. The populations of these rural councils total about 8.25 million.

This assessment does not show the significant local differences within each rural council. These variations can be caused by accident of soil type, topology, or many other factors. Larger rural councils, particularly those that extend north and south, can include both pockets of crop failure and pockets of excellent production.

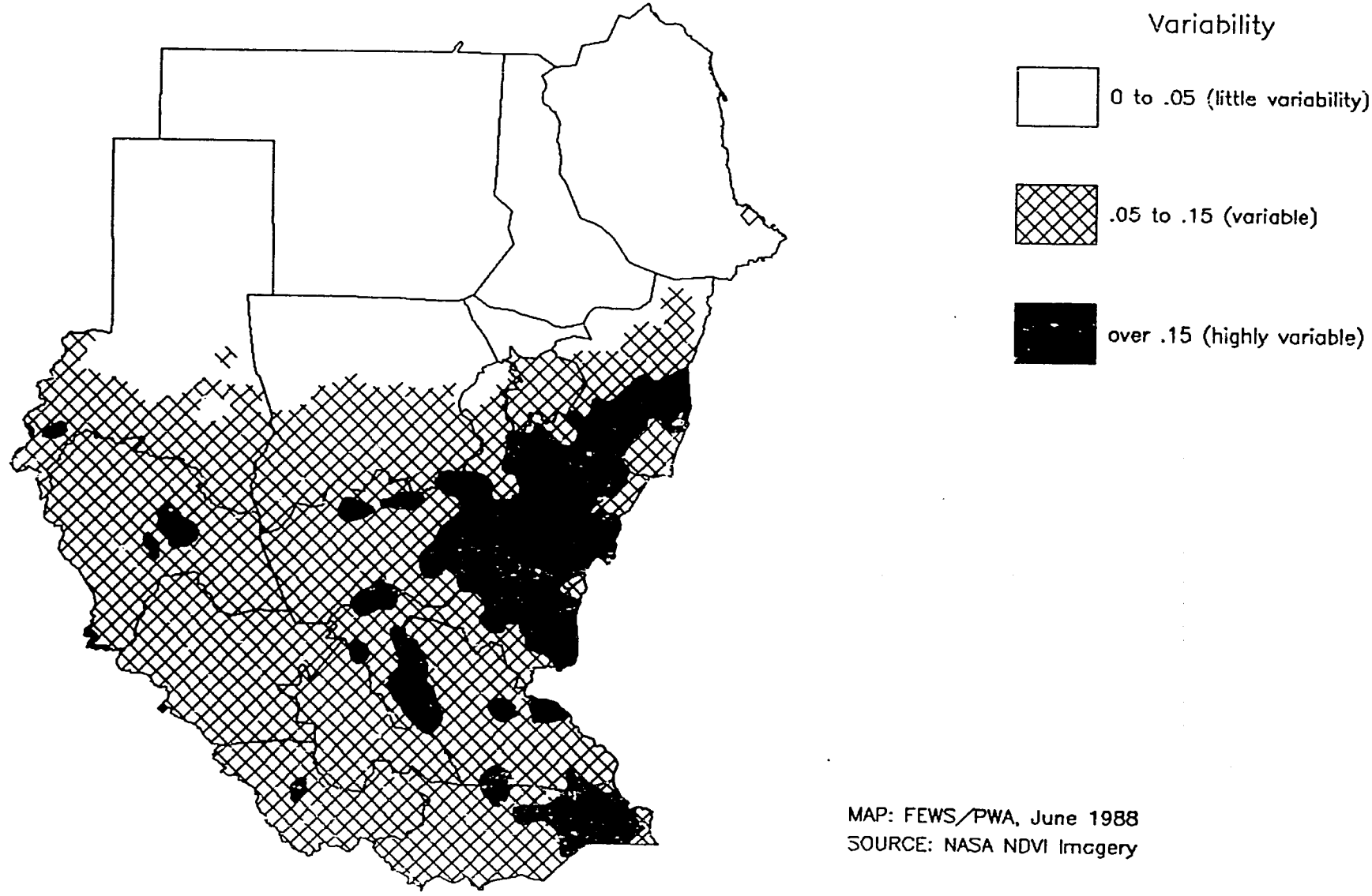
Variability of Growing Season NDVI
1982 to 1987



FEWS/PWA, June 1988

Absolute NDVI Variability, July 1 to October 31

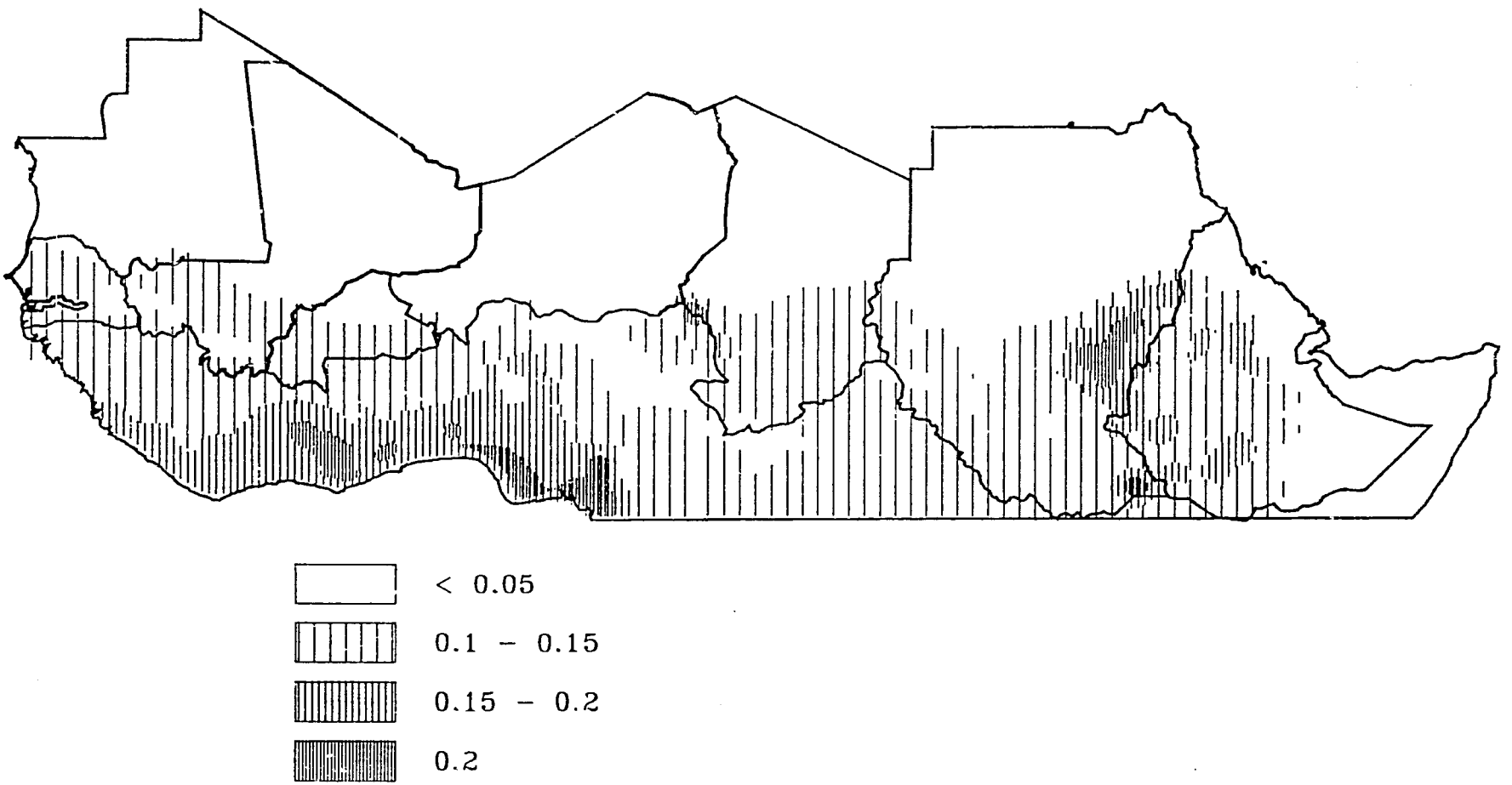
The range of the variability of vegetative vigor from year to year (1982–1987)



MAP: FEWS/PWA, June 1988
SOURCE: NASA NDVI Imagery

Range of Average NDVI for July Through October

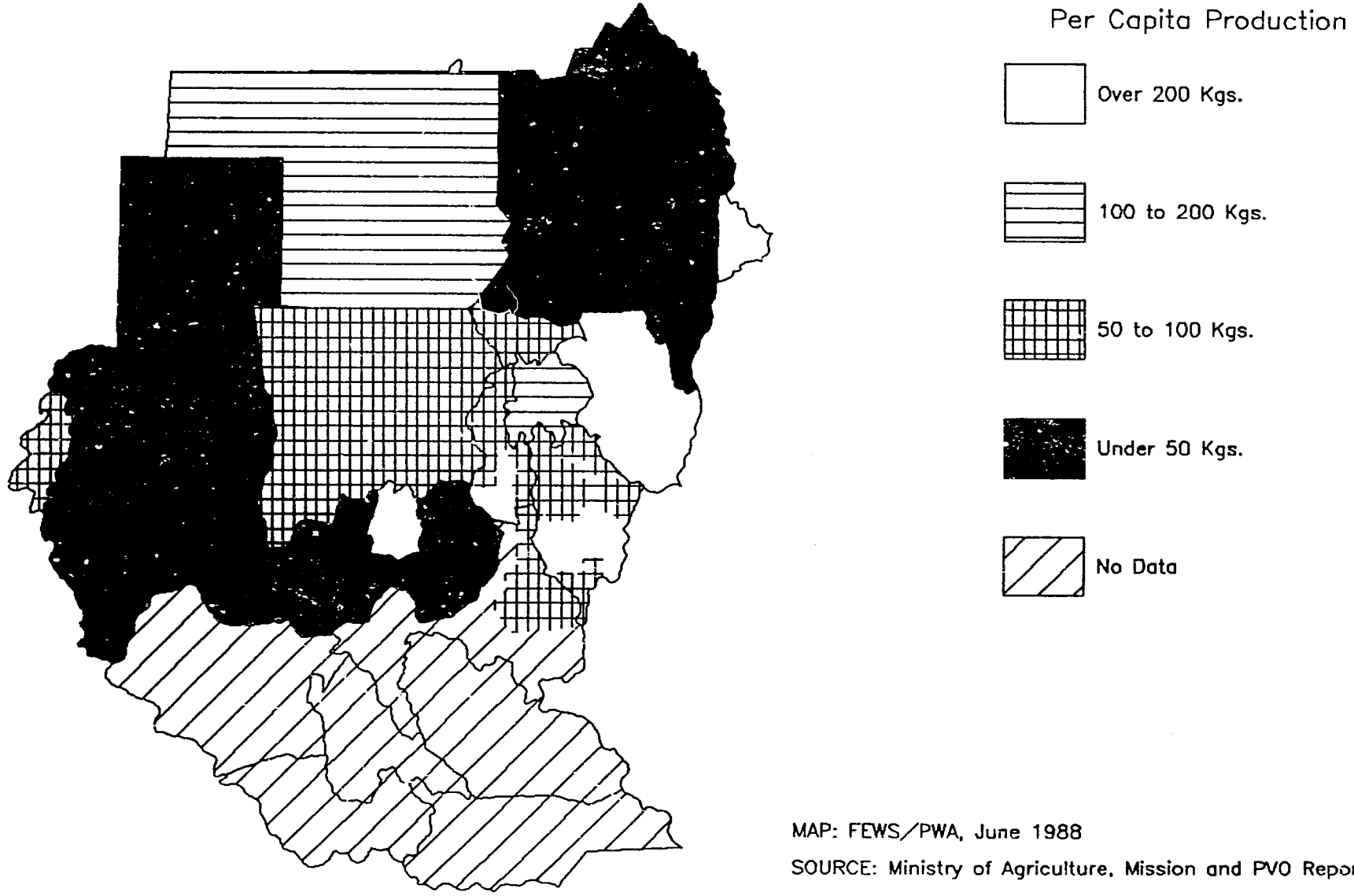
Based on Indices for 1982–1987



FEWS/PWA, June 1988

1987 Rural Per Capita Production of Grains

Rural per capita production of grains, estimated from the best available data, kilograms/person.



MAP: FEWS/PWA, June 1988

SOURCE: Ministry of Agriculture, Mission and PVO Reports.

Food Stocks Currently Available

The Central Region and Kassala Province are among the few areas where food stocks, both public and private, are sufficient for the current year. Public stocks in other regions are nonexistent. Private stocks are probably very low in North Darfur, especially in Mellit, Umm Keddada and El Fasher Districts. In South Darfur, private stocks are lower than usual in the Jabal Marra project area (as seen in their limited release to regional markets). Stocks might exist in the Western Savanna Project area, but they must make up for a severe shortfall in last year's production. Private stocks in Kordufan Region are probably very low, given last year's poor production and current assessments of food need. Nationally, extremely high grain prices suggest limited stocks, both public and private.

Detailed knowledge of on-farm, household, commercial and public food stocks would modify the picture of vulnerability produced by measures of the dependability and adequacy of production. These data are either not available or should be treated with caution. Estimates of on-farm stocks in Sudan are not reliable. Nor should too much credit be given to estimates of commercial stocks. Rarely available (and then site specific) estimates of household stocks simply cannot be extended to larger areas. Even estimates of public stocks (Agricultural Bank of Sudan) vary widely and cannot be relied upon. Total public and private sorghum stocks have recently been assessed as falling 250,000 MT short of what is required to meet sorghum needs until harvest in November. If true, this shortfall in sorghum stocks will mean, at the very least, massive childhood malnutrition throughout rural northern Sudan and may lead to major displacements of rural people to urban areas.

In the absence of good data on stocks, especially local stocks available to rural people, surrogate measures must be used. These surrogates can help establish possible ranges of stock quantities, and thus allow a broad understanding of the current situation. Map 9 shows where 1987 production would meet 1988 cereal needs (146 kg per capita) if 1987 production had gone totally to stocks, assuming no other stocks existed from prior production or purchase. This would represent the maximum quantity of grain possibly in stock for use during 1988. Based on this measure, considerable shortfalls are found throughout Sudan.

As expected, per capita production in Sudan varies greatly by region. Per capita production provides a measure of potential on-farm stocks, and offers a basis for predicting future nutritional trends. Although total production was down in 1987, there were still areas of high per capita production (e.g., Northern, Kassala, Blue Nile, and Gezira Provinces -- see Map 10). In eastern Sudan, however, most production is generated by mechanized agriculture, which traditionally uses hired labor and markets its crop. Thus, although high per capita production levels exist in the mechanized areas of eastern Sudan, this production is not necessarily available to local people.

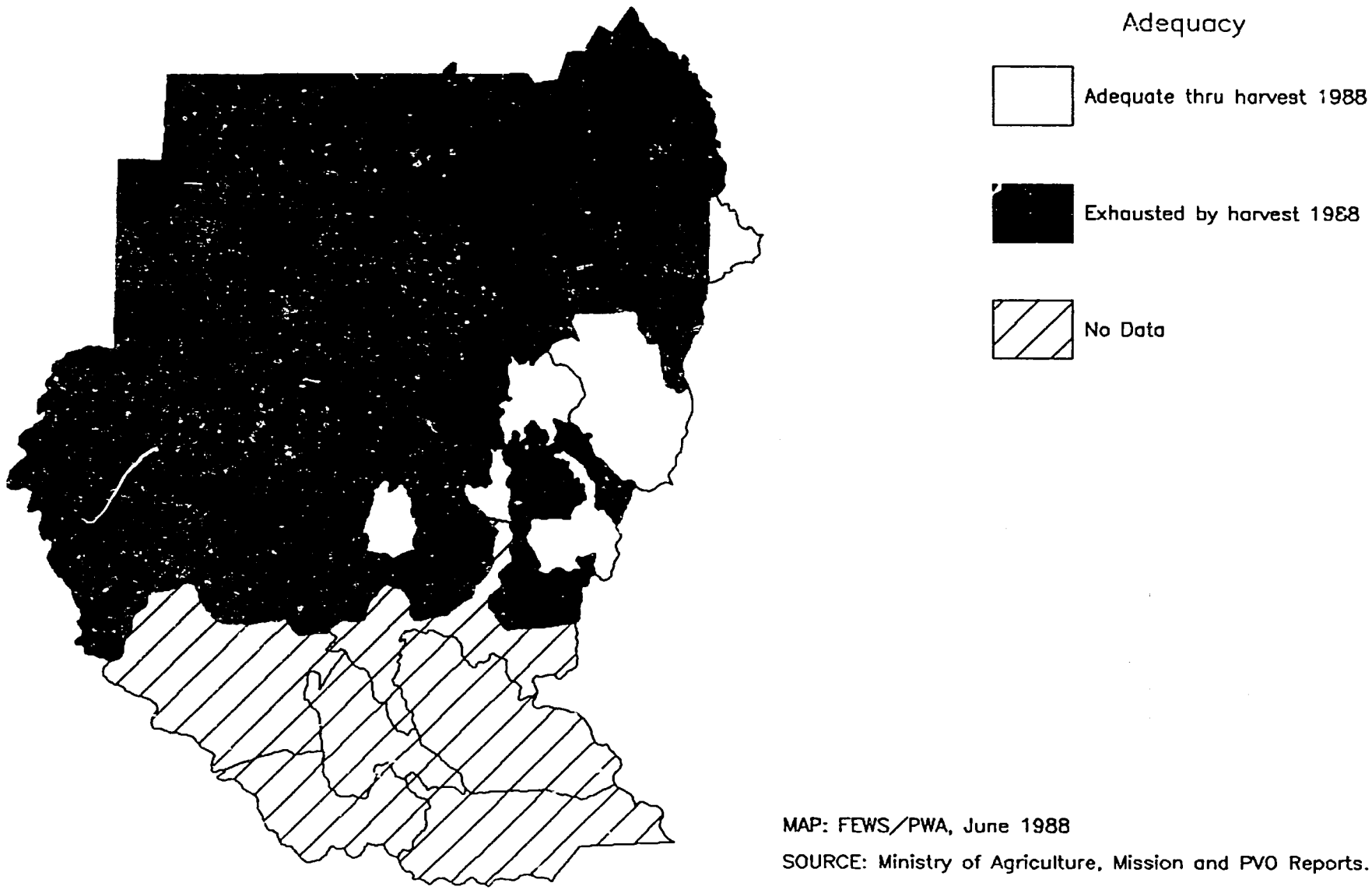
Map 4 illustrates the change in per capita production between 1986 and 1987. No significant difference, or an increase, would suggest a stable situation (which could be very poor) or some improvement in stocks or consumption. Instead, much of northern Sudan shows a decline in per capita production. In and of itself, such a decline need not be viewed as serious. An increasing decline in private stock, however, can be inferred by applying the observed (rapid) decline of public stocks. This, in combination with the decline in production in 1987, is cause for serious concern.

Poor and declining per capita production is a general cause for alarm. It suggests that whatever stocks existed previously will be seriously depleted by the end of the year. These results raise considerable concern, especially for Darfur and Kordufan Regions.

Emergency food distributions are taking place. Those for Kordufan Region appear to be adequate and to have met expectations. Most of these distributions used public stocks from inside the Region, although those have now been consumed. Emergency food distributions for Darfur Region have not

Adequacy of 1987 Rural Per Capita Grain Production

Areas where 1987 production should last rural people until harvest 1988 (Consumed at 146 kg/person/year).



MAP: FEWS/PWA, June 1988

SOURCE: Ministry of Agriculture, Mission and PVO Reports.

been adequate and will not meet targets. Those distributions used stocks from the Central Region. Most stocks are buried in *matamorra* (traditional underground storage). It is reported that, now that the rainy season has begun, they cannot be opened for fear of spoilage. If this is true, adequate relief stocks will not reach Darfur this year.

Commercial stocks, of course, are only available for purchase. These stocks are important only where cash is available from the production of cash crops or labor, and then, only where enough money is available to purchase them. Current prices are so high (especially in the west) as to limit those who can buy grain. The infrastructure is so poorly developed in Sudan that even the existence of effective demand does not necessarily provoke a market supply.

Availability of Other Resources

Some Sudanese rely upon resources other than their own food stocks to satisfy their food needs. Government employees, urban residents, military and police, and a small group of private sector employees, all largely purchase or trade for much of their food supplies. Many rural farmers also rely upon migrant remittances, gifts, and non-farm economic activity to supply that part of their diet that cannot be met by their own production. In the worst of times, people might also have to liquidate assets in order to purchase food.

The use of other resources to purchase or gain access to food is a poorly documented part of the food supply system. What information does exist is largely either dated or qualitative. For example, labor migration from western Sudan to the Central Region was a recognized pattern in the past. This has given way -- to an unquantified extent -- to permanent migration. There is no information on how the flows of remittances, back to western areas of origin, might have been affected. Certain areas which have been largely unable to provide for themselves with their own agricultural production for many years (parts of North Darfur Province, rural Red Sea Province) might have had to develop other food acquisition strategies. Yet it is not possible to quantify and measure the success of these mechanisms.

Farmers grow cash crops as well as grains. In normal times, cash crops provide enough income to purchase additional food stuffs. Last year was not normal. While sorghum and millet production decreased, there was an increase in the production of some cash crops. The Ministry of Agriculture reports that sesame production increased 8% over last year. Likewise, groundnut acreage increased 26% with a 14% increase in production. This is significant in that it reveals a shift from food crops to cash crops. Unfortunately, it cannot be determined when this shift took place, and whether this was the result of hard economic decisions by farmers at the beginning of the season or the result of drought management strategies over the course of the season.

With food prices low and cash crop prices relatively high at the beginning of the 1987-88 agricultural season, it would appear that an individual farmer would be better off producing sesame or groundnuts. On the other hand, if the shift from food crops to cash crops came toward the end of the season, it probably was the result of a shift to more drought-resistant crops. Poor rains with extended dry spells throughout the agricultural season forced farmers to plant grain crops up to three or four times. Some cash crops, like groundnuts and sesame, are more resistant to dry periods and can be planted later in the season. Likewise, they mature later than the grain crops, so the agricultural season, in effect, can be partially extended.

Although there were reports of multiple replantings throughout the agricultural season and a subsequent shift by some farmers from food to cash crops, it remains unclear to what extent the environmental factors are responsible for the change. If the major force of the shift came at the beginning of the agricultural cycle, then it reflects a choice made by farmers and based on economics.

If the shift came primarily toward the end of the season, then it was not a choice but something the farmers were forced to do in order to at least have something for the 1987-88 harvest.

Unfortunately, there was such a massive shift in the West from food crops to cash crops that food (primarily millet) production was minimal and cash crop (primarily groundnut) production was excessive. As the availability of millet declined, its price increased dramatically. Likewise, as the availability of groundnuts grew, its relative worth deteriorated. For example, in March 1987 the average monthly price of millet in El Fasher, Northern Darfur, was LS59.52 per 90 kg sack. In March of 1988, it was LS207.77, which represents an increase of over 340%. Meanwhile, the official price of groundnuts at El Obeid, Northern Kordufan, in January of 1987 was LS65.27 per sack, while in January of 1988 it was LS68.92. The purchasing power afforded by groundnuts thus decreased 330% relative to millet. With the purchasing power of western Sudanese farmers so undermined, serious problems in food security have arisen.

MANIFESTATIONS OF VULNERABILITY

Western Sudan, especially North Darfur, manifests signs of greatest current vulnerability within the country. It contains those areas with the highest childhood malnutrition, highest prices for grain and highest numbers of people already categorized as at risk. These same measures point to much of northern Sudan as vulnerable, with relatively high childhood malnutrition, high grain prices and 2,500,000 people already categorized as at risk.

The consequences of food shortages should be manifest in physical, social, and economic indicators. These indicators do not directly measure food availability as the three primary factors (production, stocks and other food sources) would, but provide evidence of a food problem. While they help to confirm patterns or degrees of vulnerability, these indirect measures reflect complex relationships between food supply and other aspects of human life. They are, therefore, much more difficult to interpret. At the same time, such indirect measures as malnutrition levels and food prices are often recommended surrogates for a direct measure of food accessibility. They have the advantage of including aspects of the famine process excluded in the direct measures.

Malnutrition

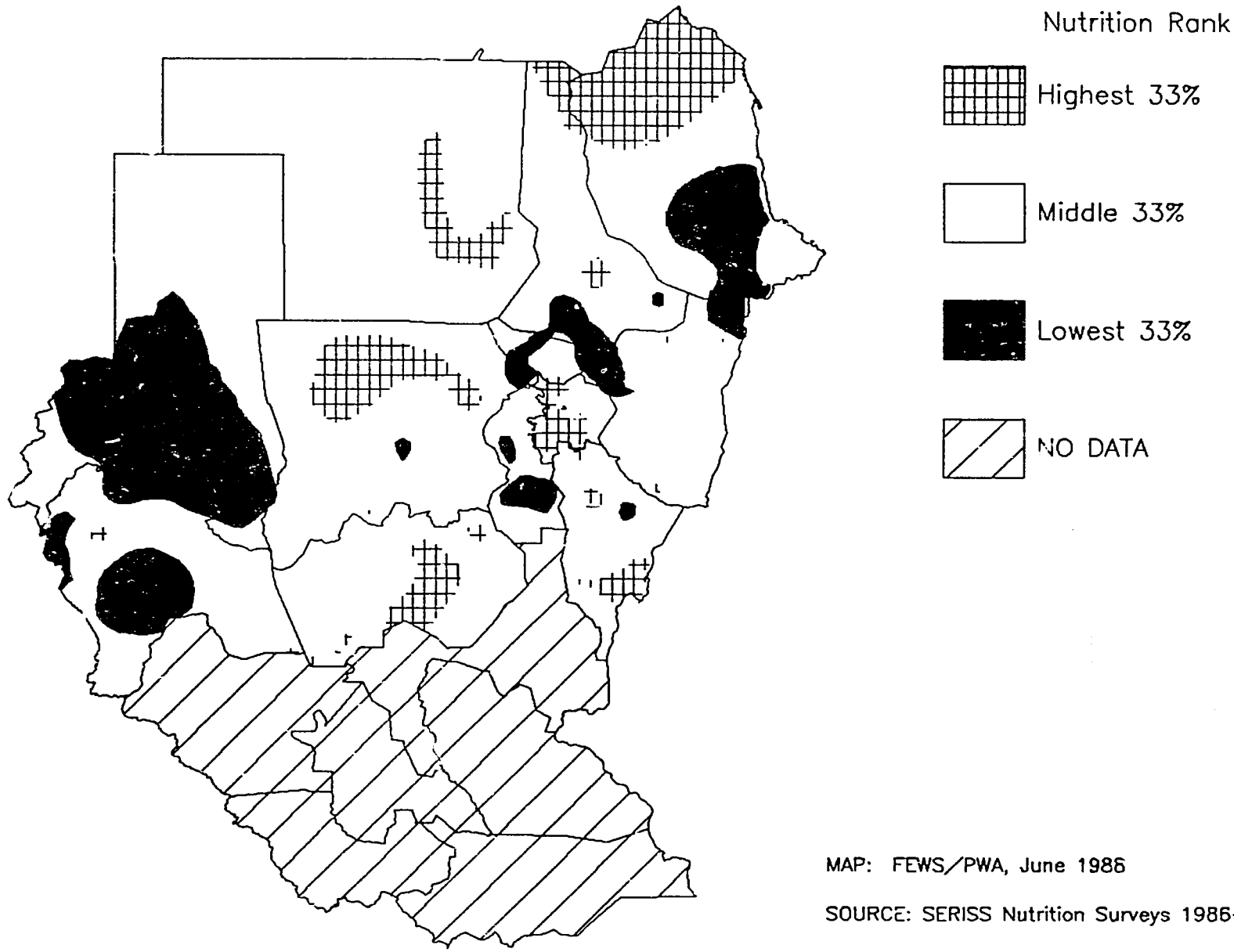
The areas of relatively high malnutrition in northern Sudan are found in Darfur Region and Red Sea Province. Gezira Province has relatively low childhood malnutrition. Normal malnutrition levels for the country, as a whole, are higher than are normally found in the other FEWS-monitored countries.

For this vulnerability assessment, childhood malnutrition is being used as a measure of historic or accumulated nutritional stress in an area. Its levels are also affected by a mix of social, cultural, and economic factors (e.g., feeding practices, weaning, sex differentiated feeding levels, on-farm stocks, and the labor market). Prior to harvest in 1987, the areas of highest childhood malnutrition in Sudan were found in Darfur Region and Red Sea Province (see Map 11). Areas with the best nutrition corresponded to the irrigated agricultural areas of the Gezira. A general decline (often massive) in per capita production in 1987 should have led to increased childhood malnutrition this year. In any case, the general rankings should remain. Recent findings of very high malnutrition in North Darfur Province were expected and confirm the pattern shown here.

Map 11 illustrates the relative levels of rural childhood (under 5 years of age) nutrition found during the Sudan Emergency Rehabilitation and Surveillance System survey in 1986 and 1987. An obvious area of poor nutrition was found in North Darfur Province, extending into South Darfur. Other areas of poor or even poorer nutrition in South Darfur Province lie in the northeast corner of Buram District (extending north into Ed Daein and Nyala Districts) and along the Chadian border in Zalingei District. Other areas of poor or even poorer nutrition were found in southern Nile, parts of Khartoum, eastern

Relative Rural Nutrition 1986–1987

The median village, with a Z–score of –0.88, could expect 13 % of its children malnourished.



MAP: FEWS/PWA, June 1986

SOURCE: SERISS Nutrition Surveys 1986–1987

Kassala, southern White Nile, and southern Red Sea Provinces (hill area). Good nutrition was found in Gezira (irrigated agriculture), north Red Sea Province (limited-agriculture, Northern Province (irrigated agriculture), North Kordufan (non-agricultural), and central South Kordufan (agricultural). A total of 468 villages were surveyed during the four rounds of the survey. These were ranked and located (to at least the rural council level), and their nutrition scores contoured. The areas in black are those that ranked among the worst 33% of all villages surveyed. (The median score for all villages, Z score = -0.88, would imply 13.1 percent of children under 5 were severely malnourished and 1.7 percent, extremely malnourished, i.e., wasted.)

While these contour lines are only an approximation of the true nutritional surface of Sudan, this nutrition map corresponds well with agricultural systems on the ground, historic vulnerability, distance from Khartoum and food aid (North Kordufan Province received very large per capita distributions in 1986, and experienced very little childhood malnutrition). North Darfur Province experienced high malnutrition in both relative and absolute terms throughout the four rounds of the survey. The irrigated area of the Gezira is particularly well defined by these nutrition contours.

It is interesting to note that patterns on this map conform to what little is known about on-farm stocks. In North Darfur Province, for example, El Geneina District has the greatest on-farm stocks -- and stands out as having the best nutrition in the Province. In South Darfur Province, a small area of excellent nutrition probably corresponds to positive nutritional experience within the Jabal Merra project area.

Prices

In general, grain prices in northern Sudan are higher than any since the 1984 drought. These prices generally decline from west to east, which corresponds, to the inverse gradients of per capita production and rural employment opportunities. As described above, grain prices have increased manyfold compared to the prices of other resources. Darfur Region was experiencing high grain prices even before last year's poor harvest. It is likely that rural people in Darfur are hard pressed to purchase adequate food stuffs, with the greatest difficulty in North Darfur. The situation is somewhat less severe in Kordufan, where prices are slightly lower and even less severe in the Central Region and Kassala Province. Prices in the Southern Region are extremely high, however, reflecting an existing insecurity-induced nutritional emergency.

Populations At Risk

Identified populations at risk in northern Sudan total about 2,500,000 people. This figure was calculated by the Technical Coordinating Committee of the RRC to target food aid efforts. Estimates of populations at risk are not always comparable due to differing criteria, access to supporting data, pre-existing conditions, and physical and political links to central authority.

Currently, Darfur Region is estimated to contain .75 million people at risk, Kordufan 1 million, Red Sea Province .4 million, Kassala Province .2 million, and the Central Region .12 million. Locating these people exactly is difficult. For Darfur Region, at least one detailed breakdown located them all in North Darfur Province, yet clearly there are people at risk in South Darfur. While the 1987 harvest was significantly worse than that of 1986, in fact, the number of people estimated by the RRC as at risk in Darfur Region remained static from one year to the next. Kordufan Region contains the largest population (in northern Sudan) currently judged to be at risk. While the Kordufan Regional government has detailed assessments of food need supporting these estimates, the numbers cannot be compared to estimates from Darfur -- which are not supported by similar data. The Kordufan Regional government has also been quick in acting to ensure food aid to its population.

Nonetheless, donors and the government of Sudan have agreed on these numbers as targets for assistance. While western Sudan is heavily weighted, significant numbers of people are at risk in the other regions of Sudan.

Relative Vulnerability to Famine in Sudan

Northern Region

Northern and Nile Provinces depend primarily on irrigated agriculture along the Nile River. Reports of large numbers of displaced people there (by the RRC) probably confused recent arrivals with other agricultural laborers. Agricultural production in both provinces is relatively stable against an ever-increasing population. Childhood nutrition there is relatively good, except in the southern part of Nile Province, where per capita grain production is poor. Nile Province must be considered slightly vulnerable.

Eastern Region

Kassala Province, with its major agricultural industry, contrasts sharply with Red Sea Province, which has a large nomadic population still recovering from the 1984 drought.

Large-scale mechanized sorghum production in Kassala Province dropped from a 1986 total of 1,020,000 MT to 355,000 MT in 1987. Even irrigated production declined slightly. In official statistics, little note is made of household production. Small scale household production is very important for the well-being of Ethiopian refugees and rural people (even those otherwise in the cash labor market). Household production probably dropped precipitously in 1987, for the same reasons mechanized production dropped (poor timing of rainfall in 1987 compared with 1986). Nutritional stress is probably high in the rural areas of the province, but no valid nutritional survey has been reported thus far during 1988. Historical nutrition patterns have been in the mid-range of the country's experience. Nevertheless, 200,000 people currently receive food aid in northern Kassala Province.

Agriculture in Red Sea Province is measured by the relatively stable production of the irrigated schemes in the Tokar Delta. Of greater concern are the approximately 400,000 nomadic people still receiving food aid as a consequence of herd losses during the 1984 drought. Their current situation remains unchanged from last year.

Khartoum

Without concessional wheat sales by donors this year, there would probably be insufficient sorghum stocks in country to provide for the urban population. The metropolis of Khartoum (Khartoum, North Khartoum and Omdurman) is a magnet for Sudanese seeking employment and stability. It suffers from the same problems as many rapidly growing capitals in resource-poor countries. Urban people in Sudan tend to eat wheat bread, and the provision of wheat to the people of Khartoum requires a major effort by both the government and international donors. Demand for wheat continues to grow and far outpaces domestic production. Agricultural production in Khartoum Province is very low.

Of great concern are the large numbers of displaced people arriving in Khartoum daily from the Southern Region of Sudan. Estimates of displaced people in the metropolis have ranged up to 1,000,000 people (which would have to include normal long-standing economic migrants). Sudanese private voluntary organizations (PVOs) currently supply arriving displaced families with minimal resources (one month's rations). Khartoum is also the illegal destination of refugees from other countries.

Central Region

Gezira and Blue Nile Provinces (along with Kassala Province in the Eastern Region) make up the breadbasket of Sudan. White Nile Province, while less productive, is also a major supplier of crops to the Sudanese economy. Insecurity in Blue Nile and low production in White Nile could threaten the national food supply.

Agriculture in the Gezira is based upon irrigation and is relatively stable from year to year, although a decline occurred last year. Production declines in the Gezira are related primarily to the deterioration of major canals and distributaries. Rural employment opportunities and wages are relatively good and rural childhood nutrition in the province is the best in Sudan.

In Blue Nile Province, mechanized agriculture provides the bulk of production and rural employment. Total grain production from all sectors fell from 1,097,368 MT in 1986 to 368,000 MT in 1987. Historic levels of nutrition in the province fall in the mid-range of the country's experience. High historic NDVI variability suggests that yields in the region will be highly variable from year to year, an assumption supported by agricultural statistics. Increasing insecurity in the south could significantly influence provincial (and thereby national) production by adversely impacting production in the Er Roseries/Damazin area.

White Nile Province also depends on mechanized agriculture and agricultural production also fell precipitously there in 1987. Sorghum production alone fell from a 1986 total of 311,000 MT to a mere 87,000 MT in 1987. White Nile Province shares high vegetative variability with Blue Nile and Kassala Provinces. Poor nutrition in south-central White Nile suggests that current nutrition is not good there. Nutritionally, White Nile did not recover from the 1984 drought as quickly as did the other provinces of the Central Region. Poor production last year, combined with high variability and poor malnutrition, flag White Nile Province as vulnerable. Currently, 120,000 people are estimated to be at risk in White Nile Province.

Kordufan Region

In recent years, much of the population of Kordufan Region has been identified as being at risk. Special efforts have been made to provide food aid to the region. These efforts met with great success and are at least partially responsible for the relatively good nutrition found over the course of the SERISS nutrition survey. This year, 1 million people in Kordufan are once again targeted for emergency food aid.

In this analysis, North Kordufan Province does not, on balance, appear as vulnerable as expected, especially given current estimates of 7.5 million people at risk. Its relatively good nutrition (compared to Darfur Region), however, is probably due to its easier access to Khartoum and might be artificially good due to food aid in 1986. On the other hand, North Kordufan suffered a comparatively small decline in grain production from 1986 to 1987. While its average per capita production of grain is low, since the grain was primarily grown by traditional rainfed agriculture, it is available to local people. In addition, livestock holdings (supposedly recovered from the 1984 drought and not reported greatly damaged by last year's drought), cash crops (such as gum arabic and sesame) and wild foods could mitigate any problem with food availability. NDVI variability in the south and southeast of the province suggests potential disruptions in agricultural systems.

South Kordufan Province, an area of higher agricultural potential than North Kordufan, experienced a drastic reduction in grain production in 1987 and did not produce enough to feed its population,except in the heavily mechanized Dilling District. As a result, an estimated .25 million people are presently at risk in South Kordufan. Vegetative variability in the eastern two-thirds of the Province is high and

limits faith in the dependability of agricultural systems there. With a similar malnutrition history as its northern neighbor, South Kordufan appears marginally vulnerable in this analysis.

Darfur Region

Darfur Region is highly vulnerable to a food emergency in 1989. Stocks, both public and private, should be depleted by harvest time. Historic malnutrition is relatively high. Emergency food distributions have been delayed this year. Rain and insecurity, if nothing else, should hinder future deliveries. Unlike Kordufan Region, nutrition levels remained low in Darfur Region despite some food aid distributions in 1986.

North Darfur Province is especially vulnerable. In all but El Geneina District, stocks are probably especially low, as evidenced by poor nutrition levels, poor production and a massive decline in production in most of the Province. High levels of NDVI variability from El Geneina across to northern Umm Keddeda District correspond to areas close to the northern margin of agriculture. Security considerations in the west, especially in Umm Barro and Karnoy Rural Councils, and reports of banditry against trucks carrying relief food also give special emphasis to the vulnerability of North Darfur. Of special concern are Mellit and Umm Keddeda Districts in North Darfur (as identified by the USAID Mission), where there was essentially no production last year. In North Darfur, El Fasher District should also be especially vulnerable -- given historic malnutrition and estimates of 1987 production.

In South Darfur, the Jabal Merra area should have produced a small surplus that could be available to regional markets. Conversely, the Western Savanna Project area (covering parts of Buram, Idd El Ghanem, Nyala, and Ed Daien Districts) was reported to have a shortfall of 100,000 MT last year. While stocks might be high in this area, last year's poor production and current extremely high prices should flag it, and the Province, as vulnerable. Historic vegetative variability and poor malnutrition in parts of the project area confirm the patterns evidenced by poor production and high prices.

Southern Region

Always worrisome, the situation in rural areas of the Southern Region appears to be deteriorating. Increasing numbers of displaced people are seeking refuge both in southern cities and northern Sudan. Of great concern are the increasing numbers seeking refuge in Ethiopia. This is a sign of stress previously identified as the one indicator that might foretell true famine in the south. While weather might have contributed to the deterioration, insecurity is the primary cause. Agricultural potential in the region is relatively high and vegetative variability is relatively low in all but Upper Nile Region and eastern East Equatoria Province.

APPENDIX

MODEL USED FOR VULNERABILITY TO FAMINE

Over the centuries there have been many definitions of famine, reflecting the complexity of the process. The concept of measuring a population's vulnerability to famine is somewhat newer, and still without a generally-accepted methodology. Early warning systems, particularly those dealing with Africa, have begun to search for a set, or sets of indicators of pre-famine conditions. FEWS assessments of vulnerability to famine form part of a continuing effort by USAID to identify incipient famine conditions, and to define important features of that process (the number of people involved, their location, and the nature of the problem). The mandate of the Famine Early Warning System is to provide an operational analysis of immediate use to decision-makers. The methodology used in this type of environment will continue to evolve.

Definitions of Famine and Vulnerability

- Famine is a sustained period during which large numbers of people consume less food than they require, giving rise to harmful physical and social consequences.

- Vulnerability to famine is the degree to which food from any source does not meet a population's minimal requirements over a period of time. Highly vulnerable populations (those "at-risk" of famine) currently are, or soon will be, unable to meet their minimal requirements for a sustained period of time. This will result in substantial harm to individuals and their society. Other, less vulnerable populations either currently appear to be meeting their minimal requirements, or are likely to fall below minimal levels for a limited period of time (i.e. they may experience a food shortage, which may also cause harmful physical and social consequences). In Sudan, virtually all rural populations are "vulnerable" to some degree.

General and Site-Specific Vulnerability Assessment

At the most basic level, access to food follows the same pattern everywhere. Food is made available by: (a) producing one's own food, and (b) acquiring food through other means: wage labor, gifts, trade, liquidation of assets, etc. An assessment of any population's current vulnerability to famine requires a measurement of the current condition and/or performance of these two basic processes. It also requires a context (the structural characteristics of vulnerability) against which to measure the range of possibilities of each process over time.

Nevertheless, in each place, the relative degree of dependence upon the individual processes, and the performance of each, is specific to the local environmental, social, and economic opportunities. In each place, the operation and performance of the food acquisition processes become site-dependent, and can only be measured accurately in the context of their many interactions. For example, migrants from Darfur Region (who send remittances to family members remaining at home) have enormous impact on their families's ability to purchase a part of their food supply, and, as well, upon the potential agricultural work force in Darfur. Even within Sudan's borders, the relative opportunities and adaptations vary greatly by area (North Darfur vs North Kordufan) and ethnic background, and must be taken into account while examining performance indicators of the food supply system.

An assessment of vulnerability to famine must also be sensitive to the season in which it is made. Sudan's food needs are often met by its own grain production. As in many other semi-arid zones, Sudan's agricultural production is concentrated in one small part of the year. The food supply, therefore, will often fluctuate seasonally around the harvest. An assessment undertaken one month before the harvest may give a very different picture from one performed one month after the harvest.

Methodology of Sudan Vulnerability Assessment

The FEWS assessment of pre-agricultural season vulnerability to famine in Sudan will attempt to identify both the structural characteristics and current conditions of vulnerability in Sudan by answering four questions.

- What is the historical dependability and adequacy of production?
- Based on the past, what other opportunities are normally available for acquiring food?
- What are the levels of current food stocks (from local production or elsewhere)?
- What other food acquisition resources are currently available?

The first two questions help to establish the historic, structural characteristics of site-specific food production capabilities and food acquisition opportunities. They provide a context against which to measure the responses to the two questions that follow. The responses to the second pair of questions allow one to judge the current vulnerability to famine. Current vulnerability frequently, but not always, stems from the same insufficiencies and irregularities that are characteristic of the structural weaknesses of the area.

In focusing on the areas thus identified as currently vulnerable, relative vulnerability will assessed through a ranking of the available indicators. The weights assigned to indicators are necessarily subjectively determined.

Finally, the areas identified as currently vulnerable will be compared to areas already reported to evidence signs of stress on the food supply, e.g., malnutrition, populations at risk. Where these areas intersect, this assessment may add to the depth of information available on the vulnerable areas. The non-overlapping areas represent districts about which further information is needed.

Restrictions of Data

Data available for Sudan vary in resolution and accuracy. Nevertheless, they can be brought together in a geographic context to illuminate current vulnerability.

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.

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). The images are derived from Global Area Coverage (GAC) approximately 4 km resolution images 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.

FEWS Publication Schedule

Country Reports

FEWS Country Reports will be published monthly during the growing season and bimonthly during the rest of the year. A preliminary harvest assessment issue will be published toward the end of the growing season for each country.

GC - General Coverage GS - Growing Season Monitoring PHA - Preliminary Harvest Assessment

	Jul	Aug	Sep	Oct
Mauritania	GS	GS	GS	PHA
Mali	GS	GS	GS	PHA
Burkina	GS	GS	GS	PHA
Niger	GS	GS	GS	PHA
Chad	GS	GS	GS	PHA
Ethiopia	GS	GS	GS	PHA
Sudan	GS	GS	GS	PHA
Mozambique		GC		GC

Bulletins

FEWS Bulletins are published every ten days during the Sahelian and East African growing season. Twelve Bulletins [*] are published annually starting with the 20th of June.

FEWS Bulletins	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sahel & East Africa	**	***	***	***	*		