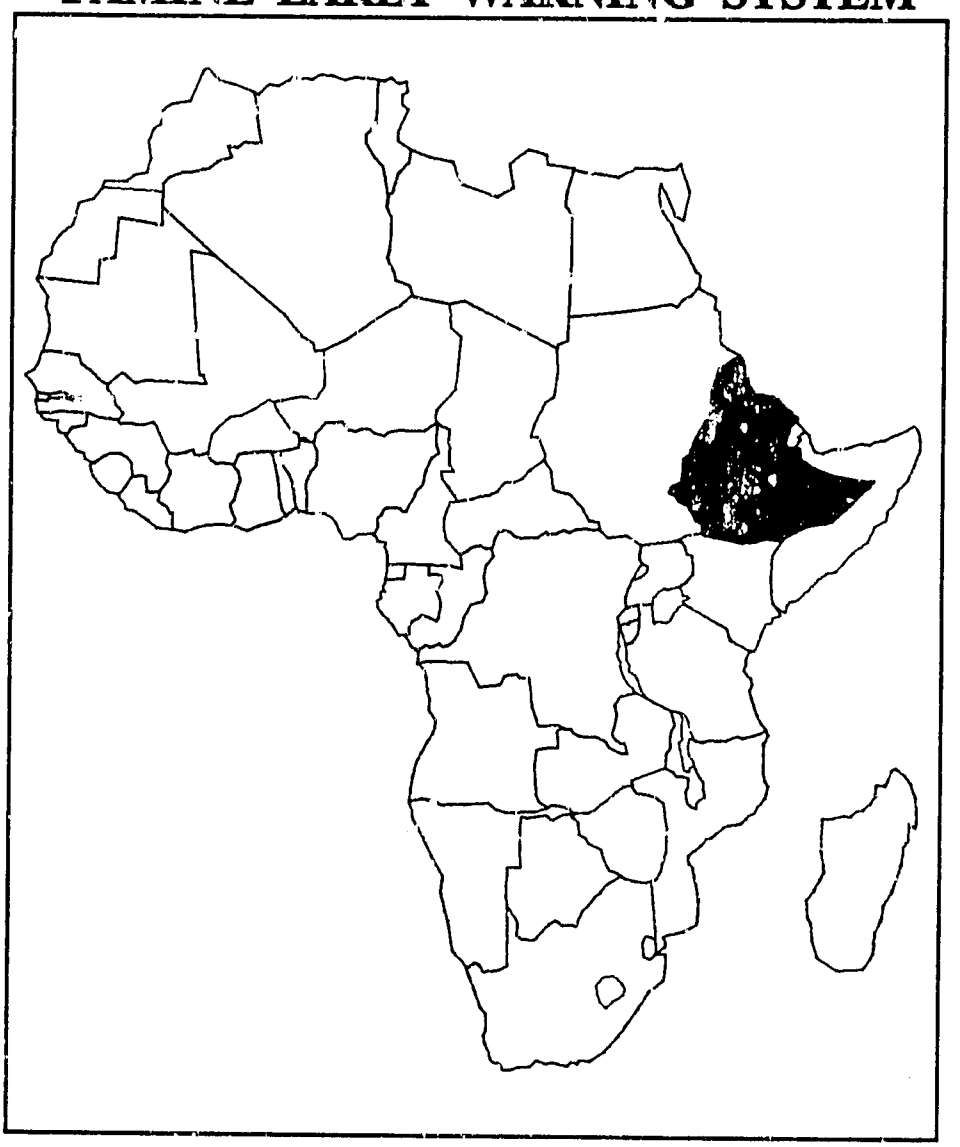
ETHIOPIA

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.

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Vulnerability Assessment

June 1989

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Executive Summary

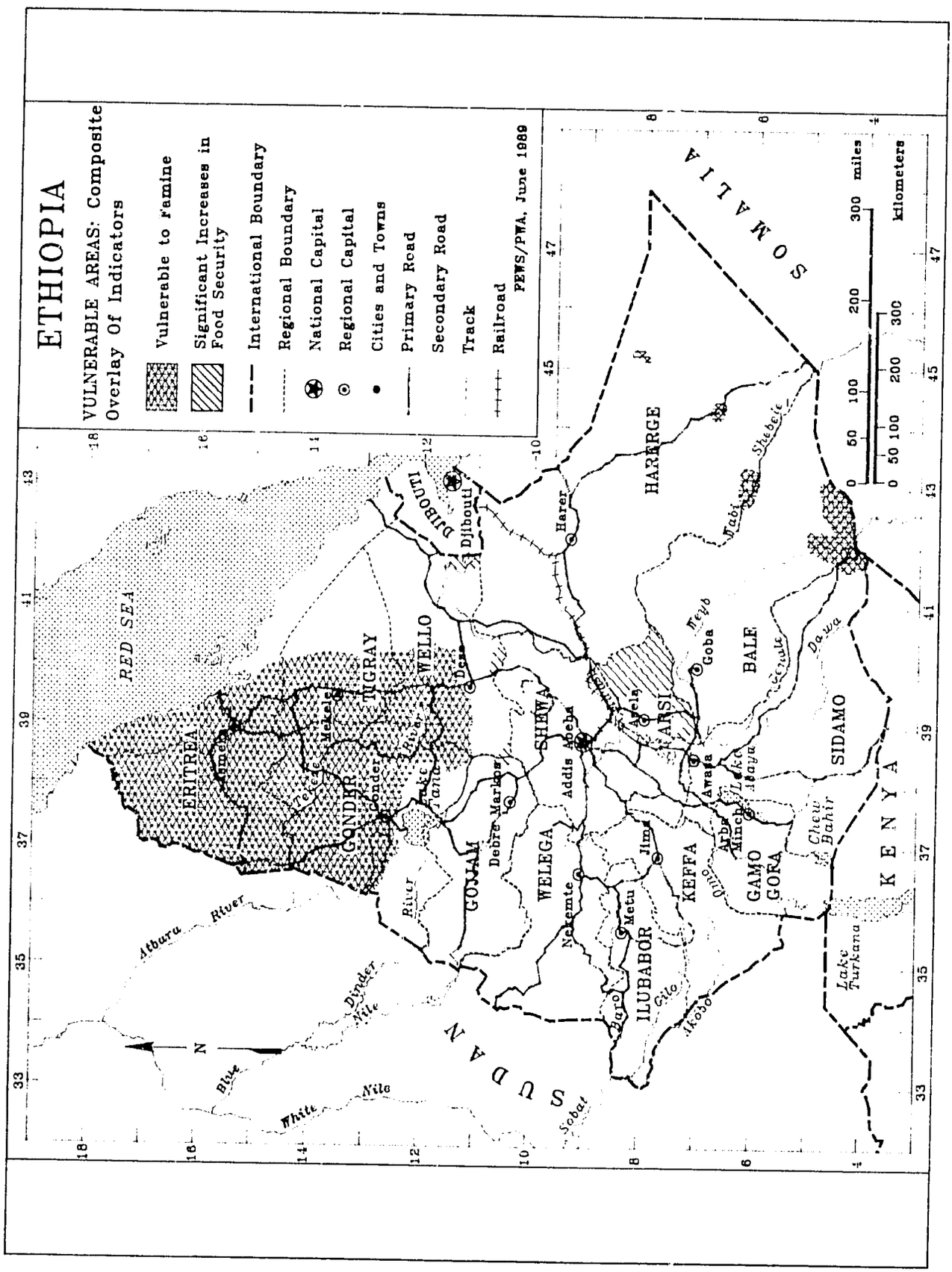
Although the general level of vulnerability to famine may have declined nationally due to good 1988 main season rains and a generous harvest, regional vulnerabilities remain severe in several areas. Conflict is the primary cause of food shortage in the North and compounds the impact of recent droughts and fundamental deficiencies in local food acquisition systems. Millions of people in Eritrea, Tigray, northern Gonder, and northern Wello remain at-risk due to these problems. Elsewhere, the current margin of food security is particularly thin among herders of the south and east and among Southern Sudanese and Somali refugees. Mediocre *belg* (short season) rains in the first half of 1989 may almost immediately have significant negative impact on local populations.

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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VULNERABLE AREAS: Composite Overlay Of Indicators
Vulnerable to Famine
Significant Increases in Food Security
International Boundary
Regional Boundary
National Capital
Regional Capital
Cities and Towns
Primary Road
Secondary Road
Track
Railroad
FEWS/PWA, June 1989
RED SEA
ERITREA
TIGRAY
GONDAR
WELLO
SHEWA
GOJAM
WELEGA
ILUBABOR
KEFFA
ARSI
HARERGE
BALE
SIDAMO
GAMO GOFA
SUDAN
SOMALIA
KENYA
DJIBOUTI
Djibouti
Harer
Goba
Awasa
Addis Abeba
Debre Markos
Nekemte
Metu
Jima
Dese
Asmera
Gonder
Lake Tana
Lake Turkana
Abbara River
Dinder
Blue Nile
White Nile
Sobat
Omo
Wabi Shebele
Dawa
0 50 100 200 300 miles
0 50 100 200 300 Kilometers
N

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.

On the whole, the 12-month period between June 1988 and June 1989 saw a general decrease in the level of vulnerability for a large majority of Ethiopia's population. This was largely due to a good national harvest and to an emergency food assistance program that reached millions. The decrease in vulnerability still left millions of people vulnerable to famine and large numbers at-risk of famine.

Populations who are currently at-risk of famine in Ethiopia include many of those found within the densely hatched area on Map 1. They number several million people in Eritrea, Tigray and northern parts of Gonder and Wello. Their vulnerabilities are persistent, long-standing ones, caused by the cumulative impacts of several severe drought years, warfare, and structural deficiencies (poor soils, climatic variability, isolation, poor infrastructure). It is perhaps not extremely significant to note that this was a generally good agricultural year in these areas, and the level of aggregate vulnerability found here may have somewhat decreased as a result.

Two other groups as a whole remain at-risk of famine. The Southern Sudanese refugees found in camps in western Ethiopia, and the Somali refugees now residing in camps in Harerghe Region, now total 600,000 to 800,000 people, and are almost entirely dependent upon emergency assistance. Their daily condition is plagued with uncertain food supply lines, water shortages, flooding, precarious nutritional states, and administrative disarray in the organizations charged with their well-being.

A large number of other groups remain vulnerable to famine, albeit less vulnerable this year than last. Here again, the root cause of the vulnerability is structural deficiencies. The herders of the east, south and southeast of the country maintain only a thin margin against hunger in the best of years. They have also come off of several difficult years since 1984 that depleted herd size and condition. Farmers in the southern and southwestern parts of the country have been plagued by a serious disease of the staple *enset* crop, and usually produce less than they require. Farmers in Ilubabor and Keffa regularly suffer shortfalls between their production and their needs due to the impacts of villageization, lack of inputs, and erratic, though generally copious, rainfall. Many of these areas are covered by the hatching which indicates a significant recent increase in food security. As will be seen in the following section on Causes of Reduced or Increased Access to Food, this was due to good rains that favored agricultural production and pasture development.

Several near-term events are important to monitor in order to assess the potential for significant changes in vulnerability. If the 1989 *belg* season harvest is confirmed to be below average in northeastern Shewa Region or in Wello Region, it will be important to locate where in those regions the decreased harvest will have the greatest impact. Over a much broader area, the

belg rains are necessary for success in land preparation and planting of the long-cycle crops, maize and sorghum. If rains were deficient or erratic, a more serious impact on the main season harvest should be feared. The location of continuing conflict will also be important in locating increased vulnerabilities. Food price information is available in-country and should also help those with access to it to gauge the location, intensity, and change in level of food stress.

The FEWS vulnerability assessment methodology is severely tested by the small number of, and poor spatial and temporal quality of, datasets available to us for Ethiopia. As will be seen in this assessment, reliance is therefore placed heavily upon remotely sensed satellite-derived vegetation indexes, internationally-reported rainfall data, and anecdotal reports about food prices, areas of conflict, and other physical and socio-economic behaviors and conditions found in Ethiopia. This particular mix of data and information provides a better, although still limited, basis upon which to qualitatively follow crop development than to judge eventual conditions of food access and degrees of vulnerability to famine. Conclusions about vulnerabilities in Ethiopia are therefore more general than in any of the other FEWS-monitored countries.

II. Causes of Reduced/Increased Access to Food

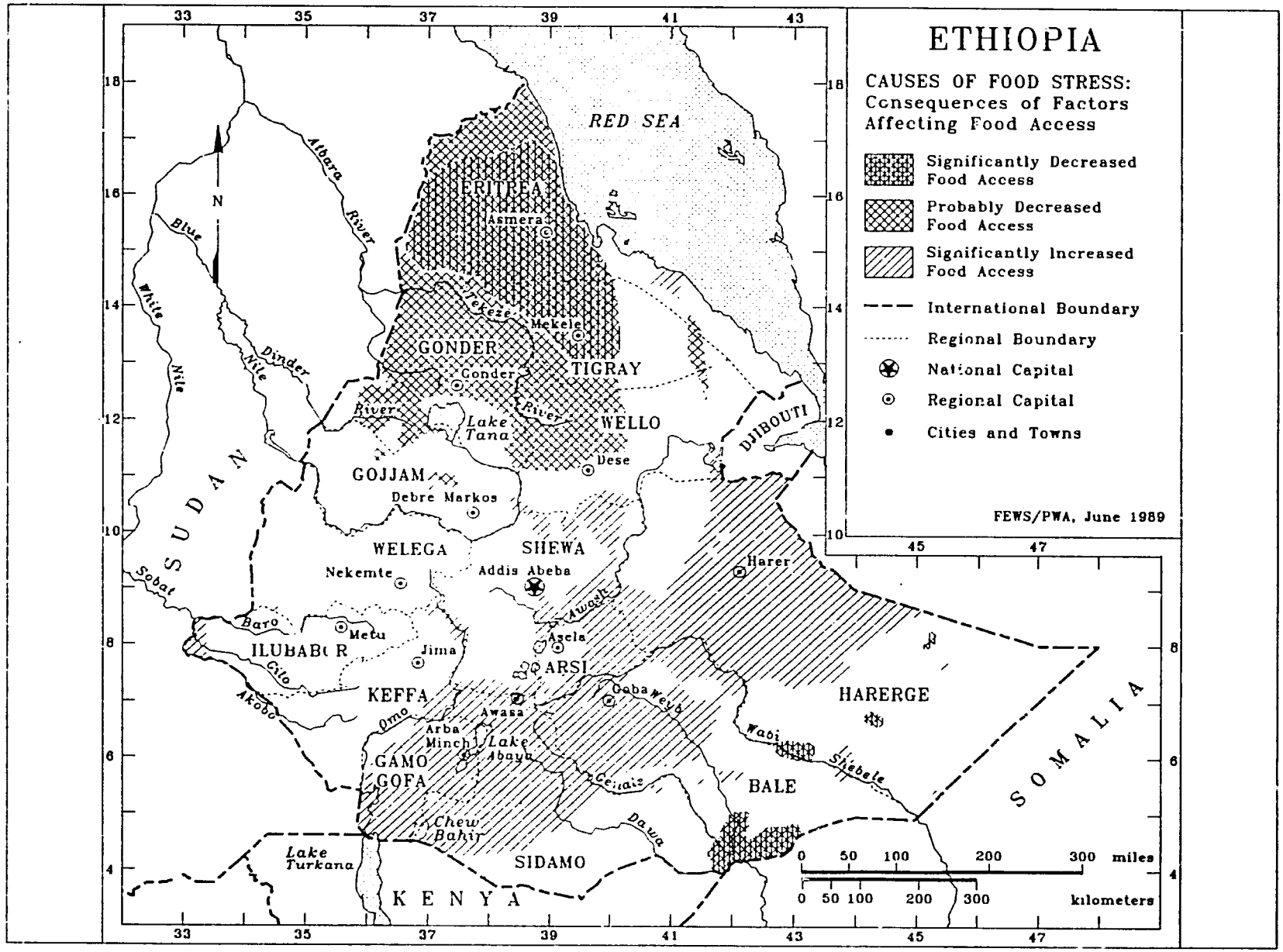
Methodology: Causes of Reduced or Increased Access to Food

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.

Over the period running from June 1988 to June 1989, warfare, rather than drought, played the primary role in reducing access to food in Ethiopia (see Map 2). The hatched areas seen in the North are based upon the location and known intensities of conflict, and cancel out indicators that would normally show extremely positive conditions if fighting were not present. Both in Ethiopia's north, as well as upon its eastern and western peripheries, millions of displaced people, refugees, and food aid-dependent populations attest to the disruption and suffering brought on by continuing internal conflicts. Nevertheless, the generally heavy rains that covered most of the country throughout the main 1988 *meher* season produced a relatively good national harvest. Regional harvests were generally average to good. Even in war-torn Eritrea and Tigray, the main harvest was one of the best in recent memory, although these regions are still severe food deficit areas.

After a slow start, Ethiopia's main 1988 rainy season proved to be a very good one, and thus similar to that of most other Sahelian countries. The generally good to excellent **cumulative rainfall** was well distributed over most of the country and provided sufficient moisture to meet most crop needs. Only in some parts of the West were rains somewhat below average. The late onset of rains in May and June in these and other areas adversely affected long-cycle (sorghum, maize) crop prospects. The exceptional rains of July and August, generated by the same systems that caused flooding in eastern Sudan and in Khartoum, waterlogged soils in northern and western Ethiopia. These rains led to local crop losses in Gonder, Tigray, and other scattered areas, and cut off access to refugee camps in the extreme western part of the country. Nevertheless, the losses in some areas due to waterlogging and lodging of crops were far off-set by increases in yields in neighboring areas due to the above-average rainfall. The war-torn areas of southern Eritrea and Tigray, as well as central and eastern Wello and northeastern Shewa especially benefitted from better than average rains.

The **belg rains** that began in February 1989 and ended in late May were not as favorable as those of the preceding main rainy season. They were characterized by several significant gaps and generally less than average amounts and may produce a less than average *belg* harvest in Wello and northeastern Shewa. Their impact on the


ETHIOPIA
CAUSES OF FOOD STRESS:
Consequences of Factors
Affecting Food Access
Significantly Decreased Food Access
Probably Decreased Food Access
Significantly Increased Food Access
International Boundary
Regional Boundary
National Capital
Regional Capital
Cities and Towns
FEWS/PWA, June 1989
RED SEA
ERITREA
Asmera
Mekele
GONDER
TIGRAY
Gonder
WELLO
Dese
Lake Tana
GOJJAM
Debre Markos
WELEGA
Nekemte
SHEWA
Addis Abeba
ILUBABOR
Metu
Jima
ARSI
Asela
KEFFA
Awasa
HARERGE
Harer
Dire Dawa
Lake Abaya
Arba Minch
GAMO GOFA
BALE
Chew Bahir
SIDAMO
Lake Turkana
DJIBOUTI
SOMALIA
SUDAN
KENYA
Abbara River
Blue Nile
White Nile
Dinder River
Rahad River
Sobat
Baro
Gilo
Akobo
Omo
Awash
Wabi Shebele
Ganale Dawa
0 50 100 200 300 miles
0 50 100 200 300 kilometers

land preparation and planting of long-cycle crops in these and other areas is still to be determined.

Satellite imagery (see description of Normalized Difference Vegetation Index, or NDVI, on back cover) confirms the better than average main season growing conditions due primarily to generous rainfall in south-central Tigray, northwest and central Wello, and several large areas of Harerghe, Arsi and Bale regions. There is an indication in this imagery that rainfall was quite deficient in southwest Gonder Region (see Map 2), an area for which there is little information about rainfall. No other data available to FEWS indicates whether this was the case and whether there was some problem with harvests in this area. The NDVI also suggests that rainfall in Gash and Setit, and Seraye awrajas (in southwestern and south-central Eritrea) was much better than average, something that is not borne out by the limited rainfall data available for Eritrea. Asmera and Gonder are the closest reporting rainfall stations, yet are too far away to confirm or deny the NDVI-derived growing conditions for this area. Nevertheless, the earlier comments relating to the good rainfall being wasted by warfare that disrupted farming may be particularly pertinent in this area.

Significantly higher NDVI values than average seen over a broad band encompassing most of the southern highlands and adjacent slopes again reflect the good main season rains and probably significantly decreased food stress in these areas. Both long and short-cycle crops and pastures were significantly better than average.

As in most other parts of Africa, there was no significant damage to food crops from **Desert Locusts** on the national scale during the main season. Extremely localized attacks, especially in Eritrea and perhaps in Tigray, may have reduced yields and in some cases devastated small areas, but the damage was well within the range of normal damage expected in any year. Other damage due to the normally present birds, rats, and other indigenous pests was probably as significant. The areas that were the worst infested by Desert Locusts were generally under control of rebel groups, a factor complicating locust control operations by the Desert Locust Control Organization. The Relief Society for Tigray (REST) reported infestations and damage to 2,500 to 3,000 hectares (ha) as of November 1988. The Eritrean Relief Association (ERA) reported 500,000 ha infested with locusts and armyworms for the same period.

The level of conflict between government and rebel forces rose in previously contested zones and spread into new areas during the summer of 1988. The areas indicating "Significantly and Probably Decreased Food Access" on Map 2 are directly related to where, and with what impact, conflict occurred. Control over much of north-central Tigray and central and south-central Eritrea was contested, and major population centers changed hands several times. These areas suffered greatly both from the effects of the fighting and from their inaccessibility to the humanitarian assistance made available in areas clearly controlled by either the government or rebels. Conflict and general insecurity also increased in both northern and eastern Gonder and northern and western Wello. Large parts of each region were inaccessible to relief operations throughout most of 1988. During the first six months of 1989, there have been major reverses to government forces in Tigray, continuing conflict in Eritrea, an attempted coup, and continuing instability in other areas.

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.

Based solely on what cereals and pulses have been made available by the 1988 *meher* season harvest, an accounting of regional food resources compared to requirements (the annual cereal and pulse requirement is assumed to be 145 kg per capita) suggests that the picture for 1988/89 is much improved over last year's. For the 1988/1989 year, Gojjam, Arsi and Shewa regions produced sufficient cereals and pulses for annual consumption requirements. Two other regions, Gonder and Wello, almost met their annual needs, and Keffa and Ilubabor also came close (see Map 3). If the 1989 *belg* harvest is an average one, Wello Region may have covered its annual cereal needs for 1988/89.

These results are much improved from the 1987/88 harvest year. Substantial increases between these two years were found in the regions that require them the most -- Eritrea and Tigray -- and also in Arsi, Bale, Gamo Gofa, Harerghe, Shewa, Sidamo, and Wello regions. Only in Gonder, Gojjam, Ilubabor, Keffa, and Wellega regions did per capita production drop between 1987/88 and 1988/89. Even so, there is a darker side to these figures if compared to a slightly longer time period. When current net per capita production from 1988's excellent harvest is compared with a base period per capita production (1980/81-1983/84), it is clear that the trend over time has declined. With concomitant increases in population, social and economic disruption due to warfare, drought, and many other factors, food production is not keeping up. Only in Arsi, Bale, Harerghe, Keffa, and Sidamo regions is current per capita production above that of the base period.

In many regions, which include some of the most vulnerable areas of Ethiopia, per capita production between the base period and 1988/89 has substantially declined. Gonder decreased from 172 kg of cereal and pulse production per capita during the base period to 98 in 1988/89. The same is true of Gojjam (209 to 184), Wello (177 to 91), and Shewa (180 to 151). Such trends are disturbing in their implications for the future, and appear to be confirmed by recent studies of food production in Ethiopia.

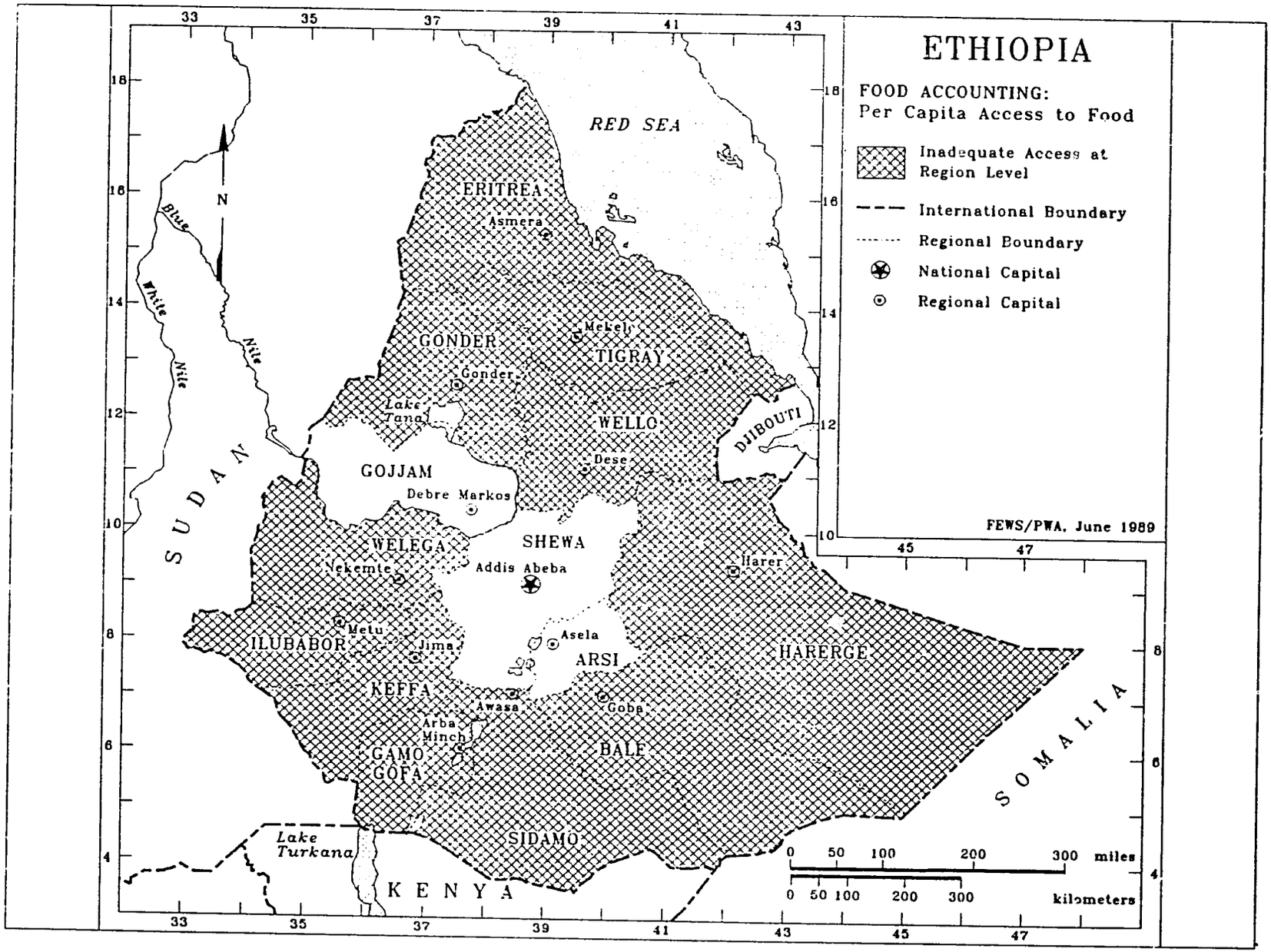
The data on which the regional food accounts are based suffer from several deficiencies. In counting only cereals and pulses, the contributions of meat, milk, roots, and other agricultural products to the regional diet are missed. In some areas, the part of the diet composed by these products is substantial. For example, *enset* is a staple in the diet of Sidamo, Gamo Gofa, and the Bale highlands. In pastoral areas as well, this analysis will underestimate the amount of food (cereals and pulses) available, and overestimate the annual requirement. The production statistics themselves are likely subject to a large degree of error, and serve best to provide a largely subjective base for inter-annual comparison.

IV. Manifestations of Reduced/Increased 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.

There are of course large populations and vast areas in which there are obvious manifestations of food stress. They include most of the North, where formal and informal surveys of populations show extremely **meager food stocks, migration** to food distribution centers, **high food prices**, the **sale of productive assets** (especially oxen), and **obvious malnutrition**. Many of these same conditions are found elsewhere on a different scale. This type of information is not, however, available to FEWS in a format that allows placing discrete boundaries around the events and conditions with any accuracy. These indicators have therefore not been mapped and incorporated into Map 1, the summary of vulnerabilities.


ETHIOPIA
FOOD ACCOUNTING:
Per Capita Access to Food
Inadequate Access at Region Level
International Boundary
Regional Boundary
National Capital
Regional Capital
FEWS/PWA, June 1989
RED SEA
ERITREA
Asmera
GONDER
Gonder
Mekele
TIGRAY
Lake Tana
WELLO
DJIBOUTI
Dese
GOJJAM
Debre Markos
SHEWA
Addis Abeba
WELEGA
Nekemte
Harer
Metu
Asela
ILUBABOR
Jima
ARSI
HARERGE
KEFFA
Awasa
Goba
Arba Minch
GAMO GOFA
BALE
SIDAMO
Lake Turkana
KENYA
SUDAN
SOMALIA
Blue Nile
White Nile
N
0 50 100 200 300 miles
0 50 100 200 300 kilometers

Map 3

Large numbers of refugees continued to enter Ethiopia throughout 1988 and into 1989 from both southern Sudan and northern Somalia. In the East, there were approximately 400,000 refugees from Somalia registered as of November 1988 at camps in Hartisheikh and Harshin and in and around Aware. With the stabilization of the situation in northern Somalia, no significant increases in refugee numbers developed after the new year. Both lack of water and low food stocks have been problems throughout the year, and they have been exacerbated rather than resolved by fundamental logistic and management problems in the administration of the relief effort. Recent malnutrition surveys have indicated a deterioration in child health in the camps. Until changes occur in the way relief assistance is administered to the camps, the situation there will remain volatile and unhealthy.

In the West, flows of Southern Sudanese refugees have continued steadily through 1988 and into 1989. More than 325,000 refugees are now registered in the camps at Itang, Fugnido, Dimma, and Asosa. Authorities are planning to provide supplies for approximately 420,000 during 1989. The problems of access to the camps due to heavy rains are now being resolved and food supplies have been adequate recently.

Food prices were reported high after the mediocre 1988 *belg* harvests, and remained high until the rains of July and August made a good main season harvest apparent. The RRC then reported that prices were falling everywhere, and particularly steeply in Eritrea, Tigray, Wello, and northern Shewa regions. This lent support to estimates of excellent harvests in these areas. Nevertheless, given the known food supply problems in some of these areas, there is obviously always cause for caution in interpreting the significance of these figures. Since this period price behavior has not indicated any reason for alarm.

APPENDIX 1

Mechanics of the Vulnerability Assessment

All available indicator data of major significance to the food security of Ethiopia 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 Ethiopia Vulnerability Assessment

NDVI - Growing Conditions: The 1988 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

Rainfall: 1988 cumulative rainfall was compared to the 30 year normal historic cumulative rainfall. All areas receiving more than 120 percent or less than 80 percent of normal were identified. Areas where 1988 cumulative rainfall was less than 200 mm were excluded from this analysis. Sources: Joint Agriculture Weather Facility, Government of Ethiopia (GOE) National Meteorological Services Agency.

Pest Damage: Areas in which pest damage was judged to have had a significant negative impact on food access were identified. Sources: USAID/Addis Abeba, FAO DLCO reports.

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

Conflict/Civil Disruption: Based on a variety of sources, a subjective judgement was made about where and to what degree conflict affected food access.

Cereal Production: Regional production figures for the last eight years were compared for trends and for per capita production figures. Sources: GOE Central Statistical Office, USAID/Addis Abeba, FAO.

Cereal Price Behaviors: Only anecdotal information is currently available to FEWS and limits its ability to analyze significance of price data.

Health and Nutrition: Limited data was available to FEWS for this assessment.

Food Accounting notes: Population figures were derived from GOE 1984 census. There is a large margin of error in these figures given the large population movements that have occurred since then. Agricultural production figures are rough estimates for Eritrea and Tigray and of only slightly better quality elsewhere.

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 number 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.